ABSTRACT

ASSESSMENT OF FACULTY ACCEPTANCE OF, BEHAVIORAL INTENTION TO USE, AND ACTUAL USAGE BEHAVIOR OF TECHNOLOGY IN INQUIRY-BASED LEARNING IN MEDICAL EDUCATION: USING THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

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Inquiry-based learning (IBL) is an umbrella term used in this quantitative study to describe three different, yet related teaching methodologies: case-based learning (CBL), problem-based learning (PBL), and team-based learning (TBL). Each of these IBL activities involves a problem or situation for students in teams to find solutions. The problems to be solved have the most impact for students when they are connected to a real-life situation. While none of the three methodologies require the use of educational technology to be successfully implemented, there are situations where it could augment or improve content delivery. In medical education, situational problems for students to solve usually incorporate instructive clinical cases to guide problem-solving and to prepare them for their professional life as doctors. Implementing these types of case-based activities can require significant paradigm shifts for both students and instructors. It can impact the level of responsibility students take upon themselves for their own learning, and the teaching methods that instructors may find unfamiliar to use to deliver content. Some faculty members might not feel comfortable using educational technologies in these types of educational environments.

Technology use in medical education can comprise the most basic tools, such as, computers, projectors, document cameras, and presentation software. While these tools are not required for the successful delivery of any content, they are fairly ubiquitous in most fields and modes of teaching. An initial challenge for medical educators includes finding their comfort-level with teaching or facilitating IBL activities. An additional challenge for them is to determine how and when to integrate appropriate educational technology into the delivery of these activities.

Therefore, the purpose of this quantitative study was to examine medical school faculty members' acceptance of, behavioral intention to use (BI), and actual usage behavior (UB) of educational technology in inquiry-based learning (IBL) activities in medical schools in the United States (US). This quantitative, nonexperimental study utilized a theory developed by Venkatesh, Morris, Davis and Davis, the unified theory of acceptance and use of technology (UTAUT) which combines the most useful aspects of eight other technology adoption theories.

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ASSESSMENT OF FACULTY ACCEPTANCE OF, BEHAVIORAL INTENTION TO USE, AND ACTUAL USAGE BEHAVIOR OF TECHNOLOGY IN INQUIRY-BASED LEARNING IN MEDICAL EDUCATION: USING THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

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CHAPTER 1

BACKGROUND AND SIGNIFICANCE OF THE PROBLEM

Introduction

Inquiry-based learning (IBL) activities in medical education do not require the inclusion of educational technology to make pedagogical experiences successful for either students or teachers. However, there may be times when the integration of specific types of technologies might influence the design and delivery of an IBL activity (Antoun, Nasr, & Zgheib, 2015). Some considerations that might affect effective utilization of technology in IBL activities for students include activating their prior knowledge (Burgess et al., 2017), building on their previous experiences (Burgess, McGregor, & Mellis, 2014), how it might impact the learner environment (Kebodeaux, Peters, Stranges, Woodyard, & Vouri, 2017), the availability of specific technologies and degree of difficulty with using them (Gomez, Wu, & Passerini, 2010), and available support mechanisms (Inuwa, Al-Rawahy, Roychoudhry, & Taranikanti, 2012). This also applies to considerations for faculty adoption and use of technology (Souders, 2017). Faculty may have numerous reasons for their resistance to accept and utilize educational technology for the design and delivery of IBL activities (de Grave, Zanting, Mansvelder-Longayroux, & Molenaar, 2014). Because of potential resistance from faculty members, opportunities for positive teaching and learning experiences can be hindered for both instructor and student. Therefore, the purpose of this quantitative study was to examine medical school faculty acceptance of, behavioral intention to use (BI), and actual usage behavior (UB) of incorporating educational technology in IBL activities in medical schools in the United States (US).

During the last century, the design and delivery of modern medical education have gone through many transformative periods. In 1910, a study commissioned by the Carnegie Foundation for the Advancement of Teaching identified critical issues in medical education up to that time (Flexner, 1910). In the early 20th century, medical education was found to be in disarray, with significant differences in student admittance procedures and educational practices among schools. The 1910 report was commissioned in the hope that it would bring some needed consistency to medical education in the US and Canada. Flexner identified that prior to its publication, colleges and universities had “in large measure failed in the past twenty-five years to appreciate the great advance in medical education and the increased cost of teaching it along modern lines” (Flexner, 1910, p. xi). As a result of the report, improvements in the delivery of instruction in medical education were implemented across the country. Innovative technologies of the era were introduced, where appropriate, that enhanced the delivery of content to students (Flexner, 1910). In his report, however, Flexner did not mention the acceptance of and the behavioral intention by faculty to use teaching and learning technology. For many decades now, the Association of American Medical Colleges (AAMC) has queried medical schools annually to determine how curricula is developed and delivered. See Figure 1 to view status of curricular change implementation among medical schools in the US during the academic year 2017-2018 as reported by the AAMC. Figure 2 shows specific types of change in medical schools for 2017-2018, including an increase in the use of team-based learning activities as reported to the AAMC by 56 medical schools in the US.

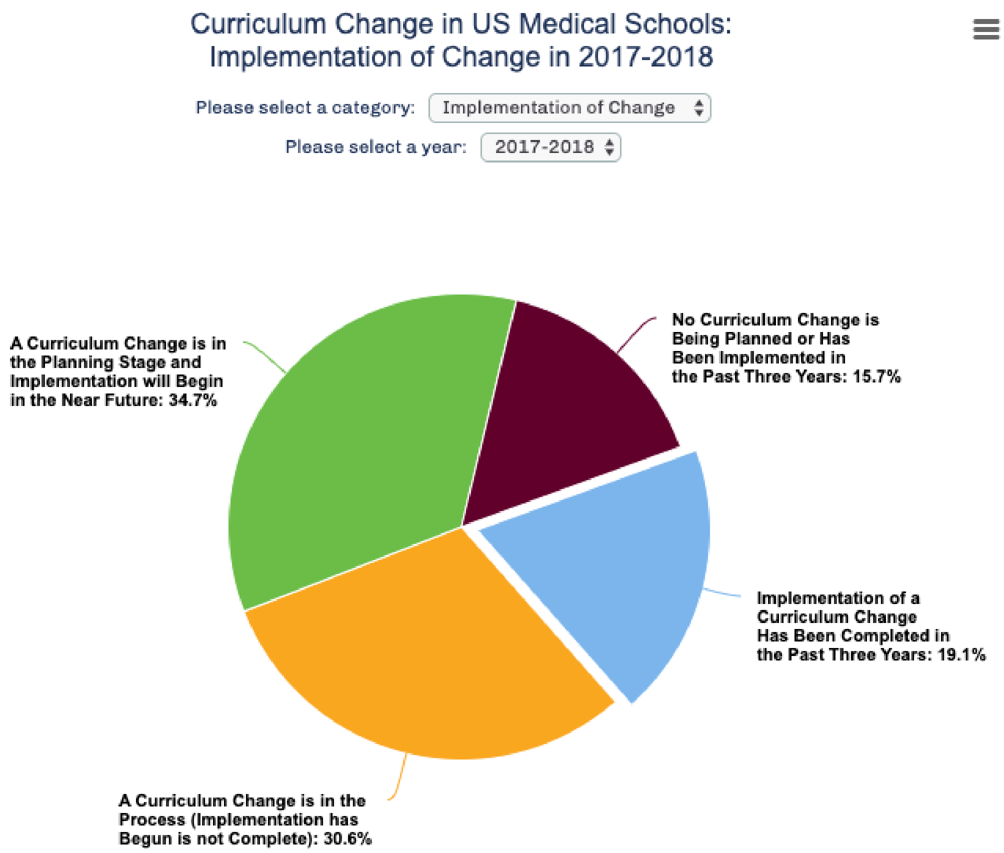

Figure 1. Status of curricular change implementation among US medical schools in AY 2017-2018 from AAMC. Reprinted with permission; see Appendix A for permission.

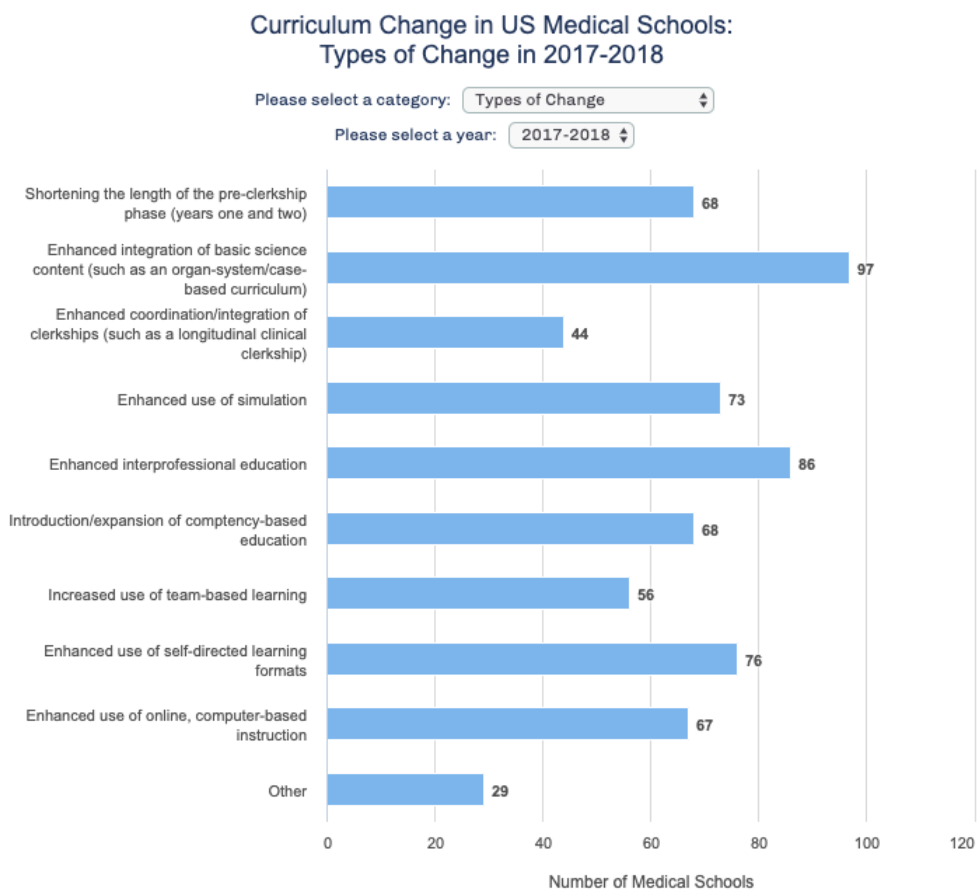

Figure 2. Specific types of curricular change in medical schools in the United States in 2017-2019 by category from AAMC. Reprinted with permission; see Appendix A for permission.

While the Flexner (1910) report brought some consistency to the delivery of medical education for a period of time, medical schools in the US and Canada have continued to experience increasingly radical transformations in curricular design as developments in technology have advanced exponentially (Harden, 2018; Spickard, Ahmed, Lomis, Johnson, & Miller, 2016), through renovations of physical spaces to encourage small-group learning (Hawick, Cleland, & Kitto, 2018), and due to the implementation of modernized innovative methods for delivering content (Parmelee & Hudes, 2012). However, change can be difficult; the introduction of state-of-the-art technologies and modern teaching methods have not always been uniformly accepted by educators in charge of implementation. There are often paradoxical relationships between investments in educational technology for use in modernized teaching methodologies and a lack of user acceptance of and behavioral intention to use those technologies in the delivery of new modes of teaching (Agarwal & Prasad, 1997).

Modernized methods of delivering educational content have become more frequent in medical education. In order to get away from traditional didactic instruction, the flipped classroom, also known as a type of active learning (Persky & McLaughlin, 2017; White et al., 2014), computer-aided instruction (Losco, Grant, Armson, Meyer, & Walker, 2017), and other instructional activities such as IBL, in which actual patient cases are typically used as a structure for guiding students in problem-solving (Fatmi, Hartling, Hillier, Campbell, & Oswald, 2013), have become increasingly pervasive in training medical students to become expert clinicians. Despite all these innovations, educators may become attached to pedagogical practices that they have already previously developed. There may be a perception that new technologies can disrupt their academic freedom and familiar teaching activities (Furco & Moely, 2012).

As a teaching methodology, IBL is a type of active learning in which students receive sequenced and scaffolded information about a particular task and/or an ill-structured problem. Using IBL, students may be expected to solve problems either individually or in groups (Cuff & Forstag, 2018; Fujikura et al., 2013; Gomez et al., 2010; Lazonder & Harmsen, 2016). For the purposes of clarity and brevity for this study, the term IBL is used to describe multiple forms of active learning, all of which have the following characteristics as a baseline:

- Deep engagement with materials and opportunities to collaborate with peers in teams and faculty to discover solutions (Ernst, Hodge, & Yoshinobu, 2017; Hsu, Lai, & Hsu, 2015),
- Scaffolding of information with a gradual reduction of facilitator direction (Lazonder, 2014),
- Ill-structured and complex problems to solve (Parmelee, Hyderi, & Michaelsen, 2017; Yadav, Vihn, Shaver, Meckl, & Firebaugh, 2014),
- Situated cognition in which instruction is based on specific realistic situations (Han, Eom, & Shin, 2013), and
- Preparatory work completion to enable more productive in-session discussion (Lazonder, 2014; Lazonder & Harmsen, 2016).

Some of the most common teaching strategies under the umbrella term of IBL are case-based learning (CBL), problem-based learning (PBL), and team-based learning (TBL); (Verduin, Boland, & Guthrie, 2013). “Cases provide context for discussing more abstract issues, and they provide illustrations of those abstract guidelines that students remember and apply in later reasoning” (Kolodner, 1992, p. 5). Each of these teaching strategies is further explained in this and subsequent chapters.

A total of 147 medical schools participated in a survey by AAMC regarding instructional methods used in the curriculum for the 2017-2018 academic year. The results of the survey show that CBL was utilized at 133 schools, PBL was utilized at 65 schools, and for TBL, 73 schools. There is likely overlap in instructional formats used at schools rather than just implementing one type of instructional format. See Figure 3, which shows this breakdown in context with other instructional methods.

Educational technologies such as tablets (Ducey & Coovert, 2016), audience response systems (Stevens, McDermott, Boland, Pawlikowska, & Humphreys, 2017), e-learning (Lewis, Cidon, Seto, Chen, & Mahan, 2014), and gamification (Kanthan & Senger, 2011) have been incorporated into many diverse methods of curricular content, including IBL activities in medical education. It is not clear, however, that medical school faculty members are adequately prepared to understand the purposes of different technologies and to make informed decisions about the inclusion of a particular technology in their teaching. It is therefore crucial to investigate how the faculty members at medical schools, especially in relation to IBL activities, accept, intend to use, and actually use educational technologies for content delivery. The unified theory of acceptance and use of technology (UTAUT; Venkatesh, Morris, Davis, & Davis, 2003) was the theoretical framework applied to investigate this issue. This study examined the acceptance of, behavioral intention to use (BI), and actual usage behavior (UB) of educational technology for IBL activities by medical school faculty.

Extant research on medical education extensively examines student reactions and attitudes regarding teaching delivery methods and practices in general (Baturay & Bay, 2010; Johnson, 2005; Rotgans & Schmidt, 2011; Walling et al., 2017) as well as instructor perspectives (Armson, Elmslie, Roder, & Wakefield, 2015; Cuff & Forstag, 2018; Wisener &

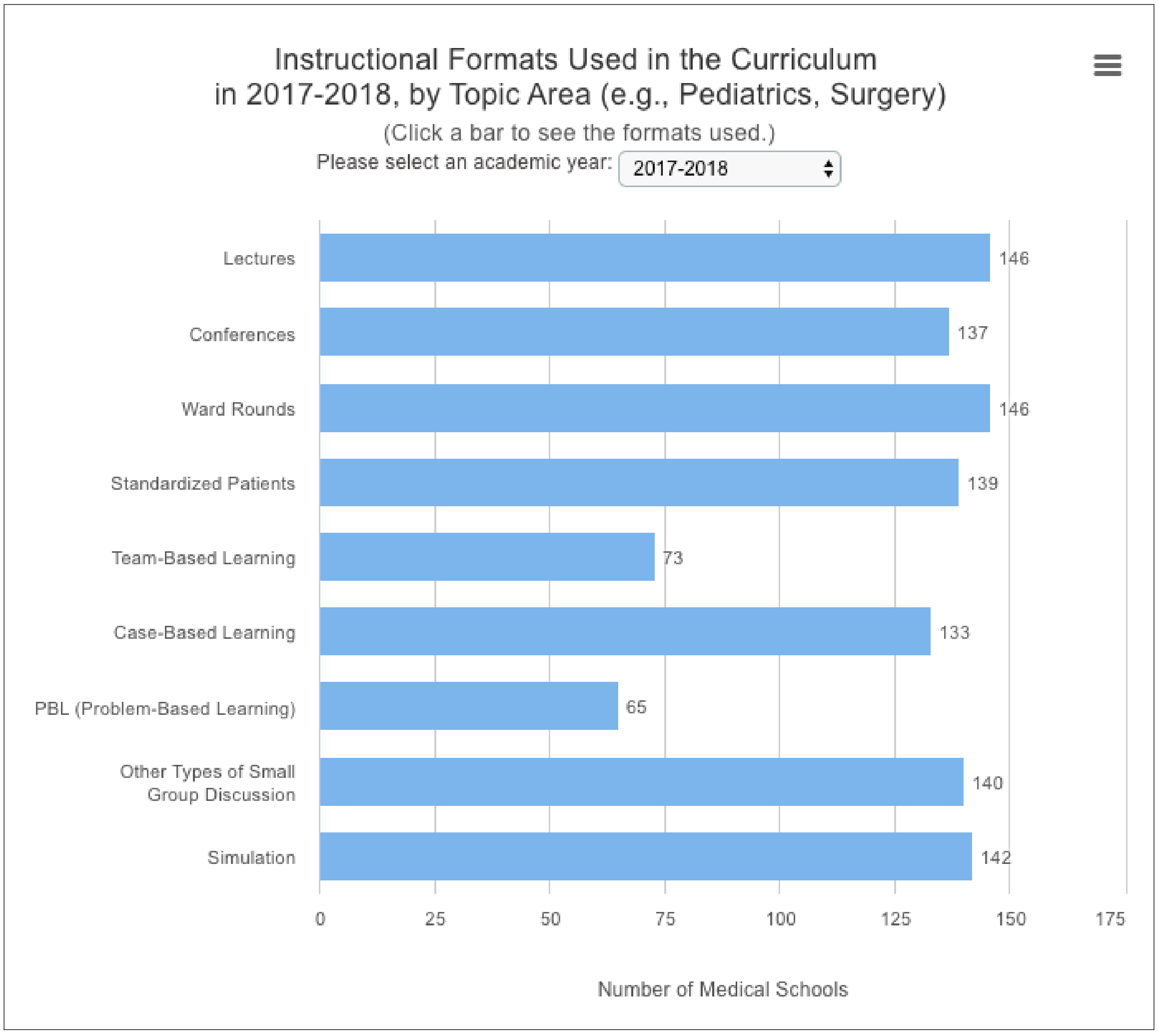

Figure 3. Instructional formats used in the curriculum in 2017-2018 by topic area from AAMC. Reprinted with permission; see Appendix A for permission.

Eva, 2018). Technology integration into the delivery of medical education content has become more common and this trend to enhance educational activities in medical education has been increasing (Kron, Gjerde, Sen, & Fetters, 2010; McMenamin, Quayle, McHenry, & Adams, 2014; Swamy & Searle, 2012); however, research on the instructor perspectives regarding the technology integration trend in medical education has not been as extensive (Ifenthaler & Schweinbenz, 2013; Mason, Turgeon, Cossman, & Lay, 2014; Rajkumari, 2016). This seeming disparity is further explored in subsequent chapters.

The traditional structure of medical schools in the US includes 3 to 4 years of undergraduate basic science followed by clinical training before residency training in specific fields such as surgery, family medicine, and gynecology. However, for much of the last century the initial 2 years of undergraduate work, typically referred to as preclerkship years, usually involve a greater focus on basic science curricula prior to any clinical training for students (Fischer & Muller-Weeks, 2012). In addition, the preclerkship curriculum establishes the groundwork for students to be successful in more intensely hands-on experiences during specific clinical rotations (e.g., emergency medicine, pediatrics, etc.) with the goal to prepare students for a successful residency in their chosen specialty (Heiman et al., 2017; Muller, Jain, Loeser, & Irby, 2008). During the past decade, curricular reforms have resulted in more intensive integration of basic science and clinical experiences, weaving longitudinal themes such as humanities, ethics, health care systems, and vulnerable populations throughout the preclerkship curriculum to better prepare students in their clinical reasoning skillset. Medical school administrators recognize the importance of introducing clinical experiences early in the curriculum and use the term vertical integration to describe it (McLean, 2016). The amount of basic science content has been reduced in many schools, while introducing clinical experiences and other nontraditional content to students earlier in their studies has been increased (Gonzalo, Caverzagie, et al., 2018; Gonzalo, Wolpaw, & Wolpaw, 2018). This has affected cornerstone basic sciences such as anatomy, which is directly related to clinical practice (Losco et al., 2017). Many medical school administrators feel that curriculum overhauls such as this–with a reallocation of focus and time along with a resource redirection–will help students to function more effectively in contemporary health systems (Borkan, George, & Tunkel, 2018).

Issa et al. (2011) stated that “most clinical faculty staff involved in medical education lack formal or structured training in the science of teaching prior to commencing their duties as educators” (p. 819). In most medical schools, basic science and clinical faculty are the primary teaching staff, along with ancillary experts in electronic health records (EHR; Han, Resch, & Kovach, 2013), public health and translational medicine (Greenberg-Worisek et al., 2019), lifestyle medicine (Muscato, Phillips, & Trilk, 2018), humanities, and ethics (Heiman et al., 2017). For all of these faculty members, their teaching roles require a high level of expertise in their field of study but do not typically require teaching experience or the ability to use educational technologies effectively (Hu et al., 2015). Generally, medical education faculty members do not usually receive formal training in pedagogy before they first step into the classroom to teach, nor do they typically receive guidance on the effective use of educational technologies (Calkins, Johnson, & Light, 2012; Dornan, Scherpbier, King, & Boshuizen, 2005).

The term pedagogy is used here and in other empirical studies, even though a more appropriate term might be andragogy. Andragogy is the theory and practice of teaching adults, versus pedagogy which is considered by some researchers to be the theory and practice of teaching children (Knowles, 1970). Other researchers such as D. C. Taylor and Hamdy (2013) considered these terms artificial and that “many of the principles of andragogy can be applied equally to children's learning (p. e1561). D. C. Taylor and Hamdy (2013) considered learning to occur on a continuum of problems and strategies that people experience in a lifetime. Despite the D. C. Taylor and Hamdy (2013) conclusion that andragogy applies to all ages of students, the term pedagogy is the term extended to all age groups and used to refer to adult learning experiences for the purposes of this study.

Medical educators are generally not naturally comfortable users of technology (Calkins et al., 2012; Fraser, Stodel, Jee, Dubois, & Chaput, 2016). It can be difficult for them to maintain their professional identity while, at the same time, trying to keep up with the increasing pace of change in medical education (Browne, Webb, & Bullock, 2018; Love et al., 2018). For example, the introduction of tablet technology (e.g., Apple iPad™, Microsoft Surface™, Android™, etc.) brings enhancements and expanded access to new information for both students and instructors. However, unless a tablet-use culture in an organization is created among all stakeholders, tablet adoption and effective use can suffer (Deutsch, Gaines, Hill, & Nuss, 2016). New technologies have changed how basic science faculty conduct their research. For example, Perkel (2017) described how smartphones have enabled scientists to take some of their experiments out of the typical laboratory setting and into the field. Some of this research is clinically related, such as using smartphone or electronics that fit on a wrist like the Apple Watch, that include capabilities to collect step count information and heart rate data from human subjects.

In medical education, in addition to laboratory responsibilities, basic science faculty often have teaching appointments in both graduate courses and medical programs and spend a great deal of time seeking grants in order to continue their research. Clinical faculty typically have responsibilities to see and treat patients in addition to any teaching responsibilities (Anton

& Jones, 2017; Lin, Lin, & Roan, 2012; Wu, Shen, Lin, Greenes, & Bates, 2008). With the advent of new and faster systems to diagnose and treat patients, their clinical work environments have also changed dramatically over the years. Yet, despite these technology innovations in many clinical settings, clinicians have not universally adopted these systems (Anton & Jones, 2017; Lin et al., 2012; Wu et al., 2008). Basic science faculty and clinical educators have also been introduced to technologies that can expedite their research processes (Cheng & Tsai, 2012) and enhance their instruction (Ellaway, 2013; Helle & Säljö, 2012). In educational settings, technologies such as anonymous polling software or certain types of game-based learning software have changed how basic science and clinical faculty interact with students and with each other if they are co-facilitating a session (Chen & Scanlon, 2018). In summary, both basic science and clinical teaching faculty face change on multiple fronts. They have faster methods and technology to conduct experiments in the laboratory setting and in the clinical setting that simplify identifying previously hard-to-diagnose conditions.

Technology in Medical Education

Technology in medical education is simultaneously similar to and different from other educational technologies found in most nonhealth sciences higher education environments. Examples of these tools that are common in other different academic subjects include document cameras, laptop/desktop computers, audience response systems (ARS) like Poll Everywhere^{TM}, and screen projectors or monitors (Stansberry, 2017). Technologies found in medical education which are not widely used in other academic fields include virtual microscopes, cardiopulmonary patient simulators and mobile ultrasound tools (Cuff & Forstag, 2018; Guze, 2015; Helle, Nivala, & Kronqvist, 2013).

The pace of technology replacement and change has accelerated exponentially in education. For example, the slide image carriage was used for many years to project text and images on a screen or other flat surface before the introduction of Microsoft PowerPoint (Gabriel, 2008). PowerPoint has been the most commonly used presentation software for decades; however, educational innovators have recently used newer tools such as Apple's Keynote™, Google Slides™, Prezi™, and Adobe Spark™ (Chapman, 2018). The wood or metal pointing stick is another example of a now-superseded tool that was common in classrooms and used to identify or highlight content on a physical blackboard or projector screen. For the most part, the hand-held laser pointer has usurped the stick, and even the laser pointer has been supplanted in some classrooms by features within PowerPoint that do essentially the same thing and offer more robust functionality (Lee, Morrone, & Siering, 2018). In the end, these examples of educational technology evolution reflect that change is continuous, and educators need to determine how to navigate these onsets (Provenzo, Brett, & McCloskey, 1999).

In general, students tend to use more educational technologies than their instructors, and this is no different in medical education. Zayim et al. (2006) illustrated how medical schools should pay close attention to the instructional technology needs and expectations of both student and faculty populations. Students are typically younger than their teachers and there are differences in the adoption rates of innovation between the generations. Chen and Scanlon (2018) elucidated that millennials and later generation radiology trainees "crave active engagement, multimedia learning, and continuous feedback" (p. 794). Some medical students have created a parallel curriculum for themselves that is different from the officially sanctioned one and includes electronic learning aids such as Osmosis™ for self-paced, spaced-repetition study; Boards and Beyond™ and UWorld™ for board-style questions; and the Sketchy™ series of videos and interactive questions whether their instructors utilize any form of technology or not (Quirk & Chumley, 2018). Chapter 2 includes an elaboration on generational differences in teaching and learning.

More examples of technologies used for instruction in medical education include three-dimensional simulation (Loke, Harahsheh, Krieger, & Olivieri, 2017; O'Reilly et al., 2016), smartphone and tablet technology for content delivery (Anderson, 2009; Boruff & Storie, 2014; Stewart & Choudhury, 2015), whiteboards in place of chalkboards (Rajkumari, 2016), artificial intelligence (Wartman & Combs, 2018), and mixed-reality anatomy visualizers (Hu, Wattchow, & de Fontgalland, 2018) such as Anatomage™ tables that can present a full-size virtual human through images that can be manipulated to show parts of the body which would not have been possible as recently as 5-10 years ago (Ward & Wertz, 2018). In addition, ARS such as hand-held clickers have been used in fields such as clinical microbiology in an attempt to increase student engagement (Stevens et al., 2017). One could conjecture that all of these tools could also be incorporated into inquiry-based teaching and learning activities. It is important to postulate that in the foreseeable future, educational technologies such as these will continue to be part of content design and delivery and that the rate of technology change will likely increase. It is also likely that faculty will continue to be asked to learn how to use technologies and to implement technology in their teaching, regardless of their acceptance of it or not. Hence, empirically studying faculty acceptance, BI to use educational technology, and UB of educational technology in IBL is imperative to determine whether there is a way to identify influencing characteristics and determine ways to support faculty more effectively.

An Institute of Medicine (IOM) report identified the importance of technology in educational activities (Cuff & Forstag, 2018). As mentioned previously, students who are joining the health professions today are typically millennials or part of generation Y. They are not digital immigrants like their parents but are digital natives, meaning that for personal, professional, and educational purposes, they have always had ready access to technologies. "These learners understand technology better than any generation before them–and better than their faculty–and typically have numerous devices at their fingertips ready to retrieve information, communicate, and explore across borders" (p. 1-3). Cuff and Forstag (2018) indicated that there are numerous products on the market now such as ReelDx™ that are promoted to medical students and faculty for use. This particular tool has over 700 video cases of patients for use in a curriculum as case study materials or to "anchor problem-based learning" (Cuff & Forstag, 2018, p. 3).

Perceptions of usefulness, effort expectancy, social influence, and overall intention are some factors that can influence faculty and predict their acceptance of and intention to implement educational technology (Anton & Jones, 2017; Securro, Mayo, & Rinehart, 2009). Studies have shown that perceived ease of use and actual use of technology tend to be strong predictors of technology acceptance and use by basic science and clinical faculty. For example, a study was conducted by Ducey and Coovert (2016) that attempted to predict tablet computer use among physicians. Researchers collected data from 261 practicing pediatricians to evaluate an extension of the technology acceptance model (TAM), which is one of the most widely used information technology adoption models (Cheng, 2018). The results of the study indicated that some of the factors that determined physician intention to adopt these devices included individual, organizational, and device characteristics. In particular, subjective norms such as organizational variables, compatibility with technology, and perceived reliability of the technology explained 72% of the variance in perceived usefulness of the technology. Compatibility and reliability explained 38% of the variance in perceived ease of use of the technology.

Inquiry-Based Learning in Medical Education

As previously mentioned, IBL in medical education is a group-based teaching methodology and usually incorporates instructive clinical cases to guide problem-solving. As will be discussed further, certain types of IBL activities require more initial work from individual group members and then the group comes to a consensus to solve a problem. Other variations of IBL activities require the group to work more closely together to solve a problem. As a teaching and learning methodology, it is considered an exceptional way for students to gain a more complete and humanistic understanding of disease mechanisms and the effect that diseases have on patients and their loved ones (Anstey, 2017). Cases used in medical education for instructional purposes sometimes combine basic science information and clinical experience to give a more well-rounded view of the problem-space (McLean, 2016; Morrison, Goldfarb, & Lanken, 2010). In standard IBL activities, students are placed in teams, and the teams are presented with ill-structured, authentic, and complex problems to solve. An ill-structured problem is one that is a potential real-life situation for which there is no obvious correct answer. The most identifiable forms of IBL in medical education are CBL, PBL, and TBL. Implementing an IBL activity sometimes requires significant behavioral pattern shifts for both students and instructors; it may impact how students take responsibility for their own learning and how instructors deliver content (Marra, Jonassen, Palmer, & Luft, 2014). As medical schools increase the number of IBL activities delivered throughout all levels of the curriculum, additional faculty development is necessary to support their integration into practice (Steinart, 2014).

Like many other methods of teaching, IBL does not require technology to be practical, but the use of technology has the potential to improve academic content delivery positively (Brooks, Woodley, Jackson, & Hoesley, 2015; Gomez et al., 2010; Kam & Katerattanakul, 2014). For example, a study by Fujikura et al. (2013) described how faculty who delivered a TBL activity in a medical school used ARS for students to give immediate feedback in a large classroom. While the students in that study did have an appreciation for the use of the ARS, the faculty "appreciated the fact that they could monitor students' understanding in real time" (p. 66). On the other hand, Kam and Katerattanakul (2014) said that the benefits of technology in IBL activities added value only if faculty who used them did something useful with these devices such as using a central electronic case repository to develop scenarios. Savin-Baden et al. (2011) stated that there can sometimes be a lack of pedagogical purpose to the use of technology for IBL activities and challenges for both students and faculty to get it to work at all, which can disrupt the teaching and learning experience. Park and Ertmer (2007) identified barriers such as finding appropriate time and resources, which can impact faculty acceptance and use of classroom technology (Fiedler, Giddens, & North, 2014; Rajkumari, 2016; Zayim et al., 2006). With all of this in mind, it is important to address teacher beliefs about technology integration into IBL activities. Addressing their behavioral beliefs can help to determine which interventions, if any, should take place to alleviate any negative impressions about this type of delivery method and to determine which support mechanisms might be necessary to provide a successful experience. The next section explains the three main forms of IBL previously identified for inclusion in this study and how they relate to the delivery of medical education.

Case-Based Learning

CBL is considered to be the longest established inquiry-based teaching and learning delivery method. Despite its longevity, "there is no international consensus as to the definition of case-based learning (CBL) though it is contrasted to problem-based learning (PBL) in terms of structure" (Thistlethwaite et al., 2012, p. e422). Thistlethwaite et al. (2012) proposed a definition as "the goal of CBL is to prepare students for clinical practice, through the use of authentic clinical cases" (p. e422). CBL falls somewhere on the continuum between PBL and TBL in terms of structure. To explain further, CBL falls closer to TBL on the continuum, as there is advance preparation required by both students and instructors whereas in PBL there is very little advance preparation required (McLean, 2016).

As previously mentioned, technology is not required to adequately deliver CBL educational activities. If technology is integrated into the delivery, however, faculty must not only be experts in the topic being discussed and have an understanding of group dynamics but also express a willingness to use appropriate technologies. An example of technology used in CBL is the electronic case library, which is a database or collection of cases in electronic format which includes problem variables and potential results, and can aid in providing the structure for the problem space (Tawfik, 2017). There is, however, a scarcity of literature on studies of faculty acceptance of and intention to use technology in delivering any of the IBL-type activities. For example, a study by Nordquist, Sundberg, Johansson, Sandelin, and

Nordenstrom (2012) concluded that “all teachers normally lecturing at the traditional Friday lectures ... were obliged to become case seminar facilitators” (p. 946); however, there was no mention of how the teachers adapted to CBL techniques or how technologies were integrated and used by faculty.

There are several departures in CBL’s delivery strategy compared to the standard lecture. One departure is comfort level. A challenge for teachers who are more comfortable with delivering didactic instruction or working with just one large group of students is to learn how to manage multiple small groups in a classroom setting. Another departure is the inclusion of technology in delivering instruction in an unfamiliar teaching methodology. As previously mentioned, some technologies for instruction such as slides, projectors, etc. are common in various content delivery methods and would likely not pose a problem if they were integrated into a new teaching methodology. However, there may be technologies that are unfamiliar to the faculty and that could affect their intentions to incorporate them into a perceived foreign type of content delivery (Quinlan, 2003). Table 1 provides a summary of the similarities and differences between the three main types of IBL activities discussed in this study.

Problem-Based Learning

PBL is a student-centered teaching approach that focuses on knowledge acquisition by solving an authentic, unstructured problem, or as D. H. Jonassen (2000) stated, “finding the unknown is the process of problem solving” (p. 65). PBL originated in the 1950s as an educational method and the impetus for its popularity was borne out of frustration with traditional lecture-based instruction that had been ubiquitous in medical education for decades

Table 1

Similarities and Differences in Inquiry-Based Learning Activities

Instruction characteristics	Case-based learning	Problem-based learning	Team-based learning
Format	Learning takes place in small groups. Learning objectives and goals are discrete and well-defined. Outcomes are measurable. CBL is more focused than PBL: on the continuum between structured and guided learning. The focus in CBL is on clinical-based knowledge and how to solve specific problems, identify diseases, etc. There is usually a minimum of one case presented.	Learning takes place in small groups. Learning objectives are loosely determined. The process is the outcome; focus is on how to go about solving the problem presented, not necessarily the content itself. Learning unfolds as the case unfolds. There is usually one case per session.	Learning takes place in small teams. The focus is on how to solve the problem presented and the content of the problem. There is usually more than one case per session.
Instructor role	One teacher facilitates learning for numerous small groups. Facilitators provide minimal guidance and direction to learners.	One teacher facilitates learning for each small group. Facilitators provide minimal guidance to learners.	One teacher facilitates learning for numerous small teams.

(continued on next page)

Table 1 (continued)

Instruction characteristics	Case-based learning	Problem-based learning	Team-based learning
Group/Team characteristics	Groups are small, and each team member is expected to participate.	There are usually six to ten students per group. Students are randomly assigned to groups. Group members stay together for 6 to 10 weeks and discuss several problems during time together.	There are usually five to seven students per team. Students are assigned to teams in a purposeful manner. Group members stay together for the duration of a course or semester.
Lecture	No traditional lectures.	Supplementary lecture may be included.	No traditional lectures.
Prior knowledge	Students are required to complete preclass readings that provide baseline knowledge in order to be able to participate in class activities.	There is little expected advance preparation. Students are not tested to determine understanding but encouraged to activate their prior knowledge through group discussion. Exposure to new content happens after initial group discussions. Students determine their own learning gaps.	Students are required to complete preclass readings in order to actively participate. Individual and team tests determine student readiness to discuss problems. Exposure to new content happens before team discussions.

(continued on next page)

Table 1 (continued)

Instruction characteristics	Case-based learning	Problem-based learning	Team-based learning
Problems	Relevant case-based problems are discussed. Learning goes beyond simple identification of correct answers. Provides more evidence of critical thinking.	Relevant case-based problems are discussed. Reasoning around problems with no specific questions.	Relevant case-based problems are discussed. Reasoning around problems with specific associated questions.
Feedback	Not clearly defined in research.	Peer feedback is less structured and formal.	Peer feedback is a structural component through which team members give feedback to each other on individual contributions to learning.

Note. Adapted from "Team-based learning: A relevant strategy in health professionals' education," by D.X. Parmelee and P. Hudes, 2012. *Medical Teacher, 34*(5), 411-413.

(Savery & Duffy, 2001). This teaching method is strongly based on the constructivist theoretical framework and can be described through its accepted five characteristics: a) interactions with the environment (e.g., artifacts, real-world examples, etc.) help the learner to construct knowledge, b) learners make sense of the world through their own set of experiences (e.g., building on prior knowledge), c) meaning and thinking are linked to the communities that are created (e.g., working with teams to collectively make decisions), d) context is created by anchored knowledge (e.g., using realistic problems like medical diagnoses), and e) knowledge is stimulated by the desire to know something (Jonassen, 2000).

In PBL activities, students work in small collaborative groups to explore the problem-space and to determine solutions to problems. Group member collaboration is essential to achievement levels (Baturay & Bay, 2010). Small groups work “under the guidance of the expert facilitator, drawing from the literature and practice, group members engage in questioning, revising, and entertaining various views of the issues they uncovered within the case” (De Simone, 2008, p. 180). Some additional characteristics of PBL include how students work on complex tasks such as open-ended or ill-structured problems, how students work in small groups and conduct self-directed learning on these tasks, and how teachers act as facilitators of learning for each group rather than directing learning or providing explicit knowledge to the class as a whole (Hmelo-Silver, 2004; Hmelo-Silver & Barrows, 2006). Complex tasks in problem-solving in PBL often require guided scaffolding of learning (Gomez et al., 2010). PBL also “goes beyond rote memorization and simple acquisition of knowledge characteristic of passive learning strategies” (Hartling, Spooner, Tjosvold, & Oswald, 2010, p. 28).

A key difference between PBL and TBL is that the roles of the student and teacher are transformed; in PBL, “the teacher is no longer considered the main repository of knowledge; she is the facilitator of collaborative learning” (Hmelo-Silver, 2004, p. 239). Another important difference between PBL and both other IBL methods is that students receive minimal information about an issue in PBL and must ask the facilitator for more information: “facilitators progressively fade their scaffolding as students become more experienced with PBL until finally the learners adopt many of the facilitators’ roles” (Hmelo-Silver, 2004, p. 245). Student commitment to their involvement in the learning process is important to the success or failure of a PBL activity (Bate, Hommes, Duvivier, & Taylor, 2014). There may be technologies that are unfamiliar to instructors which could be used for the delivery of PBL.

Faculty may find these technologies to be foreign and unusual, which may affect their acceptance of and use of them.

Team-Based Learning

TBL is an evidence-based collaborative teaching and learning strategy in which the process of delivery is well-defined and the overall structure is standardized (Parmelee, Michaelsen, Cook, & Hudes, 2012). Because it is so highly structured and standardized, the description of it is more complex than for CBL or PBL. It was introduced as a teaching methodology over 30 years ago for business and law school programs. Soon after, medical schools adopted it as a more active and participatory teaching and learning strategy compared to the standard lecture (Michaelsen, 2002). TBL is more of an instructor-driven technique that sets overall accountability for learning at the individual and team levels (Huang & Lin, 2017). In synchronous sessions in medical education, small student teams work together to problem solve, answer questions, and resolve issues related to clinical situations (Rajalingam et al., 2018). Compared to both other IBL methods, the teams usually remain together for a semester or a year (Burgess et al., 2017; Kibble, Bellew, Asmar, & Barkley, 2016).

TBL is suitable for courses with large enrollments, which sets it apart from other IBL teaching methods that would tend to require more resources, such as facilitators on hand for each team. Instead of a dedicated learning facilitator for each team, as is generally required in PBL, co-operative learning strengthens peer relationships (Kibble et al., 2016; Rajalingam et al., 2018). This reduces the need for additional human resources, which also appeals to institutions that do not have enough dedicated facilitators for each team. A main goal of TBL is to build long-term team experiences as professionals as it "engages students with the kinds of problems they will encounter in clinical practice" (Parmelee et al., 2017, p. 143). There is less guidance from a facilitator during team problem-solving in TBL (Huang & Lin, 2017). The four Ss are an important component of TBL: All teams are given a *significant* problem to solve; they are given the *same* problem to solve; they are afforded the opportunity for *simultaneous* reporting; and especially during the readiness assurance testing portion of the activity, there is a *specific* choice or answer fit (Burgess et al., 2014).

According to D. X. Parmelee and Hudes (2012, p. 412), the essential components of a TBL strategy include strategic team formation, an advance assignment, a readiness assurance process, immediate feedback for the learners, and team application exercises. Students must review and digest substantial preparatory material so they can take the individual readiness assurance test (IRAT) and group readiness assurance test (GRAT) as well as participate in additional challenging case-based application discussions during class time (Michaelsen, 2002). Figure 4 outlines this process and the order of delivery.

A computer, presentation software, and a projector are standard technologies that are omnipresent for a wide range of teaching methods. Technologies such as these are not typically required for content delivery, but they can aid in the transmission of important information to students during an activity (Gomez et al., 2010). A lack of modern technology tools can mean more back-end work for instructors and administrative staff to deliver content in courses with large enrollments (Gomez et al., 2010). For example, Scantron™ sheets are commonly used by schools for students to record their answers to the readiness assurance test (RAT), which is comprised of the individual readiness assurance test (IRAT) and the group readiness assurance test (GRAT). Because this is not an automated operation, it can take time to process the sheets

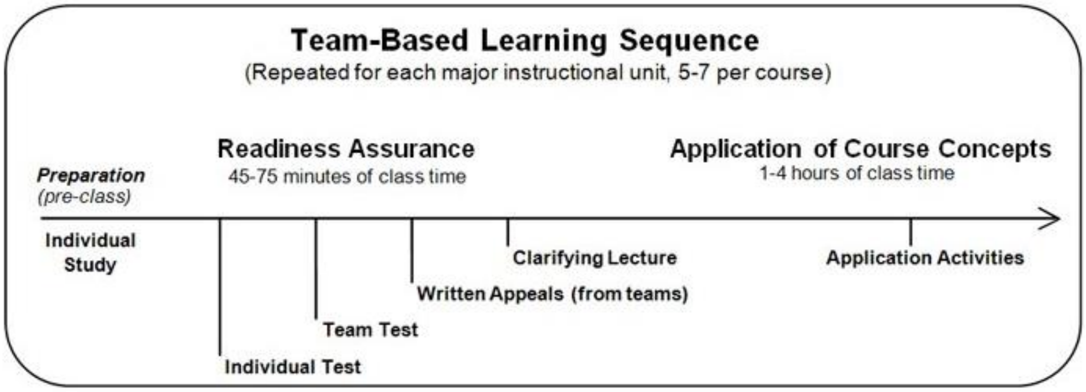

Figure 4. Team-based learning sequence. From the Team-Based Learning Collaborative website. Copyright 2019 by the Team-Based Learning Collaborative. Reprinted with permission; see Appendix B for permission.

and determine scores. Computer-supported TBL, such as through the use of a learning management system (LMS), enables alternative class meeting times that reduce constraints on physical classroom sizes and available times in the class schedule (Gomez et al., 2010). Because TBL is a structured method of delivering content, its faculty facilitator experiences less pressure to be an expert group leader (Parmelee et al., 2012; Parmelee & Hudes, 2012). However, faculty facilitators need to be able to manage a classroom of group learners who may be unfamiliar to them and be able to use technology such as InteDashboard™ that can help facilitate the sessions electronically. In one study, the faculty “appreciated the fact that they could monitor students’ understanding in real time” (Fujikura et al., 2013, p. 68) using this type of technology.

The remainder of this chapter provides a comprehensive context to support the need for this study on faculty acceptance of, behavioral intention to use, and actual usage behavior to use technology for IBL activities in medical education. The problem statement, significance, and purpose of the study; the research questions that guided it; and the underlying theoretical frameworks are next.

Statement of the Problem

This study focused on medical educators who design and deliver IBL educational activities in medical schools in the US. Despite the advantages that technology can bring to inquiry-based teaching and learning, there can sometimes be resistance from unconvinced medical educators about determining whether the advantages outweigh the disadvantages (Fraser et al., 2016; Lewis et al., 2014). As noted earlier, IBL does not require technology in order to be effective as an instructional methodology. In TBL activities for example, students can use pencils to fill out paper scantron forms. For some medical schools with large student populations, however, this has resulted in massive amounts of paper used annually in the form of documents with case information and questions as well as scantrons for the graded portions that students fill out (Antoun et al., 2015; Parmelee et al., 2012). In recent years, the use of paper has been reduced in medical schools and the use of various technologies for the delivery of TBL activities has increased. Computer-based testing was found to be "beneficial for the facilitator in reducing the time to distribute, collect, and correct tests … despite some minor but manageable technical glitches" (Antoun et al., 2015, p. 42). While this reduction in paper consumption is beneficial, buy-in from faculty to switch from paper to technological solutions determines the success or failure of the facilitation of TBL activities (Antoun et al., 2015).

Due to empirical evidence of resistance by faculty to accept and use IBL technology, it is important to study why this resistance exists to distinguish among specific determinants that might lead faculty to not accept and use technology. The extant literature on faculty perspectives relating to the acceptance and use of IBL-specific technology in medical education is inadequate. For example, Verduin et al. (2013) stated that advice to instructors for designing and delivering IBL was provided but did not include specific information on the acceptance and use of technology in this type of teaching and learning activity. The student perspective on acceptance and use of technology in IBL is more evident in the literature (Gomez et al., 2010; Kam & Katerattanakul, 2014; Ractham & Chen, 2013). Because the perspectives of medical school faculty are not as well represented, this study examined factors that may be associated with faculty acceptance of, BI to use, and UB of technology in IBL activities.

Multiple theoretical frameworks have been proposed over the years in the scholarly literature to explain determinants of technology acceptance, such as the technology acceptance model (TAM); (Park, 2009), theory of planned behavior (TPB); (Ajzen, 1991), and the theory of reasoned action (TRA); (Ajzen & Albarracín, 2007). The UTAUT model was developed by Venkatesh et al. (2003) and integrates eight models of technology acceptance including the TAM, TPB, and TRA. The UTAUT model suggests that there are three direct determinants of intention to use technology: performance expectancy (PE), effort expectancy (EE), and social influence (SI). It postulates that there are two direct determinants of actual usage behavior (UB): behavioral intention (BI) and facilitating conditions (FC). It also assumes that the effect of these central constructs is moderated by age, gender, experience, and voluntariness of use (Venkatesh et al., 2003). Since its inception, it has been empirically tested and validated as a model to examine technology acceptance and use in various disciplines (Venkatesh, Thong, & Xu, 2012). The UTAUT will be discussed in detail to explain how it can help academic organizations to better understand reasons behind resistance to the acceptance and use of technology as well as issues surrounding BI to integrate technology into IBL activities in medical education.

Purpose of the Study

In response to a gap in the literature on this topic, the purpose of this quantitative study was to attempt to contribute to the greater knowledge base by investigating medical school faculty members' acceptance of, BI to use, and UB of educational technologies to deliver IBL educational activities. The significant primary predictor of faculty members' BI to integrate educational technology in IBL activities was investigated using the UTAUT, which explores user acceptance, BI to use technology and UB of technology in different scenarios. The UTAUT can also be used to better understand what drives technology acceptance in order to create proactive interventions (Venkatesh et al., 2003). This study attempted to highlight how the four main constructs (PE, EE, SI, and FC) determined how they are related to medical school faculty members' BI to use and UB regarding technology for IBL activities. In addition, this study aimed to assess the moderating effects of demographic characteristics (age, gender, experience, and voluntariness of use) on attitudes toward BI and UB regarding technology in IBL activities.

Research Questions

This quantitative study was designed to explore the determinants of medical school faculty to accept, their BI to use, and their UB of educational technology in IBL activities and was shaped by the following four questions:

1. What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?

2. What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning activities?

3. Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?

4. Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning

Research Hypotheses

Key for terms:

BI = behavioral intention

EE = effort expectancy

FC = facilitating conditions

IBL = inquiry-based learning

PE = performance expectancy

SI = social influence

UB = actual usage behavior

VU = voluntariness of use

H_{1a} PE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{1b} PE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{2a} EE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{2b} EE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{3a} SI has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{3b} SI has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{4a} FC have a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{4b} FC have a positive effect on medical school faculty members' UB regarding educational technology in IBL.

Theoretical and Philosophical Foundations

This study presented a quantitative view of the determinants that predict faculty acceptance of, behavioral intention to use, and actual usage of educational technologies for IBL activities at medical schools in the US. The conceptual framework for this study was based on the research foundations of self-efficacy, social constructivism, and specific technology acceptance and adoption theories. A brief description of these foundations follows.

Self-Efficacy

Self-efficacy refers to the beliefs that people have in themselves that they can successfully produce a desired effect or outcome. "Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). In their daily lives, people analyze situations and make decisions about potential courses of action numerous times during a day. Humans form beliefs about what they perceive they can or cannot do. They also introspectively analyze their innate abilities to carry out these courses of action in order to attain a desired result. After these introspective analyses are performed, decisions are made, actions occur, and they reflect on the experience and determine the success or failure of their actions (Bandura, 1997). Reflection allows people to make adjustments to their strategy for the next time a given situation, or a similar one, arises. Self-belief in their efficacy can affect self-regulation of motivation to perform actions. Self-efficacy also plays a big role in the regulation of motivation. If a person feels that the decisions he or she made are poor ones and the results are not desired, motivation levels tend to decrease (Bandura, 2015). According to Bandura, "in social cognitive theory, efficacy beliefs are developed and altered not only by direct mastery experiences but also by vicarious experience, social evaluations by significant others, and changes in physiological states or how they are construed" (Bandura, 1997, p. 14).

Social Constructivism

Social constructivism is a worldview that looks at how people perceive their surroundings, themselves, and how they understand the world in which they live and work (Creswell, 2014). Knowledge is continuously reinterpreted by humans according to their sociocognitive experiences (Larochelle & Bednarz, 1998). The varied and complex experiences of the teaching faculty at medical schools in the US edify how they bring their expertise about the real world as scientists and clinicians to inform the development of clinical cases to then deliver to students. The faculty members at these schools face a potential lack of expertise in identifying appropriate educational technologies to integrate into their content delivery. These clinical cases are often delivered by teams of faculty during live face-to-face sessions, and sometimes technology is used to aid in delivery. The interactions among and between a delivery team and team members' comfort level with the technologies being used often guide negotiated meanings of success or failure during the delivery of cases (Hmelo-Silver & Barrows, 2006).

Faculty may have biases about the outcome of the cases, and this holds true especially for clinician educators. They may have been the attending physician for the patient about whom a case is developed (Hannah & Carpenter-Song, 2013). An attending physician is one who "is responsible for the overall care of a patient in a hospital or clinic setting. An attending physician may also supervise and teach medical students, interns, and residents involved in the patient's care" (National Cancer Institute, 2019). Relying on social constructivism as a worldview helped guide me to probe more deeply into teaching faculty members' acceptance of, behavioral integration of, and actual use of educational technology in IBL activities. This worldview helped me to delve deeper into these complexities and build a sense of how these faculty members understand the world in which they live and work.

Technology Acceptance Theories

The UTAUT was the main guiding theoretical framework for this study. The UTAUT was originally proposed by Venkatesh et al. (2003) and "has been widely applied and empirically tested to investigate factors that could influence individuals to adopt and use technology in various environments" (Khechine, Lakhal, & Ndjambou, 2016, p. 138). Organizational adoption of information technology has opened a virtual Pandora's box of questions about the adoption and integration of these technologies by the faculty who will ultimately use them. The UTAUT provides a system that can be used to "assess the likelihood of success for new technology introductions and helps them understand the drivers of acceptance in order to proactively design interventions (including training, marketing, etc.) targeted at populations of users that may be less inclined to adopt and use new systems" (Venkatesh et al., 2003, p. 426). The UTAUT is the result of a synthesis of eight theories of technology acceptance and use that have evolved over decades of empirical study:

- Theory of reasoned action (TRA); (Fishbein & Ajzen, 1975),
- Technology acceptance model (TAM); (Davis, 1989),
- The motivational model (MM); (Davis, Bagozzi, & Warshaw, 1992),
- Theory of planned behavior (TPB); (Ajzen, 1991),
- The combined theories of planned behavior and technology acceptance model (C-TPB-TAM); (Taylor & Todd, 1995),
- The model of personal computer utilization (MPCU); (Thompson, Higgins, & Howell, 1991),
- The diffusion of innovation theory (DOI); (Rogers, 2003), and
- Social cognitive theory (SCT); (Compeau & Higgins, 1995).

The UTAUT was developed to incorporate as many aspects of users' behavior that might not have been made possible by any one of these eight models in isolation. It suggests that there are four main core constructs (PE, EE, SI, and FC) where three of these (all except for FC) are direct determinants of BI, and BI and FC are direct determinants of UB. In addition, these core constructs are moderated by age, gender, experience, and voluntariness of use (Venkatesh et al., 2003). The UTAUT model is shown in Figure 5.

A more detailed explanation of the UTAUT, its underlying theories, and how it relates to this study follows in Chapter 2 along with a comprehensive review of the literature on the existing research related to this study.

Significance of the Study

This quantitative study was one of the first to apply the UTAUT to an investigation of

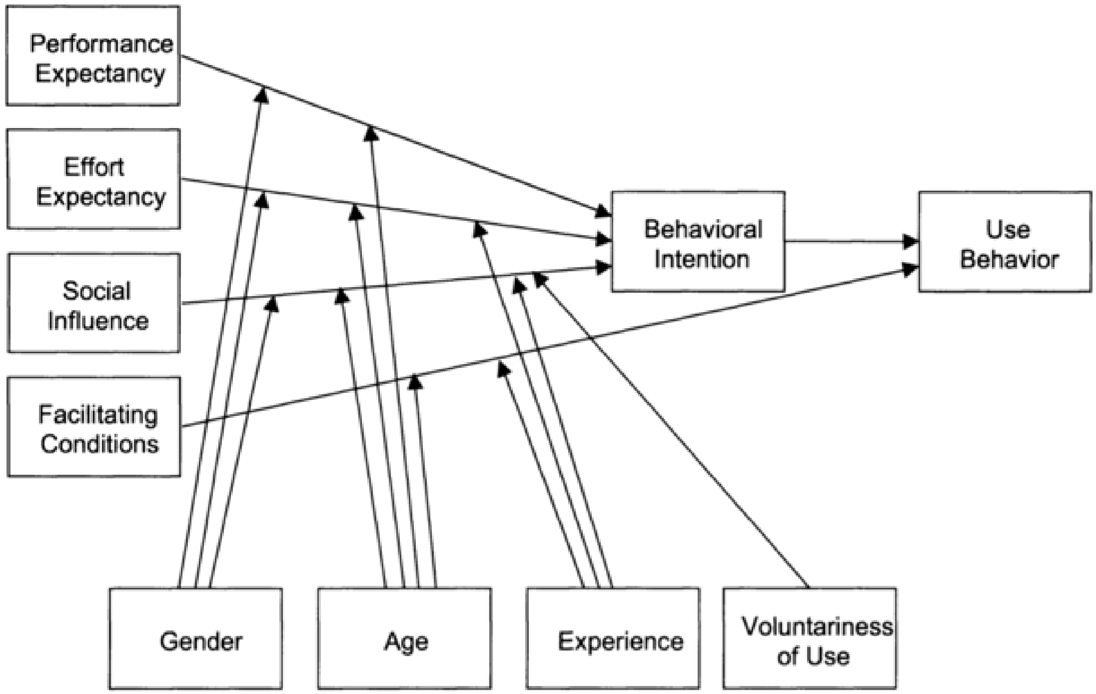

Figure 5. The UTAUT model, from Venkatesh et al., 2003. Reprinted with permission; see Appendix C for permission.

factors that predict medical school faculty members' BI to use and UB regarding technology in IBL educational activities. It contributed in various ways to the field of education technology and medical education, such as providing valuable insights into the BI and UB of medical school faculty members to integrate technology into their IBL activities. As medical school faculty members design and deliver IBL activities, they are faced with many potential technologies to integrate into their delivery of educational content. The findings may provide stakeholders with important information regarding the factors that cause acceptance or resistance to educational technology use. Some of the stakeholders who could benefit from this research include the administrators of the institutions who make purchasing decisions regarding educational technology, teaching faculty who learn from the experiences of their peers who have used educational technology in IBL activities, students who are the end-users of the technologies integrated into educational activities, and instructional designers and technologists who will have a better understanding of what impedes or encourages acceptance of technological innovations. Finally, case-based instruction is a method that is used by more than medical schools (Ractham & Chen, 2013; Williams, 1992; Yadav et al., 2014). Other institutions of higher learning can benefit from an understanding of the issues that teachers face regarding their intentions to integrate appropriate educational technology into this type of delivery method.

This study examined the perspectives of innovation and acceptance of technologies for IBL activities in the context of medical education. This included a nuanced understanding of medical school faculty beliefs regarding the use of educational technology in IBL activities. Using a quantitative approach and a modified validated survey instrument, I was able to better understand, based on study results, which interventions might need to occur to further support educators in medical schools in the US.

Definition of Terms

For the purpose of this study, the following terms are defined with support from the literature.

Active learning: See definition for flipped classroom.

Basic science: A term used in medical education to denote curriculum content that is not of a clinical nature.

Behavioral intention (BI): The likelihood of someone to use technology; a person's conscious decision to do something or to implement something in his or her future behavior (Venkatesh et al., 2012).

Blended learning: Also known as blended instruction, it is teaching and learning that combines elements of traditional classroom activities and computer-based interactivity (Hokanson & Gibbons, 2014)

Case-based learning (CBL): A method of teaching that uses an actual or created patient case to stimulate discussion and questioning as well as facilitate problem-solving and reasoning on clinical issues (Anderson, 2010).

Didactic instruction: A term used to express how knowledge is communicated through the use of lecture versus a more active learning process.

Educational technology: The design, development, utilization, management, and evaluation of a goal-oriented, problem-solving systems approach to processes, tools, and other resources used for teaching and learning (Luppicini, 2005).

Effort expectancy (EE): The degree of ease or difficulty level associated with using a technology (Venkatesh et al., 2012).

Experience: Temporal opportunities to use technologies (Venkatesh et al., 2012).

Facilitating conditions (FC): The degree to which an individual believes there is support and resources available to learn how to use technologies (Venkatesh et al., 2012).

Flipped classroom: An approach to teaching and learning in which basic concepts are provided to students as preparatory work to then use during class time and build on (Persky & McLaughlin, 2017).

GRAT: Group readiness assurance test is the same multiple-choice quiz that is administered to students as the IRAT to determine whether they have completed and synthesized the preparatory work (Fatmi et al., 2013).

Hardware: Any type of device such as electronic notebooks and tablets, personal computers, smartphones, digital audio players and game consoles which function like a computer (Molenda & Boling, 2008).

Information and computer technology (ICT): Technologies that can be used to deliver instructional materials electronically, such as audio and video conferencing, cloud storage, and electronic discussion forums (Molenda & Pershing, 2008).

Inquiry-based learning (IBL): Any type of instructional activity that includes the use of cases which is not specifically CBL, PBL, or TBL but incorporates similar aspects (Ernst et al., 2017).

IRAT: Individual readiness assurance test for TBL; a multiple-choice quiz that is administered to students to determine whether they have completed and synthesized the preparatory work (Fatmi et al., 2013).

LCME: The acronym used for the Liaison Committee on Medical Education, which is the body that is responsible for accrediting medical schools in the US and Canada. The LCME accreditation is the standard that all US and Canadian allopathic medical schools must meet in order for the school to award the degree of medical doctor (Liaison Committee on Medical Education, 2016).

Performance expectancy (PE): The degree to which users believe that a particular technology will help them make gains or achieve benefits in some way such as in their job performance (Venkatesh et al., 2012).

Problem-based learning (PBL): A teaching method in which small groups of students participate in self-directed learning to reach an understanding of how the basic science and clinical factors can solve a central diagnostic problem. The focus is on the process of determining solutions to ill-structured problems (Marra et al., 2014).

Social influence (SI): The perceived influence from peers that convinces individuals to use a particular technology (Venkatesh et al., 2012).

Software: Typically, computer code that executes commands that produce an outcome. Operating systems for computing such as Microsoft Windows™, Apple macOS™, Android™, etc. are examples of software that, in general, direct computers to function. Numerous software programs have been created to aid users to accomplish specific tasks such as visual design, web design, playing and creating music, etc.

Team-based learning (TBL): A well-defined teaching strategy used in various subjects. It is theoretically-based and empirically-grounded and is optimal for large groups of learners (Parmelee & Michaelsen, 2010).

TRAT: See GRAT.

Voluntariness of use: The extent to which the use of technologies is not mandated and users are not pressured to use them (Agarwal & Prasad, 1997).

Assumptions of the Study

Two assumptions related to this quantitative study were that medical school faculty members are somewhat familiar with the design and delivery of IBL activities, and that they are also somewhat familiar with some of the technologies that could potentially be incorporated into the delivery of IBL activities.

Limitations and Delimitations

This study had some limitations that relate to internal and external validity, which might have affected outcomes. These limitations included potential issues with sample design, study design, and the modified research instrument. A more robust description of instrument validity and reliability can be found in Chapter 3. This study included a correlational research study; therefore, causation cannot be determined because the variables cannot be controlled, which has the potential to lead to weak external validity. An online survey (questionnaire) was the instrument used to collect data, therefore participants provided self-reported information. Some limitations must be acknowledged such as acquiescence response, social desirability bias, and respondent knowledge. Online surveys can provide the respondent with an assurance of confidentiality and anonymity; however, there is the potential of bias toward a person who uses technology. This was a cross-sectional rather than a longitudinal study, so participants' responses could have changed over time.

Chapter Summary

This chapter presented the research problem regarding faculty acceptance of, behavioral intention to use, and actual use of educational technology in inquiry-based learning activities in medical education. A short history of significant shifts in the design and delivery of medical curricular content over the past century described how the use of case-based curricular activities have become more ubiquitous. Descriptions of standard medical school curricula were intertwined with examples of technological innovations that have been integrated into design and delivery of educational content. The three main forms of IBL identified that will be further explored are CBL, PBL, and TBL. This study applied the UTAUT to predict acceptance of, behavioral intention to use, and actual use of educational technology. The UTAUT was further described as a synthesis of eight other prominent technology adoption theories.

CHAPTER 2

LITERATURE REVIEW

Introduction

A comprehensive search of the literature was conducted to identify relevant sources by using electronic library databases such as Academic Search Complete, BioMed Central Open Access, EBSCOhost, OVID, and ProQuest. Other relevant resources were accessed through publications available to members of the American Educational Research Association (AERA) and the Association of Educational Communications and Technology (AECT). Keyword combinations such as inquiry-based learning, educational technology, faculty, United States, intention, and medical education were used to identify relevant empirical studies to address in this study.

This quantitative study was an investigation into medical education faculty members' acceptance, BI to use, and UB of educational technologies in IBL educational activities. The UTAUT was the guiding theoretical model for this study. This chapter reviews existing literature on faculty use of educational technology in the following areas: definitions of educational technology; historical development; its use in general education and more specifically in medical education; influence of age, gender, experience, and voluntariness of use of educators on use of educational technology; and its use in IBL activities. This chapter also covers the history and some critical reviews of the UTAUT and related technology acceptance models; the UTAUT's application to studies in healthcare, higher education, and other industries; and a rationale for the selection of the UTAUT as the theoretical framework for this study.

Educational Technology

Educational technology is defined as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (Definition and Terminology Committee of the Association for Educational Communications and Technology, 2008, p. 1). The technological processes referenced in the definition refer to "a series of activities directed toward a specified result" (Definition and Terminology Committee of the Association for Educational Communications and Technology, 2008, p. 11). The technological resources referenced in the definition refer to the human element as well as specific technologies that can help learners. This definition formulated by the committee was intended as a formal definition to help the Association of Educational Communications and Technology (AECT) to legitimize the field of educational technology; to allow professionals to consider themselves as part of a recognized field; to provide language for laws and legal documents, funding, etc.; and to help establish guidelines for future professionals (Definition and Terminology Committee of the Association for Educational Communications and Technology, 2008).

Educational technology can also be defined as the use of computer and Internet technology for pedagogical purposes and how it changes the way that students and faculty communicate, access information, interact, and eventually share data (Buchanan, Sainter, & Saunders, 2013). In contrast, Kinshuk, Sampson, and Chen (2013) asserted that "it is difficult to define what educational technology actually means but researchers and practitioners have typically attributed this term to indicate use of various sorts of technologies to facilitate educational processes" (p. 3). Luppicini (2005) posited that it refers to "a goal-oriented problem-solving approach utilizing tools, techniques, theories, and methods from multiple knowledge domains" (p. 103). Additionally, Luppicini defined educational technology as the "organization of knowledge for the achievement of practical purposes as well as any tool or technique of doing or making, by which capability is extended" (Luppicini, 2005, p. 104). Regardless of the definition, the process of information about how educational knowledge has been produced and transferred between stakeholders is worth the empirical attention given to it (Czerniewicz, 2010).

Familiar examples of educational technology include software such as Microsoft Office™ products (e.g., Excel™, PowerPoint™, Word™,), Google™ tools (e.g., Docs™, Drive™, Sheets™, Slides™), Poll Everywhere™, Prezi™, etc. Familiar examples of educational technology include hardware such as computers (e.g., laptop or desktop), navigating devices (e.g., mice or stylus), keyboards, AppleTV™, Roku™, document cameras, etc. (Chapman, 2018; Gabriel, 2008; Lee et al., 2018).

The steady increase in the integration of educational technology at all levels of teaching and learning has led researchers to reflect on educational technology's actual use and the potential barriers to its use (Johnson, Wisniewski, Kuhlmeyer, Isaacs, & Krzykowski, 2012). Among the growing uses of educational technology, mobile devices such as tablets, augmented/virtual reality, and other related tools have become popular with students and educators due to what these devices can offer in terms of new ways of teaching and learning (Coyne, Takemoto, Parmentier, Merritt, & Sharpton, 2018; Liu, Dede, & Huang, 2017). Some behavioral aspects related to educational technology integration that have been identified in the research include technology anxiety and a lack of self-confidence (Fiedler et al., 2014; Stansberry, 2017). Age can also affect acceptance and use of technology. T. Johnson et al. (2012) pointed out that "older and more experienced instructors tend to have higher levels of technology anxiety" (p. 63).

The popularization of the Internet by the public in the late 20th century resulted in the facilitation of educational activities in an online environment and ready access to shared resources by stakeholders. Varied stakeholders may interpret educational technology in different ways as a tool in terms of form and function. For example, a learning management system (LMS) such as Blackboard™ or Canvas™ is a common technology used in many academic environments (Chow, Tse, & Armatas, 2018). However, while some courses use an LMS to provide a full educational experience in an online environment including interaction between students and teachers, other courses use it primarily as a content repository with little or no interaction between students and teachers (Chow et al., 2018). Increasing numbers of primary and secondary schools have implemented tablet-based solutions for students and faculty, with varied levels of use in teaching and learning (Ditzler, Hong, & Strudler, 2016). These young students could one day be studying medicine and will have become accustomed to an all-encompassing technology world in social, business, and education environments for much of their lives. It is possible they will expect technology-rich environments from their future educators.

Technological change is expanding and evolving, which makes it challenging for instructors to remain current and well-informed about how to choose and implement new technologies for the educational activities in which they will have a positive impact (Macedo, 2017). In medical education, a staple of educational technology in the curriculum is the life-like manikins (experts also sometimes use the traditional spelling of mannequin) for students to practice maneuvers such as suturing and taking blood pressure prior to performing these functions on a human patient (Dankbaar et al., 2016; H. Han et al., 2013). Manikins, like other classroom tools, have become more sophisticated as technology has advanced, which can provide much more realistic experiences for learners and a challenge to instructors in becoming adept at using them for instruction (H. Han et al., 2013).

As the rate of change increases and educational technologies are replaced with newer, so-called shinier versions, faculty members can become frustrated and less inclined to learn how to use and apply the new tools. Reid (2012) determined there are a number of categories that help to describe why instructors might not adopt technology in addition to those referenced above. Among these categories, some faculty are threatened by technology, others feel that it takes time away from their other responsibilities, and yet others feel that there is no support structure for proper implementation (Ellaway, 2013). Not only do the faculty need to learn how and when to use tools for various educational purposes, they also need to learn new teaching styles that depart from the familiar lecture style and involve more active learning techniques such as IBL. The next section gives an historical overview of educational technology.

History of Educational Technology

An argument has been made that modern education remains a remnant of the industrial age and that there is a crisis due to educational technology being misplaced within academia (Albirini, 2007). The crisis alleged by Albirini (2007) includes obstacles to the implementation of educational technology which have existed for decades in schools. According to Albirini

(2007), some of these obstacles include lack of appropriate planning, lack of funds, lack of hardware and software, inadequacy of teacher preparation, the digital divide, and gender inequality.

Computer use for educational purposes can be traced back to the mid-1950s and is considered to be related to the industrial thought process of programming education, in which a computer is programmed to accomplish prescribed outcomes (Johansson & Gärdenfors, 2005). Luppicini (2005) suggested that a popular conception of the term educational technology "is linked to the maturation of the audio-visual movement in education and instructional training programs beginning in the First World War with developments arising out of master learning and programmed instruction trends" (p. 105). Computing in general, as we know it today, goes back much further to the work of such luminaries as the English inventor Charles Babbage and mathematician Ada Lovelace who were important for their significant contributions to the field in the 19th century (Aiello, 2016). In modern computing, software development sources from the development of computer languages such as BASIC and Fortran in the mid-20th century (Aiello, 2016; Ng, 2015). Fast forward to today, and computer languages are not limited to directing programs on laptop or desktop computers but also direct mobile devices, printers, and other peripheral devices (Fouts, 2000; Hokanson & Gibbons, 2014).

In a report for the Bill & Melinda Gates Foundation (BMGF), Fouts (2000) described how the computer was introduced into education settings in the 1970s and gave students and teachers the opportunity to learn how to develop and use programming languages. The computer quickly became a surrogate teacher in effect, as students were able to follow commands on a computer screen to answer questions and receive rewards for correct responses. Early rudimentary games and simulations were also employed to aid in the task of instruction and to augment instructor abilities (Albirini, 2007). Educational technology began to change the ecology of the classroom because it changed the process of teaching and learning. In some ways, some instructional processes began to become easier such as enabling instructors to automate some processes. However, the teaching and learning environment was dramatically changing and required teachers and administrators to adapt to this new reality (Provenzo et al., 1999).

In a medical school in Glasgow, Scotland in the 1970s, tape/slide presentations were the main method to teach students as an alternative to strict didactic activities. Audio material was on a cassette or a reel and provided information and questions for students to answer. Visual materials were in the form of 35 mm transparency slides. These slides included photographs of patients, specimens, and results of laboratory investigations including radiological imaging. Students and instructors alike had to adapt to these innovations compared to what they were familiar with previously (Harden et al., 1975).

Prior to the rise of microcomputers in the early 1970s, such as the Altair 8800, there was no such thing as a personal computer for the general public, possibly due to lack of accessibility and high cost. Companies we still recognize today such as Microsoft and Apple built upon this technology to ultimately make personal computers more commonplace, which led to innovations by these and other companies (Rajaraman, 2018). Microcomputers were not as physically small compared to what exists today, but they were petite as compared to prior-generation computers that filled entire rooms. Storage technology such as floppy disks led to compact discs (CDs), which led to flash drives, which ultimately led to today's digital-only options. Keyboards, mice, trackpads, printers, and scanners are examples of peripheral devices that all work together to accomplish actions through software (Fouts, 2000).

One way that students and instructors discovered the benefits of programs to carry out routine functions such as word processors, presentation development, and research tools was through the library environment (Nelson & Irwin, 2014). Librarians, while initially suspicious the Internet would usurp their own work and jobs, ultimately changed their mind by "leveraging the same technology that had threatened to displace them in the first place" (Nelson & Irwin, 2014, p. 893). The Internet had an explosive effect on what came next; the massive volume of information that became available changed how students and instructors interacted with each other (Chen & Scanlon, 2018). For example, in a study of radiology trainees, imaging techniques using handheld devices were discovered to be useful for students to access content. However, "applying imaging finding *[sic]* to the clinical context still requires the careful guidance of an experienced radiologist" (Chen & Scanlon, 2018, p. 796). In order to educate people who were not in close proximity to a university, the development of online courses made the prospect of delivering instruction at a distance to virtually anywhere in the world a reality (Johnson et al., 2012).

The 1980s ushered in a significant shift in the functionality of educational technologies in schools. The rise of the microcomputer and the change in thinking from behaviorist knowledge construction to more of a constructivist approach helped to create more meaningful learning environments (Albirini, 2007). Even in the early 1980s, however, much of the commercially available hardware and educational software was considered to use the drill-and-practice mode, based mainly on behaviorist approaches to learning (Czerniewicz, 2010). It was considered that enough practice by students using the educational programs would produce correct results (Jonassen, 1987). To accommodate individual differences in learning, tutorial courseware became more popular and resembled branched, programmed learning (Fouts, 2000). It was argued that while these technological enhancements provided efficient solutions to instructors, teaching staff could become "insulated into outmoded, inadequate practices merely because there is no means of comparison with more dynamic progressive areas" (Plummer, 1987, p. 183). Plummer felt that whole areas of the country could suffer from a lack of progressive thinking regarding educational technology.

Clark (1983) wrote a seminal work about the premise that media itself does not have a positive or negative impact on learning: "it seems not to be media but variables such as instructional methods that foster learning" (p. 449). On the other hand, Kozma (1991) first defined media as "technology, symbol systems, and processing capabilities" (p. 180) and then countered Clark's opinion about media's effect on learning. Kozma cited numerous studies that included various technologies of the day and how they impacted learning in a positive way. For example, in a study of children regarding a story–some of whom heard it and others who saw a video of it–he said, "compared to those who heard the story, the children who saw the video drew more details and their pictures were more accurate" (p. 192). A paradigm shift from behaviorist models to constructivist ones was posited as Albirini (2007) referenced Johansson and Gärdenfors (2005): "constructivism emphasized the importance of knowledge construction through action, exploration, discovery, and collaboration and in meaningful learning environments" (Albirini, 2007, p. 230).

In the 1990s, there was a steady increase in usage of computers and other educational technologies within teaching and learning environments (Czerniewicz, 2010). The challenges facing teachers, however, continued to include skill level and comfort with technology, commitment to embed it into instruction, challenges with technology authority, and administrative support (Agarwal & Prasad, 1997; Provenzo et al., 1999). D. H. Jonassen (1996) concluded that teachers did not need to be experts in how to use technology but had to have at least a working knowledge of tools such as e-mail and spreadsheets. There continues to be a challenge for teachers in terms of commitment and dedication: no matter how committed or dedicated they are to incorporating educational technologies into the classroom, it is not enough if the administration is not committed to changing and supporting the efforts (Ellaway, 2013)

Other obstacles to the successful implementation of educational technology include the lack of teacher training, the lack of skills to be able to select and make effective use of technology, the cost, and instructional technology support that continue to today (Provenzo et al., 1999). Educational software that was developed in the 1990s furthered the shift from behaviorist approaches to learning with technology to constructivist ones in which students had more opportunities "to construct knowledge and understanding through interaction with the computer and its software" (Provenzo et al., 1999, p. 79). Examples of educational software for general, nonmedical education in this era included Oregon Trail™, SimCity™, and Where in the World is Carmen Sandiego™ (Solomon, 2015). Medical educators did not generally use this type of educational software to instruct students because it was not perceived to be relevant to medical training. Instead, educational software in medical education typically included two-way video and Microsoft products (Klemm, 1998).

As technology in general has become more ubiquitous in society, the number of its users has increased at a remarkable rate. Anderson and Jiang (2018) produced a report for the Pew Research Center on teens, social media, and technology. Based on their research, they found that 88% of US teens owned a desktop or laptop computer and 95% owned a smartphone. This compares to an earlier Pew report that found 87% of US teens owned a desktop or laptop computer and 73% owned a smartphone (Lenhart, 2015). Resnick, Lesgold, and Hall (2005) reiterated that “ways of using technology will need to be adapted both to the new forms of learning that schools will want to foster and to the social and organizational school structures into which new technological tools are introduced” (p. 78). There was also an increased blurring of the lines, according to the authors, about what could be considered social or personal devices that became part of the classroom experience such as the smartphone and tablet.

Educational Technology Use in General Education

The scholarly literature regarding the use of educational technology is vast, therefore it is not possible to do a comprehensive review of every aspect of it in this chapter. Definitions of terms such as educational technology have shifted with the times. One that has been adopted by many educational technologists has been previously explored in this chapter: determining which, if any, technology resources or processes can aid the design and delivery of instruction (Definition and Terminology Committee of the Association for Educational Communications and Technology, 2008). Some prime examples of educational technologies utilized for general education purposes are described below.

Tablets

Educational technology has been integrated into almost every level of learning and almost every topic of study. A quantitative study was conducted with 18 preschoolers (11 girls and 7 boys) age 4-5 years old in an urban full-day preschool program in the Mid-Atlantic region of the US in which the preschoolers used a tablet device with touchscreen capabilities and a mobile application (i.e., mobile app) to develop their early sense of numbers (Broda, Tucker, Ekholm, Johnson, & Liang, 2018). The technology for that study included eight 9.1-inch iPads with special software called PhonetoMac™ that extracted specific usage data from the primary app, Fingu™, that was "designed to facilitate development of components of early number sense, including subitizing and finger gnosis" (p. 3). The measures for that study included demographic informational variables and behavioral indicators as students interacted with the Fingu™ app. The behavioral variables included time to respond (in seconds) and correctness of the response which was operationalized as a binary variable (i.e., 1 if the task was answered correctly and 0 if not). The results of that study show that at the end of the study, students responded 0.45 seconds faster than they did at the beginning of it. More specifically, the results show that girls were more accurate than boys. Age was also a factor, as older students were found to be slower and less accurate than younger students. That study did not go into any detail about the readiness of faculty to effectively use the technology or their acceptance of technology in general.

A study that researched the teacher perspective regarding tablets in the classroom was conducted by Ifenthaler and Schweinbenz (2013), in which the focus was on teacher acceptance of educational technology. For teachers, tablets offer a range of tools for instruction such as cameras and microphones, interactive electronic books, and perhaps best of all, high mobility, and few instances of software problems. That qualitative study of technology use in K-12 settings used the UTAUT as the theoretical framework, and data were collected using a semistructured interview format. Of the 18 participants in that study, three had never used a tablet before, even as a personal device. Concerns expressed by the participants included the cost to the institution of the devices, lack of clarity on how to use the devices or keep them updated, lack of technical and financial support by the institution, and the expectations of required time and effort. The capabilities of tablets since that study was completed have expanded, and the number of apps for them that are available for possible educational use has grown exponentially (Lahullier, 2018).

As many schools implement 1:1 tablet or laptop strategies (e.g., each student has a device) to ensure their students have access to these devices for learning, instructors sometimes struggle with how to integrate them effectively into instruction. Technology companies that produce these devices seemingly introduce a new version or operating system with increasing frequency, and students and teachers alike are forced to continually learn their new characteristics. A qualitative study was conducted by Ditzler, et al. (2016) to investigate that issue. The participants included 23 students and three teachers from a middle school in a lower socioeconomic area who were interviewed. During the summer prior to the beginning of the school year, a 1:1 iPad program was implemented by first providing teacher participants in the study with the devices to use so they could become more familiar with the iPads before the students received their iPads at the start of the school year. The availability of this tool for teachers to use during the summer was deemed to be critical to the expected success of the program. The results of the study show that how the students used the iPads was dependent on how the teacher preferred for the students to use the tool. For example, if a teacher only used it to upload and view assignments, the students mostly put their iPads face down on their desks until told to use the tool. In other classrooms, the teachers used the devices extensively to demonstrate a lesson, which kept the students engaged with the devices during the entire class. While the teachers were given the devices over the summer to become more accustomed to how they work, it became clear that some teachers were not adequately comfortable with using the devices for educational purposes, even though the teachers might have been perfectly comfortable with using an iPad as a personal device.

Electronic Course Management and Online Courses

While tablets do seem to be ubiquitous, other information and communication technologies (ICTs) have been used in educational environments as well (Teles, Leal, Sousa, Marques-Neves, & Abegão Pinto, 2019). Online education using an LMS and e-conferencing systems such as WebEx™ and Zoom™ are frequently found in the educational landscape. There are some unique case studies on the use of these technologies to deliver a so-called blended learning experience to students. Crawford (2016) explored how these tools could be used to deliver a quality music education to students in rural and remote schools in Australia. The author conducted a mixed methods study that involved surveys and semistructured interviews with students and teachers. Crawford found that as the teachers spent more time using the technology to deliver content during the school year, their confidence in using it increased.

Similarly, instructors who attended training to use an LMS for content delivery tended to use more of its functions such as the grade center compared to those who did not attend training. Chow et al. (2018) used a Rasch analysis to investigate the effects on two groups of teachers: those who received training about using an LMS compared to those who did not. The Rasch analysis model can be used to calibrate personal ability and difficulty regarding items on a single unidimensional scale, and constructs can be validated in terms of consistency, reliability, and accuracy (Rachman & Napitupulu, 2017). The study identified barriers to the use of an LMS which coincide with findings of other studies on technology acceptance and use.

Typical barriers include lack of teacher training and any previous experience that might impact future adoption. The results show that instructors who received training were more likely to use more tools within an LMS.

Audience Response Systems

Polling a classroom full of students about their understanding has the potential to change the dynamic of instruction from pure lecture to a more interactive experience for both student and teacher (Chapman, 2018). Technology has made it possible for students to respond to teacher inquiry in a more anonymous fashion than before by using handheld clicker devices or responding on their own mobile devices. An experimental research design study was conducted by Flosason, McGee, and Diener-Ludwig (2015) to examine the effectiveness of audience response systems (ARS), sometimes called classroom response systems (CRS), in small-group discussions. Data for the first group in the study were measured by in-class responses to predetermined questions and examination scores, and there was accompanying small-group discussion. Another group of participants included students exposed to traditional lecture that included ARS but without the discussion component of the instruction. That study queried both the students and the instructors on their use of the ARS devices for teaching and learning. The results show 78% of students in the first group preferred to use these devices in the classroom to answer questions, and 58% in the second group answered the same way. Instructors also seemed to acknowledge that the devices could be beneficial to generate class discussions that were not as common when no ARS devices were used. While that study did acknowledge the level of comfort with ARS technology that students described, the teacher perspective was not investigated.

A mixed-methods study in which the teacher perspective was investigated during ARS implementation shows that the goals of faculty sometimes dictated how the devices were used for instruction (Solomon et al., 2018). The study was conducted at a midsized research institution in the midwestern US. Professional development opportunities were made available to all instructors who either used the devices already or planned to use them in the future. The results show that there was variation in how and whether the faculty followed up on voting or polling that took place. The faculty participants indicated that the way they tended to use the devices was based on factors such as how their peers used ARS, what they learned in professional development, or how the ARS vendor suggested the devices be used.

Digital Gamification

Digital games as an educational tool have slowly become more widely accepted as a valid form of instruction and can potentially influence learning (Kenny, Gunter, & Campbell, 2017; Warren & Jones, 2017). As previously mentioned, a Pew Internet study found that 95% of teens in the US owned a smartphone (Anderson & Jiang, 2018). In addition, researchers found that 97% of teen boys play video games compared to 83% of teen girls. Overall, 90% of respondents reported that they play video games on multiple devices, including smartphones.

A formative case study by Kenny et al. (2017) sought to determine teacher assessment of mobile apps as instructional tools. They described how the term gamification is used to differentiate how digital games are utilized for classroom instruction versus the traditional view of games as distraction. Games for instruction were described as gaming devices that involve some sort of visual component; fun, interactive, and provide direct feedback to the learner; are problem-based; and provide opportunities to fail yet to learn from failure. Kenny et al. (2017) summarized that

> most mobile apps can be considered "gamified" even if their play mechanics are not strictly games based…students [can] become immersed in instructional content that help them act in meaningful ways allowing them to "play" so as to foster the internalization of content. (p. 57)

Of the instructors who agreed that specific apps could be used in their classrooms, many indicated that they were motivated to do so because of recommendations by peers, apps were free or low cost, they saw an app used in another classroom or at a conference, or they felt they had the support of their institution. All study participants agreed that apps should be vetted and analyzed for effectiveness for instruction prior to introduction into a classroom.

In summary, the examples described here do not include the full range of possible learning technologies that could be used in teaching and learning activities. Instead, the intention is to demonstrate that research in this area tends to reveal student perceptions, acceptance, and use of learning technology rather than teacher reactions to it.

Educational Technology Use in Medical Education

Students and teachers often make collaborative decisions about whether and what kind of educational technologies should be integrated into a wide range of educational activities, although they may not be aware of these decisions. People tend to forget that they use educational technology when it is as common as, for example, the use of a built-in computer in a lecture hall with presentation software and projector capabilities. These are concurrently technologies as well as teaching and learning tools, and the computer is at once a personal tool and a professional one. Smartphones and tablets also bridge the blurry gap between personal and professional use. Numerous studies exist that extol the advantages of using technology for medical education (Isaza-Restrepo, Gómez, Cifuentes, & Argüello, 2018; Ward & Wertz, 2018; Wartman & Combs, 2018). According to Buchanan et al. (2013), the past two decades have seen a rapid growth in the use of technologies for andragogical purposes. Some of these studies are advisories, such as Asher, Kondziolka, and Selden's (2009) view that technology can improve education as long as it is used to facilitate learning and not interfere with the learning process. Even with studies like these, research in this area tends to be more often about the use of technology for student learning than about the educators who might use technology for teaching.

Regarding faculty use of technology in teaching the health sciences, Blue and Henson (2015) wrote that faculty need to

> develop a conceptual rationale for incorporating technology into their teaching, identifying how it fits with their philosophy of teaching and learning. In other words, technology should not be used for its own sake, but rather only if it enhances teaching and learning. (p. 47)

Bordage and Harris (2011) added that medical education instructors who depend too much on technology might "lose sight of what the student is expected to be doing differently with respect to thinking or behaving" (p. 89). Ellaway (2013) warned medical education faculty to beware of the *shiny thing effect* with technology:

> Educators need instead to become more literate in educational technology methods so as to be able to be more directly involved in technology specification and design, not least so that we can better accommodate the emergent and innovative aspects of what we do. (p. 427)

If educators do not, and technology is expected to be used, they are likely to encounter difficulties in implementing it. For example, in any type of learning involving the use of patient cases, there are typically functional requirements, such as room size and configuration, to support its being successful, regardless of the type of educational environment (Ellaway, 2013). As technology becomes more interwoven into educational practices, the faculty can use their understanding of functional requirements to help determine which educational technologies they can integrate into various teaching methods of their content delivery.

The use of educational technology in medical education varies significantly from school to school, similar to the variability found in other types of institution and concentrations of subjects. Technology use in medical education is no longer as much of a novelty as it was in the past, and today's students are more exacting and critical users of it (Casillas & Gremeaux, 2012). Because educators may not be of the same generation as their students, there may be a disagreement with students in their decision-making about technology integration that aids in content delivery (DiLullo, 2015). For the millennial generation, for example, technology has been omnipresent in their lives. Personal computers have always existed for them, and they expect a rich learning environment that includes multimedia (Blue & Henson, 2015). Asher et al. (2009) suggested that “educators should intelligently apply multimedia and web-based technologies to promote understanding, enhance access to information, facilitate interaction, and reduce demands on cognitive processing” (p. 225). A more detailed exploration of the generational effect on learning and use of technology can be found later in this chapter.

As medical schools go about redesigning their curricula to meet the educational needs of students today and to align with accrediting bodies, “too often curriculum reforms are undertaken simply because reform is being carried out elsewhere or because it is fashionable” (Bordage & Harris, 2011, p. 90). While it is not necessary for technology to be incorporated in inquiry-based educational activities in medical education, it is important for all stakeholders to be vigilant in making thoughtful decisions to help determine which technologies meet objectives, are meaningful, and are for what purpose. Extensive research has been conducted on how students think about or decide how to use educational technology for different types of learning activities and how to gather information that is useful to them (Cordes, 2016; Savin-Baden et al., 2011). As mentioned previously, however, there is a lack of research on how medical school faculty members reflect on or decide how to integrate educational technology to deliver content for various types of educational activities, including those that are case-based (Ellaway, 2013).

A study on the impact of lectures and digital technologies on medical students applied a repeated measures design to four classes of 4th-year medical students (Teles et al., 2019). The researchers wanted to analyze medical student knowledge assessment using a traditional paper-based method compared to digital technologies. They administered a scientifically validated questionnaire before and after each class in paper form and in a digital format called Sli.do. Descriptive statistics were used to compare the results. While the bulk of the study was on the results of the students' use of paper versus digital technologies, the perspective of the teacher was considered. Teles et al. (2019) found that by using the digital technology, there were benefits not only for the students but for the teachers as well:

> it allows the professors to find gaps in teaching in order to amend them and improve their own skills, and for universities to carry out an internal evaluation of the performance of the employed teachers, which consequently benefited the students. (p. 6)

The perspective of the teacher in that study did not include whether the teachers had any role in determining which technology would be used for that purpose or any issues that might have developed during implementation.

The implementation of video as an instructional tool for medical student learning outcomes was the focus of a quasiexperimental, formative design study by Bridges, Stefaniak, and Baaki (2018). The use of lecture capture and LMSes allowed for asynchronous teaching and learning experiences. However, according to the researchers, the design of video instruction may lack vetted instructional strategies to promote learning. Participants were randomly placed into one of four groups: instructor-created elaborations, where faculty created additional worked out examples to aid in student retention; learner-created elaborations, where students created their own examples to aid in their understanding of the content; adjunct questions, which were random sets of questions for students to answer after natural breaks in a topic; and video-only, where students watched a recording of a regular lecture. The results show that participants in the groups that included instructor-created elaborations, learner-created elaborations, and adjunct questions, performed better overall than participants in the video-only group. The learner-created elaborations group in Trials 1 and 2 showed the highest overall mental effort by students (M = 58.83, SD = 11.16 and M = 65.50, SD = 16.58 respectively). The video-only group for Trials 1 and 2 showed the lowest overall mental effort by students (M = 45.11, SD = 10.91 and M = 43.69, SD = 15.67 respectively). Because that study was not about the faculty perspective in using this type of technology for teaching, it is not known how the instructors felt about creating videos for later viewing or felt about the utilization of video for instructional purposes.

Another type of technology that has been used in medical education is three-dimensional (3D) models (Loke et al., 2017). A study of the efficacy of 3D models on learning about congenital heart disease (CHD) was conducted with pediatric residency students (also known as pediatric residents). The researchers found that the use of two-dimensional (2D) models does not adequately display the critical spatial information in CHD and wanted to determine whether 3D models would better help students understand this birth defect. Residents were divided into two groups of learners: one with standard 2D displays and one with 3D models. Their knowledge acquisition was measured by comparing pre and posttest scores. The results show that there was no statistically significant difference (p = 0.39) between the groups' knowledge acquisition. There was no mention in that study of potential instructor concerns or ability with these teaching technologies.

The role of mobile devices for learning in clinical settings is on the rise, which prompted a mixed-methods, sequential explanatory design study of medical student, physician, and patient perspectives about the technology (Scott, Nerminathan, Alexander, Phelps, & Harrison, 2017). Research instruments were developed by the authors and included a survey with open and closed questions. The results of the study show that while medical students were rather savvy about mobile device usage in the clinical setting, clinical teachers required more assistance with determining pedagogically sound ways to use these devices to enhance educational activities. Students and physicians were found to make their own decisions to use mobile devices for learning and practice, despite policies that might prohibit device use in the clinical setting. The patient perspective demonstrated a slow gain in their trust regarding students and clinicians using mobile devices.

Generational Issues and the Digital Divide

As time moves forward, so does innovation in technology and the ways that humans interact with one another. Generations of students and teachers are continually introduced to new, innovative, and modern technologies developed for various purposes. These generations have been given specific names and general timeframes based on when they were born. For example, the silent generation is typically considered to be people who were born between 1925 and 1942 in the years leading up to World War II (WWII). The baby boomers were born between 1943 and 1960, during and immediately after WWII. Generation X people were born between 1961 and 1981, and millennials were born between 1982 and 2003. Based on the history of educational technology described in this chapter, one can see that different generations might have challenges with technologies that were alien to previous or later generations (DiLullo, 2015).

In medical education, many instructors are from the boomer generation who typically respect hierarchy find themselves in direct opposition to generation x ad millennials who are the students of today. Students from these more recent generations are much less tolerant of delays and expect more personalized education, which can come across as entitlement (Korb, Lui, & Lynn, 2017)

The generational timeframes and characteristics that are typically included in studies related to education in general and the adoption and use of technology are described in Table 2.

This section explores several studies that illustrate some of the differences in generational perception and use of technology. A study of a community sample of adults and their perception and use of various consumer technologies was conducted by Van Volkom, Stapley, and Malter (2013). The researchers investigated age and gender differences in technology usage as well as the interaction between these two demographic variables. The final sample included 175 men (40%) and 256 women (60%), and the age range for both genders was between 18 and 91 years of age. Participants were divided into three age groups: 118

Table 2

Characteristics of Learners Across Generations

Generation[1]	Born between these years[2]	Characteristics
Silent generation	1927-1945	Believe in hard work. Experienced a hierarchical structure of social norms. Audio instruction was introduced via radio and sound motion pictures.
Baby boomers	1946-1964	Self-centered, judgmental. Think in a linear fashion. Introduced to instructional television. Prefer lectures and face-to-face instruction. Tend to be workaholics.
Generation X	1965-1983	Not workaholics like previous generations (specifically baby boomers). Prefer work/life balance. Considered slackers by previous generations.
Millennials[3]	1984-2002	Tend to be high academic achievers. Focused on grades and performance. Do not appreciate homework they perceive as not relevant to their personal goals. Their use of technology blurs the lines between work and life. Technology has been omnipresent in their lives. Prefer less lecture and more interaction. Expect frequent formative feedback.
Generation Z / iGeneration[3]	1994-present	True digital natives. Accustomed to interacting solely in the digital world, hence prone to isolation. Demand convenience and immediacy. Limited attention span.

Note: Adapted from “The impact of generational status on instructors’ reported technology use” by S. T. Skidmore, L. R. Zientek., D. P. Saxon, and S. L. Edmonson, 2014, *Contemporary Educational Technology*, *5*(3), 179-197.

[1] There is no mutually agreed upon determination of names of each generation in the literature.
[2] There is no mutually agreed upon determination of birth years for each generation in the literature.
[3] There is overlap in the literature for the millennial and generation z years.

young adults (18-29 years old, M = 20.92, SD = 2.79); 152 adults (30-59 years old, M = 47.97, SD = 7.02); and 161 older adults (60-91 years old, M = 70.55, SD = 7.44). The men and women were evenly distributed across the age groups: χ^2 (2, N = 431) = .220, p = .90. That even distribution was created so the demographic variables could be examined separately as well as in interaction with each other. The findings show that there was not a significant difference in educational attainment by gender, χ^2 (5, N = 431) = 7.36, p = .20, but differences by gender in employment status were apparent χ^2 (2, N = 417) = 9.80, p = .007. Regarding general technology use, a two (male versus female) by three (young adults versus adults versus older adults) ANOVA revealed that gender was not a significant determinant for viewing technology as a useful tool. However, there was a significant effect for age for regarding technology as useful for communication or for entertainment purposes (F (2, 421) = 33.36, $p < .001$) and (F (2, 422) = 31.16, $p < .001$) respectively (Van Volkom et al., 2013).

Skidmore et al. (2014) conducted a study to investigate the impact of generational status on instructors' reported technology usage that included reported challenges in their ability to manage technologies in the classroom which were related to the generation they were born into. Researchers wanted to investigate faculty members' familiarity with, use of, and challenges with educational technology and used the Developmental Education Technology Survey (DETS) designed by Skidmore, Zientek, Saxon, and Edmonson (2014). That survey instrument was "specifically designed to provide more information about the present state of technology integration in developmental education across Texas" (Skidmore et al., 2014, p. 184). For the silent generation participants in that study, innovative technologies included radio and sound motion pictures. Educational activities that were developed from these technologies include the innovation of audiovisual instructional materials. Baby boomers came after and were able to build upon these technologies and harness the mediums of television and motion pictures to enhance educational delivery. Members of generation X saw the advancement of computers, and for millennials, computer usage became more common (Skidmore et al., 2014) . Thirty silent generation (*N* = 53) instructor study participants reported that it was students' off-task behavior with technology that produced significant challenges for classroom management, which was approximately the same percentage as the millennial generation instructor participants, from which 11 responded similarly (*N* = 20). For the silent generation instructor participants, only 18 (34%) reported student's technology skills as a challenge, where the result was much higher for millennial instructor participants (12, 60%). It is unclear from the study what specifically about students' technology skills resulted in classroom and technology management challenges for instructors. The researchers proposed that this type of information could inform stakeholders about various types of potential professional development opportunities for faculty.

DiLullo (2015) explained that "learner cohorts in higher education are far more likely to be comprised of individuals from multiple generations as compared to the learner cohorts in K-12 education which are predominantly composed of individuals from a single generation" (p. 11). Researchers have intensely debated about the current generation of learners in response to assumptions that the learners need to be treated differently because of their specific technology needs. Lai and Hong (2015) investigated the claim that certain generations of learners tend to think and learn differently than previous generations and documented generations' use of digital technologies. Their study involved 799 undergraduate and 81 postgraduate students at a research university in New Zealand. They found that generation was not a determining factor in the use of digital technologies for learning among students.

Inquiry-Based Learning

IBL is a form of active learning in which students, usually in teams, are given information related to an ill-structured problem to solve (Lazonder, 2014; Lazonder & Harmsen, 2016). According to Lazonder and Harmsen (2016), "inquiry-based methods, in short, enable students to learn about a topic through self-directed investigations" (p. 681). IBL is also an "organic way to make students active agents in their own learning processes" (Lazonder & Harmsen, 2016, p. 681). As previously noted, IBL is used in this study as an umbrella term to describe multiple forms of active learning that are in the same category as CBL, PBL, and TBL (Verduin et al., 2013).

Strategies common to case-based teaching methodologies include students that are put in teams and presented with ill-structured, authentic, and complex problems to solve; facilitation is scaffolded; and preparatory work in varied amounts is assigned to encourage in-session interaction. Ill-structured problems "are more difficult to solve because they have many alternative solution paths; vaguely defined or unclear goals and constraints; and multiple criteria for evaluating solutions" (Tawfik & Jonassen, 2013, p. 386). An authentic problem is one that could plausibly be a real event (De Simone, 2008). By working together, every member of a team of students contributes knowledge to the whole; therefore knowledge acquisition is facilitated and collaborative rather than individual (Antoun et al., 2015; De Simone, 2008; McMullen, Cartledge, Levine, & Iverson, 2013). Two pillars that represent the core of IBL are deep engagement in a topic and opportunities for students to collaborate in some form (Ernst et al., 2017). While many articles and studies regarding IBL tend to focus on student perspectives rather than instructor perspectives, an article by Ernst et al. (2017) offers suggestions to instructors who are getting started with IBL. The article includes suggestions for instructors on how to get buy-in from students regarding the method of instruction and on classroom management tips

Lazonder and Harmsen (2016) also acknowledged that there is no consistent definition of IBL. A meta-analysis of IBL enabled the authors to develop their own definition of IBL as a method "in which students conduct experiments, make observations or collect information in order to infer the principles underlying a topic or domain" (p. 682). Two main strands in IBL research were identified by Lazonder (2014): developmental differences in students' scientific reasoning with minimal guidance, and the effects of various types of guidance on performance success and learning outcomes. Note that the focus is on the student and not on a faculty member's ability to deliver an IBL activity or to successfully use educational technology in the delivery of instruction.

In a study by Anstey (2017), authentic inquiry learning in an anatomy course was investigated to determine students' experiences of learning through an inquiry project. Authentic learning in that context is related to learning opportunities that connect anatomical concepts to relevant practices. Similar to other researchers, Anstey determined that no one model of IBL applies universally and uniformly, and IBL is sometimes considered along a continuum from student-driven to instructor-led. In IBL, there is a balance of the amount of guidance offered to students and letting students find answers themselves (Anstey, 2017). Qualitative methodology was used in that study to investigate students' experiences using IBL for human gross anatomy projects. Eighteen students participated along with three facilitators.

Sixty-six percent identified as female, and 33% identified as male. Three groups were created with six students and one facilitator per group. The main task for the groups was to devise an inquiry question of their choosing. While that project was rather open-ended, all three groups took similar approaches to how they constructed knowledge. Significant attention was paid to the student experience in that study, while virtually none was paid to the instructor or facilitator experience.

History of Inquiry-Based Learning

The use of cases that illustrate problems for students to solve has been a teaching method in various academic disciplines for more than a century. According to Thistlethwaite et al. (2012), James Lorrain Smith, an educator in pathology at the University of Edinburgh, is considered to be the originator of CBL, which is likely the oldest among the different types of inquiry-based instruction. In 1912, Smith referred to it as a case method for teaching (Thistlethwaite et al., 2012). IBL, used as a general term here to include the three main types of teaching with cases, is considered to be based on the work of the educational philosopher John Dewey (1859-1952), who played a substantial role in educational reform in the early 20th century (Lazonder & Harmsen, 2016). Large-scale adoption of IBL as an effective way for students to learn science content took place in the 1960s (Kirschner, Sweller, & Clark, 2006).

When it was introduced into teaching delivery, IBL was determined to be more effective compared to other forms of instruction such as lecture. Ultimately, the effectiveness of IBL teaching delivery is impacted by the guidance that students receive (Hermann, 1969). In the early 2000s, a debate erupted between two camps of thought regarding the effectiveness of IBL. Kirschner et al. (2006) criticized inquiry learning as ignoring the limitations of working memory. They determined that inquiry learning was a minimally guided approach versus direct instructional guidance, and they concluded that inquiry itself was already too demanding on working memory and therefore new information might not make it into long-term memory. “Minimally guided instruction appears to proceed with no reference to the characteristics of working memory, long-term memory, or the intricate relations between them” (Kirschner et al., 2006, p. 76).

Hmelo-Silver, Duncan, and Chinn (2007) held a contrary position to that of Kirschner et al. (2006). Hmelo et al. (2007) argued that inquiry learning is successful because it employs extensive scaffolding of information for the learner, and they felt that “Kirschner and colleagues have indiscriminately lumped together several distinct pedagogical approaches–constructivist, discovery, problem-based, experiential, and inquiry-based–under the category of minimally guided instruction” (Hmelo-Silver et al., 2007, p. 99) . The next section describes the influence of different types of IBL activities in general education and then more specifically in medical education environments.

Case-Based Learning

CBL is an educational strategy that has been debated and defined by a myriad of researchers for decades. Since its inception, a single definition has not been agreed on in the literature. CBL has been implemented in many academic subjects including business, science, medicine, and law (Kantar & Massouh, 2015; McBride & Prayson, 2008; Williams, 1992; Yadav et al., 2014). Researchers tend to accept that it is a student-centered approach in which the emphasis on knowledge acquisition is based on solving authentic, open-ended, ill-structured problems (Savery & Duffy, 2001).

Traditionally, CBL has been an in-person activity; however, there are instances in the literature that describe how educational technology was introduced into its delivery such as online discussion boards. These electronic discussion boards allow teams to interact outside of typical academic time constraints in order to deliberate case information (Li & Wang, 2017; Tawfik & Lilly, 2015). Because CBL does not include a lecture format, required preparatory work is necessary for teams to participate in this active learning style of teaching and learning. A difference between CBL and typical didactic learning can be described as "if all of the information were given prior or during the session, without the need for inquiry, then the session would just be a lecture or reading" (McLean, 2016, p. 42). A series of studies related to CBL in general education settings, and then more specifically about CBM in medical education, follow here.

Case-Based Learning in General Education

A push continues for teachers to incorporate technology into teaching activities (Ertmer & Ottenbreit-Leftwich, 2010; Teo, 2012; Watty, McKay, & Ngo, 2016). A field-based and quasi experimental study by I. Han et al. (2013) investigated the effects of multimedia CBL on preservice teachers' "individual knowledge acquisition and knowledge integration of technology uses in education" (p. 126). The study participants consisted of 78 students who were enrolled in a teacher preparation course at a private university in South Korea and were divided into two groups: a group that used video cases, and another group that did not use video cases. For six weeks prior to the start of the study, students "learned about lesson planning, instructional models…and educational technology (p. 125). The study commenced during the latter part of the course and integrated this acquired basic knowledge with practical knowledge that the participants could use in educational practice. The video cases participants watched video clips that were strategically selected to introduce various elements of educational practice such as potential classroom layouts and technologies that might be needed. They watched two video clips: one per class, for 2 weeks (once a week) that were at the end of the course. After watching the video clips, the participants discussed what they observed in the videos and wrote a group-reflection paper. The no-video participants were not given video clips to watch; however, they were given PowerPoint slide decks and additional documentation such as syllabi to review that included essentially the same material as the videos. They read the provided documentation, had a discussion, and wrote a group reflection paper. I. Han et al. (2013) evaluated all of the participants with selected items from the Technology, Pedagogy, and Content Knowledge (TPACK) survey. All participants completed the pretest survey during the second week of the course to assess their prior knowledge acquisition regarding technology in the classroom. Lectures then occurred for all participants until the seventh week and just prior to the inclusion of the 2-week CBL experiment. After the CBL activities that included videos and slide decks, all participants took the posttest survey. Posttest data were analyzed using analysis of covariance (ANCOVA), with the dependent variable of intervention type and independent variables of five categories in the TPACK survey: technology knowledge (TK), pedagogical knowledge (PK), technology and content knowledge (TCK), technology and pedagogical knowledge (TPK) and the overall TPACK. The video cases participants demonstrated improved overall perception than the no-video cases participants. The results of the posttest survey show a significant difference between the two groups in regard to two of the categories: TK, $F(1, 54) = 5.548$, $p < .05$, partial $\eta^2 = .09$ and PK, $F(1, 54) = 7.831$, $p < .01$, partial $\eta^2 = .13$. The researchers determined that CBL that incorporated a multimedia approach was best for preservice teachers to become better prepared to integrate technology into classroom activities.

Case-Based Learning in Medical Education

In medical education, CBL has been used as a teaching method to help teams of students acquire solid knowledge through the use of realistic cases by integrating basic science contexts with clinical medicine information (McLean, 2016). Teams are instrumental in this way to help prepare students for their future roles as clinicians because clinicians typically do not function in isolation; rather they are part of a team of healthcare experts within patient care environments (Thistlethwaite et al., 2012). CBL affords students opportunities for clinical reasoning, decision-making, etc. in a contextual setting. While CBL is sometimes compared to PBL, they are distinctly different in function. In PBL sessions in medical education, there is little advance preparation, only one patient case is usually discussed, and there is very little direction to teams regarding their discussion about a case. In CBL, on the other hand, both students and faculty prepare in advance, and faculty guide the discussion to ensure that important facts are included (McLean, 2016).

During a semester course about surgery in an undergraduate medical program in Sweden, CBL was used to deliver an educational intervention (Nordquist et al., 2012). This Nordquist et al. (2019) qualitative study explored CBL from the perspectives of both student and teacher. The traditional Friday lectures about surgery that students attended were converted to case-based seminars in the hope that the sessions would be more interactive than strictly didactic and would stimulate students to reach higher levels of cognition. The students attended

12-15 case-based seminars in one semester and faculty were required to become master facilitators of these case seminars. As part of this class change, students were required to complete preparatory work so actual class time could be more interactive. They were required to prepare for each of the CBL session by reading and reflecting on a specific case. Their prior knowledge would ostensibly be activated, which would also stimulate their learning. In small groups, the students had the opportunity to share their thoughts and ideas on the cases with their peers, and then the case facilitator would bring the conversation back to the entire class. Unfortunately, the researchers concluded that the teachers were not given adequate training on how to be proper case facilitators due to organizational turmoil.

Interviews with students and faculty that were part of the Nordquist et al. (2012) study were analyzed and coded. The main codes were impression, preparation, implementation, facilitator, climate, function, and integration and alignment. Students and teachers responded that they felt unprepared and nervous to integrate CBL. The faculty did not appreciate the amount of time expected to properly prepare and implement these case-based sessions. One participant said,

> why should I sacrifice 2 days for CBL faculty development? I don't have time for that; I've got other things to do. "I can manage this," I thought, and then I found out that I didn't, but that's the way it happened. (Nordquist et al., 2012, p. 948)

The results of the study reflect negative attitudes toward CBL as a delivery method, and it was clear to the researchers that a well-functioning implementation process was lacking. While their experience with CBL was not satisfactory, the weaknesses in the process which were exposed provided the opportunity to create a model for successful future implementations and were not a reflection on the CBL process.

At an occupational medical school in Belgium, researchers wanted to determine which of two CBL conditions had the greater impact on perceptions and performance of their undergraduate students (Braeckman, Kint, Bekaert, Cobbaut, & Janssens, 2014). The comparative study included all of their 4th-year medical students and was conducted over a 3-year period. The two formats for learning were:

1. Students received paper cases followed by one small-group session. This was augmented a year later by incorporating collaborative work and group discussions.
2. Students no longer received paper cases but encountered real patients instead.

Student feedback was obtained by questionnaire, and their learning performance was assessed through reviews of their reports and oral presentation scores. The results show that both formats met the stated learning objectives, and the inclusion of collaborative work resulted in better test performance. However, it was the format with real patients that students gave statistically significant higher scores to compared to the format with written cases. The researchers suggested that future studies include the perspectives of teachers and patients.

Another example of CBL in medical education involved translational biomedical research. This is an area of study that discovers how to translate biomedical discoveries into everyday clinical use. Until recently, CBL was not often used to educate translational biomedical researchers; however, a group of academic researchers felt that CBL "allows scholars to actively engage with real-world material and apply their newfound knowledge as it is acquired" (Greenberg-Worisek et al., 2019, p. 213). Three courses were offered at the Mayo Clinic Center for Clinical and Translational Science:

- Course 1: Case Studies in Translation, delivered as discussion-based learning;
- Course 2: Case Studies in Entrepreneurship, delivered as team learning; and
- Course 3: Case Studies in Precision Medicine, delivered as problem-centered learning (Greenberg-Worisek et al., 2019, pp. 213-216).

Course 1 was delivered in a blended format that included in-person presentations by experts, discussion, and online readings and assessments. Each student was assigned a case study to research. Course 2 included some standard CBL techniques; however, the focus was mainly on learning from others about startup ideas. These ideas resulted in case studies that were discussed in groups. The final course was essentially a blend of techniques from Course 1 and 2. The academic researchers collected and analyzed quantitative measures at course completion. The data show positive experiences for all three courses.

The American Association of Medical Colleges (AAMC) collects data from medical schools in the U.S. Some of these data include different teaching modalities per academic year at each school. In the most recent set of data for academic year 2017-2018, the results show that out of all instructional methods employed on average for all reporting schools, CBL was over five percent (American Association of Medical Colleges, 2019). See Figure 6, which shows data going back to the 2012-2013 academic year from the AAMC regarding use of CBL as a content delivery method in medical education. Figure 7 shows more specifically how CBL was used by reporting schools as an instructional format in academic year 2017-2018.

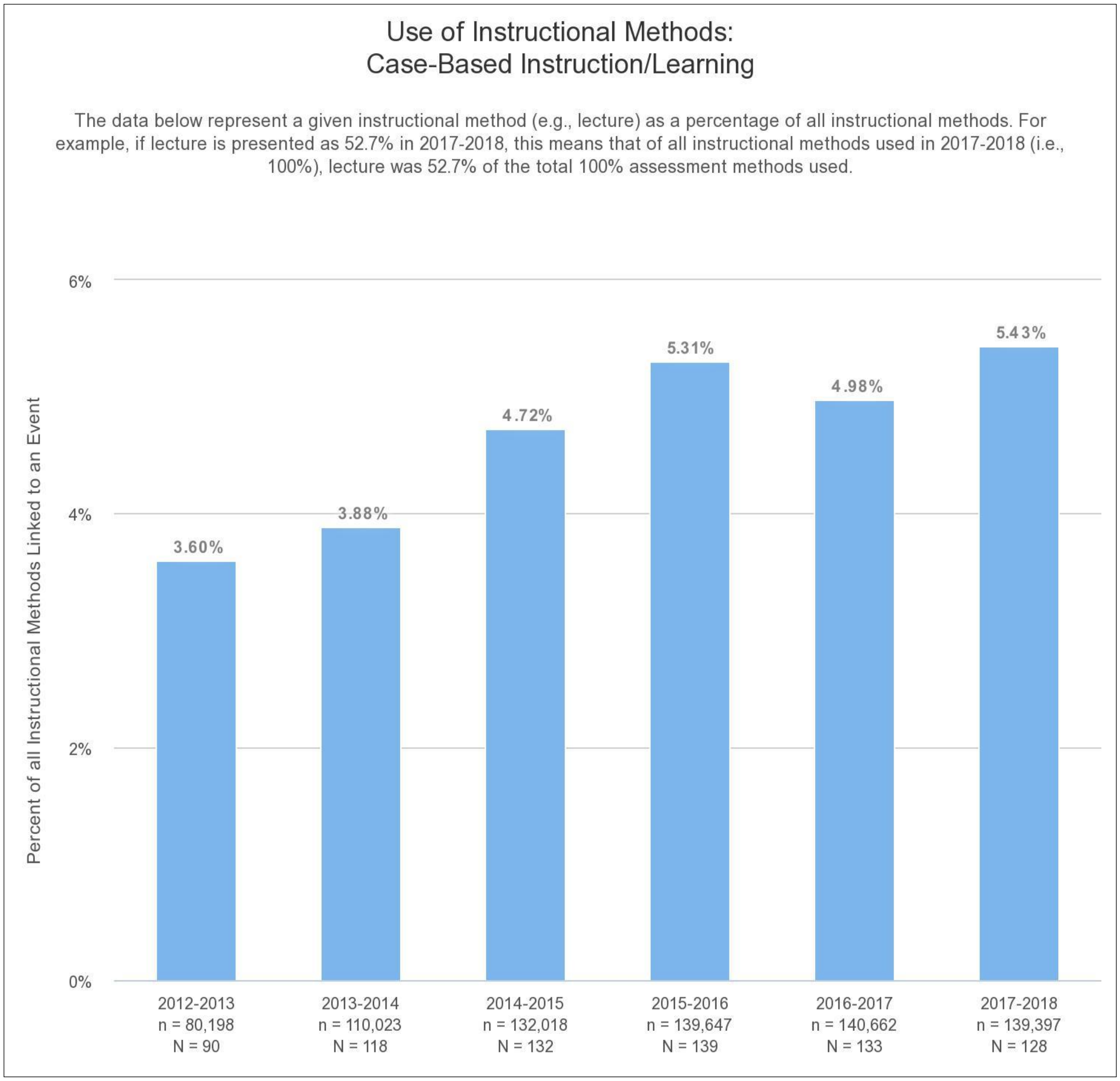

Figure 6. Use of instructional methods: case-based learning from AAMC. Reprinted with permission; see Appendix A for permission.

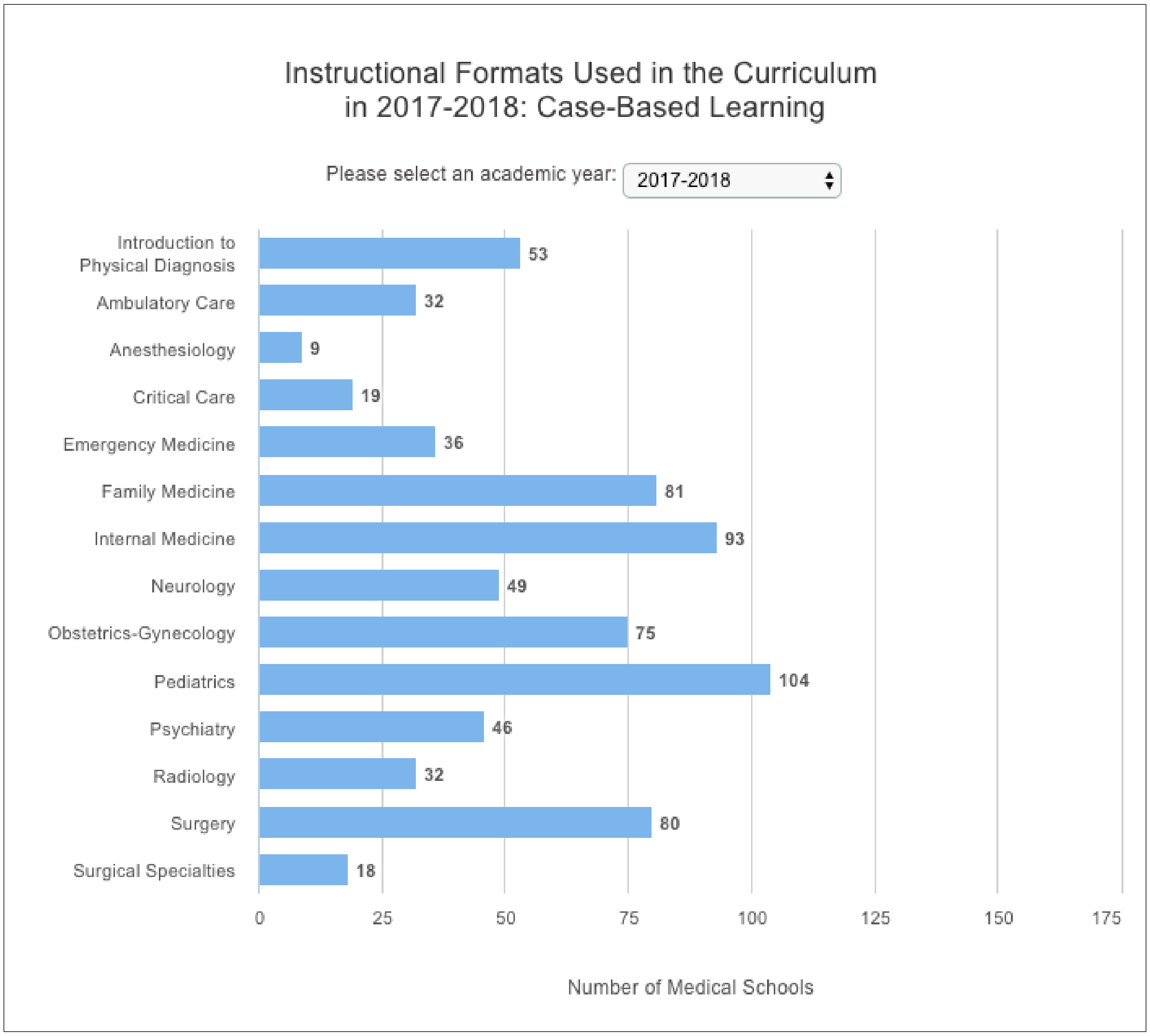

Figure 7. Instructional formats used in the curriculum in 2017-2018: case-based learning from AAMC. Reprinted with permission; see Appendix A for permission.

Problem-Based Learning

The goals of PBL include constructing a knowledge base or case library; developing problem-solving skills through practice and self-directed, lifelong learning skills; and learning how to become effective collaborators in a team environment and be motivated to learn (Hmelo-Silver, 2004). Additional characteristics of PBL include the use of problematic cases to be discussed and analyzed by teams and that the responsibility of a student is greater than in other teaching methodologies (Müller & Henning, 2017). In PBL, the roles of the student and teacher are transposed. The student can utilize the facilitator as a guide, but they are the directors of their own knowledge gathering. Students are able to construct mental models or schema to use in the synthesis of existing knowledge to the newly learned material. A. A. Tawfik and Kolodner (2016) hypothesized that educators who develop PBL activities were not always well-versed in the foundations of that teaching methodology but typically had a cursory understanding of the way it could be integrated into instruction. Just like in other forms of IBL, technology is not required as a teaching method in order to be successful.

Problem-Based Learning in General Education

Mathematics learning is a subject area that one might not necessarily think PBL is the best fit for (Müller & Henning, 2017). The main reasoning for this statement is that the study of mathematics does not typically have ill-structured problems and there are typically specific correct answers to problems; both of these characteristics are the opposite of traditional PBL. A. A. Tawfik and Lilly (2015) wanted to study student perceptions of PBL in a university mathematics course that was supported by a flipped classroom strategy. The researchers allowed the students to come up with various psychological topics of their own, including family counseling and domestic abuse issues. Problems that were developed for students to solve were based on these topics. The researchers hypothesized that because the students were interested in these topics, any prior knowledge about the issues would be activated during PBL activities. The study focused on student perspectives of PBL and did not cover instructor perspectives.

Similar to the use of virtual reality (VR) technology in TBL environments, the virtual world SecondLife™ was used in a study by Savin-Baden et al. (2011) as a platform for PBL. One aspect of using virtual worlds or online games for learning is melding the perceived amusement and fun of the virtual world or game environment with educational value. The researchers developed an approach to assembling various scenarios and materials to create immersive collaborative tutorials. They developed an evaluation form that obtained student reactions about the usability, experience, various problems encountered, and effectiveness of feedback related to these types of immersive environments (Savin-Baden et al., 2011). The results of the study found that in the virtual world SecondLife, information-driven scenarios did not work well. The technological demands and user interface of SecondLife proved to be significant barriers. That virtual world experience required a much higher level of Internet bandwidth and more computer memory than was possible on most students' laptops. More time was required for both groups of students and teachers to learn how to navigate in the SecondLife virtual world. Time constraints hindered their ability to devote any meaningful attention to the actual problem-based scenarios.

PBL was used as a teaching methodology in a secondary musical instrument methods course (Blackwell & Roseth, 2018). The PBL activities included video assessments, written scenarios, performance scenarios, group activities, and structured peer teaching (Blackwell & Roseth, 2018). Students in that course were musicians training to become teachers, and they reported that participating in PBL increased their confidence to solve problems on their own and encouraged a level of adaptability in problem-solving they had not experienced before.

Problem-Based Learning in Medical Education

The goals of PBL in medical education include "information gathering, clinical reasoning, [and] collaboration," and "focus is usually how to go about solving the problem presented, not as much what *[sic]* the content of the problem. This is a process learning activity" (McLean, 2016, p. 43). PBL was introduced in medical education as a way to develop student skills in the basic sciences and clinical expertise at the same time and to combat the lack of alternative pedagogical strategies (Marra et al., 2014).

PBL is widely used in medical schools and has been the focus of many studies; however, a limited number have focused on assessment of actual PBL processes using validated instruments (Lee & Wimmers, 2016). A study by Lee and Wimmers (2016) examined the reliability and validity of an instrument designed to assess PBL performance in the key domains of problem-solving, information use, group dynamics and process, and professionalism. Research by Lee and Wimmers (2016) found that while there have been many assessment instruments proposed in the literature, little research has been done on the validity of these instruments. Three hundred ten medical students in two cohorts participated in the study, and the study participants were rated by 158 tutors. Lee and Wimmers's (2016) findings support the instrument's reliability and validity measures.

A study by Gustin, Abbiati, Bonvin, Gerbase, and Baroffio (2018) investigated student relationships to lecture and PBL activities. The study involved a large sample of 1st-to-3rd year medical students in three French-speaking medical schools. Data were collected using validated instruments and then analyzed using path analysis, which "is a special case of structural equation modeling which is used to examine directed relationships between a set of observed variables" (p. 4). The study assessed three types of curricular techniques: PBL-based, integrated, and traditional. The results show that the PBL-based curriculum fared better with students than the lecture-based integrated and the traditional curricula and that student approaches to learning were more effective in the PBL-based versus the lecture-based or traditional curricula. However, the analysis suggested that learning approach is a complex subject and should be further explored in future studies.

Radiology in practice generally requires technology to view radiological images and accurately make decisions (Chen & Scanlon, 2018). Attitudes of radiology students about the use of a PBL learning methodology were measured using the semantic differential (SeDe) instrument (Terashita, Tamura, Kisa, Kawabata, & Ogasawara, 2016). In that study, PBL was introduced during a training in plain radiography positioning techniques, and the clinical scenario was an emergency case involving major trauma that required plain radiography. Each student group created their own workflows to review the radiography, taking diagnostic accuracy and patient safety into consideration. The SeDe questionnaire instrument was administered before and after their training. It uses a series of adjectives relative to plain radiography (Terashita et al., 2016). Fifty adjectives related to plain radiography were listed on one side of the questionnaire, and opposite adjectives were listed on the other side of the questionnaire, effectively creating a continuum on which students could indicate their degree of agreement with the adjectives. Data were explored using factor analysis, and some predominant student choices were reluctance, confidence, and exhaustion prior to the PBL training. Post training results identified expectation, self-efficacy, and realness as predominant student choices. Student attitudes toward radiography changed positively after PBL was introduced into the training. The researchers concluded that self-efficacy increased among the students due to the self-directed learning nature of PBL.

A final study to illustrate the use of PBL in medical education is a comparison of debate and role play to enhance critical thinking and communication skills among medical students in Saudi Arabia (Latif, Mumtaz, Mumtaz, & Hussain, 2018). The researchers concluded that the use of debate and role play would encourage students to reflect on their progress as professionals and help to create a sense of identity as clinicians. The participants for that comparative, cross-sectional, questionnaire-based study were second-year undergraduate female medical students. During the first semester of that study, students were exposed to debate-type sessions only, focusing on their effectiveness at debate. Subsequently, both debate and role play were employed at the same time in PBL sessions, with a focus on critical thinking and communication skills. Some of the topics included clinician-patient encounters, genetic testing, and alcohol abuse. Students in teams assumed the roles of actor, writer, etc. to create realistic debate or role play scenarios. At the end of each school year, students filled out a questionnaire.

Education in Saudi Arabia is segregated by gender, so that study was not able to include males, which was considered a limitation by the authors. The data analysis shows that, in general, students rated debate and role play as being equally effective in improving their communication skills. Both debate and role play were accepted by students as effective teaching methodologies in the PBL curriculum. Debate sessions were perceived as opening new ways of thinking by 76% of students, compared to 65% for role play ($p = 0.01$). A majority of students felt that these activities, in a PBL environment, could help ease their potential difficulties in patient communications and aid in improving their teamwork and listening skills. This summary of a few studies about the use of PBL in medical education demonstrates that PBL is used worldwide and in many ways. It is effective for the teaching of critical communication skills as well as working as a team to better understand specific science and clinical details.

See Figure 8, which shows recent data from U.S. medical schools reporting to the AAMC regarding use of PBL as a content delivery method in medical education (American Association of Medical Colleges, 2019). Figure 9 shows more specifically how PBL was used by reporting schools as an instructional format in academic year 2017-2018.

Team-Based Learning

TBL is an evidence-based collaborative teaching and learning strategy in which the process of content delivery is well-defined. There is a standardized sequence of activities, including timed individual and team tests, which makes it easier for practitioners to replicate outcomes. The Team-Based Learning Collaborative (TBLC) has created strict guidelines for what constitutes a TBL activity; practitioners must follow these specific processes of design and delivery in order for an activity to be considered a true TBL (Team-Based Learning Collaborative, 2019). This method increases the effectiveness of small groups working independently in classes with high student-to-faculty ratios without losing the benefits of faculty-led small groups with lower ratios.

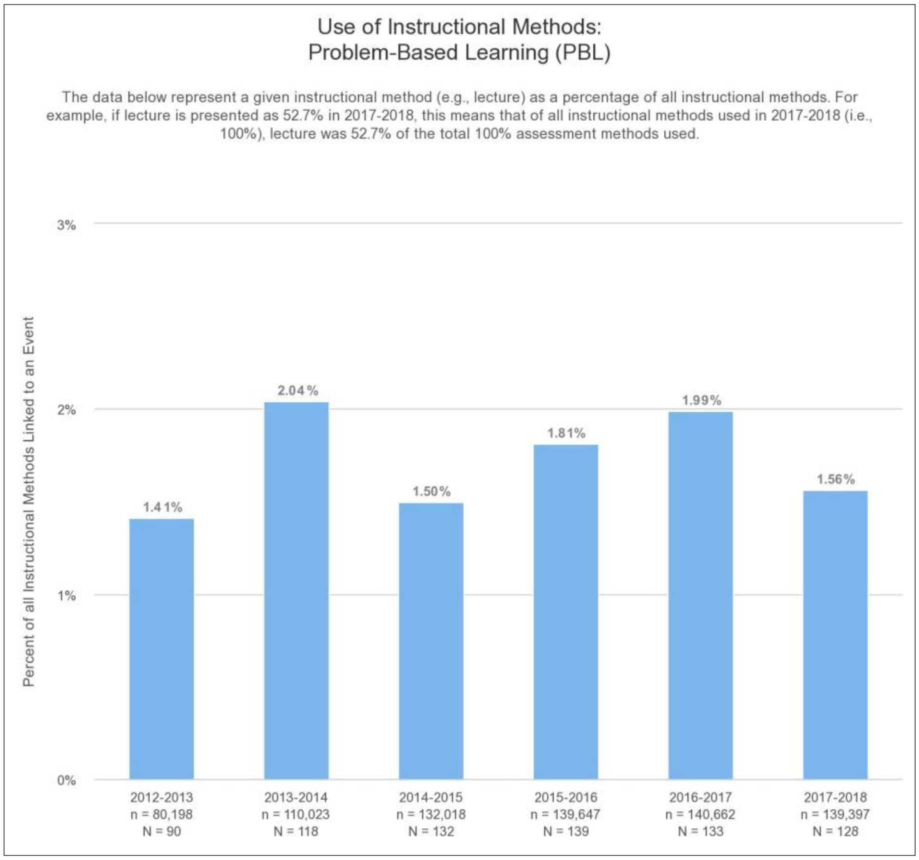

Figure 8. Use of instructional methods: problem-based learning from AAMC. Reprinted with permission; see Appendix A for permission.

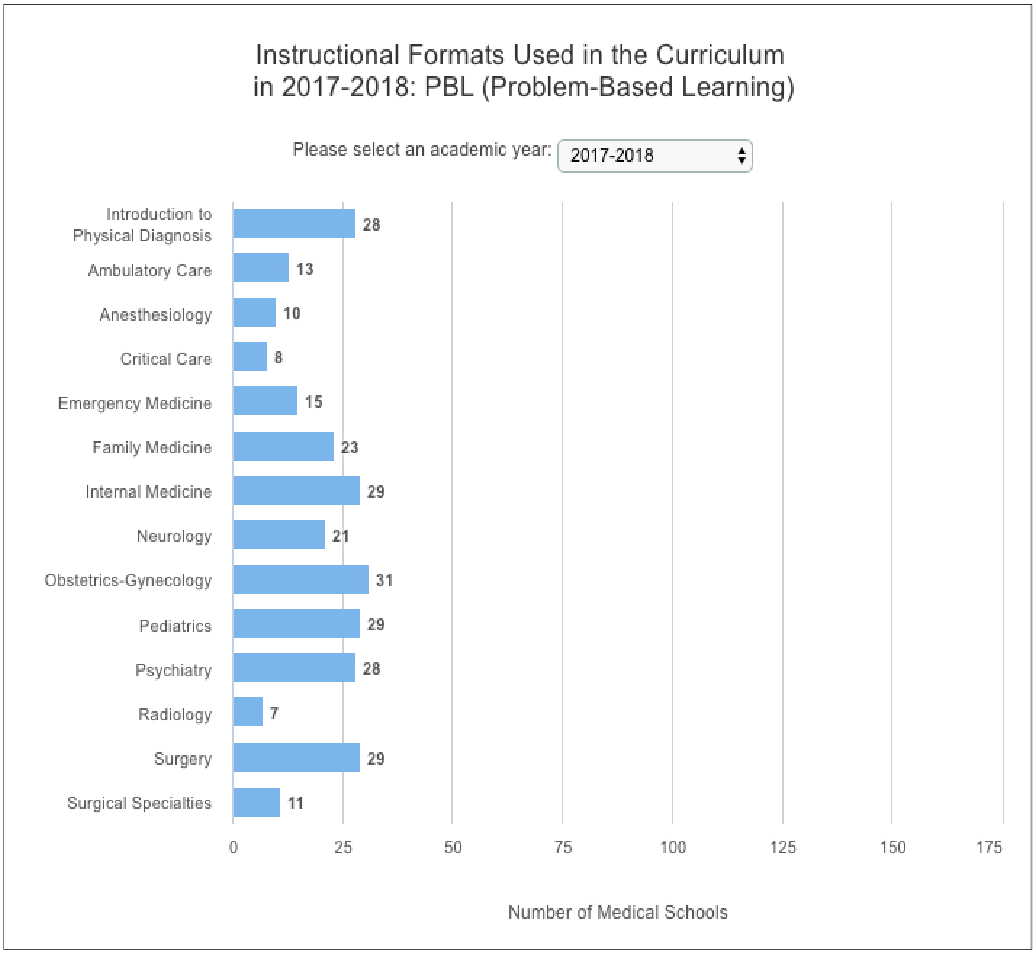

Figure 9. Instructional formats used in the curriculum in 2017-2018: problem-based learning from AAMC. Reprinted with permission; see Appendix A for permission.

Team-Based Learning in General Education

TBL is commonly used as a teaching method in business education. In a study by Huang and Lin (2017), TBL was implemented in a human resources course as an alternative to lecturing in large classroom settings. The participants in that mixed-methods research study included 120 business undergraduate students at two national universities in Taiwan. One hundred four completed surveys were collected from them with a response rate of 87%. The results of the study show that team members relied heavily on individual member contributions, and students eventually learned more effectively when these collaborations were deemed significant by team members. There was little information in that study that demonstrated the impact on faculty regarding the design and delivery of a TBL for that course purpose and no apparent information on the specific use of educational technology.

Another subject area that has implemented TBL for educational purposes is agriculture. McCubbins, Paulsen, and Anderson (2018) conducted a nonexperimental, pretest-posttest study to examine student attitudes and beliefs about learning, including their motivation to learn and how critical thinking skills are developed. The study revealed that while TBL was shown to be effective for improving student performances, it did put a significant burden on the instructor to completely redevelop a course. Resistance by faculty to adopt TBL seemed to focus on initial resistance to the active learning techniques and a perceived lack of support from administration.

The use of an online environment to deliver TBL activities has been researched as a way to further support interactivity among students and to investigate motivation and enjoyment among them in a computer-mediated TBL environment (Gomez et al., 2010). Gomez et al.'s (2010) study attempted to extend learning in small teams from the traditional classroom environment to a hybrid environment where students met face-to-face and online. The online environment was used to emphasize the importance of online team interactions. The researchers felt that by including computer-mediation, time management in the classroom would improve because students could prepare for a TBL activity on their own time rather than attending lectures as preparation. Materials were stored in a shared online repository. An addition to their utilization of TBL was to encourage the students to participate in online discussions between the face-to-face sessions to further engage students in conversation.

Team-Based Learning in Medical Education

The research in the literature surrounding the use of TBL in medical education is extensive. In a study by Zgheib, Simaan, and Sabra (2010), TBL was used to teach pharmacology to second-year medical students. Zgheib et al. (2010) wanted to examine the effect of TBL on teaching pharmacology; however, the focus was on medical students' satisfaction and performance and did not include much about the faculty or facilitator perspective. Researchers' reasons for attempting to implement TBL for pharmacology topics were due to "the fact that over the years, the case discussion sessions became mini-lectures led by the facilitator, rather than interactive discussions between facilitator and students" (Zgheib et al., 2010, p. 131). They reported that student group performance was better than individual performance, which is a common tenet of TBL (Michaelsen, 2002). The faculty perspective on TBL was discussed briefly in that study, mainly by stating that faculty had difficulty creating appropriate application questions. There was no mention of the use of educational technologies to design or deliver TBL in that study.

Faculty workload when implementing TBL in a pharmacy curriculum was the focus of a study by Kebodeaux et al. (2017). The researchers had faculty members fill out an 11-question survey to reveal their perspectives on TBL for content delivery. Twenty-eight responses were collected from 10 faculty members who taught in at least one of the semesters when TBL was implemented. While instructors reported that interactions between students and faculty in that method increased when using TBL compared to when using didactic instruction, they also reported that TBL was more difficult to design and deliver and increased their workload. There was no mention of the use of educational technologies to design or deliver TBL in that study either.

In a systems analysis and design workshop, TBL peer review was utilized as a form of formative assessment (Lavy & Yadin, 2010). The workshops in which TBL was implemented "served as a framework within which students could demonstrate and augment their understanding of the ways technology usage can develop new organizational processes and achieving *[sic]* organizational goals" (Lavy & Yadin, 2010, p. 85). While that study did include the effect of peer review using TBL from the perspective of the instructor, the researchers did not elaborate whether educational technology was utilized.

Traditionally, medical educators have use PBL as opposed to TBL (Burgess et al., 2017). Reasons for choosing one over the other tend to be determined by class size, available facilitators, and choice of assessment for learning. A quantitative study was conducted by A. Burgess et al. (2017) to determine which of the two types of IBL that students preferred. One hundred forty-four participants completed a questionnaire about PBL, and 152 of 169 participants completed a similar one about TBL. Researchers found that students preferred TBL over PBL due to the smaller class size, more immediate feedback, and the use of testing in the form of readiness assurance tests (RATs). Again, the teacher perspective on utilizing those two teaching methods was not evident in that study.

Distance education and virtual reality (VR) are making inroads into health sciences education, including TBL activities (Coyne et al., 2018). A challenge with distance education is the attempt to deliver a comparable education to students who attend remotely using online platforms versus those who attend in person. VR experiences such as within SecondLife have sometimes been used to deliver content in a completely new way. In a quantitative study by Coyne et al. (2018), VR headsets such as Oculus Rift™ and Google's™ VR headset were compared for their utility in a TBL exercise. A majority of student respondents reported strong satisfaction with using devices like these in a TBL activity. The instructor perspective was not evident in that study; however, the authors alluded to the complexity of using TBL in an online or virtual environment. See Figure 10, which sows recent data from U.S. medical schools reporting to the AAMC regarding use of TBL as a content delivery method in medical education (American Association of Medical Colleges, 2019). Figure 11 shows more specifically how TBL was used by reporting schools as an instructional format in academic year 2017-2018.

Theoretical Foundations and Defining Constructs

This quantitative study presented a view of the determinants that predict medical education faculty acceptance of and intention to use educational technologies in IBL activities. The conceptual framework for this study was based on self-efficacy, social constructivism, and technology acceptance theories, and more specifically the UTAUT. The UTAUT is the result of a synthesis of eight theories of technology acceptance and use that have evolved over decades

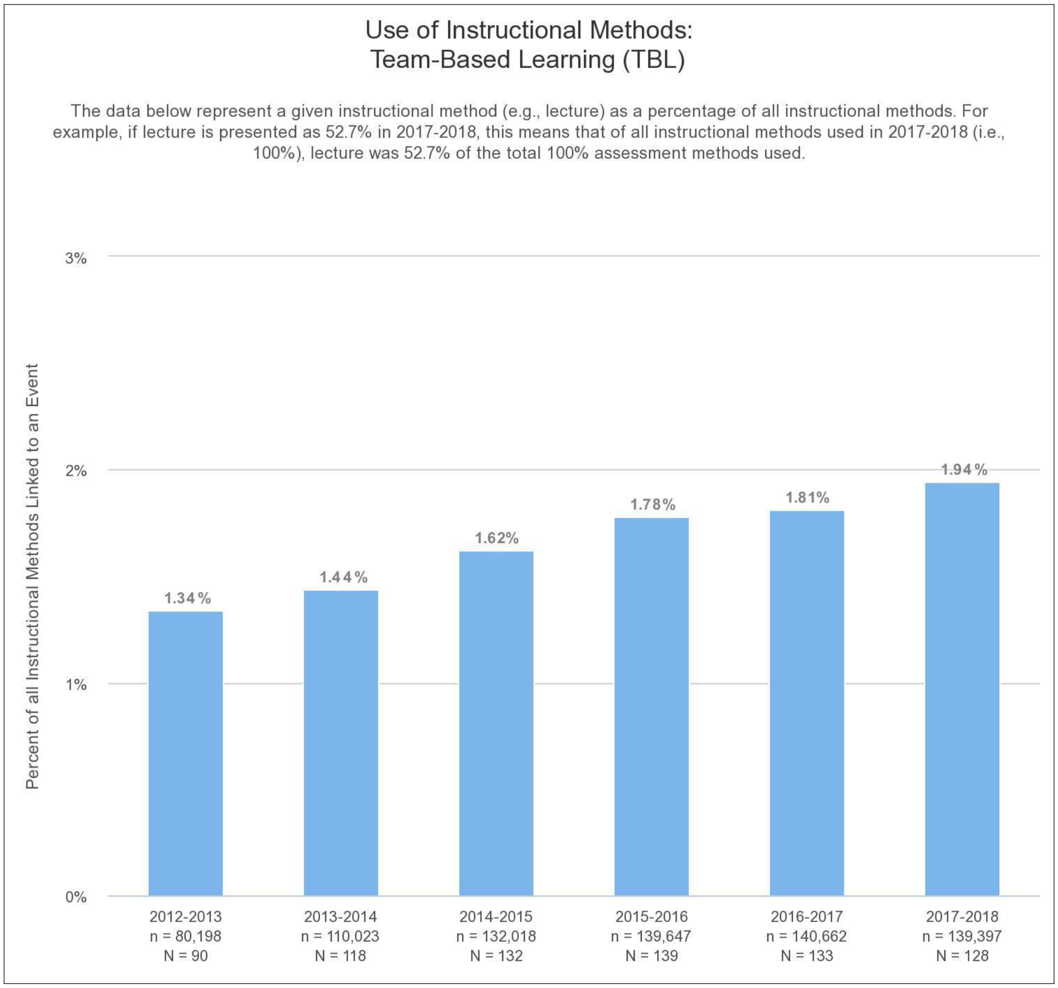

Figure 10. Use of instructional methods: team-based learning from AAMC. Reprinted with permission; see Appendix A for permission.

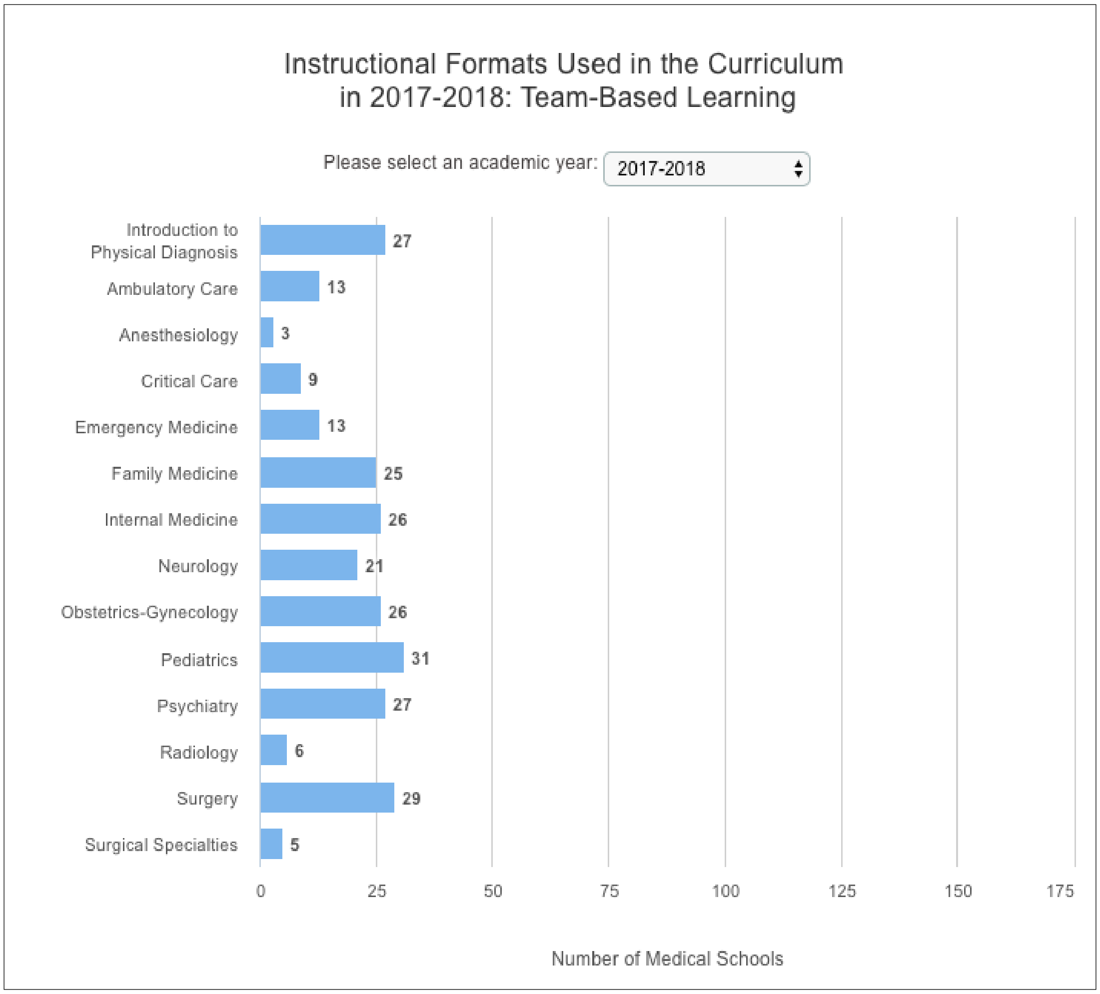

Figure 11. Instructional formats used in the curriculum in 2017-2018: team-based learning from AAMC. Reprinted with permission; see Appendix A for permission.

of empirical study: TRA (Fishbein & Ajzen, 1975), TAM (Davis, 1989), MM (Davis et al., 1992), TPB (Ajzen, 1991), C-TBP-TAM (Taylor & Todd, 1995), MPCU (Thompson et al., 1991), DOI (Rogers, 2003), and SCT (Compeau & Higgins, 1995).

Each of the eight models has at least one construct that is significant and is a direct determinant of the intention to use technology. Prior to the development of the UTAUT, researchers were forced to be more selective about their constructs (Venkatesh et al., 2003). The UTAUT model suggests that there are three direct determinants of intention to use technology: PE, EE, and SI. It postulates that there are two direct determinants of actual usage behavior: BI and FC. It also assumes that the effect of these central constructs is moderated by age, gender, experience, and voluntariness of use (Venkatesh et al., 2003).

Self-Efficacy

Self-efficacy refers to the process that people go through to determine their beliefs in their own effectiveness in producing a desired action or outcome. "Self-efficacy beliefs determine how people feel, think, motivate themselves and behave" (Bandura, 1994, p. 71). It is one of many components of social-cognitive theory. Self-efficacy "operates in concert with other determinants in the theory to govern human thought, motivation, and action" (Bandura, 1997, p. 54). This process of regulating their own intrinsic motivation and intention can help people to create a series of schema to aid in future decision-making. A person's intrinsic belief in his or her competency to perform actions is coupled with extrinsic pressures. In social environments, for example, a person's motivation is generally affected by external sociocultural influences around him or her. However, these external influences do not always compel a person to take an action. "Efficacious people are quick to take advantage of opportunity structures and figure out ways to circumvent institutional constraints or change them by collective action" (Bandura, 1997, p. 6). On the other hand, "inefficacious people are less apt to exploit the enabling opportunities provided by the social system and are easily discouraged by institutional impediments" (Bandura, 1997, p. 6). Humans are complex thinkers; therefore, it can be difficult to determine exactly what motivates a person to take an action or not. If people do not believe their actions can produce desired effects or outcomes, they have low incentive or intention to perform those actions (Bandura, 1994). "The fact that virtually all people try to bring at least some influence to bear on some of the things that affect them does not necessarily indicate the presence of an innate motivator" (Bandura, 1997, p. 2). It should be noted that Venkatesh et al. (2003) determined that "attitude toward using technology, self-efficacy, and anxiety are theorized not to be direct determinants of intention" (p. 447), and that self-efficacy is more an indirect determinant of intention (Venkatesh, 2000).

Unified Theory of Acceptance and Use of Technology

The unified theory of acceptance and use of technology (UTAUT) framework, developed by Venkatesh et al. (2003), was originally developed as a means to understand employers' acceptance of information technology (IT) by unifying the eight existing acceptance models listed above. Using data from four organizations over a 6-month period, the eight original models explained between 17% and 53% of the variance in intention to use information technology. In order to unify these models and develop the UTAUT, Venkatesh et al. (2003) conducted a within-subjects, longitudinal validation and comparison study with data from the same four organizations. The researchers' unified model, called the UTAUT, includes four determinants of intention to use of technology and actual usage of technology as well as up to four moderators of key relationships. Venkatesh et al. (2003) determined that the UTAUT accounted for 69% of the variance (adjusted R^2) in intention to use IT in the first four organizations, which was found to be a significant improvement over the original eight models (Venkatesh et al., 2003). The researchers cross-validated the UTAUT by retesting it with two additional organizations and achieved similar results (adjusted R^2 of 70%). Therefore, according to the researchers, the UTAUT

> provides a useful tool for managers needing to assess the likelihood of success for new technology introductions and helps them understand the drivers of acceptance in order to proactively design interventions (including training, marketing, etc.) targeted at populations of users that may be less inclined to adopt and use new systems. (Venkatesh et al., 2003, pp. 425-426)

The UTAUT builds on the core constructs of the eight existing acceptance models of the time. Table 3 represents the core constructs of the eight acceptance models that helped to inform the development of the UTAUT.

To better understand the UTAUT model requires elaboration on the four constructs: PE, EE, SI, and FC, as well as the dependent variables of BI and UB.

Defining Constructs

Venkatesh et al. (2003) defined four constructs, also known as determinants that indicated acceptance of, behavioral intention to use, and actual use of technology. The researchers' model indicates that there are three constructs that directly determined intention to use technology: PE, EE, and SI. The UTAUT also postulates that there are two direct determinants of UB: BI and FC. In addition, the model assumes that the effect of these constructs is moderated by age, gender, experience, and voluntariness of use (Venkatesh et al.,

Table 3

Technology Acceptance Models and Their Core Constructs

Acceptance model	Core construct(s)
Theory of reasoned action (TRA)	Attitude toward behavior, subjective norms
Technology acceptance model (TAM)	Perceived usefulness, perceived ease of use, subjective norms
Motivational model (MM)	Extrinsic motivation, Intrinsic motivation
Theory of planned behavior (TPB)	Attitude toward behavior, Subjective norms, Perceived behavioral control
Combined technology acceptance model and theory of planned behavior (C-TAM-TPB)	Attitude toward behavior, Subjective norms, Perceived behavioral control, Perceived usefulness
Model of PC utilization (MPCU)	Job fit, Complexity, Long-term consequences, Affect toward use, Social factors, Facilitating conditions
Innovation diffusion theory (IDT)	Relative advantage, Ease of use, Image, Visibility, Compatibility, Results demonstrability, Voluntariness of use
Social cognitive theory (SCT)	Outcome expectations of self-efficacy, performance, affect, anxiety

Note: Adapted from "User acceptance of information technology: Toward a unified view" by V. Venkatesh, Morris, M. G., Davis, G. B., and Davis, F. D. (2003). *MIS Quarterly, 27*(3), 425-478.

Performance Expectancy

PE is the degree to which an individual believes that using a technology tool will improve his or her job performance in some way. Venkatesh et al. (2003) found that it was the strongest predictor of BI to use a technology of the three constructs related to intention, and was moderated by age and gender, specifically among young male workers. Venkatesh et al. (2003) suggested the moderators of age and gender be used together and not independently due to the possibility that age may affect what were considered traditional gender roles.

Effort Expectancy

EE is the degree of ease associated with using an educational technology tool; has a direct impact on BI. Ease of use is expected to become more insignificant over time. Newer behavior requires more effort when there are more hurdles to overcome. EE is moderated by age, gender, and experience together. It is expected to be more significant in the early stages of a new behavior, specifically among women. Of the moderators, age has a significant effect because the ability to process complex stimuli and cognitive ability declines as age increases (Venkatesh et al., 2003).

Social Influence

SI is how an individual perceives the importance of other people using an educational technology tool and is influenced by all four moderators together. SI is complex and is contingent on numerous internal and external factors (Venkatesh et al., 2003). Mandatory contexts are likely to cause social influence to have a direct effect on use. Voluntary contexts are influenced by internalization and identification with the social group and the technology or system in question. It is expected to be more applicable to women than men; however, gender roles are changing, so this gender difference may not be as true now as it was when the theory was developed.

Facilitating Conditions

FC is defined by variances in individual belief that there is a support mechanism for use of an educational technology; it is influenced by the actual use of a technology when moderated by age and experience together (Venkatesh et al., 2003). Related to the findings of the UTAUT, "performance expectancy, effort expectancy, and social influence were theorized and found to influence behavioral intention to use a technology, while behavioral intention and facilitating conditions determine technology use" (Venkatesh, Thong, & Xu, 2016, p. 329).

Behavioral Intention

BI is related to the decisions made by an individual to use distinct technologies for specific purposes, as well as the willingness of people to use a particular system or technology (Khechine et al., 2016). BI is the likelihood of someone to use a technology; a person's conscious decision to do something or to implement something in his or her future behavior (Venkatesh et al., 2012).

Actual Usage Behavior

UB refers to the actual use of a technology by an individual versus solely the intention to use it. Self-efficacy and a person's perceived ease of use of a technology impacts his or her BI to utilize a tool and ultimately determine whether a person actually implements a technology tool or not (Davis, 1989).

UTAUT Research Studies

The UTAUT is a widely used framework that has explored technology acceptance in various disciplines. It has been used to explain IT acceptance and the determinants in fields such as healthcare, education, and business (Venkatesh et al., 2016).

Healthcare

Healthcare delivery has increasingly used mobile technology as a delivery mechanism. A study by Hoque and Sorwar (2017) attempted to identify the factors behind the acceptance and use related to mobile health (mHealth) by the elderly in Bangladesh. A structured questionnaire was delivered in person to collect data from 274 elderly participants. The internal reliability of the questionnaire was evaluated using Cronbach's alpha (α) whose level was 0.70, an acceptable level to indicate internal consistency. Researcher results were comparable to similar studies on mHealth that used the UTAUT. Based on the findings, the elderly preferred interactions with health professionals in person rather than via a mobile device.

The reliance on technology in healthcare is increasing, which prompted a study investigating patients intention to use an online format to view emergency department (ED) wait times by using a modified UTAUT framework (Jewer, 2018). Patients in a Canadian ED were surveyed, and the results were analyzed using partial least squares (PLS). The modified UTAUT was shown to produce a more substantial improvement in variance of BI than the original UTAUT (66% for the modified UTAUT compared to 46% for the original UTAUT). Jewer's (2018) model showed that PE ($r = 0.302$, $p < 0.01$) and FC ($r = 0.539$, $p < 0.01$) demonstrated significant effects with respect to visiting a website that displayed ED wait times.

Education

The UTAUT model was used in a study of teacher perspectives on interactive whiteboards (IWBs); (Šumak & Šorgo, 2016) in elementary schools in an eastern European country. The researchers used the main constructs from the original model and enhanced it by adding attitude toward using technology as a construct. They also added user type and teaching experience to the original moderating variables of age, gender, experience, and voluntariness of use. The instrument for that quantitative study was on online questionnaire-based survey. The researchers concluded that the UTAUT model was applicable in studies regarding acceptance and use of technology in schools. A significant finding was that teachers who had less than 10 years of teaching experience were less comfortable with technology than teachers who had more than 10 years of teaching experience.

The UTAUT was also used in a K-12 context to study the factors influencing teacher acceptance and use of mobile technology for classroom instruction (Ifenthaler & Schweinbenz, 2013). That study used a qualitative analysis rather than a quantitative one, mainly due to a low number of available teacher participants. The results of the study show a significant diversity of teacher attitudes toward technology and regarding PE and FC. The participants were not clear how mobile devices could be used effectively to facilitate teaching and learning, with some teachers fairly skeptical of them.

The UTAUT was also used in a study to predict multigenerational tablet adoption practices (Magsamen-Conrad, Upadhyaya, Joa, & Dowd, 2015). The four UTAUT determinants of PE, EE, SI, and FC were tested to predict BI to use tablets with three of the four moderators present (age, gender, and experience) of these key relationships. The researchers found consistent generational differences in the four determinants, with the largest differences occurring between the oldest and youngest generations. After controlling for the three moderators, EE and FC were the only determinants that positively predicted intention to use tablets.

Medical Education

There is surprisingly little use of the UTAUT in studies regarding medical education. One study from the Tabriz University of Medical Sciences in Iran used the UTAUT to research factors that influence the adoption of e-learning among medical faculty (Abdekhoda, Dehnad, Mirasaeed, & Gavgani, 2016). One hundred ninety faculty members were randomly selected to participate by using stratified sampling. The results show that the UTAUT model explained approximately 56% of the variance for adoption of e-learning by faculty members. The constructs of PE, EE, SI, and BI were found to have significant direct effects on faculty behavior toward e-learning. The construct of FC did not have significant effects on their actual use of e-learning.

Other Disciplines

The UTAUT has been used in business studies such as regarding e-commerce. Wang, Luse, Townsend, and Mennecke (2014) conducted a study comparing BI to use a content-based recommender system and a collaborative filtering system. In place of FC, they used trust as a construct along with PE, EE, and SI to create a modified version of the UTAUT. They found that PE was stronger for the content-based system, while EE was stronger for the collaborative filtering system.

Chapter Summary

This chapter summarized the history of educational technology and how it is currently used in general education and then more specifically in medical education. The history of educational technology is comparatively short, with its beginnings in the early-to-mid 20th century. Educational technology became more visible as students, instructors, and administrators learned to embrace it and discovered how to effectively integrate it into various educational activities. The types and uses of educational technology in medical education are somewhat similar to those used in general education, yet there are distinct differences such as the use in medical education of radiographic images projected on computer screens or handheld devices. IBL was also explored as a viable educational activity by describing studies about implementing it in various forms. The UTAUT was described as well, to understand how that theoretical framework has been the basis for studies in vastly different fields such as healthcare, education, and medical education.

CHAPTER 3

METHODOLOGY

This quantitative study was an investigation into medical education faculty members' acceptance of, behavioral intention (BI) to use, and actual usage behavior (UB) of educational technologies in inquiry-based learning (IBL) educational activities in medical education in the United States (US). The unified theory of acceptance and use of technology (UTAUT) was the guiding theoretical model for this study. The purpose of this chapter is to describe the methods that were used in this study and to address the study design, instrumentation, description of the study's participants, and the data collection methods. It also includes an overview of the data analysis procedures.

Research Design

The UTAUT is a model that explores BI to use technology and UB of technology among people in various situational contexts; it can be used to better understand what drives technology acceptance in order to make proactive interventions (Venkatesh et al., 2003). Four predictors of faculty BI to integrate educational technology into IBL activities were investigated in this study using Venkatesh et al.'s (2003) UTAUT model. The four predictors that served as independent variables for this study were performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). These four predictors were used to determine relatedness to medical school faculty members' BI to use and their UB of educational technology for IBL activities. BI and UB were the outcome variables for this quantitative descriptive, nonexperimental design. Since it was originally published in the early 2000's, researchers have used Venkatesh at al.'s (2003) model and survey questionnaire all over the world in multiple industries including healthcare, education, business, and IT (Hoque & Sorwar, 2017; Šumak & Šorgo, 2016; Wang et al., 2014). Previous studies show that the UTAUT constructs can predict acceptance, BI, and UB of technology (Brown, Dennis, & Venkatesh, 2014; Magsamen-Conrad et al., 2015). Brown, Dennis, & Venkatesh (2014) performed a study in Finland of short messaging service (SMS) users among employees of a company to attempt to explain the adoption and use of collaborative technology. They theorized that the characteristics of collaborative technology, along with characteristics of individuals and groups were some of the predictors of PE, EE, SI, and FC in the UTAUT. The internal consistency reliability of all constructs was greater than 0.75, thereby confirming that the scales used in the study were reliable. The results confirmed their hypotheses, thus the UTAUT constructs predicted acceptance, BI, and UB of collaborative technology among the employees.

A survey based on work by Venkatesh et al. was administered to collect data on medical school faculty BI and perceptions about integrating educational technologies into IBL educational activities. The survey was opened on October 8, 2019 and closed on October 31, 2019. Data that were collected allowed examination of the extent of medical educators' use of educational technologies in IBL activities in medical education. The collected data also allowed for the examination of potential determinants associated with faculty members' BI and UB of educational technologies in IBL activities. In addition, this study aimed to assess the moderating effects of four demographic characteristics (age, gender, experience, and voluntariness of use) on attitudes toward BI and UB of technology; these are variables that were used to determine if there was a relationship between them and faculty members' BI to use and/or UB to use educational technology in IBL activities.

Correlational research design can be used in studies to measure the association or relationship between two or more variables (Creswell, 2008). To measure the strength of the relationship between the independent variables of PE, EE, SI, and FC and the dependent variables of BI and UB, both parametric (Pearson product moment correlation coefficient) and nonparametric (Spearman rank-order correlation coefficient) analyses were used. Both coefficients can range in value from -1 to +1. The Pearson correlation coefficient measures the strength of the linear association between two continuous variables by drawing a line of best fit in the data set through the two variables and is denoted by ρ when measured in a population and r when it is measured in a sample. The Spearman rank-order correlation coefficient measures the monotonic relationship and strength of association between two continuous or ordinal variables and is denoted by r_s or ρ (Field, 2013).

Cross-Sectional Survey Design

This study utilized a cross-sectional survey design. This type of survey "collects data to make inferences about a population of interest (universe) at one point in time" (Lavrakas, 2008, p. 173) and can also be used to measure multiple variables at one point in time. The survey instrument was administered for approximately three weeks. Appendix D includes the consent form, and Appendix E contains the survey instrument. An initial email (Appendix F) was sent during the first week, inviting participants to complete the survey. During the second week, an initial reminder email was sent (Appendix G), and then a second reminder email was sent during the third week (Appendix G). The initial invitation email (Appendix F) included the purpose of the study and the link to the survey.

Research Questions

The following four research questions were examined:

1. What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?

2. What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning activities?

3. Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?

4. Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning activities?

Research Hypotheses

The hypotheses that were tested include the following:

H_{1a} PE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{1b} PE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{2a} EE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{2b} EE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{3a} SI has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{3b} SI has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{4a} FC have a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{4b} FC have a positive effect on medical school faculty members' UB regarding educational technology in IBL.

Target Population

Various virtual communities of practice using electronic discussion listservs such as DR-ED, the Team-based Learning Collaborative (TBLC) and specific listservs from EDUCAUSE (e.g., INSTTECH (instructional technologists), BLEND-ONLINE (blended learning), and INSTRUCTIONALDESIGN (instructional design), were used to access the target population for this study. It is not known how many members are on each of EDUCAUSE lists as repeated requests for this information were ignored. DR-ED is an electronic listserv for medical educators managed by Michigan State University's (MSU's) College of Human Medicine (CHM), Office of Medical Education Research and Development (OMERAD). According to the MSU website (2019), there are more than 2,800 subscribers worldwide in over 30 countries. The TBLC list has approximately 923 subscribers. This study's target population were medical educators who work in medical school programs in the US and who have had experience delivering IBL activities within the last five years. The limit of within five years of experience with IBL was included as a requirement to complete the survey and the reasoning was that if a participant had not delivered an IBL activity within that time period might prove to be a limitation of their memory. In order to select only participants with experience delivering IBL activities, one of the first questions in the survey instrument requested that they respond affirmatively or negatively regarding their experience. If they responded in the affirmative, the survey continued; if they responded in the negative, the survey ended with a 'thank you' message and the survey would close.

Sample Population

Adequate minimum sample size was established by performing a priori power analysis using G*Power3.1.9.3, a free, downloadable software program (Faul, Erdfelder, Buchner, & Lang, 2009). A priori power analysis for correlation statistical tests was calculated using an alpha level of 0.05, effect size at 0.30 or larger, and a desired power of 0.80 or greater. To detect a significant correlation of 0.30 or larger, a minimum of 64 participants (n = 64) was needed. A multiple regression a priori power analysis was completed using an alpha level of 0.05, power of 0.80, with a maximum of four predictors. To detect a medium effect size (f = 0.15), a minimum of 85 participants (n = 85) was needed.

Data Collection Procedures

An online survey developed in the software Qualtrics™ was distributed to the following electronic discussion listservs: DR-ED, Team-based Learning Collaborative (TBLC), and related instructional design lists from EDUCAUSE such as INSTTECH (instructional technologists), BLEND-ONLINE (blended learning), and INSTRUCTIONALDESIGN (instructional design). All emails that were sent to this list were linked to the University of Illinois Outlook email system due to the fact that the researcher was already an active member on these lists with that particular work email address. Information identifying the researcher as a doctoral student at Northern Illinois University was included in the body of the email. An initial email invitation was sent after the study was approved and institutional review board (IRB) authorization was obtained (Appendix F). A second reminder was sent out one week after the initial email (Appendix G) and a third email was sent out during the final week

(Appendix G). Details around informed consent were included in the survey in Qualtrics (Appendix D), and participants were prompted to agree or disagree to the terms of the consent form. If the terms were accepted, participants were then prompted to complete the survey (Appendix E).

Instrumentation

A survey research instrument developed by Venkatesh et al. (2003) was modified and implemented for data collection. The survey items for this study were based on Venkatesh et al.'s original work with slight modifications of items to fit the needs of this study. The researcher received Venkatesh's permission to use the survey instrument to conduct this study (Appendix C). In addition, the survey included a section to collect demographic information from participants such as age, gender, educational level, years of experience with educational technologies, and level of voluntariness of use of educational technologies.

An 55-item instrument (Appendix E), adopted from Venkatesh et al. (2003) was used for data collection. It consisted of four categories: demographic information (3 items), employment information (10 items), UTAUT constructs of PE, EE, SI, and FC (30 items), voluntariness of use (4 items), and, behavioral intention and actual use (7 items). The first question was related to whether the potential participant had delivered IBL activities within the previous 5 years. The demographic section examined such variables as age, gender, highest degree earned, years teaching, academic rank, and clinical experience. The employment section examined teaching strategies used, resources available in information technology (IT) departments, topics taught, and primary age of students taught. The four constructs used to measure the UTAUT were PE (7 items), EE (8 items), SI (7 items), and FC (8 items). A 5-point Likert scale was used to measure each item in the UTAUT, ranging from 1 (strongly disagree), 2 (disagree), 3 (undecided), 4 (agree), to 5 (strongly agree). Three questions for EE were negatively worded, so during data analysis, these questions were reverse coded. The rating options were limited to five and ordered from the most negative feelings possible to the most positive possible. Including additional rating options might have confused survey respondents because people differ in their interpretation of options if there are too many of them (Fowler, 2013). The researcher developed the demographic and employment survey items. Table 4 summarizes the alignment between constructs and survey questions, and Table 5 shows the moderators of the key relationships with constructs and their alignment with survey questions.

Instrument Reliability and Validity

Internal consistency reliability is described by Fowler (2013) as "the extent to which people in comparable situations will answer questions in similar ways" (p. 86). Prior studies have shown reliable results for the constructs used in this study (Kalavani, Kazerani, & Shekofteh, 2018; Magsamen-Conrad et al., 2015). To reduce or minimize threats to the reliability and validity of this study, questionnaire items for the survey instrument used were based on those developed by Venkatesh et al. (2003). To confirm the study findings, Cronbach's alpha (α) was calculated to examine the internal consistency reliability of each measure of faculty professional use of educational technology in IBL activities. Cronbach's alpha (α) can range from 0.0 to 1.0 and quantifies the degree of correlation among different items on an instrument. A level of 0.70 is generally accepted as an indicator of an acceptable

Table 4

Constructs and Alignment With Survey Questions

Construct	Survey Question(s)
Behavioral Intention (BI)	I intend to start using or continue using educational technologies in the future for my delivery of IBL activities.
	I am determined that I will use educational technologies in the future for my delivery of IBL activities.
	I plan to use educational technologies frequently for my delivery of IBL activities.
Actual Usage Behavior (UB)	I currently use educational technologies in my delivery of IBL activities.
	If you do not use educational technologies in your delivery of IBL activities, what are some of your reasons? (Select all that apply)
	I use the following educational technologies in my professional life, for other than the delivery of IBL activities.
	I use the following educational technologies in my delivery of IBL activities.
Performance Expectancy (PE)	I find educational technology to be useful in my delivery of IBL activities.
	Using educational technology helps me accomplish tasks more quickly in my delivery of IBL activities.
	Using educational technology increases my productivity in my delivery of IBL activities.
	Using educational technology would make my delivery of IBL activities easier.
	Using educational technology can increase the quantity of output for the same amount of effort in my delivery of IBL activities.
	Using educational technology improves the quality of my delivery of IBL activities.
	Using educational technology enhances my effectiveness in the delivery of IBL activities.

(continued on next page)

Table 4 (continued)

Construct	Survey Question(s)
Effort Expectancy (EE)	Learning how to use educational technologies to deliver IBL activities is easy for me.
	I would find educational technologies easy to use in my delivery of IBL activities.
	My interaction with educational technologies is clear and understandable in my delivery of IBL activities.
	I find educational technologies easy to use in my delivery of IBL activities.
	It is easy for me to become skillful at using educational technologies in my delivery of IBL activities.
	Using educational technologies takes too much time from my normal delivery of IBL activities.
	Using educational technologies involves too much time doing mechanical operations during my delivery of IBL activities.
	It takes too long to learn how to use educational technologies to make it worth the effort for delivery of IBL activities.
Social Influence (SI)	People who are important to me think that I should use educational technologies in my delivery of IBL activities.
	People who influence my behavior think that I should use educational technologies in my delivery of IBL activities.
	People whose opinions that I value prefer that I use educational technologies in my delivery of IBL activities.
	Administrators have been very supportive of the use of educational technologies for the delivery of IBL activities.
	In general, my organization has supported the use of educational technologies for the delivery of IBL activities.
	People in my organization who use educational technologies for IBL activities have a high profile.
	People in my organization who use educational technologies to deliver IBL activities have more prestige than those who do not.

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Table 4 (continued)

Construct	Survey Question(s)
Facilitating Conditions (FC)	I have the resources necessary to use educational technology in my delivery of IBL activities. I have the knowledge necessary to use educational technology in my delivery of IBL activities. Educational technology is compatible with the technology I use in my delivery of IBL activities. I can get help from others when I have difficulty using educational technology in my delivery of IBL activities. Specialized instruction concerning educational technologies for the delivery of IBL activities was has been available to me. A specific person (or group) is available for assistance with educational technology difficulties during the delivery of IBL activities. Using educational technologies fits into my delivery style for IBL activities. Given the resources, opportunities and knowledge it takes to use educational technologies, it would be easy for me to use them for the delivery of IBL activities.

Table 5

Moderators of Key Relationships With Constructs and Alignment With Survey Questions

Moderator	Survey Question(s)
Demographic Information	What is your age in years?
	What is the gender with which you most identify?
	What is the highest level of education you have attained?
Experience / Employment Information	For how many years have you been teaching? What is your current academic rank? Do you hold a tenure-track position? Are you involved in clinical medicine? (e.g., teach in a clinical environment, supervise in a healthcare environment, etc.)
	Does your clinical medicine time involve any of the following? (Select all that apply)
	I am encouraged to use different teaching strategies, other than traditional didactic ones (e.g., lecture) to engage students.
	What teaching strategies do you use? (Select all that apply)
	Does your institution have a readily available and resourceful information technology (IT) department?
	In what topic areas do you teach? (select all that apply)
	What is the primary age group that you teach? (select all that apply)
Voluntariness of Use (VU)	Although it might be helpful, using educational technologies in my delivery of IBL activities is certainly not compulsory.
	My delivery of IBL activities does not require me to use educational technologies.
	My supervisor or administration do not expect me to use educational technologies in my delivery of IBL activities.
	Using educational technologies for delivering IBL activities is voluntary (as opposed to required as part of my job).

internal consistency on measures (Field, 2013). Internal consistency measures the general agreement between multiple items and is the "degree to which items measure the same thing" (Davenport, Davison, Liou, & Love, 2015, p. 4). However, much like other statistical analyses, it can display certain weaknesses. For example, "a high correlation among items reflects good internal consistency but tells us little about the validity of the measure" (Adamson & Prion, 2013, p. e179). For each construct, internal consistency is demonstrated through examples from the literature.

There were potential threats to validity for this study. A main threat to validity was item nonresponse, if participants chose to not respond to certain questions. In an attempt to avoid nonresponse, in Qualtrics, almost every question included a warning to the participant if they missed answering a question, however, they could still choose to skip it. Another potential threat to validity was missing data during the collection phase. In this case, imputation techniques were applied to any missing data. Imputation is "a standard approach for handling item nonresponse…and the resultant completed data are typically analyzed as if there were never any missing values" (Rässler, Rubin, & Zell, 2013, p. 21). Validity is described by Fowler (2013) as "the extent to which the answer given is a true measure and means what the researcher wants or expects it to mean" (p. 86).

The constructs of PE, EE, SI, FC, BI, and UB were previously defined in Chapter 2, therefore this section will focus on the performance of these constructs in research studies. According to Venkatesh et al. (2012) and the UTAUT, "performance expectancy, effort expectancy, and social influence are theorized to influence behavioral intention to use a technology, while behavioral intention and facilitating conditions determine technology use" (2012, p. 159).

Performance Expectancy

PE is "the extent to which an individual perceives that using a system will enhance his or her productivity, and thus lead to performance gains" (Brown et al., 2014, p. 13). In a study to understand the factors that influence adoption of mHealth services by the elderly, researchers found that PE, EE, and SI significantly influenced elderly people's BI to use mHealth services (Hoque & Sorwar, 2017). Cronbach's alpha (α) results showed strong internal consistency on that measure with a value of 0.869. In another study of the acceptance and use of whiteboards in the classroom by Šumak and Šorgo (2016), the Cronbach's alpha (α) for PE was 0.92, showing strong internal consistency. In this study, PE represented the medical educator's belief that the use of educational technology in IBL activities will help him or her attain gains in content delivery.

Effort Expectancy

EE is "the extent to which using a system is free of effort" (Brown et al., 2014, p. 13), or the degree of ease with using a system or product (Venkatesh et al., 2012). In the study referenced above regarding use of mHealth services by the elderly, Cronbach's alpha (α) results for EE showed strong internal consistency with a value of 0.904 (Hoque & Sorwar, 2017). In the study about whiteboards referenced above by Šumak and Šorgo (2016), EE showed strong internal consistency with a Cronbach's alpha (α) value of 0.90. In this study, EE represented the medical educator's belief about the ease of use of educational technology in IBL activities.

Social Influence

SI is "the extent to which an individual perceives that important others think that he or she should use the target system" (Brown et al., 2014, p. 13), in particular, in response to peers, family, or friends (Venkatesh et al., 2012). In the study referenced above regarding use of mHealth services by the elderly, Cronbach's alpha (α) results for SI showed strong internal consistency with a value of 0.788 (Hoque & Sorwar, 2017). In Šumak and Šorgo's (2016) study on the acceptance and use of interactive whiteboards, SI was shown to have strong internal consistency with a Cronbach's alpha (α) of 0.82. The role of social influence in the adoption and use of technologies can be complex and be affected by a wide range of contingencies (Venkatesh et al., 2003). In this study, SI represented the medical educator's perceptions of how others believe he or she should use educational activities in IBL activities.

Facilitating Conditions

FC is "the perception regarding the availability of organizational and technical resources to support use of the targeted system" (Brown et al., 2014, p. 13). In the above-referenced study by Hoque and Sorwar (2017) about use of mHealth services by the elderly, Cronbach's alpha (α) results showed strong internal consistency for that measure with a value of 0.86. In the above-referenced whiteboard study by Šumak and Šorgo (2016), the construct of FC showed strong internal consistency, with a Cronbach's alpha (α) level of 0.81. In this study, FC represented the medical educator's belief regarding the level of technical support that is available.

Behavioral Intention

BI refers to the conscious decisions a person has made to perform or not perform a specific task, use a specific technology, or behave in a certain way (Maruping, Bala, Venkatesh, & Brown, 2017). That measure showed strong internal consistency in a study about mHealth use by the elderly (Hoque & Sorwar, 2017). The Cronbach's alpha (α) value for that measure was 0.831. In a study about whiteboards by Šumak and Šorgo (2016), BI showed strong internal consistency with a Cronbach's alpha (α) value of 0.98. In this study, BI represented the medical educator's intention to use educational technology in IBL activities.

Actual Usage Behavior

UB refers to the actual use of educational technology in a specific way. In a study about whiteboards by Šumak and Šorgo (2016), the UB construct showed strong internal consistency with a Cronbach's alpha (α) value of 0.91. In this study, UB represented actual use of educational technology for IBL activities by medical educators.

Moderators

Age, gender, experience, voluntariness of use. For this survey, age was coded as a continuous variable, which is consistent with existing research and gender was coded as a 0/1 dummy variable with is also consistent with existing research (Maruping et al., 2017). Age has been shown in some empirical studies to have an effect on a person's ability to process information crucial to the deployment and use of educational technologies. In other words, as age increases, it is more likely to negatively affect technology adoption and use (Khechine et al., 2016; Lakhal, Khechine, & Pascot, 2013; Venkatesh et al., 2003). Questions related to experience and voluntariness of use were included within the survey, using a 5-item Likert scale.

Human Subject Compliance

An IRB from Northern Illinois University was approved for the researcher to conduct this study; the researcher's collaborative institutional training initiative (CITI) compliance is up to date. The survey instrument began with an informed consent form that stated the purpose of the study and provided contact information for the researcher and chair of the dissertation committee. The participants were asked to agree to the informed consent form by clicking on a button with the word Agree on it.

Data Analysis

To examine these research questions, two statistical approaches of descriptive and inferential statistics were used. After data collection, descriptive statistics were used to describe the basic features of each item in this study such as age, gender, highest degree earned, years teaching, faculty employment status, academic rank, and clinical experience. Quantitative variables were initially described by the mean, median, mode, and standard deviation. These data were graphically examined using histograms and bar charts to check for data distribution and normality assumptions before continuing on with analysis.

Inferential statistics were conducted using correlations, linear regression, and logistic regression analyses. Scatterplots were used to display the relationships between the variable's associations. A multiple linear regression analysis was conducted to assess whether the independent variables predict the dependent (criterion) variables. A multiple linear regression assesses the relationship among a set of dichotomous, or ordinal, or interval/ratio predictor, variables on an interval/ratio criterion variable (Hinkle, Wiersma, & Jurs, 2003b). In this instance, the independent variables were PE, EE, SI, and FC, and the dependent variables were BI and UB. To examine the odds of BI and UB, logistic regression was used with dichotomized variables.

To address Research Questions 1 and 2, bivariate correlations were examined between the independent variables (PE, EE, SI, and FC) and the dependent variables (BI and UB). In addition, multiple linear regression and logistic regression were used to examine the following:

Research Question 1: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC)$

Research Question 2: UB = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC)$

In the multiple regression model and the logistic regression model addressing Research Question 1, the simultaneous effect of the predictors (PE, EE, SI, and FC) were examined with respect to their combined effect on BI; likewise, the predictors were used to examine their effect on UB in Research Question 2.

In Research Question 3, the following regression models were used:

Research Question 3a: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Age)$

Research Question 3b: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Age) + b_6(Age \times PE) + b_7(Age \times EE) + b_8(Age \times SI) + b_9(Age \times FC)$

Research Question 3c: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Gender)$

Research Question 3d: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Gender) + b_6(Gender \times PE) + b_7(Gender \times EE) + b_8(Gender \times SI) + b_9(Gender \times FC)$

Research Question 3e: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Experience)$

Research Question 3f: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Experience) + b_6(Experience \times PE) + b_7(Experience \times EE) + b_8(Experience \times SI) + b_9(Experience \times FC)$

Research Question 3g: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Voluntariness)$

Research Question 3h: BI = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Voluntariness) + b_6(Voluntariness \times PE) + b_7(Voluntariness \times EE) + b_8(Voluntariness \times SI) + b_9(Age \times FC)$

In Research Question 4, the following regression models were used:

Research Question 4a: UB= $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Age)$

Research Question 4b: UB= $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Age) + b_6(Age \times PE) + b_7(Age \times EE) + b_8(Age \times SI) + b_9(Age \times FC)$

Research Question 4c: UB = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Gender)$

Research Question 4d: UB = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Gender) + b_6(Gender \times PE) + b_7(Gender \times EE) + b_8(Gender \times SI) + b_9(Gender \times FC)$

Research Question 4e: UB = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Experience)$

Research Question 4f: UB = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Experience) + b_6(Experience \times PE) + b_7(Experience \times EE) + b_8(Experience \times SI) + b_9(Experience \times FC)$

Research Question 4g: UB = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Voluntariness)$

Research Question 4h: UB = $b_0 + b_1(PE) + b_2(EE) + b_3(SI) + b_4(FC) + b_5(Voluntariness) + b_6(Voluntariness \times PE) + b_7(Voluntariness \times EE) + b_8(Voluntariness \times SI) + b_9(Age \times FC)$

In Research Questions 3 and 4, the impact of covariates (age, gender, experience, and voluntariness of use) was examined with respect to their effect as moderators for the key relationships with PE, EE, SI, and FC. As such, interaction terms were created to test the hypotheses relating to their role as moderators. Models with and without interaction terms were evaluated to check for model fit and coefficient estimates (standardized and unstandardized).

Standard multiple linear regression–the enter method–was used. The standard method enters all independent variables (predictors) simultaneously into the model. The enter method was the standard for variable entry for this study. Variables were evaluated by what they added to the prediction of the dependent variable which is different from the predictability afforded by the other predictors in the model. The *F*-test was used to assess whether the set of independent variables collectively predicted the dependent variables. *R*-squared–the multiple correlation coefficient of determination–was reported and used to determine how much variance in the dependent variable was accounted for by the set of independent variables. The *t*-statistic for each regression coefficient was used to determine the significance of each predictor, and beta coefficients were used to determine the magnitude of prediction for each independent variable. For significant predictors, for every one-unit increase or decrease in the predictor, the dependent variable increased or decreased by the number of unstandardized beta coefficients.

The assumptions of multiple regression–linearity, homoscedasticity, and multicollinearity–were assessed. Linearity assumes a straight-line relationship between the predictor variables and the criterion variable, and homoscedasticity assumes that scores are normally distributed in relation to the regression line. Linearity and homoscedasticity were assessed by examination of scatter plots. The absence of multicollinearity assumes that predictor variables are not too related and will be assessed using variance inflation factors (VIF). VIF values above 10 suggest the presence of multicollinearity (Statistics Solutions, 2013). During data analysis, there was an apparent absence of multicollinearity.

For the independent variables (moderators of key relationships with main constructs)–age, gender, experience, and voluntariness of use–simple linear regression was conducted to assess whether each independent variable separately predicted the dependent (criterion) variable. A simple linear regression assessed the relationship between a dichotomous, or ordinal, or interval/ratio predictor, variable on an interval/ratio criterion variable (Hinkle, Wiersma, & Jurs, 2003a). Logistic regression was also used to assess the same relationships and to compare with the result of the linear regression analyses.

Research Questions 1 and 2 asked about the relationship among the four constructs of the UTAUT on BI and UB of educational technology in IBL, implying the need for correlational coefficients. Research Questions 3 and 4 sought to determine the effect of age, gender, experience, and voluntariness of use on the relationships between the four constructs of the UTAUT on faculty members' behavioral intention to use and actual usage behavior to use educational technology. Due to the impact that age, gender, experience, and voluntariness of use may have on BI, multiple regression was used to analyze the data. A descriptive statistical analysis was provided of demographic data collected.

Protection of Human Subjects and Ethical Considerations

IRB approval from Northern Illinois University was obtained before the start of data collection. Qualtrics™, a well-known online survey product, maintains confidentiality and is compliant with the Health Insurance Portability and Accountability Act (HIPAA). It also uses secure sockets layer (SSL) encryption to secure data transmittal. Data obtained through Qualtrics™ was examined by the researcher's committee, which included a statistician, and himself. The researcher is the only person who had direct access to the data on Qualtrics™. Information from Qualtrics™ was downloaded onto a universal serial bus (USB) device and kept in a locked drawer in his office.

Chapter Summary

In this chapter, the research design and methodology for this study was discussed. Information on sampling, potential participants, procedures for recruitment of participants, and distribution of the survey instrument were included. The UTAUT's constructs were defined and data collection and analyses were explained. The validity and reliability of the survey instrument were discussed, as were coding of the dependent variables, independent variables, and moderators. Potential tests for assumptions relevant to quantitative correlations research were also identified.

CHAPTER 4

DATA ANALYSIS

Introduction

The purpose of this quantitative study was to examine medical education faculty members' acceptance of, behavioral intention (BI) to use, and actual usage behavior (UB) of educational technologies in inquiry-based learning (IBL) activities. In addition, it served as an exploration as to how key constructs of the unified theory of acceptance and use of technology (UTAUT) potentially impact adoption. It also included an examination of the association of demographic factors such as age and experience of medical education faculty to use educational technology. This chapter describes the sample population, how the data were analyzed, and the study findings.

Survey data were collected over a three-week period, October 8, 2019 to October 31, 2019. During this time, an invitation email was sent to various electronic discussion listservs such as DR-ED, Team-based Learning Collaborative (TBLC), and those specific to EDUCAUSE. During the second week, a follow-up email reminder was sent, and a final reminder email was sent during the third week to potential participants. At the conclusion of the data collection period, 125 subjects participated in the study. Data were exported to the Statistical Package for the Social Sciences (SPSS) 26. Raw data were reviewed to ensure that consent was given and to assess completeness of each entry. Although 125 subjects gave their consent to complete the survey, only 119 subjects went on to actually complete portions of it. Further review of the data showed that an additional 27 subjects completed the first few questions but did not go on to complete the remainder of the questions, so these responses were deleted, resulting in a sample size of 92. Of these participants, a small portion of them (fewer than 4%) did not complete one or two of the questions, so hot deck imputation was used to complete their responses. “Hot deck imputation replaces each missing value with a random draw from a ‘donor pool’ consisting of observed values of that variable; donor pools are created by finding units with complete data with ‘similar’ observed values as the unit with missing data” (Rässler et al., 2013, p. 22). Questions 27, 28, and 29 in the section of the survey on effort expectancy (EE) were reverse coded during analysis because the questions are negatively worded.

Description of Sample

The study sample included participants from electronic discussion listserv communities such as DR-ED, TBLC, and specific listservs from EDUCAUSE. Participants’ mean age was 53.47 (n=92; SD=11.08; Range=32–77 years). With respect to gender, males were the majority of respondents (n=47, 51.1%) and most respondents held a doctorate degree as their highest degree (n=46; 50.0%). Years teaching, age, and academic rank varied. See Table 6 for demographic characteristics of the medical education faculty who participated in the survey.

Table 6

Medical Education Faculty Sample Population Demographic Characteristics

Variable	(*N*=92) Number of respondents (%)
Age	
32-40 years	13 (14.3%)
41-50 years	25 (27.3%)
51-60 years	28 (30.3%)
61-70 years	19 (20.6%)
> 71 years	7 (7.7%)
Gender	
Male	47 (51.1%)
Female	45 (48.9%)
Educational experience	
Masters	5 (5.4%)
Doctoral (e.g., PhD, EdD, etc.)	46 (50.0%)
MD	37 (40.2%)
Other	4 (4.3%)
Teaching experience	
Mean	92 (22.35%)
< 5 years	0 (0%)
6-10 years	14 (15.2%)
11-15 years	13 (14.1%)
16-25 years	29 (31.5%)
26-35 years	25 (27.2%)
36 or more	11 (12.0%)
Academic rank	
Adjunct Associate Professor	2 (2.2%)
Adjunct Professor	1 (1.1%)
Lecturer	1 (1.1%)
Instructor	2 (2.2%)
Assistant Professor	15 (16.3%)
Associate Professor	15 (16.3%)
Professor	35 (38.0%)
Clinical Assistant Professor	3 (3.3%)
Clinical Associate Professor	4 (4.3%)
Clinical Professor	6 (6.5%)

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Table 6 (continued)

Variable	(*N*=92) Number of respondents (%)
Research Assistant Professor	1 (1.1%)
Research Associate Professor	1 (1.1%)
Visiting Associate Professor	1 (1.1%)
Visiting Professor	1 (1.1%)
Other	4 (4.3%)
Tenure-track	
Yes	48 (52.2%)
No	44 (47.8%)
Involved in academic clinical medicine	
Yes	43 (46.7%)
No	49 (53.3%)
Types of academic clinical medicine experience	
Teaching students or residents in a clinical or healthcare environment	41 (44.6%)
Supervising students or residents in a clinical or healthcare environment	28 (30.4%)
Simulation-based training	10 (10.9%)
Other	2 (2.2%)
Encouraged to use different teaching strategies	
Yes	92 (100.0%)
No	0 (0%)
Teaching strategies employed	
Didactic (e.g., lecture)	68 (73.9%)
Flipped classroom	74 (80.4%)
Blended learning	26 (28.3%)
Case-based learning	48 (52.2%)
Problem-based learning	32 (34.8%)
Team-based learning	48 (52.2%)
Online classes	20 (21.7%)
Case studies	53 (57.6%)
Simulation	35 (38.0%)

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Table 6 (continued)

Variable	(*N*=92) Number of respondents (%)
Artificial intelligence	4 (4.3%)
Group projects	29 (31.5%)
Laboratory	23 (25.0%)
Other	4 (4.3%)
Readily available and resourceful information technology department	
Yes	79 (85.9%)
No	13 (14.1%)
Topic experience	
Basic sciences (e.g., anatomy, biochemistry, pharmacology, genetics, etc.)	48 (52.2%)
Clinical sciences (e.g., pathophysiology, pathology, psychiatry, pediatrics, genetics, etc.)	41 (44.6%)
Clinical care (e.g., teaching/mentoring students or residents)	31 (33.7%)
Community health/population health	8 (8.7%)
Evidence-based medicine	24 (26.1%)
Foundations of medicine	20 (21.7%)
Leadership	13 (14.1%)
Professional issues and trends	17 (18.5%)
Research skills	19 (20.7%)
Other	8 (8.7%)
Student age	
18-21	9 (9.8%)
22-25	82 (89.1%)

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Table 6 (continued)

Variable	(*N*=92) Number of respondents (%)
26-29	53 (57.6%)
30-33	14 (15.2%)
34+	6 (6.5%)
Not sure	4 (4.3%)

Analysis of Research Questions

Prior to analysis, Cronbach's alpha was calculated to test for internal consistency reliabilities of all survey items, and this demonstrated that each scale was highly reliable. As previously mentioned, three questions in the section about EE were reverse coded as the questions were negatively worded. See Table 7 for main construct internal consistency reliability scores.

After internal consistency reliability was determined, the means for the main constructs were established by transforming each variable to create a new dataset that represented the means of performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), and behavioral intention (BI). While the centering of means is fairly standard, they were not centered for these analyses, because there were no issues found with multicollinearity in the data (correlated independent variables that can impact estimation). The recognized threshold for variance inflation factor (VIF) is between one and ten. For example, if VIF is < 1 or > 10, multicollinearity is present. All of the variables in the data were within the limits for VIF, therefore no multicollinearity was determined to exist.

Table 7

Reliability Analysis for Measured Main Constructs of the UTAUT

Construct	Variable Type	Sample Item	Number of items	Cronbach's alpha (α)
Performance expectancy (PE)	Independent	Using educational technology improves the quality of my delivery of IBL activities.	7	0.94
Effort expectancy (EE)	Independent	I find educational technologies easy to use in my delivery of IBL activities.	8	0.92
Social influence (SI)	Independent	People who influence my behavior think that I should use educational technologies in my delivery of IBL activities.	7	0.81
Facilitating conditions (FC)	Independent	I have the resources necessary to use educational technology in my delivery of IBL activities.	8	0.87
Behavioral intention (BI)	Dependent	I intend to start using or continue using educational technologies in the future for my delivery of IBL activities.	3	0.93
Actual use (UB)	Dependent	I currently use educational technologies in my delivery of IBL activities	1	N/A

Note. Three variables for EE were recoded because they were negatively worded.

On a 1 to 5 Likert scale, with 1 being strongly disagree and 5 being strongly agree, the mean scores for each construct were only mildly varied. BI was found to have the highest mean score (*M* = 4.32, *SD* = 0.76) while SI had the lowest mean score (*M* = 3.71, *SD* = 0.68). See Table 8 for the number of items, mean, and standard deviation for the dependent and independent variables study measures.

Table 8

Descriptive Data for Dependent and Independent Variable Study Measures

Construct	Number of items	Mean	*SD*
Behavioral intention	3	4.32	0.76
Actual usage behavior	1	3.93	0.94
Performance expectancy	7	4.02	0.80
Effort expectancy	8	3.81	0.80
Social influence	7	3.71	0.68
Facilitating conditions	8	3.96	0.72

As a reminder, the following research hypotheses were tested:

H_{1a} PE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{1b} PE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{2a} EE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{2b} EE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{3a} SI has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{3b} SI has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{4a} FC have a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{4b} FC have a positive effect on medical school faculty members' UB regarding educational technology in IBL.

Research Question 1

Research Question 1 asked: what are the relationships between performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) and medical school faculty members' behavioral intention (BI) to use educational technology in inquiry-based learning activities (IBL)? Pearson's product-moment correlations were conducted to assess the relationships among the main UTAUT constructs and BI to use educational technology. Preliminary analyses demonstrated that each relationship was linear, and no outliers were detected. SI had the strongest positive correlation $r(92) = .594$, $p < .001$ with BI to use educational technology. FC had the weakest positive correlation $r(92) = .512$, $p < .001$ with BI to use educational technology. There were no substantial correlations ($r > .90$) therefore no issues with multicollinearity, as previously mentioned. The strength of association was not too varied, and a moderate correlation was detected for the relationship of each construct to BI. See Table 9 for specific information related to medical faculty members' BI to use educational technology for the delivery of IBL activities.

Table 9

UTAUT Constructs and Their Correlational Relationships to Behavioral Intention

Variable	*r*	*p*
Performance expectancy	.56	< .001
Effort expectancy	.59	< .001
Social influence	.59	< .001
Facilitating conditions	.51	< .001

The overall multiple regression model demonstrated that the four main constructs taken together (as independent variables) showed a statistically significant model fit to BI (dependent variable) $F(4, 87)$, $p < .001$. The constructs of PE, EE, and SI separately showed a statistically significant relationship to BI, while FC did not. The results were consistent when logistic regression was run on the same main constructs and a dichotomized BI. For every point increase in PE, it increases BI by .19. For every point increase in EE, it increases BI by .04. For every point increase in SI, it increases BI by .45. For every point increase in FC, it increases BI by .05. All of the research hypotheses that predicted there would be a positive effect between medical school faculty members' BI to use educational technology in IBL activities were supported, except for one concerning FC. See Table 10 for the regression analysis summary for the independent variables and their relationships to behavioral intention.

Table 10

Independent Variables and Their Relationships to Behavioral Intention

Variable	*B*	*SE B*	β	*t*	*p*
Performance expectancy	.19	.09	.20	2.25	.027*
Effort expectancy	.04	.01	.33	3.64	.001**
Social influence	.45	.09	.05	4.85	.001**
Facilitating conditions	.05	.10	.40	.50	.620*

Note. R^2 = .57 (*N*=92, **p* < .05, ***p* < .001).

Research Question 2

Research Question 2 asked: what are the relationships between performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) and medical school faculty members' actual use (UB) of educational technology in inquiry-based learning activities (IBL)? Pearson's product-moment correlations were conducted to assess the relationship among UTAUT constructs and actual use behavior (UB). Preliminary analyses demonstrated that each relationship was linear, and no outliers were detected. Effort Expectancy (EE) had the strongest positive correlation $r(92) = .44$, $p < .001$ with UB of educational technology. Social influence (SI) had the weakest positive correlation $r(92) = .283$, $p < .05$ with UB of educational technology. The strength of association was somewhat varied, and a moderate correlation was detected for the relationship of each construct to UB. There were no substantial correlations ($r > .90$) therefore no issues with multicollinearity. See Table 11 for specific information related to medical educators' actual use behavior of educational technology for the delivery of inquiry-based learning activities.

Table 11

UTAUT Constructs and Their Correlational Relationships to Actual Usage Behavior

Variable	*r*	*p*
Performance expectancy	.39	.001**
Effort expectancy	.44	.001**
Social influence	.28	.003*
Facilitating conditions	.35	.001*

Note. *$p < .05$, **$p < .001$.

The overall multiple regression model demonstrated that the four main constructs taken together (as independent variables) showed a statistically significant model fit to actual use behavior (UB; dependent variable) $F(4, 87) = 6.96$, $p < .001$ and 24.2% of the variability in UB is explained by the four predictors. The constructs of PE, SI, and FC separately did not show a statistically significant relationship to UB; however, EE did show a statistically significant relationship. The results were consistent when logistic regression was run on the same main constructs and a dichotomized BI. The only research hypotheses that predicted there would be a positive effect between medical school faculty members' UB to use educational technology in IBL activities that was supported was for EE. See Table 12 for the independent variable coefficients and their relationships to actual usage behavior.

Table 12

Independent Variable Coefficients and Their Relationships to Actual Usage Behavior

Variable	*B*	*SE B*	β	*t*	*p*
Performance expectancy	.17	.14	.14	1.21	.228
Effort expectancy	.04	.02	.29	2.42	.018
Social influence	.15	.15	.08	.97	.334
Facilitating conditions	.01	.16	.11	.62	.534

Note. $R^2 = .24$ (N=94; $p < .05$).

Research Question 3

Research Question 3 asked: do age, gender, experience, and voluntariness of use (VU) moderate the relationships between performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) and medical school faculty members' behavioral intention (BI) to use educational technology in inquiry-based learning (IBL) activities?

Pearson's product-moment correlations were used to analyze the effect of age, gender, experience, and voluntariness of use on the relationships between PE, EE, SI, and FC and medical school faculty members' BI to use educational technology in IBL activities. See Table 13 for a summary of these correlational relationships.

Table 13

UTAUT Moderators and Their Correlational Relationships With Behavioral Intent to Use Educational Technology in IBL Activities

Variable	*r*	*p*
Age	–.119	.097
Gender	–.121	.540
Experience	.385	.007
Voluntariness of use	–.222	.030

Note. $p < .05$.

For each construct of the UTAUT, multiple regression analysis was computed to determine relationships. A separate analysis was conducted for each scale of the UTAUT; other independent variables such as age, gender, experience, and voluntariness of use were included as interaction terms. Logistic regression was run on the same main constructs with a dichotomized BI.

The model with main effects including age demonstrated that increased age significantly affects BI to use educational technology for IBL activities, $F(5, 86) = 23.94$, $p < .001$ and 58.2% of the variability in BI is explained by age. The model with the interaction effects demonstrated that increased age significantly strengthens the overall relationships between PE, EE, SI, and FC, and BI to use educational technology for IBL activities, $F(8, 83) = 14.42$, $p < .001$ and 58.6% of the variability in BI can be explained by age interacting with the four main variables. The interaction effects of age on the relationship between PE, EE, SI, and FC and BI individually were not significantly significant.

The model with main effects including gender demonstrated that gender significantly affects BI to use educational technology for IBL activities, $F(5, 86) = 22.81$, $p < .001$ and 57% of the variability in BI is explained by gender. The model with interaction effects demonstrated that gender significantly strengthens the overall relationships between PE, EE, SI, and FC, and BI to use educational technology for IBL activities, $F(8, 83) = 15.98$, $p < .001$ and 60.6% of the variability in BI can be explained by gender interacting with the four main variables. The interaction effects of gender on the relationships between PE and FC and UB individually were statistically significant, while EE and SI were not statistically significant.

The model with main effects including experience demonstrated that experience significantly affects BI to use educational technology for IBL activities, $F(5, 86) = 26.14$, $p < .001$ and 60.3% of the variability in BI is explained by experience. The model with interaction effects demonstrated that experience significantly strengthens the overall relationships between

PE, EE, SI, and FC, and BI to use educational technology for IBL activities, $F(8, 83) = 17.46$, $p < .001$ and 62.7% of the variability in BI can be explained by experience interacting with the four main variables. The interaction effect of experience on the relationship between PE individually was significantly significant, while EE, FC, and SI were not statistically significant.

The model with main effects including voluntariness of use (VU) demonstrated that VU significantly affects BI to use educational technology for IBL activities, $F(5, 86) = 24.90$, $p < .001$ and 59.1% of the variability in BI is explained by VU. The model with interaction effects demonstrated that VU significantly strengthens the overall relationships between PE, EE, SI, and FC, and BI to use educational technology for IBL activities, $F(8, 83) = 16.23$, $p < .001$ and 61.01% of the variability in BI is explained by VU. The interaction effect of VU on the relationship between PE was statistically significant, while EE, FC, and SI were not statistically significant. See Table 14 for a summary of multiple regression analyses related to behavioral intention to use educational technology in IBL activities.

Research Question 4

Research Question 4 asked: do age, gender, experience, and voluntariness of use (VU) moderate the relationships between performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) and medical school faculty members' actual use (UB) of educational technology in inquiry-based learning (IBL) activities?

Assumptions of multiple regression were tested for outliers, multicollinearity, and linearity and violations were not observed so centered means were not calculated. Pearson's

Table 14

UTAUT Variables and Predictability of Medical School Faculty Members' Behavioral Intention to Use Educational Technology

Variable	*B*	*SE B*	β	*t*	*p*
PE with interaction					
Age	–.01	.01	–.12	–1.68	.097
Gender	–.07	.11	–.04	–.62	.540
Experience	.24	.09	.20	2.75	.007
Voluntariness of use	–.11	.05	–.16	–2.21	.030
Age x PE	.01	.01	.52	.61	.544
Gender x PE	.35	.01	.95	2.00	.049
Experience x PE	–.28	.14	–1.36	–1.97	.053
Voluntariness of use x PE	.18	.09	1.28	2.07	.041
EE with interaction					
Age	–.01	.01	–.12	–1.68	.097
Gender	–.07	.11	–.044	–.62	.540
Experience	.24	.09	.20	2.75	.007
Voluntariness of use	–.11	.05	–.16	–2.21	.030
Age x EE	–.01	.01	–.40	–.50	.616
Gender x EE	.09	.17	.23	.52	.606
Experience x EE	.11	.19	.48	.56	.576
Voluntariness of use x EE	–.02	.09	–.16	–.27	.789
SI with interaction					
Age	–.01	.01	–.12	–1.68	.097
Gender	–.07	.11	–.04	–.62	.540
Experience	.24	.09	.20	2.75	.007
Voluntariness of use	–.11	.05	–.16	–2.21	.030
Age x SI	.00	.01	.11	.21	.836
Gender x SI	.02	.18	.06	.13	.895
Experience x SI	–.04	.12	–.16	–.31	.759
Voluntariness of use x SI	–.08	.08	–.46	–.99	.326

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Table 14 (continued)

Variable	*B*	*SE B*	β	*t*	*p*
FC with interaction					
Age	–.01	.01	–.12	–1.68	.097
Gender	–.07	.11	–.04	–.62	.540
Experience	.24	.09	.20	2.75	.007
Voluntariness of use	–.11	.05	–.16	–2.21	.030
Age x FC	–.00	.01	–.36	–.38	.708
Gender x FC	–.47	.20	–1.25	–2.40	.019
Experience x FC	.25	.17	1.13	1.50	.138
Voluntariness of use x FC	–.11	.08	–.77	–1.33	.188

Note. $p < .05$.

product-moment correlations were used to analyze the effect of age, gender, experience, and voluntariness of use on the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use behavior of educational technology in IBL activities. See Table 15 for these correlational relationships.

For each construct of the UTAUT, multiple regression analysis was computed to determine relationships. A separate analysis was conducted for each scale of the UTAUT; other independent variables such as age, gender, experience, and voluntariness of use were included as interaction terms. Logistic regression was run on the same main constructs with a dichotomized BI.

The model with main effects including age demonstrated that increased age significantly affects UB to use educational technology for IBL activities, $F(5, 86) = 6.57$, p <

Table 15

UTAUT Moderators and Their Correlational Relationships With Actual Use Behavior of Educational Technology in IBL Activities

Variable	*r*	*p*
Age	.191	.034
Gender	–.118	.130
Experience	.335	.001
Voluntariness of use	–.292	.002

Note. $p < .05$.

.001 and 27.7% of the variability in actual usage behavior is explained by age. The model with the interaction effects demonstrated that increased age significantly strengthens the overall relationships between PE, EE, SI, and FC, and UB to use educational technology for IBL activities, $F(8, 83) = 5.06$, $p < .001$ and 32.8% of the variability in actual usage behavior is explained by age interacting with the four main variables. The interaction effect of age on the relationship between EE and UB was statistically significant, while PE, SI, and FC were not statistically significant.

The model with main effects including gender demonstrated that gender significantly affects UB to use educational technology for IBL activities, $F(5, 86) = 5.61$, $p < .001$ and 24.6% of the variability in actual usage behavior is explained by gender. The model with the interaction effects demonstrated that gender significantly strengthens the overall relationships between PE, EE, SI, and FC, and UB to use educational technology for IBL activities, $F(8, 83) = 4.17$, $p < .001$ and 28.7% of the variability in actual usage behavior is explained by gender interacting with the four main variables. The interaction effect of gender on the relationship between PE and UB was statistically significant, while EE, SI, and FC were not statistically significant.

The model with main effects including experience demonstrated that experience significantly affects UB to use educational technology for IBL activities, $F(5, 86) = 7.28$, $p < .001$ and 30% of the variability in actual usage behavior is explained by experience. The model with the interaction effects demonstrated that experience significantly strengthens the overall relationships between PE, EE, SI, and FC, UB to use educational technology for IBL activities, $F(8, 83) = 5.09$, $p < .001$ and 33% of the variability in actual usage behavior is explained by experience interacting with the four main variables. The interaction effect of experience on the relationships between PE, EE, FC, and SI were not statistically significant.

The model with main effects including voluntariness of use (VU) demonstrated that VU significantly affects UB to use educational technology for IBL activities, $F(5, 86) = 8.84$, $p < .001$ and 34% of the variability in actual usage behavior is explained by VU. The model with the interaction effects demonstrated that VU significantly strengthens the overall relationships between PE, EE, SI, and FC, and UB to use educational technology for IBL activities, $F(8, 83) = 6.13$, $p < .001$ and 37.1% of the variability in actual usage behavior is explained by voluntariness of use interacting with the four main variables. The interaction effect of VU on the relationship between FC and UB individually was statistically significant, while PE, EE, and SI were not statistically significant. between PE was statistically significant, while EE, FC, and SI were not statistically significant. See Table 16 for a summary of multiple regression analyses related to actual usage behavior of educational technology in IBL activities.

Table 16

UTAUT Variables and Predictability of Medical School Faculty Members' Actual Usage Behavior

Variable	*B*	*SE B*	β	*t*	*p*
PE with interaction					
Age	.02	.01	.19	2.02	.047
Gender	–.12	.18	–.06	–.65	.518
Experience	.37	.14	.24	2.60	.011
Voluntariness of use	–.29	.08	–.33	–3.56	.001
Age x PE	.01	.02	.49	.45	.651
Gender x PE	.51	.29	1.18	1.75	.083
Experience x PE	–.05	.24	–.18	–.19	.289
Voluntariness of use x PE	.16	.14	.89	1.14	.258
EE with interaction					
Age	.02	.01	.19	2.02	.047
Gender	–.12	.18	–.06	–.65	.518
Experience	.37	.14	.25	2.60	.011
Voluntariness of use	–.29	.08	–.33	–3.56	.001
Age x EE	–.04	.02	–2.47	–2.49	.015
Gender x EE	–.36	.28	–.76	–1.28	.204
Experience x EE	–.34	.32	–1.23	–1.07	.289
Voluntariness of use x EE	.09	.13	.49	.63	.529
SI with interaction					
Age	.02	.01	.19	2.02	.047
Gender	–.12	.18	–.06	–.65	.518
Experience	.37	.14	.25	2.60	.011
Voluntariness of use	–.29	.08	–.33	–3.56	.001
Age x SI	.02	.01	.94	1.37	.175
Gender x SI	.09	.29	.19	.31	.758
Experience x SI	.06	.19	.20	.29	.769
Voluntariness of use x SI	–.08	.13	–.36	–.61	.547

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Table 16 (continued)

Variable	*B*	*SE B*	β	*t*	*p*
FC with interaction					
Age	.02	.01	.19	2.02	.047
Gender	–.12	.18	–.06	–.65	.518
Experience	.37	.14	.25	2.60	.011
Voluntariness of use	–.29	.08	–.33	–3.56	.001
Age x FC	.02	.02	1.25	1.01	.314
Gender x FC	–.28	.33	–.61	–.87	.386
Experience x FC	.41	.28	1.49	1.46	.148
Voluntariness of use x FC	–.24	.13	–1.34	–1.82	.072

Note. $p < .05$.

Summary

The sample for this study included 92 medical faculty members in the United States. Because the survey was sent to multiple electronic discussion listservs, it is almost impossible to determine an accurate response rate. Professional use of educational technologies for use in inquiry-based learning activities was examined along with factors that impact its use by measuring their relationships to constructs in the UTAUT model. The constructs of the UTAUT model were positively related to medical faculty members' behavioral intent to use and their actual use of educational technologies for the delivery of IBL activities. Every participant reported that they are encouraged to use different teaching strategies other than traditional didactic ones, and every participant reported that there is a readily available and resourceful information technology department at their institutions. Regarding behavioral intent to use, use of educational technologies were predicted by PE, EE, and SI only. Regarding actual use, use of educational technologies was predicted by EE only.

CHAPTER 5

DISCUSSION OF FINDINGS

Introduction

This study examined medical education faculty members' acceptance of, behavioral intention to use (BI), and actual usage behavior (UB) of educational technology in the delivery of inquiry-based learning (IBL) activities. The unified theory of acceptance and use of technology (UTAUT) was the guiding framework for this study and purports that there are four main constructs: Performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) and four potential moderating variables (age, gender, experience, and voluntariness of use) that influence BI to use and UB of technology (Venkatesh et al., 2003). Three of these constructs are direct determinants of BI to use technology: PE, EE, and SI. There are also two direct determinants of UB of technology: BI and FC. This study was one of the first of its kind to use the UTAUT for this purpose. The benefit for stakeholders is that it assesses "the likelihood of success for new technology introductions and helps them to proactively design interventions (including training, marketing, etc.) targeted a populations of users that may be less inclined to adopt and use new systems" (Venkatesh et al., 2003, p. 426). This chapter will provide a discussion of the study's findings in relation to the relevant literature, limitations, and potential implications, as well as recommendations for future research.

Summary of the Study

A quantitative, descriptive, nonexperimental design was used for this study. A survey was administered during 3 weeks in October 2019 and a total of 92 usable surveys were returned. It is difficult to determine the response rate as the methods for dissemination of the survey included electronic discussion listservs with potentially changing populations of users. Data were collected to answer the following research questions:

1. What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?
2. What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning activities?
3. Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?
4. Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning activities?

Discussion of Findings

Sample Population

The sample population used for this study was medical educators who have taught inquiry-based learning (IBL) activities in the United States (US) within the last five years. Various electronic discussion listservs such as DR-ED, Team-based Learning Collaborative (TBLC), and EDUCAUSE lists (e.g., INSTTECH, BLEND-ONLINE, and INSTRUCTIONALDESIGN) were used to find potential participants. The DR-ED listserv was the most useful in terms of finding participants because it is directed specifically at medical educators. The TBLC list is a targeted list for practitioners of team-based learning activities. It is not specifically directed at medical educators; however, it was still useful for finding participants. The EDUCAUSE lists were least likely to include medical educators or those who deliver IBL activities; however, the hope was that subscribers would pass the survey request on to relevant colleagues.

In the survey data, age was a continuous variable and the mean age of participants was 53.47 years old. Groups of ages were created during data analysis to more easily describe the results. The age group with the most participants was 51-60 years old, which comprised 30.3% of the survey respondents, followed by 41-50 years old, and 27.3% of respondents. It is perhaps interesting to note that there were seven respondents who were over the age of 71, which comprised 7.7% of the respondents. The retirement age in the US is currently 66 years and two months for those born in 1955 or later, but it was traditionally set at 65 years old (National Academy of Social Insurance, 2019). It could mean that there were at least seven respondents who were still working after the traditional retirement age, or since one of the first questions requests responses from those who have delivered IBL in the past five years, it might mean they are no longer in the workforce. Gender responses were almost split down the middle, with males comprising 51.1% of the respondents and females comprising 48.9%. Educational experience showed that primarily those with terminal degrees (e.g., PhD, EdD, MD, etc.) responded to the survey, with just a small number of those with master's degrees or other relevant educational experience, including those with library science degrees.

For the question relating to teaching experience, the range with the highest percentage was 16-25 years (31.5%) followed by 26-35 years (27.2%). Academic rank reflected that most respondents were assistant professors (16.3%), associate professors (16.3%, and professors (38%). Similar to the question about gender, tenure track was almost split down the middle with those who are on a tenure track (52.2%) compared to those who are not on a tenure track (47.8%). Respondents involved in academic clinical medicine (46.7%) were compared to those who are not (53.3%). Academic clinical medicine experience results showed that those who teach students or residents in a clinical or healthcare environment comprised 44.6% of the participants responses. Supervising students or residents in a clinical or healthcare environment comprised 30.4% of the responses, and simulation-based training comprised of only 10.9%.

Every respondent reported that they are encouraged to use different teaching strategies other than traditional didactic instruction. However, despite being encouraged to try something different, 73.9% reported that they use traditional didactic methods when teaching. Those who have used the flipped classroom type of instruction comprised of 80.4%, which was the highest percentage of all of the options listed in the survey. In terms of IBL activities, case-based learning (CBL) comprised of 52.2%, problem-based learning (PBL) comprised of 34.8%) and team-based learning (TBL) comprised of 52.2% or respondents. Interestingly, 57.6% of respondents also chose case studies as an option. It could be argued that this option should not have been included in the survey since CBL, PBL, and TBL are all based on case studies, so it may have been a redundant choice. Participants were able to select more than one option for this question; therefore the results do not add up to 100%.

All 92 respondents reported that their institutions have a readily available and resourceful information technology department. There is an apparent contradiction with responses to some of the EE questions (e.g., it takes too long to learn how to use educational technologies to make it worth the effort for delivery of IBL activities). Some of the actual results for these specific EE questions showed that participants somewhat agreed that it did take too long to learn, despite having a resource such as information technology department. It could be that for those participants, that particular department is not responsible for teaching faculty how to use educational technologies.

Research Question 1

The first research question was focused on the relationships between performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC), and medical school faculty members' behavioral intent (BI) to use educational technologies in IBL activities. Prior to data analysis, the reliability of the overall UTAUT was confirmed. Cronbach's alpha was utilized and revealed strong reliability of each construct which was aligned with previous research findings (Hoque & Sorwar, 2017; Maruping et al., 2017; Šumak & Šorgo, 2016; Wang et al., 2014).

To examine this research question, Pearson's product-moment correlation was conducted to analyze the relationships between the main UTAUT constructs and BI to use educational technology for IBL activities. It was identified in the regression model that the four main constructs taken together showed a statistically significant relationship to BI $F(4, 87) = 28.63$, $p < .001$. Individually, the constructs of PE, EE, and SI showed statistically significant relationships to BI ($p < .001$ for EE and SI, and $p = .027$ for PE, however, FC did not show a significant relationship ($p = .620$). Therefore, the research hypotheses that predicted a positive relationship were supported in part, except for the one hypothesis concerning FC. This result is not surprising as other research studies have shown that FC has a more significant relationship to UB, and not so much to BI (Magsamen-Conrad et al., 2015; Venkatesh et al., 2003). This lack of relationship between FC and BI is supported by findings in other research. A study on the influence of factors on adoption of mhealth by the elderly found that PE, EE, and SI significantly influence BI to use mhealth products. Their findings also suggested that no significant relationship exists between FC and BI (Hoque & Sorwar, 2017).

It is not surprising that PE, EE, and SI have demonstrated such strong relationships to BI, because this is also reflected in the literature (Ifenthaler & Schweinbenz, 2013; Jewer, 2018). PE is defined as the benefits that could be created by using educational technologies in IBL activities. Venkatesh et al. (2003) declared that PE is dependent on individuals' personal opinion or view on their ability to properly use educational technology in IBL activities. It also suggests that faculty need to create a frame of reference to determine if and how technology could be integrated into their instruction practices. One way this can be done is to "focus on the purpose of the innovation and develop learner-focused teaching strategies in line with the purpose" (p. 388). The data reflects that medical educators are more likely to intend to use educational technology in their IBL activities if it would further their efforts and help them to be more confident in their content delivery.

EE is defined as the ease of use associated with using educational technologies in IBL activities. In a study by Chavoshi and Hamidi (2019) on social, individual technological and pedagogical factors influencing mobile acceptance in higher education in Iran, the authors found that "the better the control over the device will lead the less complexity of use, and therefore access to different parts requires less effort" (p. 156). The more user-friendly a design is, the more likely it will be perceived as requiring the least amount of effort to use. Fiedler et al. (2014) described barriers to educational technology adoption, which can impact faculty members' behavioral intention to use technology among nurse faculty members in terms of technical skills, pedagogical considerations, and institutional support. For technical skills, it was found that "one barrier that faculty must overcome in adopting new technologies is the need to learn the technical skills associated with the tool" (p. 388), which relates directly to EE.

SI is defined the way people perceive potential influence by others to use educational technologies in IBL activities. In a study by Murire and Cilliers (2017) on social media adoption among lecturers at a university in Eastern Cape Province of South Africa, SI was the largest contributor to the UTAUT model. The authors hypothesized that "a possible reason for this could be that academics, senior management and department of higher education need to support lecturers to use emerging technologies for teaching and learning purposes" (p. 5).

For this study, one could surmise that institutional support relates directly to EE and perhaps even FC, as resources such as training, support, and funding should be provided to faculty who are interested in incorporating educational technologies in their delivery of content. In this study, FC was found to not have a positive relationship to BI, which could be interpreted as a perceived lack of support or resources to support faculty members' intention to integrate educational technologies in IBL activities.

SI and EE had the most significant relationships ($p < .001$ for each) to BI. For SI, it appears that the perception of others influenced whether they intended to use educational technologies for IBL. It could represent a form or perception of peer pressure by colleagues. For EE, it was clear that the effort that someone has to make to use educational technology for IBL determined whether they intended to use it or not. More effort meant less likelihood to intend to use educational technologies, while less effort on the part of the teacher / facilitator meant more of a likelihood to intend to use educational technologies.

The weakest correlate of the constructs, FC, had a moderate relationship to BI, similar to the other three constructs. In the literature, FC is typically found to have a more direct influence on UB and bypasses the BI step altogether, which will be discussed in more detail in question two. FC is defined as a person's perception of the resources available to support the faculty in their usage of educational technologies in IBL activities.

Therefore, the following hypotheses were supported by this study's results:

H_{1a} PE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{2a} EE has a positive effect on medical school faculty members' BI to use educational technology in IBL.

H_{3a} SI has a positive effect on medical school faculty members' BI to use educational technology in IBL.

The following hypothesis was not supported by the study results:

H_{4a} FC have a positive effect on medical school faculty members' BI to use educational technology in IBL.

Research Question 2

The second research question was focused on the relationships between PE, EE, SI, and FC, and medical school faculty members' UB of educational technologies in IBL activities. To examine this research question, Pearson's product-moment correlation was conducted to analyze the relationships between the main UTAUT constructs and UB to use educational technology. It was identified in the regression model that the four main constructs taken together showed a statistically significant relationship to UB $F(4, 87) = 6.96$, $p < .001$. Taken individually, only EE had a significant relationship with UB, $p = .018$, while the significance value for PE was $p = .228$, SI was $p = .334$, and FC was $p = .534$.

These results could mean that with faculty development or other assistance available, faculty would be more likely to use technologies in their delivery of IBL activities. In a study by Ifenthaler and Schweinbenz (2013), participants felt strongly that for them to actually use certain devices for instruction purposes, the technology in question must be relatively free from effort on their part. A more appropriate research question for this study might have asked about the strength of the relationship between BI and FC on UB since that is what most studies using the UTAUT have investigated (Jewer, 2018; Mtebe, Mbwilo, & Kissaka, 2016) and this was also found to be the case when the UTAUT was first developed (Venkatesh et al., 2003). For example, in a study by McKeown and Anderson (2016) on an attempt to capture differences in undergraduate versus postgraduate learning in Australian schools, the researchers found that BI and FC were statistically significant in predicting UB for learning using the Moodle platform. The two-predictor model of UB was able to reflect 70% of the variance in undergraduate students and 63% of the variance in post graduate students.

Even though this research question could be perceived as flawed based on protocols in previous studies, the following hypothesis was supported by this study's results:

H_{2b} EE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

The following hypotheses were not supported by the study results:

H_{1b} PE has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{3b} SI has a positive effect on medical school faculty members' UB regarding educational technology in IBL.

H_{4b} FC have a positive effect on medical school faculty members' UB regarding educational technology in IBL.

For both Research Questions 1 and 2, the results were consistent when logistic regression was run on the same main constructs and a dichotomized BI and UB respectively and can be found in Tables 17 and 18 (Appendix H).

Research Question 3

The third research question was focused on determining if the variables of age, gender, experience, and voluntariness of use had a moderating effect on the relationships between PE, EE, SI, and FC, and medical school faculty members' BI to use educational technologies in IBL activities. According to theory, "a moderating factor may increase or decrease the effect of a construct on the dependent variables – intention and use behavior" (Gruzd, Staves, & Wilk, 2012, p. 2348).

When Venkatesh et al. (2003) performed their original studies to validate the UTAUT, they found that PE is typically a determinant of intention. The data for this study showed that there was a two-way interaction for PE here, with significant effects for the moderating variables of gender and VU ($p < .05$ for both), while age and experience did not have significant effects on the relationship between PE and BI. As the data show, gender was almost split evenly down the middle. The results could explain that a person's gender has only a slight impact on the strength of the relationship between PE and BI. The interaction of PE and VU was shown to be statistically significant ($p = .04$). This could mean that faculty feel that if their use of educational technologies is voluntary, they are more likely to intend to use it in their delivery of content. In their studies, Venkatesh et al. (2003) found that "the effect of performance expectancy was in the form of a three-way interaction–the effect was moderated by gender and age such that was more salient to younger workers, particularly men" (p. 461). The results of this study do not mirror the original work by Venkatesh et al.

None of the moderating variables had a significant interaction effect on the relationship between EE and BI. "The effect of effort expectancy on intention is also moderated by gender and age such that it is more significant for women and older workers" (Venkatesh et al., 2003, p. 467), and these effects tend to decrease with experience and support in using technologies that are available to them. However, this was not the finding for this study. None of the moderating variables had a significant interaction effect on the relationship between SI and BI.

In a study by Gruzd et al. (2012), the four moderating variables were not explored in relation to BI. However, they did observe that VU had a moderating effect on SI. For FC, only gender had a significant interaction effect on the relationship between FC and BI ($p < .05$). A study by García Botero, Questier, Cincinnato, He, and Zhu (2018) on acceptance and use of mobile assisted language learning by higher education students also did not explore the relationships between the moderating variables and the main constructs on BI. Their reasoning was that the study participants were all from the same university and had similar characteristics.

Research Question 4

The fourth research question was focused on determining if age, gender, experience, and voluntariness of use moderate the relationships between PE, EE, SI, and FC, and medical school faculty members' UB of educational technologies in IBL activities. Relationships of each moderator were examined before performing a multiple regression with interaction terms.

Gender did not have a significant relationship to UB. However, age, experience, and VU did have significant relationships to UB. As mentioned for question three, gender was almost split evenly down the middle, therefore it is perhaps not surprising that gender did not have a significant impact. Experience on the other hand did have a significant relationship ($p < .05$). The more experience a person has with a technology determines the likelihood of them actually using it for teaching IBL activities. Similarly, if using a technology is voluntary, it is more likely that faculty will actually use it.

In the extant research, age and experience have been found to be inversely related to faculty members' anxiety levels in their actual use of technology. In other words, the older and more experienced an instructor is, the more likely they have anxiety about their ability to use technology (Johnson et al., 2012). For the interaction terms with PE in this study, none of the moderator variables showed a significant effect on the relationship between PE and UB. This does not echo previous studies that showed PE and VU were the main predictors of actual use (Garone et al., 2019). For the interaction terms with EE, only age showed a significant effect (p = .02) on the relationship between EE and UB. This could mean that as age increases, the effort expected by the instructor to use a technology for delivering IBL activities goes up as well. For the interaction terms with SI, none of the moderator variables showed a significant effect on the relationship between SI and UB. For the interaction terms and FC, none of the moderator variables showed a significant effect on the relationship between FC and UB. This result aligns with a study by Murire and Cilliers (2017) on social media adoption among lecturers at a university in South Africa. However, Venkatesh et al. (2003) found that “the effect of facilitating conditions on usage was only significant when examined in conjunction with the moderating effects of age and experience–i.e. they only matter for older workers in later stages of experience” (p. 467). As mentioned for question two, a more appropriate question might have asked more specifically about the relationship between BI and FC (along with moderating variables) and their effect on UB. As has been found previously, “in predicting usage behavior, both behavioral intention and facilitating conditions were significant, with the latter’s effect being moderated by age (the effect being more important to older workers)” (Venkatesh et al., 2003, p. 461).

For both Research Questions 3 and 4, the results were consistent when logistic regression was run on the same main constructs with interaction terms and a dichotomized BI and UB respectively, and they can be found in Tables 19 and 20 (Appendix H).

Limitations and Recommendations for Future Study

One potential limitation of this study is the number of usable survey results. When a power analysis was run to determine the minimum number of results needed to support the study results, that number was 85. The usable results from the survey numbered 92, a positive difference of seven. Selection bias may have occurred among potential participants who are perhaps more familiar with IBL than those who are not and the former would be more inclined to complete the survey.

The results of this study may have various implications for future research. This study examined BI and UB of educational technology in IBL activities by employing the UTAUT. This study has shown that PE, EE, and SI are significant predictors of behavioral intent to use educational technology in IBL activities. Future research must now determine what interventions may be necessary to help faculty with their expectations of technology. For PE and EE, faculty development may be needed to fully understand perceptions of how technology should perform and how much effort they think is necessary for them to use technology appropriately. Future researchers can also look more closely at SI in their intention to use technology, for example, do faculty feel peer pressure to use technology?

In addition to these potential research opportunities, it would be worth investigating how EE impacts UB of educational technology, and why PE, SI, and FC do not impact it. The addition of variables (age, gender, experience, and voluntariness of use) open up a wide range of possibilities for future research. For example, researchers might want to investigate the linkages between age and gender and BI or UB of technology. Researchers might also want to look at levels of experience with technology and how it is impacted by age and gender.

While this study examines how PE, EE, SI, and FC predict BI and UB, it does not include how perceived barriers to the use of technology might influence its adoption. The results of this study can really only be generalized, and future researchers should try to replicate it with a larger sample and to investigate the effect of perceived or real barriers. It would be appropriate to study more specifically how faculty use certain technologies to deliver IBL activities and delve more deeply into the impacts that age, gender, and level of experience might have on it.

Implications for the Discipline of Medical Education

Results of this study are pertinent to medical education for a variety of reasons. Faculty do not always make optimal use of technologies for teaching and learning (Stols et al., 2015). This could be due to a perceived lack of internal support, though the data for this study demonstrated that all participants replied that their institutions have some sort of support mechanism available to them. Perhaps they only know that there exists such a support department, but do not know how to utilize the available support appropriately. Administrators could perform internal investigations on the usage of such support by faculty to determine what interventions might be needed, if any. Generational differences seemed to not have any impact on any aspect of intention to use technology but did have an impact on actual usage behavior. It might be worth exploring why this difference exists.

Even though reported gender was split almost evenly down the middle, it did show an impact on the relationships between PE, FC, and BI. Further investigation by administrators might uncover a belief system of behavioral intention that is somehow impacted by a faculty members' gender. Ensuring that the use of technology is voluntary is integral to a faculty members' level of expectation and their intention to use technology but does not seem to have an effect on their actual use of it for teaching purposes.

As technology continues to evolve and becomes more ubiquitous, intention to use and actual usage of it will also likely be impacted by how faculty members perceive it can improve their delivery of IBL activities. Our reliance on technology for teaching is only increasing as technologies blur the line between personal and professional use cases. Junior faculty need to cultivate their "network of peers, their professional image, and their portfolio of work and expertise" (Gruzd et al., 2012, p. 2349), whereas it is not perceived as important by more senior faculty. As faculty retire, future studies on this topic might reflect significantly different results, which will in turn require different interventions by administrators.

Summary

This study examined medical education faculty members' behavioral intent and actual usage of educational technologies for inquiry-based learning activities, using the unified theory of acceptance and use of technology. Major findings demonstrated that performance expectancy, effort expectancy, and social influence have a significant relationship with behavioral intention to use technology for teaching case-based activities. In addition, gender and voluntariness of use were both found to have significant effects on the relationship between performance expectancy and behavioral intention to use technology, and gender has a significant effect on the relationship between facilitating conditions and behavioral intention to use technology. For actual use of technologies, only age was found to have a significant effect on the relationship between only one of the main constructs, effort expectancy, and use. This was possibly the first of its kind on the application of this theoretical model to medical educators' behavioral intention to use and actual usage behavior of educational technologies for the delivery of inquiry-based learning activities. The results of this study can aid stakeholders in creating training and support mechanisms for faculty to adopt technology for teaching and learning.

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APPENDICES

APPENDIX A

EMAIL REQUEST FOR USE OF INQUIRY-BASED LEARNING INSTRUCTIONAL METHODS IN MEDICAL EDUCATION CHARTS

Subject: Re: Thank you for the AAMC Data Request
Date: Thursday, August 22, 2019 at 12:24:53 PM Central Daylight Time
From: External Data Request
To: Anderson, Max Carl
CC: salesforceauto-response@aamc.org

Max,

Great news, you may go forward with you intention to use the data, with proper citation (described midpage here https://www.aamc.org/initiatives/cir/curriculumreports/, in your dissertation).

Walter Fitz-William

--------------- Original Message ---------------
From: External Data Request [datarequest@aamc.org]
Sent: 8/22/2019 9:57 AM
To: max@uic.edu
Cc: salesforceauto-response@aamc.org
Subject: Re: Thank you for the AAMC Data Request

Hi Max,

I see the form you completed previously, I'll see if what else needs to be done to allow expanded use of the report.

Walter
--------------- Original Message ---------------
From: Anderson, Max Carl [max@uic.edu]
Sent: 8/22/2019 7:57 AM
To: datarequest@aamc.org
Cc: salesforceauto-response@aamc.org
Subject: Re: Thank you for the AAMC Data Request

Thank you, Walter – this helps quite a bit. And I apologize for MY delay in responding!

I am working on my PhD dissertation and part of it is on inquiry-based learning usage in medical schools. Do I have permission to take screenshots of some of these graphs and use them in my dissertation, with proper citation?

Thank you!

Max

From: External Data Request <datarequest@aamc.org>
Date: Thursday, August 1, 2019 at 1:02 PM
To: "Anderson, Max Carl" <max@uic.edu>
Cc: "salesforceauto-response@aamc.org" <salesforceauto-response@aamc.org>
Subject: Re: Thank you for the AAMC Data Request

Max,

It was brought to my attention that I did not answer your questions below. I apologize for the extensive delay in response. On the CI based graph, ci07, the percentages are provided across all instructional events submitted by

APPENDIX B

EMAIL REQUEST FOR PERMISSION TO USE TBL DIAGRAM FROM TBLC

Monday, February 25, 2019 at 8:43:39 AM Central Standard Time

Subject: Re: Permission to use TBL Image for Dissertation
Date: Monday, February 25, 2019 at 08:00:28 Central Standard Time
From: Danielle Inscoe
To: Anderson, Max Carl
Attachments: image001.png

Hi Max,

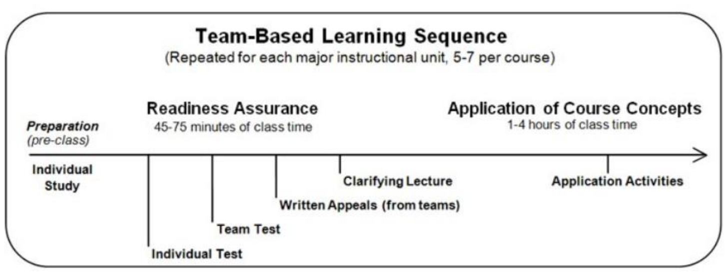
You can absolutely use that image. Thank you very much for checking!

Best regards,
Danielle

noto
Danielle Inscoe
Managing Director, TBLC
A 1000 5th Ave, Suite 100 Huntington WV 25701
P 304 208 8011
E danielle@tblcadmin.org W www.teambasedlearning.org

On Sat, Feb 23, 2019 at 7:43 PM Anderson, Max Carl <max@uic.edu> wrote:

> Hi Danielle!
>
> I'm currently writing my dissertation (Northern Illinois University, PhD in Instructional Technology) on behavioral intention of medical education faculty to use educational tech in inquiry-based learning.
>
> Can I use this image in my dissertation as long as I cite TBLC?



APPENDIX C

EMAIL REQUESTS FOR PERMISSION TO USE UTAUT THEORETICAL FRAMEWORK, SURVEY INSTRUMENT, AND MODEL

Note: I was not able to get permission from Dr. Michael G. Morris, one of the authors of the original paper where UTAUT is introduced.

From: **Ankur Arora** AArora@walton.uark.edu
Subject: Re: Permission to use UTAUT Model &
Date: March 18, 2019 at 13:34
To: Max Anderson z1812299@students.niu.edu

Hello Max,

Did you check your spam folder? I would request to submit the request again else you can take this email as an approval email to use the UTAUT model. But, you also need to get permission from the other authorities as mentioned in my earlier email.

Respectfully
Ankur Arora

From: Max Anderson <Z1812299@students.niu.edu>
Sent: Monday, March 18, 2019 1:31:53 PM
To: Ankur Arora
Subject: Re: Permission to use UTAUT Model &

Hi Ankur,

I submitted my request about a week or so ago via the website like you mentioned, but I haven't received a confirmation. For my dissertation, my chair insists that I have a document included in the appendix that show I got permission to use the image and the survey instrument.

I already bought his book! It's great.

Thank you!

Max

On Feb 24, 2019, at 16:10, Ankur Arora <AArora@walton.uark.edu> wrote:

> Dear Max,
>
> My name is Ankur and I am contacting on behalf of Prof. Venkatesh regarding your request. Thank you for your interest.
>
> All permissions and access to papers are handled through website: http://vvenkatesh.com. Once you go to papers section in the website, search for the respective paper and click on the download. You will be taken to a form and there you can specify your request and submit.
>
> Please note that you would also have to seek the necessary permission from the other authors and copyright owner (typically, the publisher of the journal) for any reproduction of any materials contained in the paper.
>
> You may also find Prof. Venkatesh's book to be of use: http://www.vvenkatesh.com/book/
>
> Thanks
> Ankur
>
> -------- Original message --------
> From: Max Anderson <Z1812299@students.niu.edu>
> Date: 2/23/19 7:58 PM (GMT-06:00)

From: **Gordon Davis** davis001@umn.edu
Subject: Re: Requesting permission to use UTAUT figure from 2003 article and theoretical framework instrument
Date: March 18, 2019 at 22:16
To: Max Anderson Z1812299@students.niu.edu
Cc: fred.davis@ttu.edu

Yes, go ahead.

The article and test are in the public domain. You do not need to contact all of the authors. You can use it with proper documentation of its source.

Gordon B Davis

On Mon, Mar 18, 2019 at 1:50 PM Max Anderson <Z1812299@students.niu.edu> wrote:

> Hello Dr. Davis, and Dr. Davis,
>
> I am a PhD candidate at Northern Illinois University writing about faculty members' behavioral intention to use educational technology. I would like permission to use the UTAUT framework, the Research Model as it appears on p. 447 of your 2003 study, and modify the instrument to meet the needs of my proposed study.
>
> I received permission from Dr. Venkatesh, but I can't seem to get in touch with Dr. Morris to get his permission. Do either of you have his information so I can request it?
>
> Thank you!
> Max Anderson
> PhD in Information Technology (ABD)
> Northern Illinois University

--
Gordon B Davis, Professor Emeritus of Information Systems
Carlson School of Management - University of Minnesota
New home address:
525 Fairview Avenue South
Apt. #204
St. Paul, MN 55116
Home phone: 651-695-5248
Cell phone: 651-645-4787

From: **Davis, Fred** Fred.Davis@ttu.edu
Subject: RE: Requesting permission to use UTAUT figure from 2003 article and theoretical framework instrument
Date: March 18, 2019 at 14:12
To: Max Anderson Z1812299@students.niu.edu

I think it is okay to proceed with the permission from Vnekatesh.

-----Original Message-----
From: Max Anderson <Z1812299@students.niu.edu>
Sent: Monday, March 18, 2019 1:50 PM
To: davis001@umn.edu; Davis, Fred <Fred.Davis@ttu.edu>
Subject: Requesting permission to use UTAUT figure from 2003 article and theoretical framework instrument

Hello Dr. Davis, and Dr. Davis,

I am a PhD candidate at Northern Illinois University writing about faculty members' behavioral intention to use educational technology. I would like permission to use the UTAUT framework, the Research Model as it appears on p. 447 of your 2003 study, and modify the instrument to meet the needs of my proposed study.

I received permission from Dr. Venkatesh, but I can't seem to get in touch with Dr. Morris to get his permission. Do either of you have his information so I can request it?

Thank you!
Max Anderson
PhD in Information Technology (ABD)
Northern Illinois University

APPENDIX D

INFORMED CONSENT

Dear Medical Educator,

You are invited to participate in a research study conducted by Max C Anderson, MLIS, MS, a PhD candidate in Instructional Technology from Northern Illinois University. I hope to learn more about educational technology use by faculty in medical education in specific educational activities. The purpose of this study is to measure acceptance of and behavioral intention to use educational technology by medical education faculty, specifically in inquiry-based learning (IBL) activities, using the unified theory of acceptance and use of technology (UTAUT) model. IBL activities considered for this study are case-based learning (CBL), problem-based learning (PBL), and team-based learning (TBL). The results will contribute to the completion of my dissertation study, *Assessment of Faculty Acceptance of, Behavioral Intention to Use, and Actual Usage Behavior of Technology in Inquiry-Based Learning in Medical Education: Using the Unified Theory of Acceptance and Use of Technology Model*.

If you decide to participate in this study, there are no more anticipated risks of harm than you would experience in everyday life. There is no cost to participate except the approximately 20-30 minutes of your time to complete the survey. The survey will be distributed by Qualtrics™. Qualtrics is a password-protected Internet survey website and is Health Insurance Portability and Accountability Act (HIPAA) compliant using an encrypted address to secure data that is transmitted via the Internet. The encrypted site allows anonymous survey results to be sent back directly to the researcher.

Data gained from this study will be stored up to three years and then destroyed. After three years, the survey on Qualtrics will be deleted with your responses, all saved information on the Statistical Package for the Social Sciences (SPSS) will be deleted, and all paper documents with questionnaire information will be shredded. Prior to this occurring, all data will be kept in a locked cabinet in the investigators home office. Results on Qualtrics are secured with password protection. Information that is collected may be used by the primary investigator at a future time; however, confidentiality will be maintained.

Your participation is voluntary. Refusal to participate and/or discontinuation of your participation at any time will involve no penalty or loss of benefits. To discontinue your participation in the research study, simply close your Internet browser. Directions on how to complete the survey will be provided on the actual survey itself. Information that is entered should represent your professional use of educational technology for IBL activities in medical education and your intent to use it in the future.

If you have any questions or concerns about this study, your rights in the study, or health-related concerns, please contact the principle investigator, Max C Anderson at 312-919-5143 or max.anderson@niu.edu. If you have questions related to the IRB approval or conduct of the research, please contact Dr. Cindy York (cindy.york@niu.edu).

Thank you for your consideration in completing this survey.

Max C Anderson, MLIS, MS

APPENDIX E

SURVEY INSTRUMENT

Title: Assessment of Faculty Acceptance of, Behavioral Intention to Use, and Actual Usage Behavior of Technology in Inquiry-Based Learning in Medical Education: Using the Unified Theory of Acceptance and Use of Technology Model

Max Carl Anderson
Northern Illinois University

Clicking below indicates that I have read the description of the study and I agree to participate in the study.

I agree (button)

1. Do you currently, or have you in the past 5 years, delivered (e.g., taught, facilitated) a minimum of one inquiry-based learning session (e.g., case-based learning, problem-based learning, or team-based learning) for medical students in the United States?

   Note: Please respond, even if you were part of a team of facilitators and did not deliver it by yourself.

   a. Yes *(continue on to Q2)*
   b. No *(branch to end of survey and thank you message)*

Demographic Information

2. What is your age in years?
   (dropdown list by age year from 18-90)

3. What is the gender with which you most identify?
   a. Male
   b. Female
   c. Non-binary
   d. Trans
   e. Prefer not to say

4. What is the highest level of education you have attained?
   a. Masters
   b. Doctoral (e.g., PhD, EdD, etc.)
   c. MD
   d. OD
   e. Other (please specify)

Experience / Employment Information

5. For how many years have you been teaching?

(dropdown list by number from 1 year or less – 40 + years)

6. What is your current academic rank?
    a. Adjunct Assistant Professor
    b. Adjunct Associate Professor
    c. Adjunct Professor
    d. Lecturer
    e. Instructor
    f. Assistant Professor
    g. Associate Professor
    h. Professor
    i. Clinical Instructor
    j. Clinical Assistant Professor
    k. Clinical Associate Professor
    l. Clinical Professor
    m. Research Instructor
    n. Research Assistant Professor
    o. Research Associate Professor
    p. Research Professor
    q. Visiting Assistant Professor
    r. Visiting Associate Professor
    s. Visiting Professor
    t. Other (please specify)

7. Do you currently hold a tenure-track position?
    a. Yes
    b. No

8. Are you involved in academic clinical medicine? (e.g., teach in a clinical environment, supervise in a healthcare environment, etc.)
    a. Yes *(branch to Q9)*
    b. No *(branch to Q10)*

9. Does your academic clinical medicine time involve any of the following? (Select all that apply)
    a. Teaching students or residents in a clinical or healthcare environment
    b. Supervising students or residents in a clinical or healthcare environment
    c. Simulation-based training
    d. Other (please specify)

10. I am encouraged to use different teaching strategies, other than traditional didactic ones (e.g., lecture) to engage students.
    N-S-AHT-M-A

11. What teaching strategies do you use? (Select all that apply)
    a. Didactic (e.g., lecture)
    b. Flipped classroom
    c. Blended learning
    d. Case-based learning
    e. Problem-based learning
    f. Team-based learning
    g. Online classes
    h. Case studies
    i. Simulation
    j. Artificial intelligence or virtual reality
    k. Group projects
    l. Laboratory or other hands-on work, including using cadavers
    m. Other (please specify)

12. Does your institution have a readily available and resourceful information technology (IT) department?
    a. Yes
    b. No

13. In what topic areas do you teach? (select all that apply)
    a. Basic sciences (e.g., anatomy, biochemistry, pharmacology, genetics, etc.)
    b. Clinical sciences (e.g., pathophysiology, pathology, psychiatry, pediatrics, genetics, etc.)
    c. Clinical care (e.g., teaching / mentoring students or residents)
    d. Community health / population health
    e. Evidence-based medicine
    f. Foundations of medicine
    g. Leadership
    h. Professional issues and trends
    i. Research skills
    j. Other (please specify)

14. What is the primary age group that you teach? (select all that apply)
    a. 18-21 years
    b. 22-25 years
    c. 26-29 years
    d. 30-33 years
    e. 34 + years
    f. I am not sure

Performance Expectancy
Performance expectancy is defined as 'the benefits that educational technology will create while performing activities in IBL.' Educational technologies can include computers, projectors, microphones, and software, etc.

15. I find educational technology to be useful in my delivery of IBL activities.

SD-D-U-A-SA

16. Using educational technology helps me accomplish tasks more quickly in my delivery of IBL activities.

SD-D-U-A-SA

17. Using educational technology increases my productivity in my delivery of IBL activities.

SD-D-U-A-SA

18. Using educational technology would make my delivery of IBL activities easier.

SD-D-U-A-SA

19. Using educational technology can increase the quantity of output for the same amount of effort in my delivery of IBL activities.

SD-D-U-A-SA

20. Using educational technology improves the quality of my delivery of IBL activities.

SD-D-U-A-SA

21. Using educational technology enhances my effectiveness in the delivery of IBL activities.

SD-D-U-A-SA

Effort Expectancy
Effort expectancy is defined as 'the degree of ease associated with your use of educational technology in your delivery of IBL activities.' Educational technologies can include computers, projectors, microphones, and software, etc.

22. Learning how to use educational technologies to deliver IBL activities is easy for me.

SD-D-U-A-SA

23. I would find educational technologies easy to use in my delivery of IBL activities.

SD-D-U-A-SA

24. My interaction with educational technologies is clear and understandable in my delivery of IBL activities.

SD-D-U-A-SA

25. I find educational technologies easy to use in my delivery of IBL activities.

SD-D-U-A-SA

26. It is easy for me to become skillful at using educational technologies in my delivery of IBL activities.

SD-D-U-A-SA

27. Using educational technologies takes too much time from my normal delivery of IBL activities.

SD-D-U-A-SA

28. Using educational technologies involves too much time doing mechanical operations during my delivery of IBL activities.

SD-D-U-A-SA

29. It takes too long to learn how to use educational technologies to make it worth the effort for delivery of IBL activities.

SD-D-U-A-SA

Social Influence

Social influence is defined as 'the way you perceive influential individuals' views on if you should use educational technologies in your delivery of IBL activities.' Educational technologies can include computers, projectors, microphones, and software, etc.

30. People who are important to me think that I should use educational technologies in my delivery of IBL activities.

SD-D-U-A-SA

31. People who influence my behavior think that I should use educational technologies in my delivery of IBL activities.

SD-D-U-A-SA

32. People whose opinions that I value prefer that I use educational technologies in my delivery of IBL activities.

SD-D-U-A-SA

33. Administrators have been very supportive of the use of educational technologies for the delivery of IBL activities.

SD-D-U-A-SA

34. In general, my organization has supported the use of educational technologies for the delivery of IBL activities.

SD-D-U-A-SA

35. People in my organization who use educational technologies for IBL activities have a high profile.

SD-D-U-A-SA

36. People in my organization who use educational technologies to deliver IBL activities have more prestige than those who do not.

SD-D-U-A-SA

Facilitating Conditions

Facilitating conditions is defined as ‘your perceptions of the resources available to support educational technologies in your delivery of IBL activities.’ Educational technologies can include computers, projectors, microphones, and software, etc.

37. I have the resources necessary to use educational technology in my delivery of IBL activities.

SD-D-U-A-SA

38. I have the knowledge necessary to use educational technology in my delivery of IBL activities.

SD-D-U-A-SA

39. Educational technology is compatible with the technology I use in my delivery of IBL activities.

SD-D-U-A-SA

40. I can get help from others when I have difficulty using educational technology in my delivery of IBL activities.

SD-D-U-A-SA

41. Specialized instruction concerning educational technologies for the delivery of IBL activities was has been available to me.

SD-D-U-A-SA

42. A specific person (or group) is available for assistance with educational technology difficulties during the delivery of IBL activities.

SD-D-U-A-SA

43. Using educational technologies fits into my delivery style for IBL activities.

SD-D-U-A-SA

44. Given the resources, opportunities and knowledge it takes to use educational technologies, it would be easy for me to use them for the delivery of IBL activities.

SD-D-U-A-SA

Voluntariness of Use
Voluntariness of use is defined as 'the lack of a requirement to use educational technologies in your delivery of IBL activities.' Educational technologies can include computers, projectors, microphones, and software, etc.

45. Although it might be helpful, using educational technologies in my delivery of IBL activities is certainly not compulsory.

SD-D-U-A-SA

46. My delivery style of IBL activities does not require me to use educational technologies.

SD-D-U-A-SA

47. My supervisor or administration do not expect me to use educational technologies in my delivery of IBL activities.

SD-D-U-A-SA

48. Using educational technologies for delivering IBL activities is voluntary (as opposed to required as part of my job).

SD-D-U-A-SA

Behavioral Intention
Behavioral intention is defined as ‘the intent to use educational technology in your delivery of IBL activities now or in the future.’ Educational technologies can include computers, projectors, microphones, and software, etc.

49. I intend to start using or continue using educational technologies in the future for my delivery of IBL activities.

SD-D-U-A-SA

50. I am determined that I will use educational technologies in the future for my delivery of IBL activities.

SD-D-U-A-SA

51. I plan to use educational technologies frequently for my delivery of IBL activities.

SD-D-U-A-SA

Actual Use of Educational Technologies
Educational technologies can include computers, projectors, microphones, and software, etc.

52. I currently use educational technologies in my delivery of IBL activities.

N-S-AHT-M-A

53. If you do not use educational technologies in your delivery of IBL activities, what are some of your reasons? (Select all that apply)
    a. Privacy concerns
    b. Timeliness
    c. Unfamiliar with the technology
    d. Unreliable information technology (IT) department
    e. Lack of resources at the organizational level
    f. Other (please specify)
    g. N/A *not included in data analysis*

54. I use the following educational technologies in my professional life, **for other than the delivery of IBL activities.**
    (matrix of N-S-AHT-M-A for each possible selection)
    a. Microsoft PowerPoint™ or other presentation software
    b. Projector
    c. Document camera (e.g., ELMO, etc.)
    d. Laptop / desktop computer
    e. Microphones and/or headset
    f. Webcam
    g. Web meeting software (e.g., WebEx, Zoom, Blackboard Collaborate, etc.)
    h. Learning Management Systems (e.g., Blackboard, Canvas, Moodle, etc.)
    i. Tablets (e.g., Apple™ iPad, Android™, Microsoft™ Surface Pro, etc.)
    j. Visual Microscope software

55. I use the following educational technologies in my delivery of IBL activities.
    (matrix of N-S-AHT-M-A for each possible selection)
    a. Microsoft PowerPoint™ or other presentation software
    b. Projector
    c. Document camera (e.g., ELMO, etc.)
    d. Laptop / desktop computer
    e. Microphones and/or headset
    f. Webcam
    g. Web meeting software (e.g., WebEx, Zoom, Blackboard Collaborate, etc.)
    h. Learning Management Systems (e.g., Blackboard, Canvas, Moodle, etc.)
    i. Tablets (e.g., Apple™ iPad, Android™, Microsoft™ Surface Pro, etc.)
    j. Visual Microscope software

Thank you for your responses. Your participation will help with understanding about how medical education faculty integrate technology in inquiry-based learning activities.

APPENDIX F

INVITATION EMAIL

Dear Medical Educator,

You are invited to participate in a research study conducted by Max C. Anderson, MLIS, MS, a doctoral student in instructional technology at Northern Illinois University.

The purpose of this study is to investigate the acceptance of educational technologies to deliver inquiry-based learning (IBL) activities among medical school faculty members. IBL is defined in this study as one of the three main types: case-based learning (CBL), problem-based learning (PBL), and team-based learning (TBL). Since the pedagogical delivery method of focus for this study is IBL, medical education faculty members who have experience in delivering a curricular session using IBL are requested to complete the survey. In addition, this study will investigate faculty members' behavioral intent to use and actual use behavior to integrate educational technologies in the delivery of IBL activities. The Unified Theory of Acceptance and Use of Technology (UTAUT) is the theoretical framework for this study.

The results will contribute to the completion of my dissertation study: *Assessment of Faculty Acceptance of and Behavioral Intent to Use Technology in Inquiry-based Learning in Medical Education: Using the Unified Theory of Acceptance and Use of Technology Model*.

Your input is greatly valued and will contribute to the limited body of knowledge related to this topic. Some of the small print:

- You understand that this project is designed to gather information about the use of educational activities among medical school faculty for inquiry-based learning activities.
- Your participation is completely voluntary.
- You understand that you will not be paid for your participation and you may withdraw and discontinue participation at any time.
- The survey should take you approximately 15-20 minutes to complete.
- Your responses will be kept confidential.

If you decide to participate in this confidential study, the survey can be access from:
[link]

Thank you for your consideration in completing this survey.

Sincerely,

Max C. Anderson, MLIS, MS
Northern Illinois University, PhD Candidate, Instructional Technology

APPENDIX G

REMINDER EMAIL

Dear Medical Educator,

You were invited to participate in a research study conducted by Max C. Anderson, MLIS, MS, a doctoral student in instructional technology at Northern Illinois University.

The purpose of this study is to investigate the acceptance of educational technologies to deliver inquiry-based learning (IBL) activities among medical school faculty members. IBL is defined in this study as one of the three main types: case-based learning (CBL), problem-based learning (PBL), and team-based learning (TBL). Since the pedagogical delivery method of focus for this study is IBL, medical education faculty members who have experience in delivering a curricular session using IBL are requested to complete the survey. In addition, this study will investigate faculty members' behavioral intent to use and actual use behavior to integrate educational technologies in the delivery of IBL activities. The Unified Theory of Acceptance and Use of Technology (UTAUT) is the theoretical framework for this study.

The results will contribute to the completion of my dissertation study: *Assessment of Faculty Acceptance of and Behavioral Intent to Use Technology in Inquiry-based Learning in Medical Education: Using the Unified Theory of Acceptance and Use of Technology Model*.

Your input is greatly valued and will contribute to the limited body of knowledge related to this topic. Some of the small print:

- You understand that this project is designed to gather information about the use of educational activities among medical school faculty for inquiry-based learning activities.
- Your participation is completely voluntary.
- You understand that you will not be paid for your participation and you may withdraw and discontinue participation at any time.
- The survey should take you approximately 15-20 minutes to complete.
- Your responses will be kept confidential.

If you decide to participate in this confidential study, the survey can be access from:
[link]

Thank you for your consideration in completing this survey.

Sincerely,

Max C. Anderson, MLIS, MS
Northern Illinois University, PhD Candidate, Instructional Technology *s*

APPENDIX H

LOGISTIC REGRESSION ANALYSES

Question 1

What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?

Table 17

Question 1 Logistic Regression Data Results

Variable	*B*	*SE B*	95% CI	*OR*	*p*
Performance Expectancy	.802	1.115	[.837, 5.943]	2.230	.109
Effort Expectancy	1.138	1.685	[1.082, 8.991]	3.119	.035
Social Influence	1.034	1.591	[.929, 8.523]	2.813	.067
Facilitating Conditions	-.378	.390	[.225, 2.092]	.686	.507

Note. $p < .05$.

Question 2

What are the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning activities?

Table 18

Question 2 Logistic Regression Data Results

Variable	*B*	*SE B*	95% CI	*OR*	*p*
Performance Expectancy	.374	.623	[.628, 3.366]	1.453	.383
Effort Expectancy	.908	1.184	[.972, 6.320]	2.478	.057
Social Influence	.070	.495	[.434, 2.652]	1.072	.880
Facilitating Conditions	.007	.488	[.390, 2.605]	1.001	.988

Question 3

Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' behavioral intention to use educational technology in inquiry-based learning activities?

Table 19

Question 3 Logistic Regression Data Results

Variable	*B*	*SE B*	95% CI	*OR*	*p*
PE with interaction					
Age	–.015	.030	[.927, 1.046]	.985	.623
Gender	–1.449	.169	[.057, .965]	.235	.044
Experience	1.208	1.899	[1.100, 10.176]	3.346	.033
Voluntariness of use	–.133	.352	[.398, 1.924]	.875	.740
Age x PE	.117	.081	[.976, 1.295]	1.124	.104
Gender x PE	.563	1.736	[.253, 12.189]	1.757	.569
Experience x PE	–1.400	.277	[.027, 2.232]	.247	.213
Voluntariness of use x PE	2.261	8.319	[1.752. 52.505]	9.591	.009
EE with interaction					
Age	–.015	.030	[.927, 1.046]	.985	.623
Gender	–1.449	.169	[.057, .965]	.235	.044
Experience	1.208	1.899	[1.100, 10.176]	3.346	.033
Voluntariness of use	–.133	.352	[.398, 1.924]	.875	.740
Age x EE	–.045	.061	[.845, 1.083]	.956	.480
Gender x EE	.832	2.864	[.200, 26.422]	2.299	.504
Experience x EE	–.934	.745	[.010, 16.162]	.393	.622
Voluntariness of use x EE	–.397	.472	[.170, 2.660]	.672	.572

(continued on next page)

Table 19 (continued)

Variable	*B*	*SE B*	95% CI	*OR*	*p*
SI with interaction					
Age	–.015	.030	[.927, 1.046]	.985	.623
Gender	–1.449	.169	[.057, .965]	.235	.044
Experience	1.208	1.899	[1.100, 10.176]	3.346	.033
Voluntariness of use	–.133	.352	[.398, 1.924]	.875	.740
Age x SI	–.037	.050	[.872, 1.065]	.964	.468
Gender x SI	.539	1.948	[.185, 15.892]	1.715	.635
Experience x SI	–1.363	.271	[.032, 2.046]	.256	.199
Voluntariness of use x SI	–.344	.405	[.231, 2.170]	.709	.546
FC with interaction					
Age	–.015	.030	[.927, 1.046]	.985	.623
Gender	–1.449	.169	[.057, .965]	.235	.044
Experience	1.208	1.899	[1.100, 10.176]	3.346	.033
Voluntariness of use	–.133	.352	[.398, 1.924]	.875	.740
Age x FC	–.048	.065	[.834, 1.090]	.953	.485
Gender x FC	–2.180	.150	[.008, 1.522]	.113	.100
Experience x FC	3.697	73.484	[1.135, 1433.320]	40.339	.042
Voluntariness of use x FC	–1.542	.145	[.056, .811]	.214	.023

Question 4

Do age, gender, experience, and voluntariness of use moderate the relationships between performance expectancy, effort expectancy, social influence, and facilitating conditions and medical school faculty members' actual use of educational technology in inquiry-based learning activities?

Table 20

Question 4 Logistic Regression Data Results

Variable	*B*	*SE B*	95% CI	*OR*	*p*
PE with interaction					
Age	.058	.031	[1.001, 1.121]	1.060	.048
Gender	–.355	.406	[.226, 2.176]	.701	.539
Experience	1.117	1.568	[1.118, 8.354]	3.055	.030
Voluntariness of use	–.856	.171	[.193, .934]	.425	.033
Age x PE	–.004	.055	[.894, 1.109]	.996	.938
Gender x PE	1.892	6.590	[.946, 46.502]	6.632	.057
Experience x PE	–1.191	.288	[.047, 1.946]	.304	.209
Voluntariness of use x PE	.916	1.591	[.718, 8.702]	2.500	.150
EE with interaction					
Age	.058	.031	[1.001, 1.121]	1.060	.048
Gender	–.355	.406	[.226, 2.176]	.701	.539
Experience	1.117	1.568	[1.118, 8.354]	3.055	.030
Voluntariness of use	–.856	.171	[.193, .934]	.425	.033
Age x EE	–.127	.059	[.773, 1.004]	.881	.057
Gender x EE	–.533	.681	[.060. 5.696]	.587	.646
Experience x EE	–.367	.816	[.069, 6.975]	.693	.756
Voluntariness of use x EE	.365	.947	[.397, 5.228]	1.440	.580

(continued on next page)

Table 20 (continued)

Variable	*B*	*SE B*	95% CI	*OR*	*p*
SI with interaction					
Age	.058	.031	[1.001, 1.121]	1.060	.048
Gender	–.355	.406	[.226, 2.176]	.701	.539
Experience	1.117	1.568	[1.118, 8.354]	3.055	.030
Voluntariness of use	–.856	.171	[.193, .934]	.425	.033
Age x SI	.059	.045	[.976, 1.154]	1.061	.164
Gender x SI	1.191	3.254	[.474, 22.863]	3.291	.228
Experience x SI	.360	1.025	[.353, 5.823]	1.434	.614
Voluntariness of use x SI	–.610	.282	[.196, 1.504]	.543	.240
FC with interaction					
Age	.058	.031	[1.001, 1.121]	1.060	.048
Gender	–.355	.406	[.226, 2.176]	.701	.539
Experience	1.117	1.568	[1.118, 8.354]	3.055	.030
Voluntariness of use	–.856	.171	[.193, .934]	.425	.033
Age x FC	.085	.078	[.946, 1.253]	1.089	.236
Gender x FC	–2.640	.086	[.006, .759]	.071	.029
Experience x FC	1.417	4.432	[.502, 33.891]	4.124	.187
Voluntariness of use x FC	–.899	.223	[.139, 1.189]	.407	.100