2022

Oil Rig Trainees' Perspectives on the Influence of Drilling Simulation on Their Learning and Motivation

Adel Mohamed Hassanein Abdelaziz
Walden University

Walden University

College of Education

This is to certify that the doctoral dissertation by

Adel Mohamed Hassanein Abdel Aziz

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Loren Naffziger, Committee Chairperson, Education Faculty
Dr. Heather Pederson, Committee Member, Education Faculty
Dr. Alice Eichholz, University Reviewer, Education Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2022

Abstract

Oil Rig Trainees' Perspectives on the Influence of Drilling Simulation on Their Learning and Motivation

by

Adel Mohamed Hassanein Abdel Aziz

MSc, Walden University, 2012

BSc, Ain Shames University, 1977

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Education: Learning, Instruction, and Innovation

Walden University

November 2022

Abstract

Low enrollment levels in vocational drilling training programs in the Arabian Gulf area have resulted in a talent gap, with little success in building and retaining national crews. With current simulation technology, it is believed that trainees' learning, motivation, and achievements will increase; however, further study is needed to determine if these conclusions hold. The purpose of this basic qualitative study was to explore how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at an oil-field drilling rig's vocational training facility. Davis's technology acceptance model concerning user reception of information systems formed the conceptual framework. Semistructured virtual interviews were conducted with 10 purposely sampled drilling crew trainees. Data were transcribed, and manual descriptive coding was used to identify five themes that addressed the research questions. The first three themes reflected the ease and usefulness of teaching drilling application skills using the simulator technology. The other two themes applied to how using the drilling simulator motivated the trainees and made them eager to complete their studies. The study's findings showed that drilling simulators are an effective teaching tool, creating an easy-to-operate, hands-on-the-job training environment and increasing overall competencies. Results from the study could inform drilling contractor training facilities' leaders about the importance of increasing drilling simulation practices covering all possible drilling job activities. The use of drilling simulations could promote positive social change at the trainee level, the country's drilling rig workforce level, and the regional level through better learning and understanding of drilling processes.

Oil Rig Trainees' Perspectives on the Influence of Drilling Simulation on Their Learning and Motivation

by

Adel Mohamed Hassanein Abdel Aziz

MSc, Walden University, 2012

BSc, Ain Shames University, 1977

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Education: Learning, Instruction, and Innovation

Walden University

November 2022

Dedication

This dissertation is dedicated to the Almighty God; I thank you for providing me with the guidance, strength, love, and wisdom necessary to complete it. I dedicate this to my family. My beloved wife of 32 years, Abeer; my son, Abdullah; and my daughter, Aya, for their continuous support and encouragement to accomplish such a great dream. To my mom and to my dad, who did not live to see me complete this journey, and who always believed in me and planted a deep passion for learning. To all people who believed in me and supported me, you helped me achieve this goal and have the love in my heart to do good for others and help our society. I couldn't have done this without your faith, love, and support. I extend special thanks to the partnering organization's management team; to Eng. Mohamed El Gamal for his effective coordination, wise help, and support; and to all the drilling crews' patinate participants who inspired me to complete this study in such a way.

Acknowledgments

I would like to acknowledge my dissertation committee chair, Dr. Loren Naffziger, for his thorough guidance, patience, and continuous support. Thanks, Dr. Naffziger, for believing in me and directing me throughout this dissertation journey. Thank you, Dr. Heather Pederson, for your wise guidance and support towards my dissertation methodology, and thank you, Dr. Alice Eichholz (URR). I greatly appreciate your effort spent on this; I could not have done it without it.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Society is continuously integrating technological development into education. Kiryakova et al. (2018) stated that the education system must adapt to society's development to provide an innovative learning environment that can prepare learners for the future. Kiryakova et al. found that most of the present learning delivery methods are designed for a learner who is a passive participant in the learning process, which is nonproductive and does not lead to promising results. They also noted that combining new technologies with advanced pedagogical techniques and practices will develop an immersive digital learning environment where collaborative research and interaction between learners are possible. In such an environment, learning will be more engaging and exciting for learners and motivate them to participate in the educational process. Consequently, training's consistency and efficacy will be improved (Kiryakova et al., 2018).

Fernandez (2017) stated that augmented reality (AR) allows learners to perceive the environment around them with more engagement and interaction. AR motivates the student to stay focused and attentive in the classroom (Kiryakova et al., 2018). However, by examining various empirical studies, Huang and Laiw (2018) indicated that more research is required to explore how using AR in learning settings may influence trainees' learning and motivation. Therefore, this study explored how using simulation training technology applications in drilling education affected trainees' learning and motivation on oil rigs.

This chapter will address the background, problem, and purpose of exploring the

influence of using a drilling simulator on trainees' learning and motivation. I will provide the research questions (RQs) that guided this research study, the conceptual framework, the nature of the study, relevant definitions, and assumptions. Additionally, I will describe the study's scope and delimitations, limitations, and significance.

Background

A variety of simulation technologies are used in different training and educational settings. For example, using simulation in training health science students has helped improve learners' safety, competency, and job skills compared with conventional educational training methods (Cowling & Birt, 2018). Accordingly, many current studies have addressed the effect of using simulations in training and educational settings. Akçayır and Akçayır (2016) completed a systematic literature review on the effects of using AR simulation technologies in educational settings. Studies completed by Reyhan et al. (2018) and Chiang et al. (2014) showed that using AR and simulation technology may improve students' communication skills, critical thinking, professional skills, motivation in their focus of study, trust, and professional accountability. Akçayır and Akçayır, Chiang et al. and Reyhan et al. concluded that the introduction of simulation technology applications in education would increase learning, motivation, and the learning achievements of students and provide a unique advantage in a working environment by mixing virtual and actual objects.

In quantitative studies by Awad et al. (2019) and Martin and Omrani (2015), the researchers identified the relationship between simulation technology use and nursing students' and employees' attitudes. The results indicated that simulation would be an

excellent bridge between theoretical structure and implementation when used in nursing education. Hence, Awad et al. concluded that the study group's nursing students showed a positive attitude toward using simulation technology in their teaching and training applications. Martin and Omrani also confirmed that innovative work practices are positively correlated with employees' positive attitudes, and these attitudes are positively related to their intention to stay at work.

Retaining Generation Y oil and gas workforce trainees requires that they become motivated, engaged, and rewarded in order to be willing to keep their jobs. Jauhar et al. (2017) studied the impact of rewards and transformational leadership on Generation Y employees' intentions to leave their jobs in the oil and gas industry and the moderating effect of job satisfaction. Their study provided evidence that job satisfaction is one of the most crucial factors in keeping Generation Y in the oil and gas industry—more than rewards and transformational leadership. Jauhar et al. provided insight into primary concerns regarding oil and gas Generation Y employees' motivation and job satisfaction factors.

Although a substantial amount of research has been done on the efficacy of using simulation technologies, only a few have investigated the learning and motivation effects of using simulation technologies in education (Huang & Laiw, 2018). Therefore, it is not clear how using simulation training technologies may influence trainees' learning, motivation, and perspectives about completing their education at the oil-field drilling rig's vocational training facilities. My study explored how using simulation technologies

influenced trainees' learning, motivation, and perspectives about their education at these training facilities.

Abulhassan (2016) completed a study on professional drilling workers and found that using a live computer-based drilling simulator that combines hands-on drilling practices and theoretical explanations was more successful than a typical classroom environment alone. In this study, I explored how using a drilling simulator helped the drilling trainees to know and learn more about the drilling equipment, oil-well-control principles, and operations procedures. The study also examined the drilling vocational trainees' perspectives about how using these simulators in educational settings may have motivated them and positively affected their decisions to complete their education. The study results helped close the research gap by providing an understanding of how drilling simulations can improve learning and motivation as well as impact trainees' perspectives to complete their vocational training program.

Problem Statement

The problem is that there is a talent gap and little success in building and retaining national crews using the drilling vocational training facilities in Saudi Arabia and the Gulf area (Saudi Aramco, 2018). The results of a nationwide feasibility study showed the need for approximately 90,000 Saudis to be trained over the next 20 years to meet the drilling rig industry's growth plans (Saudi Arabia Drilling Academy [SADA], 2016). Using simulations in education settings may improve trainees' communication and professional skills, critical thinking, and professional accountability. Simulations may also reduce the trainees' concerns during practice and positively influence their entry into

this profession (Reyhan et al., 2018). However, it is not clear how using drilling simulation technologies may influence trainees' learning, motivation, and intention to complete their vocational training program. Chiang et al. (2014) stated that integrating simulation technology such as AR into education would enhance trainees' learning, motivation, and learning achievements. Akçayır and Akçayır (2016) noted that using AR in an educational setting offers a unique advantage—a combination of virtual and real objects in a working environment.

AlNajdi's (2022) study findings demonstrated that AR in education could offer positive opportunities and impact the development of education and support for students. The researcher agreed with Tsiavos and Sofos (2019, as cited in AlNajdi, 2022) that AR's positive impact on education includes (a) learning benefits, (b) offering a motivating environment, (c) engaging students, (d) helping students to focus on the lesson, (e) changing students' attitudes positively toward the lesson, (f) exciting students, (g) increasing students' eagerness, (h) growing students' knowledge, (i) increasing students' eagerness, and (j) developing students' observational skills. AlNajdi's study emphasized the need for future research to examine and assess AR settings for the purpose of verifying their design through instructional design models to ensure their compatibility with education and student characteristics.

Huang and Laiw (2018) reported that only a few empirical studies had examined the relationship between learning motivation and learning outcomes while using AR in an educational setting. Therefore, the authors emphasized the need for further research to explore how the educational environments, while using simulation applications, would

affect the trainees' learning and motivation. Closing this research gap may help provide an understanding of how the drilling simulations' influence could enhance trainees' learning and motivation and influence their perspectives regarding completing their vocational education.

Purpose of the Study

The purpose of this basic qualitative study was to explore how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at the oil-field drilling rig's vocational training facility. Abulhassan (2016) claimed that using a live computer-based drilling simulator that combines hands-on drilling practices and theoretical explanations is more successful than a typical classroom environment alone. Using a drilling simulator may help the drilling crews understand how the drilling equipment works and how to use it efficiently, as well as to learn oil-well-control principles and procedures. Supporting learners' success with simulation technologies may help Gulf Cooperation Council countries achieve their national plans concerning the development of the native workforce within the drilling industry and to build localized talent pools (Saudi Aramco, 2018). There is a problem in Saudi Arabia regarding obtaining and retaining local talent. Despite the Saudi government's efforts to recruit workers, 90% of technical positions, such as jobs at drilling rigs, are occupied by expatriates (Yamada, 2018).

Research Questions

To address the problem and purpose of this study, I used the following RQs as a guide:

RQ1: What are drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their learning?

RQ2: What are drilling-rig vocational trainees' perspectives on the influence of drilling simulation technologies on their motivation to complete their education?

Conceptual Framework

This study's conceptual framework was based on Davis's (1985) technology acceptance model (TAM), a theory about user acceptance of information systems. TAM explains technology users' learning and motivation by two significant constructs: perceived ease of use (PEOU) and perceived usefulness (PU). Davis defined PEOU as "the degree to which a person believes that using a particular system would be free from effort" (p. 26) and PU as "the degree to which a person believes that using a particular system would enhance his or her job performance" (p. 26). This refers to whether trainees perceive the simulation technology as useful for their training, if they perceive that it is easy to use, and if they view it as encouraging and motivating.

TAM theory fit broadly as a conceptional framework for this research. The two constructs, PEOU and PU, guided the study through the role of the drilling simulators to determine whether their use influenced the drilling trainees' learning and motivation and, consequently, their decisions to complete their studies. The ease of using the drilling simulator may encourage the trainees to practice and complete their training applications. The anticipated usefulness of the drilling simulator practices could be a significant factor in improving trainees' performance during hands-on training practices, enhancing their

learning, increasing their self-confidence, and motivating them to join and complete drilling training programs.

The constructs of the conceptual framework (PEOU and PU) were used to develop two groups of semistructured interview questions. One group was used to measure the ease of use of the drilling simulator and how this PEOU attracts trainees and encourages them to understand and complete their practices. The second group was used to explore the usefulness of the simulator and how the PU may improve trainees' performance, skills, and motivation. Interview questions were open ended and guided by the list of subjects explored (see Merriam & Tisdell, 2016).

Nature of the Study

For this study, I used a basic qualitative research design. Merriam and Tisdell (2016) stated that the researcher should be interested in understanding people's meaning-making and qualitative research processes. Merriam and Tisdell described basic qualitative research as philosophically derived from constructionism, phenomenology, and symbolic interaction. It is used to help the researcher understand: "1- how people interpret their experiences, 2- how they build their worlds, and 3- what meaning they attribute to their experiences" (Merriam & Tisdell, 2016, p. 23). The main reason for using this design was to better understand the meaning of people's lives and experiences. This qualitative research design also allows flexibility in sample size and data collection procedures (Patton, 2015) and for the researcher to focus solely on interviews for data collection.

Definitions

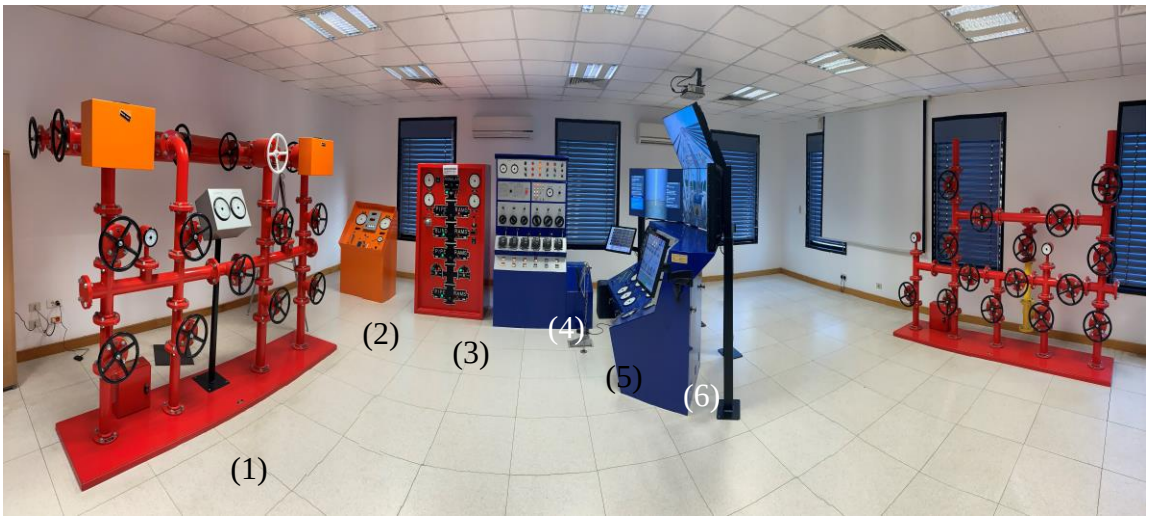
The following terms are used extensively in this research study.

AR: A technology that integrates digital information with real environments, which, in turn, allows it to be processed and produced in real time (Fernandez, 2017).

Drilling simulator: A computer-based program that simulates the drilling of live oil and gas well operations and provides a combination of practical, hands-on training in addition to theoretical explanations (Abulhassan, 2016). Figure 1 shows a photograph of a drilling simulator.

Figure 1

Drilling Simulator



Note. Drilling simulator components: (1) standpipe and chock manifold; (2) chock control panel; (3) blow-out preventer remote panel; (4) driller control panel; (5) manual brake; and (6) driller console. Photo DS500, by Drilling Systems, 2022.Copyright 2022. Reprinted with permission (see Appendix A).

Motivation: W. C. Liu et al. (2016) defined this as “the force that activates, directs, and sustains goal-directed behavior” (p. 1).

Virtual reality (VR): A technology that offers users the chance to immerse themselves in a controlled world that simulates reality. Individuals may be submerged in such realities with the sense of sight by using visualization goggles, with touch by wearing haptic gloves, and with hearing by using headphones. The technology that makes VR possible is based on software technologies that communicate with peripherals (Fernandez, 2017).

Assumptions

Assumptions are elements of a study that the researcher believes are true but cannot be validated. This study was built on several assumptions. First, I assumed that the participants would openly answer the interview questions based on their experiences of interaction with the drilling simulator. After I experienced the simulator benefits myself, I generated interview questions by selecting and reviewing pertinent literature and considered my understanding in this area. Second, I assumed that the participants had engaged in and completed all assigned drilling simulator training applications before the interviews, as their experiences and interactions with the drilling simulator were essential for them to answer the interview questions. Lastly, I assumed that my professional background in drilling simulation training and as an oilfield subject matter expert would help me understand the participants' technical expressions within the study’s context.

Scope and Delimitations

The scope of this study was based on certain boundaries. The purpose of this qualitative study, which was to explore how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at the oil-field drilling rig's vocational training facility, was one of the boundaries. The empirical literature on integrating simulation technology applications in educational settings was mainly focused on high school and undergraduate education. This gap in the literature indicated a need to obtain students' and trainees' perspectives on the influence of simulation technologies on learning, motivation, and achievements (see Akçayır & Akçayır, 2016; Chiang et al., 2014; Reyhan et al., 2018). A basic qualitative research design was chosen as the best approach to work within the boundaries of the study's purpose, as the literature pointed to a gap in descriptions of trainees' perspectives about the influence of using drilling simulators on their learning and motivation.

Delimitations refer to the study's scope and the extent to which its findings could be generalized. The delimitations of this study apply to the selection of the participants based on specific inclusion criteria. First, the sample only included trainees from a drilling vocational institute who had proactively completed their drilling simulator training sessions. Second, the trainees' ages ranged from 24–32 years and included those with good command of the English language in addition to Arabic language speakers. Arabic was the mother tongue of all the trainees. Lastly, the participants had either recently graduated from the drilling vocational institute or had completed the final technical training module.

Limitations

The study's limitations are defined as flaws in the design or the methodology used to conduct the research, affecting the findings' generalization (Price & Murnan, 2004). The limitation in doing a basic qualitative study is that the participants' perceptions are considered data and do not represent empirical or numerical findings. However, conducting in-depth interviews and being immersed in the culture and the oil industry helped me collect research-specific data through subject-focused interview questions.

The study was conducted using convenience instead of random sampling, which may have increased the risk of bias. Creswell (2009) suggested that the ability to generalize from a convenience sample is limited. The sample may not be an accurate representation of all drilling institutes' vocational trainees in different settings and different circumstances.

The difference in circumstances, such as the drilling vocational institute's procedures for simulation experiences, different types of simulators, how the simulation content of the topic was delivered, and the trainees' preparation for the simulation experiences, could not be controlled and may have influenced outcomes during the simulation experiences. However, there are commonalities in the drilling simulator applications in the industry across the globe. Additionally, Saudi Arabia's oil community has created a formal drilling vocational training academy in addition to the presence of a few drilling corporations and internal training facilities that could be considered equivalent to vocational training institutes (SADA, 2016). Such conditions indicated that it was suitable to explore how using simulation technologies may influence trainees'

learning, motivation, and perspectives about completing their education at the oil-field drilling rig's vocational training facilities.

To decrease possible bias, I made sure that I did not know or meet with the participants before the research. I had no affiliation with the drilling vocational training facility. The trainees were provided detailed information about the research study; participation was voluntary and without retribution if they did not wish to take part. Such noncoercive measures for participation decreased any bias I might have had with the trainees' interview data and increased the study's validity.

Significance

This study is significant because it provides insight into how using simulation technologies in educational settings may increase trainees' learning and motivation and positively influence their intent to complete their education at drilling vocational institutes. Such a positive environment may also encourage more Saudi nationals to join drilling vocational institutes. The influence of using drilling simulators in training and work-related environments was examined to identify how using simulation technologies affects trainees' learning, motivation, and intent to complete their education.

My goal for this study was to apply my knowledge and effort to real-life situations through careful study to determine the reasons behind the study's problem and suggest solutions that help resolve it and promote social change. The study may promote positive social change when drilling simulation, including AR, is used to educate, motivate, and encourage current trainees to complete their training programs. It could also attract more nationals to the oil drilling industry, foster social responsibility, and

help create more job opportunities for Saudi youth, of whom approximately 40% are currently unemployed (Yamada, 2018). Other benefits are possible when more trainees decide to complete their education and stay within the industry. More trainees will reduce the high training costs per individual, increase competitiveness, and increase national employment levels, particularly among the rigs' technical job families.

Summary

The use of innovative technology, such as drilling simulators in educational settings, has become essential. It helps attract more trainees, which is significant given the low number of trainees at oil drilling vocational training institutes. Chapter 1 included an overview of the study's problem: that there is a talent gap and little success in building and retaining national crews in Saudi Arabia and the Gulf region. The chapter provided a discussion of how the problem is significant in the oil drilling industry and included a brief background on how using simulation technology, including AR, has helped to resolve similar problems in different educational settings.

Chapter 2 includes a solid foundation as shown in the research literature on the use of simulation technology, including VR and AR, in different educational settings. This chapter provides a literature review regarding integrating simulation technology and its applications in learning, which may improve different training settings for education and various specialties. The chapter also contains a discussion on how this affects the trainees' learning achievements and how it is related to this study.

Chapter 2: Literature Review

The drilling vocational training facilities within the Arabian Gulf area suffer from an ongoing failure to build and retain national crews (SADA, 2016). A Saudi nationwide feasibility study indicated the requirement to train approximately 90,000 Saudis over the next 20 years to meet the drilling rig industry's growth plans. To address this problem, Akçayır and Akçayır (2016), Chiang et al. (2014), Reyhan et al. (2018), and AlNajdi (2022) identified that integrating simulation technology and its applications such as VR and AR into learning may help attract new students and retain current ones through improving educational settings, trainee motivation, and achievements.

Akçayır and Akçayır (2016), Chiang et al. (2014), and Reyhan et al. (2018) completed different studies on the effect of using simulations in education. These studies showed that using simulations may improve students' communication skills, critical thinking, professional skills, and professional accountability. Simulations could also reduce student concerns during practice and positively influence their entry into the profession. Akçayır and Akçayır, Chiang et al., and Reyhan et al. agreed that integrating simulation technology applications in education would enhance student learning, motivation, and learning achievements and offer the unique advantage of combining virtual and real objects in a working environment.

Several empirical studies were examined by Huang and Laiw (2018) to identify the relationship between learning motivation and learning outcomes while using simulation technology, including AR, in an educational setting. The authors of these studies indicated that more research is needed to explore how using simulation

technology, including AR, in learning settings may influence the trainees' learning and motivation (Huang & Laiw, 2018). It is not clear how using training simulation technologies including AR in drilling education may improve learning and motivation for trainees or affect their intention to complete their vocational training program. Closing this research gap includes providing a better understanding of how the drilling simulators' influence would enhance these outcomes.

The purpose of this basic qualitative study was to explore how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at the oil-field drilling rig's vocational training facility. Using simulation technologies could provide time for practice and feedback, increasing hope and self-efficacy (Bragg et al., 2017). Such conditions, in turn, may motivate trainees at drilling vocational institutes and positively affect their decisions to complete their education. Supporting learners' success with simulation technologies, including AR, could help Gulf Cooperation Council countries achieve their national plans to develop the native workforce within the drilling industry and build localized talent pools (Saudi Aramco, 2018). There is a problem in Saudi Arabia concerning recruiting and retaining local workers. Despite the Saudi government's efforts, 90% of technical positions, such as jobs at drilling rigs, are occupied by expatriates (Yamada, 2018).

AR technology dates back more than 50 years and can be used on several platforms, such as PCs, laptops, and smartphones. It is an essential contribution to education and is utilized in many fields, such as history, biology, health, physics, chemistry, geometry, astronomy, and many other areas, including engineering education,

military training, special education, and cultural knowledge instruction. AR is primarily used to identify objects not able to be seen by the human eye, simulate unsafe situations, simplify and clearly explain indefinable concepts, and present different scenarios for complex subjects (Yilmaz & Göktaş, 2018). Using AR in education is expected to increase attention and learning effectiveness, make learning more enjoyable, and improve student interaction and motivation. However, schools need to provide the necessary technical foundation and train more teachers to improve in using AR in education. More research is also needed to determine learning approaches, teaching methods, and the use of AR in learning environments (AlNajdi, 2022).

This chapter provides details regarding the literature search strategy for peer-reviewed articles used for the study. I discuss Davis's (1985) TAM, a theory concerning user acceptance of information systems. TAM explains technology users' learning and motivation with two significant constructs: PEOU and PU. A technology user's motivation and learning outcomes while using simulation technology, including AR, as part of the educational setting will be evaluated based on these constructs.

Literature Search Strategy

Various and extensive literature search strategies were utilized for this research study, focusing on peer-reviewed literature. Keywords were used to search throughout the databases of Walden University Library, Thoreau, and Google Scholar. Other databases searched included ABI/INFORM Collection, ProQuest Central, ERIC, SAGE Reference, and EBSCOhost. The keywords used for searches included *vocational education training, medical education, innovative technology, interactive learning,*

simulation, VR, AR, iteration, dropout, oil and gas, learning motivation, cognitive load, mobile learning, safety, high school, active learning, game-based learning, students' attitude, TAM, satisfaction, and on-the-job training. The search targeted peer-reviewed articles within the past 5 years except for seminal and influential articles and books related to the study. Walden University Library dissertations related to this subject area were also reviewed via ProQuest.

Conceptual Framework

Davis's (1985) TAM formed the conceptual framework for this study. According to Davis (1989), TAM relies on two significant constructs, PU and PEOU, as determining factors of user behavior. PU represents the perceived enhancement in job performance by using a specific system. The amount of effort to use such a system is related to the PEOU. The impact of PU on system utilization was initially suggested by the work of Schultz and Slevin (1975) and Robey (1979), while the PEOU was supported by Bandura's (1982) extensive research on self-efficacy. This study used both constructs as determining factors for understanding any changes in drilling simulator user behavior toward both learning and motivation.

TAM is considered one of the most common research models utilized to explore the use and acceptance of individual users' technology and information systems. Many researchers have studied, verified, and used TAM to examine user technology acceptance behavior in various information systems constructs (Davis, 1989). According to Davis et al. (1989), TAM was adapted from the theory of reasoned action. The theory is a social psychology model for analyzing the factors of conscious behaviors (Ajzen & Fishbein,

1980). TAM is meant to explain the contributing factors in accepting computer use. The model correlates computer acceptance behaviors to two principal depositories: PU and PEOU. PU is the user's perception or belief that using a specific computer system will enhance their job performance within the organization. PEOU is the user's perception that utilizing a chosen method will not require effort.

Several researchers, such as Hauser and Shugan (1980), Larcker and Lessig (1980), and Swanson (1987), have suggested that PU and PEOU are different from one another. The model helps to trace the impact of external forces, such as social, cultural, and political factors, on internal beliefs, including behaviors, personalities, and intentions. TAM uses the theory of recent action model as theoretical support to show the academic relationship among these variables. Adaptations of the theory, supported by careful evidence, were made using goals based on TAM. Like the theory of recent action model, TAM uses the hypothesis that behavioral intention determines computer usage. However, TAM is different in that behavioral intention is determined by two factors: the individual's perception of using the system and PU. Behavioral intention is the measure of the likelihood of a person utilizing the application. The attitude toward using a particular information system application involves the user's evaluation of the likability of utilizing such an application (Davis et al., 1989).

Literature Review Related to Key Variables and Concepts

The literature reviewed in this section explains how simulation technology, including AR and VR, has been used in different educational and training settings for different specialties, such as health and medical, military, and engineering schools, as

well as postgraduate education. I provide an understanding of the background of the study's problem regarding how using simulation technologies, including AR, in different educational and training settings may increase trainees' learning and motivation and positively influence their intent to complete their education.

This section provides a discussion of simulation training for the health and medical disciplines, including nursing, paramedic, and pharmaceutical education, as well as surgical, neurosurgical, and dental student training. The literature reviewed for this study also addressed simulation applications, including AR and VR, for military education and training, engineering education, and educational settings to teach a variety of subjects. AR simulation-based learning settings are also discussed for vocational training.

Simulations Training for the Health and Medical Disciplines

Sakakushev et al. (2017) stated that the continuous development of simulation technology resulted in a rapid expansion of medical simulation within the health and medical education fields. Simulations help to reduce training hours while increasing procedural complexity. Using simulation training increased patience, enhanced technical competency, and eliminated the human factor in a risk-free environment. Simulation training is particularly applicable to practical, procedure-oriented specialties; it can be useful for teaching beginners and experienced clinicians. Simulation training has become an essential tool in delivering medical education, creating a paradigm shift in how medical professionals should be educated and trained. Simulation training should not rely on current simulation platforms; training designers need to restructure these to create

metric-based simulation curricula and adopt skills standards.

Nursing and Paramedic Education

Health science and medical education organizations have widely used simulation training for their students, including nursing and paramedic education. Cowling and Birt (2018) stated that using simulation in training health science students would improve the learners' safety, competency, and job skills compared with conventional educational training methods. However, such simulation methods were not useful for distance learning students. The authors addressed this problem by using a design-based research methodology detailed by Reeves (2006, as cited in Cowling & Birt, 2018) and the model of putting pedagogy before technology to develop a mixed reality education solution suitable for distance learning students. The developed model gained significant acceptance when testing was completed on two rounds by second-year distance paramedic students. It also helped them to develop and improve the required professional job skills.

Nursing Education. Researchers have conducted several studies to explore the effect of using simulation training in nursing education. Register et al. (2020) developed and implemented a series of simulations for the Acknowledge, Introduce, Duration, Explanation, and Thank You nurses' education program. Kim et al. (2018) used simulation problem-based learning. Both studies used simulation-based training methods to enhance communication with patients, decrease nursing students' fear of communication with patients, and improve levels of communication and assertiveness while interacting with patients, thus decreasing patient anxiety (Kim et al., 2018; Register

et al., 2020). Both researchers also concluded that using Acknowledge, Introduce, Duration, Explanation, and Thank You simulation training increased patient communication objectives, targeting the patient's ability to understand the procedure. According to Register et al., the nurses' comments included, "I liked the hands-on experience versus watching the video" (p. 17). Register et al. recommended running simulation training regularly for all treatment unit staff.

In a study by Kim et al. (2018), simulated problem-based learning measured four areas: communication apprehension, assertiveness, nursing clinical self-efficacy, and satisfaction with simulation practical education. The study results showed that communication fears decreased after simulation problem-based education, which also helped communication skills improve. The assertiveness of the students also increased after this learning method; however, it was nonsignificant, as students had to focus primarily on problem solving in an urgent clinical situation and not on making decisions. The simulation also increased the nurses' clinical self-efficacy, which helped with high scores regarding student satisfaction with the simulation and increased nursing staff competencies (Kim et al., 2018).

Kapucu (2017), Rossler et al. (2018), and Unver et al. (2018) completed studies to explore the effect of using simulation-based training for nursing students in real-life scenarios, including chest trauma, acute respiratory failure, acute coronary syndrome, gastrointestinal bleeding, cerebral vascular accident, and sepsis in addition to emergency room cases. They employed a simulation environment to determine if using simulation training for newly registered nurses would promote their transition into clinical practice

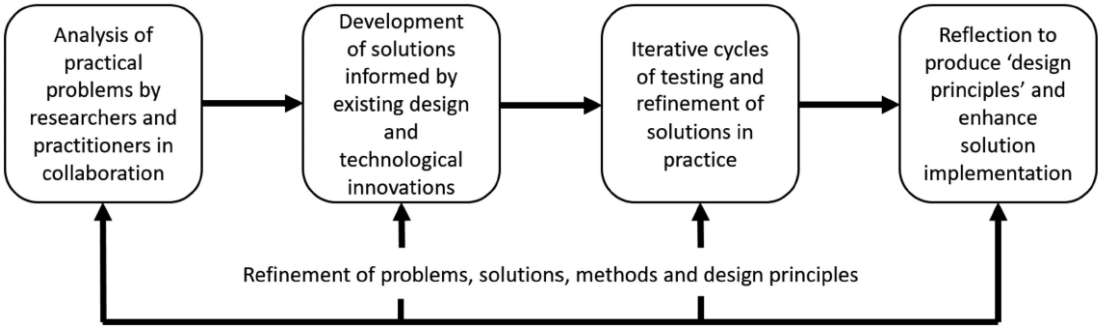
settings. The researchers were also looking to help nursing students gain significant knowledge and experience and increase their competencies and confidence. Kapucu, Rossler et al., and Unver et al. indicated that simulation training was useful for improving the nursing students' skills beyond treating a mannequin by increasing students' confidence and preparing them for real-life clinical settings. Successful implementation of simulation-based training for nurses during their internship program training indicated that simulation practice would promote a new form of licensure, which would increase nurses' knowledge. The researchers also stated that simulation-based nursing education allows for combinations of theoretical information and technical skills before implementing clinical activities.

Paramedic Education. Another design-based research was used by Birt et al. (2018) to experiment with two mobile mixed reality interventions across two Australian higher education paramedic classrooms in medicine and health sciences to discover their efficacy for medical health and science students. The first learning intervention focused on knowledge and learner perceptions; the second intervention focused on learned skills. Reeves's (2006) four-step model (see Figure 2) was frequently used to assess the relevance of how the case studies presented led to the development of mixed reality simulation. For knowledge and learner perception, physiology, and anatomy, students interacted in VR and AR lessons regarding the brain, brainstem, and spinal cord in the first intervention. In the second intervention, 2nd-year paramedic students were asked to use an app, and 30 of the students were chosen at random. To compare the change in skill competence, all students who participated in the intervention completed a pretest.

Research results indicated that mixed reality gave the participants full control of their learning experience, enhancing experiential learning and engagement. In addition, they experienced how to deal with challenging content in the medical and health sciences (Birt et al., 2018).

Figure 2

Design-Based Research Using Reeves's Model



Note. From "Design Research From a Technology Perspective," by T. C. Reeves, 2006, in J. Van den Akker, K. Gravemeijer, S. McKenney, and N. Nieveen (Eds.), *Educational Design Research* (p. 58). (https://doi.org/10.4324/9780203088364). Copyright 2006 by Routledge. Reprinted with permission (see Appendix B).

Pharmaceutical Education

Hattingh et al. (2018), Frenzel et al. (2018), and Komperda and Lempicki (2019) conducted studies to explore the effect of using the simulated hospital program Journey and other simulation-based training packages to assist in educating pharmacists and pharmacy students. Hattingh et al. studied how simulation-based training packages would help pharmacists understand hospital medication management and its procedures. Frenzel et al. explored if using simulation would help reduce medication errors, promote patient

safety, and increase pharmacists' overall competencies. Komperda and Lempicki studied the effects of using simulation to increase pharmacy students' competencies toward medication reconciliation and elevate medication reconciliation skills to a higher level than previous educational methods. The researchers concluded that online simulation-based training helped fill the gap between traditional methods and experiential learning. It was also beneficial for engaging students in reliable, self-directed, flexible learning (Hattingh et al., 2018). The results of the study by Frenzel et al. indicated the use of simulation in the curriculum promoted a change in the students' knowledge, attitudes, and skills; it also helped to increase their competencies regarding medication errors by stressing the pharmacists' pivotal role in decreasing this error. Using simulation-based training alongside lectures and workshops helped improve medical reconciliation (Komperda & Lempicki, 2019).

Frenzel et al. (2018), Hattingh et al. (2018), and Komperda and Lempicki (2019) concluded that simulation-based training programs were positively received and approved by pharmacists and pharmacy students. Using these programs showed an improvement in students' knowledge, application of clinical tools, and self-confidence in managing medication. Simulation-based training helped to increase students' knowledge, skills, and attitudes regarding medication errors. It also helped increase their confidence and competencies toward medical reconciliation.

Surgical Training

Sakakushev et al. (2017) made a list of advantages and disadvantages for each surgical training model based on the technologies used in a comparison study between

different simulation training types. The medical simulators discussed in this study were animals-cadavers, synthetic models-towers, and VR and AR simulators. All of them underwent five different validities: (a) face validity, which determines if the simulator represents what it is supposed to; (b) content validity, which evaluates the appropriateness of the simulator through experts; (c) construct validity, which allows for a distinction between an experienced and inexperienced surgeon based on their performance score; (d) concurrent validity, which compares a previous simulator's performance scores to another that is being tested; and (e) predictive validity, which correlates the performance scores with future performance.

Sakakushev et al. (2017) concluded that the simulation-enhanced training curriculum resulted in a superior training outcome in psychomotor and nontechnical skills. It also ensured the comprehensive proficiency of the trainee before exposure to patient care. Simulation-based training has shifted the model of medical and surgical-based training. Because the shift began in the surgical sector and has proven to provide significant results, it could help in the development of procedural-based medicine regarding how it will be learned and practiced.

Neurosurgery Training

Suri et al. (2016) conducted a literature review to determine how various neurosurgery simulations from the past may affect simulations today and how they will inspire the future. The study included different simulation types, such as an augmented VR system, immersive VR, and mixed-reality simulators. Web-based surgical simulation, three-dimensional (3D) printing technology in neurosurgery, and a virtual presence in

neurosurgery were also included in the study. After assessing the trainees' skill levels, Suri et al. stated that simulation models allowed the trainees to acquire and improve surgical skills and knowledge in a controlled setting with no risk to real patients. They encouraged the development of VR simulators and 3D printers to complement current neurosurgical training and stated that its innovation and implementation must be encouraged in the future. Suri et al. also noted that future research would help assess the training module's impact and categorize the results into an evaluation, knowledge-based written exams, and structured assessment of technical skills.

Dental Students' Training

Sabalic and Schoener (2017) studied how exposure to VR-based technologies may increase dental students' and educators' knowledge, attitudes, and practice. The researchers used anonymous paper and online surveys; 121 students and dentists from 35 countries across Africa, America, Asia, and Europe completed an online questionnaire. Based on the survey results, Sabalic and Schoener stated that dental students and educators had comprehensively positive attitudes toward VR-based technologies. Simulation training had the most significant advantage, with the ability to repeat the procedure several times. The majority of students would have liked to have VR-based technologies' curriculum stress the importance of new technologies in the dental field. The survey also showed that the main disadvantage of VR-based technologies was the cost of the equipment. However, most of the equipment was in the experimental phase and did not simulate real clinical situations. Sabalic and Schoener concluded that implementing VR-based technologies in education programs could affect future dental

practitioners' knowledge, attitudes, and practice, as well as enhance critical assessment of new dentistry trends.

Simulation Applications in Military Training and Education

Simulation training applications, including VR and AR technology, have been widely developed and implemented in many fields in recent years; its use also extends and flourishes in the military (X. Liu et al., 2018). Military training facilities have used simulation and VR training curricula as an effective way to assist with military procedures and operations, such as core procedural skills that enhance the performance and self-confidence of general medical officers (X. Liu et al., 2018; Spooner et al., 2019). Spooner et al. (2019) completed a study on using a simulation training curriculum that included 21 core procedural skills for general medical officers. The study showed that simulation training increased confidence levels in early career general medical officer physicians. It allowed for the exchange of ideas and information, which can be observed and evaluated. The simulation training also helped increase the participants' awareness and psychomotor skills to increase their knowledge and competencies (Spooner et al., 2019).

In a study by X. Liu et al. (2018), the researchers noted that VR training could help assess soldiers in small-scale combat by simulating an actual vehicle. They explained that VR training is already applied in a large-scale setting, such as the theater of war and strategic exercises, which separate people into teams in a realistic battlefield confrontation scenario. The scenarios may have an unlimited geographical area, and weapons can be adjusted and enhanced. VR can also be used to improve weapon

development as it allows the learner to see the scheme of the weapon at all angles and therefore interpret and add new developments to these with ease. X. Liu et al. concluded that the development of VR simulations would help enhance military soldiers' competencies in a cost-efficient manner.

Bhagat et al. (2016) and Jenab et al. (2016) completed studies on a 3D VR system's ability to increase learner competencies and motivation regarding military live firing training. A 3D VR training could also prepare pilots for aviation through military combat training. The VR live-fire training software allowed for a realistic firing range, promoting a human-machine interactive learning environment. It helped to create higher learning motivation among trainees and improve their learning outcomes. The simulation applications also allowed the learner to immerse themself in the scenario and store bullet impact point records. These records help the trainer to develop future teaching strategies by identifying the learner's weak points in shooting and improving their skills and competencies (Bhagat et al., 2016).

Regarding pilots' VR applications, Jenab et al. (2016) noted that these applications allowed them to thoroughly understand the parts of an aircraft and perform inspections and maintenance. The researchers stated that virtual aviation training has several forms. One includes a program called Virtual Flight Deck, which provides a virtual simulation of the flight deck combined with Virtual Aircraft, giving the specific location, system operation, troubleshooting, fault isolation procedures, and return-to-service tests. There is also a VR hanging harness, which is used to help learners know how to use a parachute during an emergency. It allows the learner to feel a 4000-foot

jump with different scenarios, such as a change in wind conditions, combat zones, and different environmental terrains. Bhagat et al. (2016) and Jenab et al. concluded that VR simulations are cost-effective compared to military live firing training and conventional pilot training programs. The researchers recommended that VR be an integral part of the military training process, which will help assess and teach trainees innovatively and effectively.

Garcia et al. (2019) and Fan and Wen (2019) explored police officers' and soldiers' use of VR to increase their competencies during a high-risk situation or competencies in a battle imitating real-life scenarios. Garcia et al. found that the VR policeman scenario increased a subject's subjective and objective indicators of presence. Both Garcia et al. and Fan and Wen concluded that the simulation was a cost-effective and adequate approach to immerse up to six participants into a realistic hostage situation. A fully immersive simulation training provided an effective way of imitating real situations that are dangerous, avoiding putting trainees at risk (Fan & Wen, 2019).

Simulation Training in Engineering Education

In recent years, simulation training, including VR and AR, has been rapidly recognized and adopted in building engineering education and training due to providing an engaging and immersive environment as well as improvement in these programs' quality. A comprehensive literature review completed by Wang et al. (2018) indicated that studies using different VR and AR applications showed increased construction engineers' competency. Wang et al. stated that immersive VR, 3D-game-based VR, and AR have tremendous potential to increase students' motivation, interest, and

competencies. Building information modeling-enabled VR is related to using 3D objects to present relevant properties information that allows the student to visualize factors like cost and material type. These factors help develop an effective building design in real-time, enhancing students' understanding of their environment. AR also uses sensory technologies to include AR information in a live direct or indirect view of a physical environment, helping students interact with a real environment to receive information or data.

Several researchers have explored the effectiveness of using VR learning applications to address safety risks in the construction and engineering sectors. Douglas-Lenders et al. (2017) and Kassem et al. (2017) examined the impact of experiential simulation-based learning on construction workers' occupational safety. The research showed that VR types, such as building information modeling, serious games, VR, and AR, positively affected the participants' competencies to identify hazards and increased learner engagement. Kassem et al. concluded that VR and virtual environments helped increase the possibility of identifying and managing risk at different construction sites. Douglas-Lenders et al. found that experiential simulation-based learning helped to increase the participants' leadership, communication skills, and competencies and provided opportunities for increased safety awareness in the establishment. These changes were the result of increased participant self-efficacy, learning confidence, and learning motivation, as well as higher levels of supervisor support for workers.

Simulation Training in Education

Fernandez (2017) stated that using innovative approaches in education, such as

simulation, VR, and AR, provided students with a more efficient learning environment to increase their perception and understanding of learning outcomes as well as acquire precise knowledge while performing educational activities. This technology enabled students to have different means of interaction with their professors and peers. Simulation is produced by using a computer to replicate a real-world process or system, and it requires a model or a mathematical explanation of the real system.

VR is a computer-generated simulation using 3D objects to create an alternative world or life. The user knows it is imagination or the artificial environment. It may look real; however, one can differentiate between reality and imagination. AR technology combines both computer-generated virtual information with the real physical world in which people live, and everything is processed and generated in real-time. AR differs from VR; while AR technology uses the real world to integrate digital information with real environments, in contrast, VR uses an artificial environment that will immerse the user in a programmed world that simulates reality.

Fernandez (2017) stated that AR-based applications, games, systems, and tools have been used in education since their development. Many educational applications have been employed in different areas, such as health, science, or engineering, have been launched and tested or are still under verification. AR assists the educational sector as it creates an environment that can be superimposed onto the classroom where the session is being conducted. Not only does AR create a realistic setting, but it also has a social factor by directly interacting with the classrooms.

Researchers have conducted studies to explore the effect of using simulation

technologies, including VR applications, in education. Stavroulia et al. (2016) examined the emotional impact of using classroom simulation (simSchool) to train preservice teachers in the classroom. Capatina et al. (2017) completed a pilot study to emphasize the role of VR technologies to discover how these could change higher education and motivate students to learn. Capatina et al. asked 50 participants from different academic backgrounds to fill out a 10-item questionnaire. These included various topics, such as VR's role in making the learning environment more entertaining, thus driving academic awareness. The questions also included how to change the educational process into an interactive platform, how to feel included in this environment and learning experience, and how to practically adopt it in the workplace. The research findings indicated that using simulation generated real-time emotions in preservice teachers. Capatina et al. concluded that VR helped assess students and provided a better understanding of academia. Stavroulia et al. (2016) completed their study using pre- and postsimulator activity questionnaires with two groups of participants: one from the School of Pedagogical and Technological Education and the other from the Democritus University of Thrace. According to Stavroulia et al., using simulations motivated participants to keep using them by creating feelings of excitement, satisfaction, and interest. At the same time, awareness of VR benefited the international campus.

According to Liou et al. (2017), VR learning environments can include virtual phenomenon concepts for students, but users cannot interact with actual elements. Conversely, learning experiences with AR combine real-world experiences so that AR may improve the effects of computer simulation and facilitate practical interaction for

students. AR-based learning environments do, however, have several real complex objects, which can increase the mental effort of learners.

Liou et al. (2017) completed a study to identify the differences in learning achievements and task performance while using AR and VR in educational settings. The researchers applied an inquiry-based teaching method in curricular activities. Fifty-four fourth grade students—26 males and 26 females—participated in this study. The students used tablet PC applications with AR and VR observation tools to collect data related to the moon. The results of the quantitative analysis used to compare learning performance and technology acceptance between VR and AR environments indicated that the AR group performed better than the VR group in a variety of areas. Significant differences in usefulness and attitude were found in the two groups, as AR users could easily integrate virtual objects and real environments while decreasing mental load, which improved learning. A greater sense of immediacy was prominent in the AR group compared to the VR group. This immediacy motivated the students to continue the task. Liou et al. concluded that an AR-based environment was beneficial for improving learning compared to VR. Future research was recommended for additional qualitative results, such as behavior pattern analysis and eye-tracking techniques. The nonimmersive VR system used in this study limited the VR results' full capacity compared to AR.

Researchers have completed studies on the effect of using AR-based applications, systems, and tools in educational settings to improve teaching applications and information delivery and to help in constructing students' knowledge in subjects such as natural science, physics, and English as a foreign language (Cai et al., 2017; Chang et al.,

2016; Ho et al., 2017; Karagozlu & Ozdamli, 2017; Wu et al., 2018; and Yoon et al., 2017). For the AR-based Flora system, Chang et al. (2016) completed a quasi-experimental evaluation to validate its effectiveness in student learning about plants compared with digital video learning. Wu et al. (2018) explored the impact of a mindtool-based AR learning system on students' learning achievements, cognitive load, and degree of satisfaction in a natural science course. Yoon et al. (2017) conducted a study during a field trip to a science museum to identify students' understanding of how Bernoulli's principle works after interacting with AR devices compared with students who used conventional methods. Karagozlu and Ozdamli (2017) and Cai et al. (2017) studied the effects of new mobile AR applications and AR motion-sensing software on teaching natural science and physics subjects compared to traditional learning methods. Ho et al. (2017) conducted quantitative research using different learning strategies and cognitive styles to examine the learning performance of new AR-based, empirically used ubiquitous learning instruction system to improve the learning performance of English as the foreign language students in an authentic situation.

All researchers discussed in this section showed that AR was more effective as a teaching application compared to traditional learning methods. Chang et al. (2016) found that the AR-based Flora system helped to create greater knowledge retention in comparison to digital video. It also helped students become more motivated and involved in the study of plants. The AR-based repertory grid has benefited students in improving their learning achievements with high satisfaction. Wu et al. (2018) recommended that AR-aided mindtools should be adopted for future research in different subjects to support

students of different ages and in diverse AR learning environments. Yoon et al. (2017) stated that AR served as a valuable learning method and enabled students to visualize the activity's scientific procedures while presenting it in an interactive and informal environment. AR conditions helped students attain significantly better understanding and knowledge than students in non-AR conditions.

Karagozlu and Ozdamli (2017) found that AR was helpful for both students and teachers alike in covering topics through visuals, understanding what topics were reviewed, and through sufficiently lengthened scripts, suitable and appealing colors, and animations that were adequate and attracted students' attention. However, some students preferred longer animations. While teaching physics using AR motion-sensing software, Cai et al. (2017) observed that AR technology was effective in teaching students about magnetic fields and magnetic induction lines. Students achieved higher retention of information, provided positive feedback on the AR activity, and felt enthusiastic about the learning procedure.

Ho et al. (2017) introduced and used a ubiquitous learning instruction system with AR, which was found to help participants learn English as a foreign language in a real-life context. This, in turn, aided them in enriching their English vocabulary and provided a realistic learning experience. The ubiquitous learning instruction system with AR can also enhance the comprehensive learning experience due to its capacity to recognize learning difficulties and address them as they arise.

Squires (2017a, 2017b) explored the impact of teaching while using AR applications on students' working memory and cognitive memory loads. Squires (2017a)

conducted a sequential mixed methodologies study to explore the impact of using AR applications on working memory recall. Squires (2017b) also completed a literature review to determine how useful AR has been in enhancing memory in various areas, including education, online learning, and workforce training. The study participants found there to be a positive influence in using AR for understanding online content, and it increased their ability to remember online learning material. A variety of participants also valued the experience, noting it was rewarding and an ideal alternative to a face-to-face environment. Few participants had problems with the technology itself. Most noted that the AR education program was engaging; it helped them recall information and content and increased retention of details compared to reading or seeing a picture. In addition, Squires's (2017b) review of the literature indicated that AR had been found to decrease cognitive load, which frees energy to focus on learning tasks. That, in turn, increases working memory utilization, which helps process information. Squires (2017a, 2017b) recommended that future AR studies integrate multiple methods and strategies to enhance memory utilization in higher education.

Several researchers explored the impact of the gaming approach that supports AR-based learning activities. Lu et al. (2018) studied the effect of puzzle games embedded in AR on students' learning and achievement motivation, using a quasi-experimental design to evaluate two learning game versions for fifth grade natural science students. One version was paper-based, and the second integrated AR. Lu et al. found that using puzzle games enhanced students' knowledge of natural sciences.

However, using puzzle games that integrated AR technology significantly increased their performance.

Lu and Liu (2015) also completed a study of digital game-based learning theory to explore how AR would enhance learning instruction for elementary school students regarding marine life. They conducted four stages of an experiment, including an interactive game-based practice, to explore the students' learning motivation and assess if they had achieved the knowledge goal from the AR activity. Lu and Liu collected the post-AR activity data for statistical analysis and compared learning achievement before and after the AR activity. Students appeared to be relaxed during the activity, showing excitement and pleasure in their ability to learn through play. Somatosensory interactive technologies have been found to create a teaching environment that offers a higher level of diversity and engagement for marine education than conventional methods (Lu & Liu, 2015). This method also uses puzzle-based games, increasing the students' physical interaction, confidence, and engagement. Overall, this improved the students' capability to achieve target knowledge and performance (Lu & Liu, 2015).

G.-J. Hwang et al. (2016) explored the effectiveness of a proposed AR-based gaming approach compared to the conventional AR-based mobile learning method during elementary school ecology course field trips. They conducted their experiment in an elementary school ecology course to explore which method was more effective: a proposed AR-based gaming approach or the conventional AR-based mobile learning approach. A group of 30 fifth grade students was the experimental group and used an AR-mobile game on butterfly ecology. The other group, the control group, consisted of

27 fifth grade students who used the conventional AR-based mobile learning system. G.-J. Hwang et al. concluded that integrating learning into a gaming experience while using AR can help students' learning experience and content. Their research indicated that the AR-based gaming approach improved both the students' learning attitudes and learning performance.

Finally, using AR in Saudi Arabian schools began before the COVID-19 pandemic, which helped students transition and teachers broaden the process and possibilities for improving education. Quick response codes in schools have grown in popularity as they offer teaching clips, e-textbooks, AR experiments, and learning games, which have gained support from teachers, parents, and principals. AlNajdi's (2022) study findings demonstrated that using AR in education can offer positive opportunities to develop education and support students. The researcher agreed with the statement by Tsiavos and Sofos (2019, as cited in AlNajdi, 2022) that AR's positive impact includes (a) learning benefits, (b) offering a motivating environment, (c) engaging students, (d) helping students to focus on the lesson, (e) changing students' attitudes positively about the lesson, (f) exciting students, (g) increasing students' eagerness, (h) increasing students' knowledge, (i) integrating VR in the real-world to enhance locative perception, and (j) developing students' observation.

Vocational Training

Bacca et al. (2018) conducted a study to identify which factors need to be studied to increase trainees' motivation toward AR experiences in vocational education and training. Bacca et al. achieved several results; they found a positive correlation between

student and motivation feedback. There was also a correlation between learning outcomes, a student's degree of success, and motivation. Attention also increased while using AR, which improved the students' motivation to learn. Bacca et al. showed that the AR application caught the trainees' attention and increased their motivation. One of the findings indicated that student confidence might decrease because of a negative perception of being unable to solve a problem, but this needs further research. Additional research is also required to demonstrate that AR can increase learning activities.

Summary and Conclusions

The literature reviewed in this chapter demonstrated how simulation technology, including AR and VR, is used in different educational and training settings. The literature provides an understanding of the background of the study regarding how using simulation technologies, including AR, in educational and training settings may increase trainees' learning and motivation and positively influence their intent to complete their education.

This chapter provided a discussion of simulation training for the health and medical disciplines, including nursing and paramedic education, pharmaceutical education, surgical training, neurosurgical training, and dental students' training. The literature review also included simulation applications, including AR and VR, for military education and training, simulation training for engineering education, and in other educational settings to teach a variety of school subjects. AR simulation-based training settings were also discussed for vocational training.

Fernandez (2017) and Kiryakova et al. (2018) showed that simulation technology's continuous development increased the perception and understanding of

learning outcomes and helped the learner acquire specific knowledge while performing different educational activities. Abulhassan (2016) stated that using a live well simulator computer-based drilling program that incorporates realistic, hands-on, and theoretical explanations was a more effective solution than a traditional classroom environment alone. Using a drilling simulator could help drilling crews cover the mechanical handling of the equipment, training development plans, and oil well-control principles and procedures (Hodgson & Hassard, 2006). However, there is a gap in the research regarding using drilling simulations, including AR, on the trainees' learning and motivation. Hodgson and Hassard (2006) noted that further research would help determine if other well-control training programs using simulation technology could improve drilling crews' competence.

The researchers in this literature review showed that simulation technology, including AR, made learning interactive and engaging as well as motivated learners to stay focused and attentive to the learning sessions. Chapter 3 will provide information about the research design of this study and its rationale, my role as the researcher, and methodology, including recruitment, sampling procedures, and instrumentation. Issues of trustworthiness and ethical considerations will also be discussed.

Chapter 3: Research Method

The purpose of this basic qualitative study was to explore how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at the oilfield drilling rig's vocational training facility. In this chapter, I discuss the study's research design and rationale, my role as the researcher, and methodology. This chapter contains information on issues of trustworthiness, including credibility, transferability, dependability, and confirmability, and ethical procedures.

Research Design and Rationale

I selected a basic qualitative approach for this study, which allowed me to examine the trainees' learning and motivation with the flexibility to examine other areas if needed. The study's conceptual framework was based on Davis's (1985) TAM, a theory concerning user acceptance of information systems. TAM explains technology users' learning and motivation through two significant constructs: PEOU and PU. The constructs of the conceptual framework were used to develop open-ended questions for the semistructured interviews guided by the subjects explored (see Merriam & Tisdell, 2016).

Davis (1985) defined the PEOU as "the degree to which a person believes that using a particular system would be free from effort" (p. 26) and the PU as "the degree to which a person believes that using a particular system would enhance his or her job performance" (p. 26). In this study, this refers to whether or not the trainees perceived the simulation technology as useful for their training and if they perceived the technology as easy to use, which may encourage and motivate them. Thus, the TAM theory broadly

applies as a conceptual framework. The research study was guided by TAM's two constructs (PEOU and PU) through the drilling simulator's role to determine whether using these simulators would influence the drilling trainees' learning, motivation, and decision to complete their studies. The RQs that guided this study were as follows:

RQ1: What are drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their learning?

RQ2: What are drilling-rig vocational trainees' perspectives on the influence of drilling simulation technologies on their motivation to complete their education?

The basic qualitative research design, or generic qualitative inquiry, allowed me to examine the drilling simulation technologies in the classroom setting and how they influenced the trainees' learning, motivation, and perspectives about completing their studies. Merriam and Tisdell (2016) stated that researchers use a basic qualitative research design if they are interested in understanding people's meaning-making and qualitative research processes. They also stated that basic qualitative research is philosophically derived from constructionism, phenomenology, and symbolic interaction. Merriam and Tisdell noted that the basic qualitative research design is used by researchers who are interested in how individuals interpret and make meaning of their experiences and construct realities. They also considered its use when a study's overall purpose is to understand the meaning of people's lives and experiences. Patton (2015) stated that the basic qualitative research design allows flexibility in sample size and data collection procedures so as to focus solely on interviews for data collection.

Two qualitative research designs were considered for this research. Initially, I contemplated using a case study approach to investigate single or multiple cases of recent, real-life incidents (see Yin, 2014). Case studies are widely recognized as appropriate when the situation is time and place limited (Creswell, 2012). They also focus on a specific event that binds the participants (Schoch, 2016). This approach aligned with my research problem and purpose; it could have allowed me to investigate drilling simulators' influence on the drilling institutes trainees' learning and motivation. The vocational drilling institute represented the limited location; time was limited as the study was conducted with participants immediately after they had completed the drilling simulator training classes. The case study approach also would have allowed me to use various data sources, including interviews, direct observations, documents, artifacts, and others. However, I selected the basic qualitative approach because I wanted the data collected to be solely from participant interviews.

Phenomenology was the second approach considered. This design can function as both a research method and a philosophy that is intended to explain a group of individuals' lived experiences of a phenomenon, which does not need to be bounded by time and space; data collection is usually through interviews (Creswell, 2012). This approach aligned with my research problem and the purpose of investigating the group experiences of using drilling simulators. However, I used the basic qualitative approach as I wanted the study's data to be based on descriptions, experiences, and meaning from the participants. This form of qualitative inquiry stood on its own as a reasonable way to

discover what happened during the drilling simulator sessions that might have influenced the trainees' choices (see Patton, 2015).

Role of the Researcher

As a doctoral student, I carried out my role as a qualitative researcher. In this role, I was concerned about research integrity and was committed to an investigative methodology that objectively explored all aspects of the research subject (see Ravitch & Carl, 2016). I relied on my competence, openness, and honesty. Accordingly, I monitored and reduced any disposition to interpret data with bias and control this interference quickly. My previous job as a technical advisor with a vocational training institute increased my concern about avoiding bias in data collection and reporting. While working and being part of such a professional training institute, I was passionate about solving the drilling learners' training issues. As a researcher, I interviewed the participants by phone, recorded and reported the data collected, and presented my findings and interpretations with confidence.

Ethical principles are numerous, nuanced, context dependent, evolving, and relational; these are particularly important to recognize in qualitative research (Ravitch et al., 2015). This requires that researchers understand, consider, and address their positions with modesty and carefully consider these concerns collaboratively and relationally to ensure that they are acting ethically. Accordingly, this ensures that honest and explicit opinions are reported (Ravitch & Carl, 2016).

As a qualitative researcher, I explained the study to each participant without bias and conducted interviews ethically. According to the study's design, I asked open-ended

questions, listened and thought about the participants' responses, and asked additional questions to collect rich, thick data. I made appropriate field observations and analyzed and interpreted the research-based data.

Methodology

This section provides information on the research study's methodology. I provide details regarding participant selection logic and instrumentation. I outline procedures for participant recruitment, participation, and data collection. I also review my data analysis plan.

Participant Selection Logic

Before obtaining Institutional Review Board (IRB) approval from Walden University to collect the data, I communicated with the training manager of a drilling vocational institute in Saudi Arabia, where I reside. I obtained his approval to interview 10–15 of his employees. After I received IRB approval, I recruited 15 individuals as target participants. The potential participants' inclusion criteria were discussed with the vocational institute training manager to identify trainees who completed their drilling simulator training (the essential criteria). Knowing that Arabic was the mother tongue of all the Saudi trainees, I considered the possibility of using either Arabic or English for the interview when needed. I intended to interview eight to 12 participants out of the 15 selected based on their availability and the amount of data collected.

Although many factors affect sample size in qualitative studies, researchers generally use saturation as a guiding principle during data collection (Mason, 2010). I used a purposive sampling strategy, which allows a researcher to select knowledgeable

and experienced research participants serving as information-rich sources (see Creswell, 2012). Ten participants were determined to be needed to reach saturation from a review of multiple studies that indicated that six to 12 interviews produce an acceptable amount of data for qualitative research (see Guest et al., 2006; Namey et al., 2016).

Instrumentation

I developed an interview guide, which is found in Appendix C. The sequence and form of the questions and subquestions were a format that I adopted based on the RQs. In the interview protocol, checking and follow-up questions were used as suggested by Ravitch and Carl (2016). I could have used face-to-face interviews; however, as a result of the COVID-19 pandemic, all interviews were conducted over the phone, as preferred by the interviewees.

To confirm the interview guide's content rigor and credibility, I revised it to show agreement with Watson's (1997) eight principles for preparing an interview: (a) choosing an environment with little distraction as the interview location, (b) explaining the purpose of the interview, (c) outlining confidentiality terms, (d) discussing the interview format, (e) stating how long the interview typically took, (f) telling the participants how to contact me later if they wished, (g) asking them if they had any questions before starting the interview, and (h) recording the interview responses. I used my work or home office as a quiet place for the interviews. I informed the participants of an approximate interview duration of 30–60 minutes, which I mentioned in both the interview invitation and the informed consent. I field-tested the interview protocol by completing the interview process with two volunteer interviewees. I received good feedback, which I

used to revise my interview questions in consultation with my committee.

The interview questions focused on the interviewee's perceptions and experiences about the influence of drilling simulators in training. Confidentiality was the primary ethical consideration and was explained to the participants. Discussing confidentiality with participants meant informing them that I would be using alphanumeric codes and changing or not disclosing other identifying facts.

Table 1 shows the alignment between the interview questions and the study's RQs. The interview questions were designed to collect information about the drilling trainees' experiences with the drilling simulators and how they might influence their learning and motivation to complete their education. Data collected for RQ1 were elicited from Questions 1–9. These questions focused on the trainees' perspectives on their drilling simulator training experiences that might influence their learning. Data to answer RQ2 were provided by Interview Questions 10–12. These questions focused on the trainees' perspectives on their drilling simulator training experiences that might influence their motivation.

Table 1

Interview Questions for Drilling Training Participants and Corresponding Research Questions

No.	Interview questions	RQ1	RQ2
1	Tell me about yourself. Your name, age, specialty?	X	
2	Describe why and how you joined the drilling training program.	X	
3	Explain how you feel about your training courses? What is your favorite course? Probing questions: What about the drilling simulator workshop? Is it one of your favorite courses? Why?	X	
4	Explain why drilling simulation experience must be required as part of your learning courses.	X	
5	What does the use of a drilling simulator look and feel like to you and your colleagues? Probing question: Was it easy to understand and use?	X	
6	Explain if and how it was easy to understand. How was it easy to operate?	X	
7	While using the drilling simulator to learn a new skill, did you find it easier, harder, or the same compared to the conventional drilling rig console?	X	
8	What was your experience with the drilling simulator training program? What did you do?	X	
9	What do you think of the drilling simulator training program concerning: a. Program usefulness? b. Skills attained? c. Strengths? Weaknesses? d. Things liked? Things disliked? e. Things that should be changed or added to increase usefulness?	X	
10	How do you think the involvement in the drilling simulator training program affected you regarding the following areas: a. How it affected your self-confidence? b. Attitudes towards the drilling training program? Probing: How that encourage/discourage you to continue and complete your drilling education? c. Any effects on your future ambitions?		X
11	What are your future expectations? What changes do you perceive in yourself concerning the following areas: a. Future work plans? b. Future income development and expectations? c. Lifestyle expectations or plans?		X
12	Would you like to share any other information about the drilling simulation training before we finish this interview?	X	X

Procedures for Recruitment, Participation, and Data Collection

I initially contacted the management of the partner organization using a letter of intent and received consent to recruit drilling workforce participants for my study. Next, I submitted an application for IRB permission to Walden University. Once I received approval, I contacted the training manager of the vocational training facility to obtain the contact information for 15 possible volunteers. I also submitted the inclusion criteria for the study and requested that the database of the training facility be used to compile the contact information. A senior training instructor was tasked to liaise with me regarding participant selection; he generated a spreadsheet with the 15 participants' names, email addresses, job titles, and confirmation of simulation training completion. This was done after receiving the participants' initial consent to take part in the study via the senior training manager. Initially, all 15 individuals agreed to attend the interviews. Next, I sent each a formal invitation email (see Appendix D). The letter of invitation included a statement of the purpose of the study and what constituted participation. The email also included an informed consent letter as an attachment file for the participants to read and send to me in a reply email with the words "I consent" if they were interested. After receiving the participants' consent, I contacted each and scheduled a date and time to conduct the interview over the phone. I sent follow-up emails to those prospective participants who did not answer the first until I was able to obtain consent from 10 participants to interview; five were unable to participate due to their difficult work schedules or personal obligations.

Only a few participants wanted to review the transcript of their interview; accordingly, I sent a follow-up email within 72 hours to each participant with his interview transcript to verify his responses. If errors or omissions were found, the participant had the opportunity to communicate them to me by email. Transcripts of interviews were analyzed as part of my study, and I shared the results with my committee. I will hold interview recordings and transcripts in a secured place for 5 years to comply with Walden's IRB requirement.

In this study, I was the primary source of data collection, using the interview protocol for in-depth semistructured interviews with self-developed questions in a preprepared interview guide. The original plan was to meet with the interviewee via the Zoom web conferencing platform using its audio recording function. Zoom would also automatically transcribe the interview. The main reason for using the Zoom audio virtual meeting was the current COVID-19 pandemic. Zoom emulates face-to-face interviews and is a prompt and synchronous communication method. However, all 10 participants preferred the phone for the interviews, as internet signals were not consistent. The interviews were recorded in English or Arabic language using a phone audio recording application. The participants' experiences and perceptions were collected regarding their retrospective evaluation of their experiences with the drilling simulator practices. The interviews were approximately 30–60 minutes in length, with variations due to the depth and amount of the participants' information.

Interview audio records were transcribed by a specialized transcription company for the Arabic interviews. These were then translated into English using the Microsoft

Windows Word translation capability. I used the Otter program for English interview transcriptions. I revised the transcripts to correct mispronunciations and grammatical errors and identify slang and nonverbal sounds without changing the exact wording. All personal data were deidentified during transcription, and I assigned each participant an alphanumeric code, such as Participant 1 (P1), Participant 2 (P2), etc., to protect their privacy in the publication of the study's results. I also included the recorded field notes taken during the interviews in the transcripts. I stored each transcript in a file on a safe, password-protected computer accessible only by myself and printed a hard copy kept in a locked file cabinet when not in use following the interview. After transcription, I was able to methodically evaluate, interpret, and organize the data into meaningful patterns to explore the influence of the drilling simulator phenomenon I was investigating.

Data Analysis Plan

In-depth semistructured interviews were the source of data for this basic qualitative inquiry. Specific questions were asked of all participants to help answer the two RQs. The sequence and form of the interview questions and subquestions created a unique and personalized direction for the discussions. In the interview protocol, follow-up questions were recommended and used appropriately (see Ravitch & Carl, 2016). A manual descriptive coding process with a Word document and Excel spreadsheets was used to move deductively from coded units to more extensive representations, including patterns, categories, and themes. According to Saldaña (2016), the descriptive coding process involves (a) preparing the interview transcription data files, (b) taking a closer look at the text, (c) creating an initial listing of all individual first and second cycle codes

in a way that ensures reliability and significance, (d) double-checking field notes to make sure that code meanings are precise, (e) spending time to find and highlight commonalities among different codes, (f) grouping codes to form a category, and (g) with a closer look, grouping similar categories to reflect different themes. Rubin and Rubin (2012) explained that themes are summary claims, causal, or assumptions; they explain why something happened, what it means, or how the interviewee feels about it.

Excel is mainly used as a calculator and synonymous with quantitative data analysis; however, it is often useful as a qualitative tool. Excel can accommodate large quantities of data, has multiple attributes, and provides various display techniques (Meyer & Avery, 2009). I used Excel for hand coding because it was easier to tabulate the data to compare with the interview transcripts for each question from all participants in one sheet. I used one sheet per participant and tabulated it.

Initially, I copied all questions and the participant responses from the transcripts into the Excel sheet after assigning a tab for each participant. Then, I began the first cycle of coding using descriptive codes, a single word or short description to identify the interview contents. Next, I completed the descriptive coding column by identifying remarks that described each aspect of the data from the responses. I also entered quick memos to record my impressions while completing the coding process. I then moved to the next column and completed concept coding, a more interpretive coding style, where I identified the meaning or concept after reading each text while highlighting it in red. Interpretive codes were either an indicative word, short phrase, or comment. I also continued to write quick memos (see Rubin & Rubin, 2012).

After completing the first cycle of coding for all participants, I started the second cycle of pattern coding by looking at the data collected for each question from all participants. I tried to find trends or similarities in what the participants stated, which were either similar words or phrases or had collective meaning. I labeled all potential patterns across the second cycle patterns column (see Rubin & Rubin, 2012). Similar patterns were grouped under one category, and categories were then grouped under themes. As a second-cycle process, pattern coding was a way to group summaries into a smaller number of categories and themes that derived information from the first cycle of coding into more practical and frugal analytical units (see Saldaña, 2016).

Issues of Trustworthiness

Qualitative researchers should employ methods to establish trustworthiness as qualitative analysis and trustworthiness are frequently challenged. Some researchers, such as Pitts (1994), have tried to link trustworthiness to validity and reliability problems. Like Guba (1981), many naturalistic investigators have chosen to use four parameters: credibility, transferability, reliability, and confirmability. Guba believed investigators should be regarded as valid metrics for each study, and many have embraced such constructs. To ensure my qualitative research's consistency, trustworthiness, and reputation, I adopted the following techniques.

Credibility

Internal validity was established when the participants agreed with the study's constructs and interpretations. I achieved triangulation by interviewing a diverse group of participants who had different levels of experience. Individual-specific perspectives and

experiences can be verified against others. Several individual contributions can build a rich image of the participants' views, needs, actions, or experiences (Shenton, 2004), strengthening the data's credibility. The participants' range of responses during the interviews helped shed light on their behavior and supported triangulation.

Being thoroughly familiar with the participants' working culture due to my long work experience in the oil field and particularly the drilling specialty helped me have prolonged engagement during data collection, leading to credibility. Lincoln and Guba (1985) recommended prolonged engagement between the researcher and participants to obtain an appropriate understanding of the participants' organizational culture and the phenomenon of interest and to create a relationship of trust between them. The initial introduction for the individual interviews was extended to build trust, establish rapport with the participants, and facilitate productive discussion and clear and detailed responses. In addition, the researcher's background, credentials, and experience are essential. According to Patton (2015), the researcher's credibility is significant in qualitative research, as they are a critical tool in data collection and analysis.

Member checks include returning data collected and analyzed during the study to respondents for authentication and verification for truthfulness; it allows for respondent validation of findings (Creswell, 2012; Lincoln & Guba, 1985). It also assures the consistency of the respondents' experiences and perceptions (Shenton, 2004). For this study, I performed member checks at least twice. Some of the participants checked the transcribed interviews to ensure accuracy; furthermore, I sent the themes established during data analysis to the participants to determine and validate whether the results were

consistent with their beliefs. According to Lincoln and Guba (1985), the participants should review the final interpretations and express whether their opinions and experiences have been correctly expressed.

Frequent debriefing sessions for research were encouraged, in addition to opportunities for the research to be reviewed by colleagues, peers, and scholars. Essential debriefing sessions were completed by the study committee's chairperson, who helped me work in a supervisory environment, discussed alternative approaches, addressed all possible errors, drew my attention to any defect in my work progress, and helped eliminate bias. In addition to peer scrutiny from knowledgeable colleagues, this gave me a fresh perspective concerning other individuals, challenged my assumptions, enabled me to refine my methods, established a more significant explanation of the research design, and reinforced my arguments based on the comments made (see Shenton, 2004).

Transferability

Transferability is needed to achieve external validity. It requires collecting background data to assess the study's context and a thorough explanation of the phenomenon in question and allows for comparisons. Lincoln and Guba (1985) and Shenton (2004) identified transferability as the applicability of the research results to other situations or a larger population with similar characteristics. This implies the study could be duplicated, thus providing similar findings. I interviewed diverse participants with different levels of experience; their perspectives and experiences were compared, and the contributions of several individuals were used to build a rich image of their views, needs, actions, or experiences (see Shenton, 2004).

This study may be transferable due to the similarities of the industry's drilling simulator applications across the globe. The use of real-time drilling simulator practices has been mainly developed and accredited by the primary international training licensing bodies, the International Association for Drilling Contractors and the International Well Control Forum. Accordingly, the participants would have been through the same drilling simulator practices that drilling trainees go through in the United States, Canada, Colombia, or anywhere else (see Abulhassan, 2016).

In this study, I provided detailed descriptions of the setting and data collection process. I also listed data analysis measures and results to include direct participant quotes to contribute to transferability. A thorough explanation of the experiences studied and the approach that fostered this detailed understanding helps readers assess validity and relevance to other conditions and was included (see Lincoln & Guba, 1985; Shenton, 2004).

Dependability

According to Lincoln and Guba (1985), dependability addresses reliability and refers to repeating or replicating the study under similar conditions. To assure dependability, I provided information about the research design and execution, explaining what was planned and implemented at a strategic level. I also included operational details of data collection and what was achieved in the field, in addition to reflective project assessment and evaluation of the efficacy of the investigation process. Information was provided and presented in detail to allow study replication (see Lincoln & Guba, 1985; Shenton, 2004).

Confirmability

Triangulation techniques are used to minimize bias and ensure that the study's results are derived from the participants' observations and opinions rather than the researcher's characteristics and preferences to achieve objectivity (Lincoln & Guba, 1985; Shenton, 2004). I included audio-recorded interviews transcribed verbatim to the individual participants who wanted to verify that their responses were recorded correctly. The final themes formed after coding and data analysis were sent to the participants; further authentication of the results demonstrated I had accurately represented the participants' expectations and experiences.

Ethical Procedures

Attention was given to the participant's ethical and legal treatment; the aim was to protect their rights and minimize any risk to them before and after receiving IRB and the research site approval. Before receiving approval, I sent a letter of intent to the vocational training facility's training manager to conduct the study. Next, I submitted an application to Walden's IRB and received permission to proceed with my research. I contacted the training manager to obtain the contact information of 15 potential participants. I also provided the study's inclusion criteria and asked to use the training facility's database to help me prepare this contact information. I was able to recruit 15 individuals who previously consented to be interviewed with the coordination of the facility senior instructor. I sent each an email invitation to participate in the research study. The invitation included a statement of the purpose of the study and what constituted participation. The email also included the informed consent letter as an attachment file

for the participants to read and send me a reply email with the words “I consent” if they were interested. As soon as I received the reply email with consent, I contacted each participant and scheduled a date and time to conduct the interview over the phone. I developed an interview guide to ensure interview questions’ consistency and uniformity, which was given to each participant.

I audio-recorded the interviews, which lasted 30-60 minutes. I sent a follow-up email within 72 hours to those participants who asked to review their interview transcripts to verify their responses. If errors and omissions were found, the participants had the opportunity to communicate them to me by email. Transcripts of interviews were analyzed as part of my study and shared with my committee in addition to my analysis of the data. The interview recordings and transcripts will be kept in a password protected computer for 5 years and then destroyed. The participants were not exposed to any harm, and all were made aware of the study’s outcomes.

Ethical concerns, including confidentiality, were the primary considerations I had when designing the interview questions. The participants’ responses regarding their perceptions of the training program included critical feedback that may have affected their career development if known to the institute’s leadership team. Discussing confidentiality with the participants included informing them I would use alphanumeric codes and changing or not disclosing other identifying facts.

Summary

This chapter included a description of the research design and rationale, followed by a discussion of my role as the researcher. I described the study’s methodology,

including the target population, sampling strategy, sampling procedures, procedures for recruitment of participants, data collection, and data analysis plans. The final section included issues of trustworthiness, stating the appropriate strategies to establish credibility, transferability, dependability, and confirmability. Ethical procedures were discussed, indicating measures taken to ensure IRB guidelines were followed. Chapter 4 includes the data collection and analysis process and the results of the study.

Chapter 4: Results

The purpose of this basic qualitative study was to explore how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at the oilfield drilling rig's vocational training facility. Abulhassan (2016) claimed that using a live computer-based drilling simulator that combines hands-on drilling practices and theoretical explanations is more successful than a typical classroom environment alone. Using a drilling simulator may help drilling crews understand how the equipment works, the oil and gas well drilling and well-control process and applications, and how to use drilling equipment efficiently.

The problem and purpose of the study were addressed using the following RQs:

RQ1: What are drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their learning?

RQ2: What are drilling-rig vocational trainees' perspectives on the influence of drilling simulation technologies on their motivation to complete their education?

In this chapter, I describe the setting in which data collection occurred. I also provide the participants' demographics, data collection process, and data analysis. Finally, I address evidence of trustworthiness and the study's results.

Setting

The participants were purposely sampled based on meeting the inclusion criteria, with particular attention to completing the drilling simulator training. I interviewed both Arabic and English speakers. The participants were selected from the training facility of a

major drilling contractor company in Saudi Arabia that offers advanced drilling simulator training courses as a part of their employee professional training. The participants were working a rotational on-and-off schedule, which required me to be flexible in arranging the interviews. When conducting the interviews, I used my work or home office, where I could not be interrupted. I asked every participant the same open-ended questions. All participants preferred phone interviews to avoid weak internet connections. I recorded the audio of all interviews and saved the recordings to a designated thumb drive.

Demographics

All study participants were men employed by the Saudi drilling contractor company. Initially, there were 15 participants recruited for this study; however, five were unable to complete the interviews, mainly due to their difficult work schedules and personal obligations, leaving me with a total of 10 study participants. All participants had at least one simulation experience from the courses in which they participated before the study. Exposure to simulation activity enabled them to share their experiences with drilling simulation training, which helped them have in-depth knowledge about the purpose of the study. Table 2 provides the demographics of the participants.

Table 2

Participant Demographics

Participant	Age	Years of drilling experience	Drilling position	Educational level
P1	30	8	Assistant driller	Jubail Voc. College
P2	27	5	T. assistant driller	High school/SPSP
P3	30	7	T. assistant driller	High school/SADA
P4	32	7	Assistant driller	Drop high school/DAD
P5	27	6	Floorman	High school
P6	24	6	Derrickman	High school/SADA
P7	32	0.5	Trainee manager	Mech. Eng. MSc
P8	24	7	Assistant driller	High school/SPSP
P9	32	0.5	Trainee manager	Elec. Engl. BSc
P10	30	10	Driller	High school

Note. SPSP = Saudi Petroleum Services Polytech; DAD = Driller Advanced Development.

Data Collection

After receiving IRB approval from Walden University (Approval No. 08-20-21-0239921), I recontacted the partner organization's training development manager to begin recruiting 15 participants based on the study's inclusion criteria. He introduced me to a senior training instructor to coordinate the recruitment process and assure that the participants' selection was completed without interruption to employee work schedules. Participant recruitment occurred in groups of one to three persons and was completed in 7 months due to the nature of the oilfield's busy work schedule. The senior instructor contacted the potential participants and received their permission to be interviewed and to allow me to have their contact information.

I contacted the 15 prospective participants by sending an email invitation to each of them (Appendix D). The email body had an invitation to participate in the research study; the letter of invitation included a statement of the purpose of the study and what

constituted participation. The email also included an attached informed consent letter in English and Arabic for the participant to read and respond to via email with “I consent” if he was willing to participate.

I collected data through one interview with each consenting participant. Data from 10 participants regarding their experiences and perceptions were based on their retrospective evaluation of their experiences with the drilling simulator practices. I was the primary source of data collection using in-depth semistructured phone interviews. I used questions that I developed and was aided by a preprepared interview guide. I agreed with the participants to speak in whatever language they preferred (either Arabic or English) so that they could explain their perspectives while answering the interview questions fluently. The interviews were conducted over the phone because the participants preferred not to use the Zoom platform to avoid internet instability in some remote areas.

The interviews lasted from 30 to 60 minutes, with variations of up to an extra 15 minutes due to the depth and amount of individual participants’ information. The phone audios were recorded using a phone call recorder application and another backup recording device. I also noted extra details applicable to the interviewees; verbal responses to the questions, which were captured in field notes and used in association with the interview record and transcription.

Interview audio recordings were transcribed; I used a specialized transcription company for Arabic interviews and then translated them into English using the Microsoft Windows Word translator. I used the Otter program for the English interview

transcriptions. I revised the transcripts to correct mispronunciations and grammatical errors and identify slang and nonverbal sounds without changing the exact wording. All personal data were deidentified during transcription, and I assigned each participant an alphanumeric code to protect their privacy (P1, P2, etc.). I also included the field notes taken during the interview in the transcript. I stored each transcript in a file on a safe, password-protected computer accessible only by myself. I printed a hard copy and kept it in a locked file cabinet when not in use. Figures 3 and 4 show example snapshots from both the Arabic-language interview transcript and the English-translated transcript.

Figure 3

Screenshot of Interview Arabic Transcript

الوقت	المتحدث	النص
08:59	عادل	الله يبارك فيك، بص يا محمد السؤال التأني بقولي أوصف لي وإزاي انت اشتغلت في برنامج التدريب على الحفر؟ يعني ليه انت فضلت التدريب على الحفر وازاي اشتغلت فيه معلش يمكن في حاجات مكررة ولكن محتاجين نقولها.
09:27	محمد	بالنسبة للبرنامج نفسه الحفر أنا داخل فيه من نفس دور الشيء اللي راح يكون فيه تطور وبالنسبة للحفر تحديدا نقطة مختلفة وله فروع كثيرة يعني أنا حبيت من ناحية التخصصات راح تكون كثيرة وناحية الخبرة راح تكون عالية، الحمد لله.
10:06	عادل	والمستقبل؟
10:09	محمد	المستقبل في إن شاء الله في يرفع الراس يعني الواحد إذا طالما على شيء معين راح يوصل فيه إن شاء الله ويحقق اللي في راسه.
10:21	عادل	إن شاء الله رب العالمين، طيب، بالنسبة للدورات التدريبية اللي انت خدتها ايه شعورك من ناحيتها يعني حاسس بتعملك ايه معلش أنا مأدرش أقول تفسير الإجابات أنا أسأل وانت قولي، دوراتك التدريبية بتأثر عليك إزاي؟
10:41	محمد	الدورة تعطيك صورة تانية للشغل بالعكس يعني شيء ممتاز إنك تحضر دورات تدريبية وتعرف يعني أشياء مش كتير نتكلم فيها في الـ Rig بالنسبة إلى أوزان وطبقات الأرض يعني مجمل التدريب عن مضمون البير مضمون الشغل إلي بنسويه وهذا شيء ممتاز يعني الواحد اتدرب واتعلم فيه وراح إن شاء الله يتعلم أكثر وأكثر وهذا زين يعني الدورات أغلب هذا المجال يحاول إنه يدرب يدخل دورات تدريبية لان العمل يكون في اتجاه واحد أما التدريب فهيطرق لاتجاهات كتيرة.
11:42	عادل	صحيح، طيب ايه هي الدورة المفضلة ليك؟
11:49	محمد	الصراحة أنا حين خدت الـ Well Control Introductory وأخدت Well Control Driller وأخدت Stuck pipe أنا حبيت Driller level بالنسبة لـ simulator موجود فيه والتدريب عليه يعلم كيف تعيش الجو يعني تعيش جو الشغل.

Figure 4

Screenshot of Translated Interview English Transcript

Sentence #	Text	speaker	time
Q2	May God bless you. Look, Muhammad. The second question says, describe to me, how did you join the drilling training program? I mean, why did you prefer training in drilling and how did you work in it? Forgive me, there may be repeated information, but we need to say them.	Researcher	08:59
1	As for the program itself, drilling. I am in it with the same role as it will have development. As for drilling in particular, it is a different and has many branches. I mean, I liked it in terms of specializations, it will be many, and in terms of experience, it will be high, praise be to God.	Participant 2	09:27
	And the future?	Researcher	10:06
	The future, God willing, will raise the head, meaning one. If I work on a certain thing, I will reach it, God willing, and achieve what is in his mind	Participant 2	10:09
Q3	God willing, Lord of the Worlds, OK, as for the training courses that you took, how do you feel about them? I mean, feel your work. What is wrong with me? I can't explain the answers .	Researcher	10:21
2	The course gives you another picture of the job. On the contrary, it is an excellent thing that you attend training courses, and you know, I mean, there are many things that we do not talk about on time at the rig. Such as the weights and layers of the Earth, I mean the overall training on the content of the well, the content of the work that we do is in one direction, however training is the way to see many directions.	Participant 2	10:41
Q3 p	Right, so what is your favorite course?	Researcher	11:42
1	Frankly, when I took the Introductory Well Control and I took Well Control Driller and I took Stuck pipe I loved Driller level for simulator training that is there and training on it teaches how to live in the environment, meaning you live the atmosphere of work.	Participant 2	11:49

After transcription, I evaluated, interpreted, and organized data into meaningful patterns to explore the influence of the drilling simulator phenomenon I was investigating (see Bogdan & Biklen, 2007). I completed the analysis of all interview transcripts and shared the results with my committee. The interview recordings and transcripts will be kept in locked storage for 5 years according to IRB guidelines, after which they will be destroyed.

Data Analysis

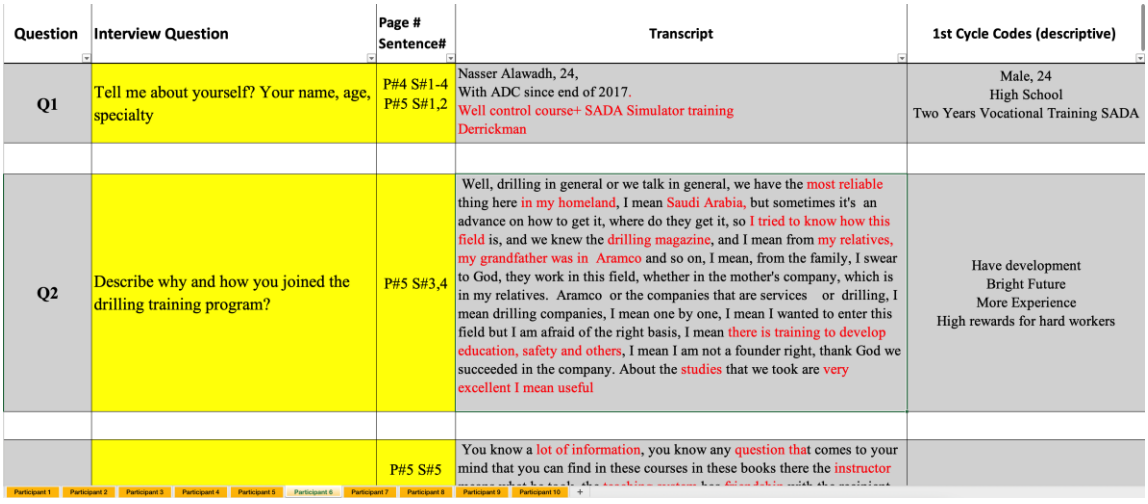
In-depth semistructured interviews were used as the main data source for this basic qualitative study. All respondents answered 12 questions designed to provide data to help answer the two RQs. The sequence and form of the questions and subquestions helped create a unique and personalized direction for the discussions. I transcribed the English language interviews and employed a transcription company to process the Arabic language interviews. For accuracy and trustworthiness, a log was kept on how the transcript was made and verified, as well as the level of detail in the data.

The manual descriptive coding process was done with a Word document and Excel sheets to move deductively from coded units to more extensive representations, including patterns, categories, and themes. I preferred to use manual coding rather than learning and using a qualitative data analysis software program, as it helped me immerse myself in the interview data, capture the deeper meaning of the data, and appreciate themes as they emerged. I followed Saldaña's (2016) descriptive coding process, which involved (a) preparing the interview transcription data files, (b) taking a close look at the text, (c) creating an initial listing of all individual first- and second-cycle codes in a way that ensured reliability and significance, (d) double-checking field notes to make sure that code meanings were precise, (e) spending time to find and highlight commonalities among different codes, (f) grouping codes to form a category, and (g) with a closer look, grouping similar categories to reflect different themes. Rubin and Rubin (2012) noted that themes are summary claims, causal, or assumptions. Themes explain why something happened, what it means, or how the interviewee feels.

By immersing myself in the data provided by all interviews while employing Saldaña's (2016) descriptive coding process, I identified five themes. The first three themes applied to how safe, easy, and useful it is to teach drilling application skills using the simulator technology. The other two themes represented how using the drilling simulator motivated the trainees, made them eager to complete their studies, and gave them a positive perspective with faith in a bright future. There were no discrepancies in the data.

Figure 5

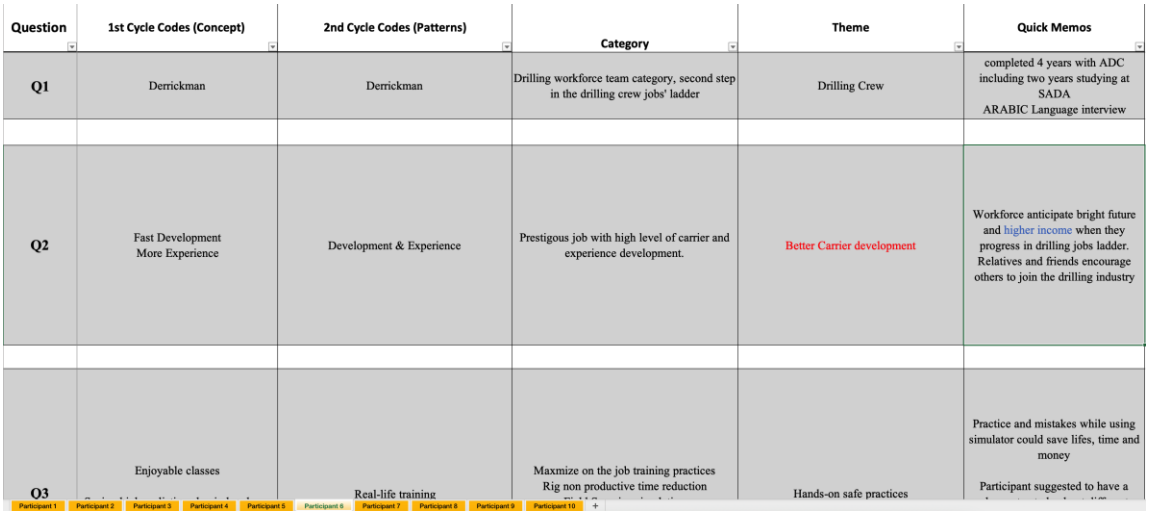
Snapshot for P6 Data Analysis Excel Sheet (Left-Hand Side Section)



Question	Interview Question	Page # Sentence#	Transcript	1st Cycle Codes (descriptive)
Q1	Tell me about yourself? Your name, age, specialty	P#4 S#1-4 P#5 S#1,2	Nasser Alawadh, 24, With ADC since end of 2017. Well control course+ SADA Simulator training Derrickman	Male, 24 High School Two Years Vocational Training SADA
Q2	Describe why and how you joined the drilling training program?	P#5 S#3,4	Well, drilling in general or we talk in general, we have the most reliable thing here in my homeland, I mean Saudi Arabia, but sometimes it's an advance on how to get it, where do they get it, so I tried to know how this field is, and we knew the drilling magazine, and I mean from my relatives, my grandfather was in Aramco and so on, I mean, from the family, I swear to God, they work in this field, whether in the mother's company, which is in my relatives. Aramco or the companies that are services or drilling, I mean drilling companies, I mean one by one, I mean I wanted to enter this field but I am afraid of the right basis, I mean there is training to develop education, safety and others, I mean I am not a founder right, thank God we succeeded in the company. About the studies that we took are very excellent I mean useful	Have development Bright Future More Experience High rewards for hard workers
		P#5 S#5	You know a lot of information, you know any question that comes to your mind that you can find in these courses in these books there the instructor	

Figure 6

Snapshot for the P6 Data Analysis Excel Sheet (Right-Hand Side Section

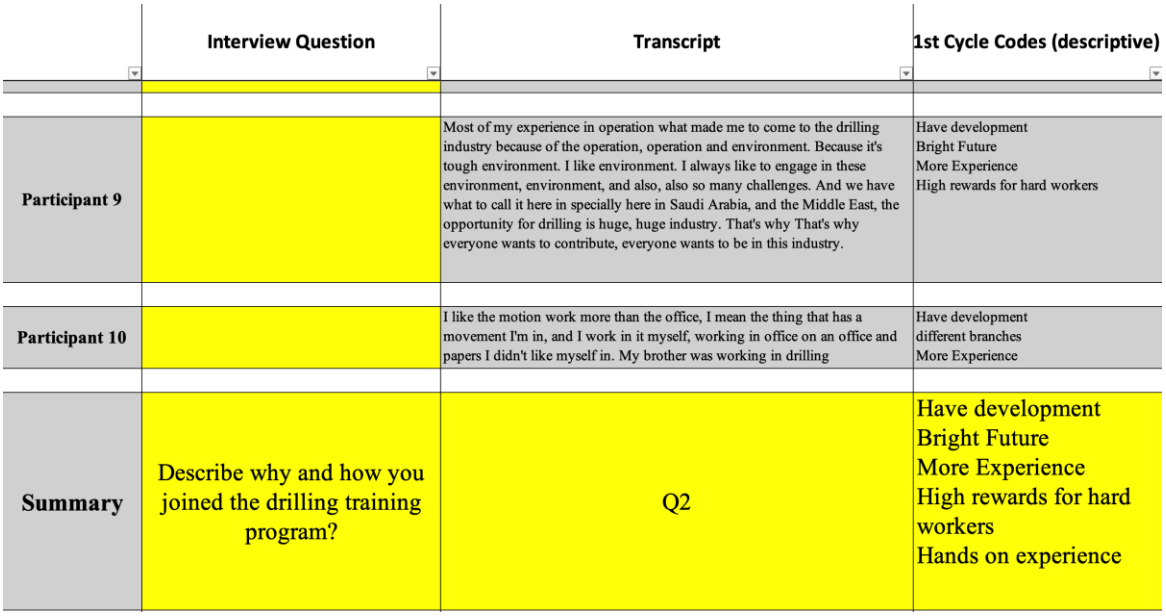


Question	1st Cycle Codes (Concept)	2nd Cycle Codes (Patterns)	Category	Theme	Quick Memos
Q1	Derrickman	Derrickman	Drilling workforce team category, second step in the drilling crew jobs' ladder	Drilling Crew	completed 4 years with ADC including two years studying at SADA ARABIC Language interview
Q2	Fast Development More Experience	Development & Experience	Prestigous job with high level of carrier and experience development.	Better Carrier development	Workforce anticipate bright future and higher income when they progress in drilling jobs ladder. Relatives and friends encourage others to join the drilling industry
Q3	Enjoyable classes	Real-life training	Maxmize on the job training practices Rig non productive time reduction	Hands-on safe practices	Practice and mistakes while using simulator could save lifes, time and money Participant suggested to have a

Participant 1 | Participant 2 | Participant 3 | Participant 4 | Participant 5 | Participant 6 | Participant 7 | Participant 8 | Participant 9 | Participant 10 | +

Figure 7

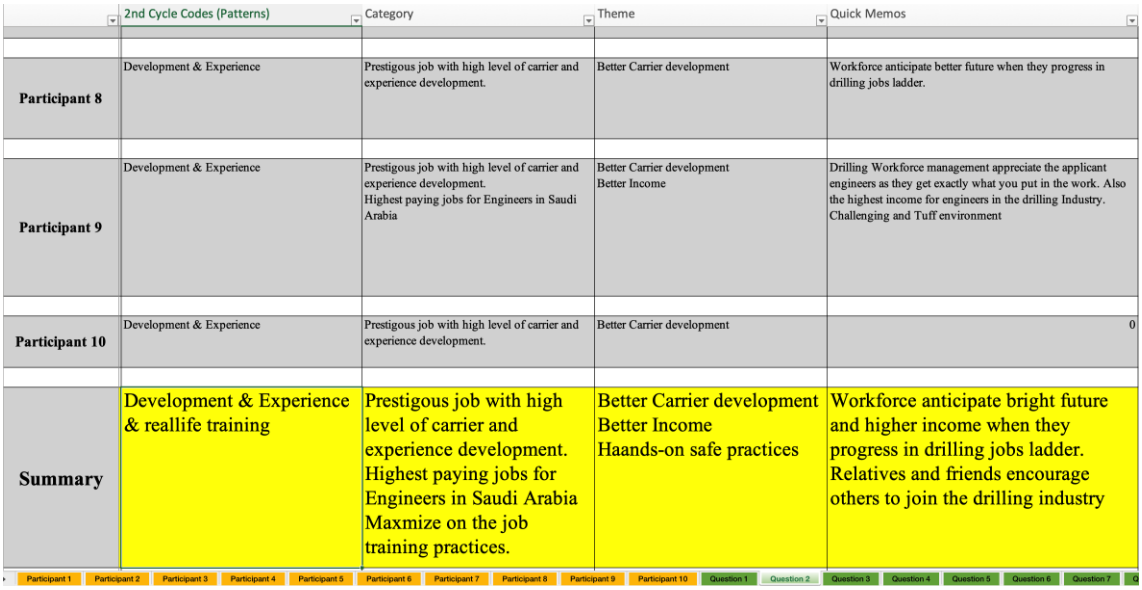
Snapshot for the Data Analysis Compiled Excel Sheet (Left-Hand Side Section)



	Interview Question	Transcript	1st Cycle Codes (descriptive)
Participant 9		Most of my experience in operation what made me to come to the drilling industry because of the operation, operation and environment. Because it's tough environment. I like environment. I always like to engage in these environment, environment, and also, also so many challenges. And we have what to call it here in specially here in Saudi Arabia, and the Middle East, the opportunity for drilling is huge, huge industry. That's why That's why everyone wants to contribute, everyone wants to be in this industry.	Have development Bright Future More Experience High rewards for hard workers
Participant 10		I like the motion work more than the office, I mean the thing that has a movement I'm in, and I work in it myself, working in office on an office and papers I didn't like myself in. My brother was working in drilling	Have development different branches More Experience
Summary	Describe why and how you joined the drilling training program?	Q2	Have development Bright Future More Experience High rewards for hard workers Hands on experience

Figure 8

Snapshot for the Data Analysis Compiled Excel Sheet (Right-Hand Side Section)



	2nd Cycle Codes (Patterns)	Category	Theme	Quick Memos
Participant 8	Development & Experience	Prestigous job with high level of carrier and experience development.	Better Carrier development	Workforce anticipate better future when they progress in drilling jobs ladder.
Participant 9	Development & Experience	Prestigous job with high level of carrier and experience development. Highest paying jobs for Engineers in Saudi Arabia	Better Carrier development Better Income	Drilling Workforce management appreciate the applicant engineers as they get exactly what you put in the work. Also the highest income for engineers in the drilling Industry. Challenging and Tuff environment
Participant 10	Development & Experience	Prestigous job with high level of carrier and experience development.	Better Carrier development	0
Summary	Development & Experience & reallife training	Prestigous job with high level of carrier and experience development. Highest paying jobs for Engineers in Saudi Arabia Maxmize on the job training practices.	Better Carrier development Better Income Haands-on safe practices	Workforce anticipate bright future and higher income when they progress in drilling jobs ladder. Relatives and friends encourage others to join the drilling industry

Participant 1 | Participant 2 | Participant 3 | Participant 4 | Participant 5 | Participant 6 | Participant 7 | Participant 8 | Participant 9 | Participant 10 | Question 1 | Question 2 | Question 3 | Question 4 | Question 5 | Question 6 | Question 7

Table 3 shows example codes with an explanation of what they mean and the quotes from the participants that helped generate the codes. The complete code book can be found in Appendix E. Table 4 indicates both the categories and the themes identified for each RQ.

Table 3

Example of Codes, Meaning, and Corresponding Participant Quotes

Code	Meaning	Participant quote
Bright future	A promising future	P4: "My entrance to the drilling industry was due to one of the many open positions that were open when there was a bright future."
More experience Different branches	Additional work knowledge Many services line	P2: "As for drilling, in particular, it is different and has many branches. I mean, I liked it in terms of specializations; it will be many and in terms of experience."
High rewards for hard workers	High pay for hard workers	P7: "The highest paying jobs in Saudi Arabia are thrown [*sic*] in the drilling industry." P9: "The opportunity for drilling is huge; huge [in the] drilling industry. That's why, that's why everyone wants to contribute. Everyone wants to be in this industry."
Interesting subjects and visual training	Motivating topics with a strong emphasis on visuals	P9: "Everything in the drilling was interesting, like especially now how to call the simulations. Okay, like you know [you] feel interested; like you will be engaged. You will feel like you know after you see that in the book. You will see it even when it comes to the work. I already have this experience, to be honest now."
Hands-on experience	Experiential learning	P6: "I saw everything we were hearing about it. I saw my work. We worked with them; we put our hands with [*sic*] them better than studying and learned the names of equipment better than I studied it—I mean practiced the thing with my hand. I worked on [the] drilling simulator cyber and hand brake."

Table 4

Categories and Themes for Each Research Question

RQs	Themes	Categories
RQ1: What are drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their learning?	Hands-on safe practices	Maximizes on-the-job training practices. Reduces the rig's nonproductive time Field scenarios simulation. Safe on the job training environment. Reduces training costs.
	Drilling simulator ease of use	Gain an actual job control position. Elevates trainee's confidence while playing the driller role. Repetitive practice chances facilitate the use. Professional instructions and supervision. Trainee familiarization with running and handling rig equipment. Practice on operations problematic scenarios. Cope with actual work stress while training in a safe environment.
	Drilling simulator learning usefulness	Increase the working experience. Enhance the trainee's rig handling and operation sequences. Develop a teamwork spirit. Develop the overall trainee skills of the rig's drilling and well-control parameters. Simple and easy to operate. With failed practice, just reboot the system to re-do. More scenarios of real operations problems are required. Create a safe and low-cost training environment.
RQ2: What are drilling-rig vocational trainees' perspectives on the influence of drilling simulation technologies on their motivation to complete their education?	Drilling simulator motivational value	Develop the trainee's self-confidence by using planned and safe training applications. Develop trainees' competencies through well-planned practices, encouragement, and professional supervision. Feeling confident and competent results in motivated trainees. Enhance the experiences of using drilling technology.
	Future expectations	Trainees are eager to know what is next and move forward with their careers. Positive future expectations as more experience comes with high expectations of worker value and compensation.

Evidence of Trustworthiness

This basic qualitative study's trustworthiness was established by implementing a thorough research plan comprised of detailed data collection goals and analysis procedures and an unbiased interpretation of the data collected. According to Ravitch and Carl (2016), trustworthiness is demonstrated through the study's credibility, transferability, dependability, and confirmability. This section provides a detailed discussion of the measures taken to ensure this study's trustworthiness.

Credibility

Credibility refers to the degree of certainty that data analysis and interpretation can be traced back to the original data collected from the participants (Ravitch & Carl, 2016). I achieved triangulation by interviewing diverse participants who had different levels of experience. Individual-specific perspectives and experiences can be verified against others. Several individual contributions can build a rich image of the participants' views, needs, actions, or experiences (Shenton, 2004), strengthening the data's credibility. Being thoroughly familiar with the participants' working culture due to my long work experience in the oil field and particularly the drilling specialty helped with prolonged engagement during data collection, leading to credibility. Lincoln and Guba (1985) recommended prolonged engagement between the researcher and participants to understand their organizational culture concerning the phenomenon of interest to create a relationship of trust. The initial introduction for individual interviews was extended to build trust, establish rapport with the participants, facilitate productive discussion, and obtain clear and detailed responses. In addition, the researcher's background, credentials,

and experience are essential; their credibility is significant in qualitative research, as they are a critical tool in data collection and analysis (Patton, 2015).

Member checking includes returning the data collected and analyzed during the study to respondents for authentication and verification; it allows the participants to validate the findings (Creswell, 2012; Lincoln & Guba, 1985). Member checking ensures the respondents' experiences and perceptions are accurately represented (Shenton, 2004). In this study, I conducted member checking by sending the transcribed interviews to those participants who wanted to check them for accuracy. Furthermore, I discussed the themes that emerged during data analysis with the participants to determine and validate whether the results were consistent with their beliefs. According to Lincoln and Guba (1985), the participants should review the final interpretations and express whether their opinions and experiences have been correctly expressed.

Frequent debriefing sessions for the research were encouraged. The chair of the research committee helped me work in a supervisory atmosphere, explore alternative approaches, address errors, and draw my attention to any deficiency in my work in progress. It provided me with a fresh perspective concerning other individuals, challenged my assumptions, and allowed me to develop methodologies, establish a more substantial explanation of the research design, and strengthen my arguments based on their comments (see Shenton, 2004).

Transferability

Thick and rich contextual descriptions of the participants' experiences demonstrate another dimension of a study's trustworthiness. As a result, readers have the

impression that their experience overlaps with the story told in the research. I interviewed diverse participants with different levels of experience. Their perspectives and experiences were compared, and the contributions of several individuals were used to build a rich image of the views, needs, actions, or experiences of the participants (see Shenton, 2004).

Transferability was indicated by the commonalities of the industry's drilling simulator applications and processes used across the globe (see Abulhassan, 2016). In this study, I provided detailed explanations of the setting and data collection process. I also described data analysis measures and results, including participant quotes. Throughout the data collection and analysis process, I maintained reflexivity, reminding myself of my job as a researcher and avoiding interjecting my personal experiences while reading and analyzing the participants' responses.

Dependability

Dependability is another element of trustworthiness that addresses reliability; it refers to repeating or replicating the study under similar conditions (Lincoln & Guba, 1985). Dependability is reflected in the study's procedural details (Ravitch & Carl, 2016). This study demonstrated dependability in the research design's description and execution; I explained what was planned and implemented at a strategic level. I also showed this through the operational details of data collection, descriptions of what was done in the field, and reflective project evaluation of the efficacy of the investigation process. Information was described and presented in detail to allow study replication (see Lincoln & Guba, 1985; Shenton, 2004).

Confirmability

Triangulation techniques minimize the researcher's bias and ensure study results are driven by the participants' observations and opinions rather than the researcher's characteristics and preferences to achieve objectivity (Lincoln & Guba, 1985; Shenton, 2004). Audio-recorded interview transcripts were completed using a professional third party for Arabic interviews and the Otter program for transcribing English interviews. I reviewed both for accuracy. The final themes formed after data coding and analysis were discussed with the participants; this authentication of the results accurately represented the participants' expectations and experiences. Confirmability was also established by using a research journal, which helped provide a better understanding of the participants' perspectives in addition to my discussion with them regarding the study's findings.

Results

The study's findings were placed into groups based on the two RQs. RQ1 focused on the participants' perceptions of using the drilling simulator in their training and how this helped the trainees learn, encouraging them to understand and complete their practices, which may improve their performance and skills. RQ2 focused on the participants' perception of the influence of drilling simulator training on their motivation and intention to complete their drilling education. Data from interviews with each participant, field notes, and reflexive journaling were analyzed to discover relationships between data sources and themes. The following section is organized by RQ and its corresponding themes and addresses each with supporting data, using quotes from the transcripts.

Themes for Research Question 1

The first RQ was, "What are drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their learning?" All 10 participants provided positive responses regarding the ease of using the drilling simulator after having initial direction from the training instructor. They also agreed that drilling simulator training programs are essential for their learning, which could improve their professional skills and performance. P8 highlighted these training benefits:

> You know a lot of things. . . . They teach you many things, meaning the simulator, not just to drill. . . . The skills I've learned so much, for example, I'm telling you now because I've had a kick case [a flow of gas from the formation rock to inside the well as a result of unbalanced downhole pressures] and nothing; I'll know how to do it. It's all from the simulator training, which taught me many things. . . . I learned a lot from the simulators. It's true that I used the small simulator; I was able to apply everything I learned more, and I get into it more and understand it more, [to] teach me a lot of things.

The themes that emerged from the interviews representing the answers for RQ1 are safe hands-on practices, drilling simulator ease of use, and drilling simulator learning usefulness.

Safe Hands-On Practices

There was an agreement from all the participants that the drilling simulator training practices produced a hassle-free and safe training environment compared with the possibility of running this training at the drilling rig site. Such training maximizes on-

the-job training practices, reduces nonproductive rig time, allows using different field scenario simulations, perfectly simulates the on-the-job safe training environment, and reduces overall training costs. P6 explained the value of hands-on simulations: “The thing you practice with your hand, you know how to deal with it. I mean, you know what is required from you . . . the student will be sitting on the console of the simulator; he knows how to deal with it.”

P5 explained the value of simulator practices:

> The simulator introduces you to the concept of control and trains you to use it. But without the simulator work, you may not understand or be able to resolve risks. It is critical to practice what you learned using the simulator to become familiar with it. Simulator courses are required to sit alone on rig devices; otherwise, an instructor should always be present. The simulator allows you to make mistakes and learn from them, but in actual work, you can’t make mistakes because it means a lot that can’t be fixed.

The participants highlighted a need to maximize simulator job practices to increase competency and reduce rig-site accidents. P9 illustrated this concept:

> Of course, seeing the simulation before going to the rig is much better. It’s vital to see the results, to know that this person is competent. We can’t bring some people like me, for example, because I fit in a simulation of these experienced people, and that’s important before you go to that life. Managing people’s lives is a big responsibility. You must be competent; you must comprehend all facets, and you must understand what lies behind all of this.

P3 highlighted the value of an on-the-job safe training environment: “You work in a dangerous environment where the rig crew’s lives at risk. . . . The whole environment is scary, but you know that with the simulator, there would be no danger, and you can practice and learn.” P7 explained that simulator training would save time, energy, and money: “I think the simulator may be a great method to learn before going into the rig. . . . It saves time to recall everyone instead of just leaving them. . . . It saves money, time, and energy, as well as saving transportation and safety.” Again, P6 highlighted the value of hands-on practices: “We put our hands on them, [which is] better than studying and learned the names of equipment better than I studied it, I mean, practiced it with my hand. I worked on cyber drilling and hand brake.” P7 identified how the participants could learn from mistakes at no cost:

> Everything became very clear. When you are using the simulator, you are just focused on learning. Innocent to make any mistake. That’s why we can do anything for our peace of mind. Every mistake is not counted. . . . As we just mentioned, mistakes of innocence, right? Mistakes are an essential use of simulation.

Simulation training removes the fear of serious problems if mistakes are made. The program can be restarted so the trainee can try to overcome the initial challenge.

Drilling Simulator Ease of Use

All participants stated how it was easy to use the simulator with introductory direction and the professional supervision of training instructors. In addition, the repetitive simulator practices helped facilitate its use. The participants explained that the

ease of using the drilling simulator helped them to gain job control, elevated their self-confidence through practicing the driller role, familiarized them with handling and running the rig equipment, gave them the chance to practice the operations' problematic scenarios, and helped them cope with work stress while training in a professional and safe environment. P1 explained how the instructors gave him training motivation:

> They give me a demo plan for everything. . . . He gave me some problems to deal with . . . we are supposed to take the simulator training before we do the job itself, not after it to tik boxes; this is how it would be useful.

P2 shared his perception of how using the drilling simulator to learn a new skill was easier and better compared with using the conventional drilling rig console: "Of course, it will be easier [practicing] with the simulator; it is better in terms of safety, in terms of saving money, and in terms of understanding more and more details."

P3 iterated how training in a safe environment led to accident free learning, eliminated fear, and taught him how to cope with work stress:

> Simulator training is easier. The simulator will alleviate the fear of making mistakes. Fear is a major issue when working in a dangerous environment with life-threatening situations for the rig crew. You are afraid of doing anything wrong that may cause a problem, and you are afraid of causing a problem for the driller, who is responsible for the crew's safety. The whole environment is scary, but you are confident that there will be no dangerous situations in the simulator, and you can practice and gain confidence.

Overall, the participants explained how easy it is to use and operate the drilling simulator. They stated it is like Cyber Rig (rigs that are operated using a software program to run its various mechanical parts) but has some differences compared with the conventional rig. P5 stated,

> Of course, the first use of the simulator means similar things to the field rig at work. You may [have] heard of some applications or equipment but never used it at the rig; the instructor will point it out. He says in the simulator not to leave anything that could help you unused. It's a lot, but the instructor taught me about it, and we dealt with it. Simulator learning is easier than rig learning. In the rig, you may need three to four people to do a job, but in the simulator, you can do it alone, and it is much easier than the rig.

P6 highlighted the importance for all the drilling workers to learn and master reading and writing in the English language as all drilling expressions are in English:

> I didn't have any difficulty; not even my colleagues faced any difficulty in dealing with a simulator. You have it, as you say keyword for a question . . . we have skills for the English language speaking, writing, etc. You are good.

P8 stated how real the simulation is: "Originally in the real situation; it's the same as the simulator." P4 explained that the simulations include various ways of learning and more real-world problems:

> The drilling simulation program simulates the applications and stimulates the person who worked on it. The drilling simulation experience contains more than one drilling scenario, user reactions that absorb downhole problems, and error

> detection from real-world reactions [and therefore] avoiding most group problems. It is vital because it reveals the trainees' reactions to problems, revealing their weaknesses.

The driller's fast and corrective actions to regulate any downhole problem are vital to keep the well under control and to save the lives of the drilling crew. Corrective action is one of the important skills that would be gained through drilling simulation training.

Drilling Simulator Learning Usefulness

Each participant uniquely expressed how the drilling simulator is useful for learning drilling process skills, applications, and for troubleshooting problems throughout the simulator training programs. Based on the participants' perspectives, the drilling simulator training programs helped improve their working experience, creating a safe and lower-cost training environment. This helped to enhance the trainees' rig handling and operation sequences, create a spirit of teamwork, and develop skills concerning the rig's drilling and well-control applications. This made it simple and easy to operate, with no fear of failed practices; the system could just be rebooted for further practice. However, all participants recommended including more scenarios of real operational problems within these training programs.

P1 approached the problems of having outdated simulator software or limited simulator hardware capabilities, which hinder simulator training capability:

> The problem with our system itself [simulator needs to be updated] [is] because it is lagging and sometimes you have to repeatedly switch it off and restart it, losing

> valuable training time. Accordingly, the time is taken for one trainee; the instructor can train two if the program is good.

P3 valued the training and how it developed his professional skills and boosted his self-confidence at work:

> Yes, the simulator training program works. It helped me gain confidence and skills. When the driller has a problem and wants to assign tasks to the assistant driller, the assistant driller will know exactly what to do and save the driller time explaining. The simulator teaches us how to drill, build pipes, etc. When the assistant driller is confident and well-trained, the supervisor will not be afraid to delegate responsibility. He liked it all. The course lacked tasks. I wished it was a full training course, with joystick training and all the required practices. This necessitates Cyber Rig simulator training.

P4 was an ambitious person working as an assistant driller and had a high level of work experience, although he initially dropped out of high school and joined the workforce. The company's internal drilling training program, DAD, in addition to his 7 years of hands-on rig experience, gave him significant insight into the usefulness of the drilling simulator training programs:

> The program's various benefits include revealing human errors in dealing with downhole issues; first, a simulator must be a likeness. The trainees are tested using drilling simulators but without loss. One of the advantages of drilling simulation is that no accidents occur. This program's skills are numerous, but the most important is strengthening the formation and understanding of the traditional

> drilling rigs' work. Workers who understand the traditional drilling rig if someone from outside his specialty came and taught him everything about the drilling simulator. We believe the simulator system improves practical skills slowing us to spend less time in traditional situations, like a fast and appropriate response to a gas kick. The simulator has both strengths and weaknesses; the training program's mistakes [troubleshooting applications] are the strengths. These are the trainee's strengths, and their development simulates reality. One of the simulator's weaknesses is the trainee's belief that there are no losses during his simulator training, which may affect his reaction. This issue needs to be considered when practicing.

P3 indicated that the training application was based on reality: "Sure, [the drilling simulator is my favorite] because the thing you're applying is practical. For example, doing my job better than sitting and listening because you're doing the thing; putting yourself in the job itself." P6 highlighted another simulator weakness, stating that the program should

> cover all the drilling operation operations while on the rig. I mean, in addition to other services like coiled tubing, you have wireline [tools that take technical images for the rocks], slikline [mechanical services to control tool settings inside the well], and you have well completion [pipes used to help have the oil production move out of the well].

Current drilling simulator training applications include only well-control and drilling practice applications, whereas many other activities take place after drilling. P6 highlighted the necessity of having simulation training applications for these activities.

Themes for Research Question 2

The second RQ was, "What are drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their motivation to complete their education?" Optimistic and encouraging feedback was received from each of the 10 participants on how drilling simulator training raised morale, motivated them to pursue additional education, and acquire more skills to move forward with their careers. The themes that emerged from the interviews representing the answers for RQ2 are drilling simulator motivational value and future expectation.

Drilling Simulator Motivational Value

Many participants saw a significant motivational effect from the simulator training program, particularly at the beginning of their careers. They attributed this to the fact that the simulation training program helped them develop their self-confidence by using planned and safe training applications. They developed their competencies through well-planned practices in addition to the instructor's encouragement and professional supervision. This helped to enhance their experience using drilling technology. P2 stated that the drilling simulator gave him self-confidence at work through working experience:

> There is something else regarding self-confidence. You will have self-confidence. This program made me feel more confident. I was more confident in myself, and I even started explaining to the young people at the rig: "You will have everything

> you will need to learn until you are aware of the situation—until you have principles of controlling the well, and that means saving the life of the people you have."

P3 was excited recalling his first simulation training program:

> I want to give you too many words. After completing the training, I looked up while lifting my chest [feeling proud], as working as a driller is like a big dream. Yes. Yes. It did encourage me and motivate me. It made me feel that I want to complete my training quickly, and I want to work hard until my dreams come true. It made me more confident, and I hoped that the negative people around me would not affect me and push me back.

P4 had further explanations regarding the motivation value of the drilling simulator training program:

> It boosted my self-esteem. Everything [at the rig] was just like my training and role. The instructor ran the simulation software, which helped the program develop confidence. After this training, I didn't want to stop learning anything. Another key factor was the psychological stress I had to endure, which I have learned how to face during the training [learning how to function under pressure]. Learn about the drilling program and typical drilling. To be honest, I picture the future based on one word, learning, as one may not learn, be fatigued, or understand future demands. We don't look at salary, money. The requirements are certain but never comparable to knowledge. My goal is to become a drilling manager.

Participant 5 also enthusiastically expressed even more ideas about how drilling simulator training helped to motivate him:

> It may have a great impact on my self-confidence if I can use the simulator to deal with problems, as well as I would prefer if we could have training on a big simulator that has more screens [capabilities]. One who took a course only on the simulator for 1 week would be great; this greatly benefits him. Basically, the drilling companies' workers' development programs [are] to develop a qualified driller [and can] motivate anyone. Whether he is looking for a position, it aspires [*sic*] him to deliver such an excellent program. It encourages a person to aspire to deliver and get promoted to higher positions, and one of the things that makes a person or a drilling worker happy or likes the field of drilling. It gives great motivation. Such long and repeated simulator training will motivate and encourage him to deliver.

All the other participants (P1, P9, P3, P7) had clear statements about how simulation training positively motivated them and affected their self-confidence. P9 explained how he also gained the necessary work experience:

> [A] Person that will take this course's training program. . . . Each month after this program . . . he will be more, like, understanding of each aspect around him. So, he will gain more experience. He will be in the future something that we will not; we cannot imagine. . . . Maybe he will be rig manager one day, so these courses would be pushing him to the maximum.

P9 explained how simulation training supported his work experience and helped him build optimistic future expectations.

Future Expectations

All participants had high expectations regarding their future work success; however, all agreed that hard work would be the only way to achieve this. They stated that the drilling simulation training program made them eager to know what is next for them and move forward with their careers. They all had positive future expectations, as gaining more experience creates higher anticipation of worker value and compensation. P4 stated,

> Honestly, my future plans are unlimited because our field is unlimited. Now my ambitions are to be a drilling manager, but I know that I want to go higher and higher when I am a drilling manager. Of course, our country is based on the income from work. I mean a state budget; a state's income budget is based on oil. Our salaries are never low, but everyone looks at a drilling manager or higher, and at least as well, they all became rich, God willing, so much money that they work on projects that benefit the country outside of the oil field. Of course, it affects positively; of course, it affects positively. Families will be happy for sure.

P3 talked about how his family would be affected by his job promotions:

> God willing, [being] automatically promoted to higher positions with higher income; I will not stop growing [in] my career. It will make me live a comfortable life. I can give my children the best education; I want to see them study outside the country. [This] means sure [*sic*] lifestyle and everything will get better.

P5 discussed the future regarding his career, salary, and family:

> I felt that my future progress could be unimaginable. I mean, in the drilling field because anyone can do or deliver these things. Those who did not attend these courses, simulator training or well-control training, may believe that this is a difficult business [drilling] or that perform or provide. Sure, there is a lot of growth in the drilling area. Promotions boost your salary, which means you will have a better level of life. This inspires anyone involved in drilling. This job development will help me do the best things for my children.

P8 also highlighted the financial development working in drilling: "The more you get promoted, the more you earn. The more you earn, the more skills you will have. You will not be able to reach more and increase your income if you do not have these things." P2 concurred,

> Income? It will be better, and it will be enough for you; it will make you build a house, and you will live a good life. You will educate your children and buy the things you like—the things that the children need and like. And you will do many things, meaning other money. I can use the money to invest in other projects that will help my country.

All the participants claimed that more simulation training applications and time are necessary for their overall development. P2 stated, "For the simulator, we need more training time. I will take [*sic*] an example when we complete a simulator training program, and we succeed in it. We need to have more training time to develop our skills." P4 mentioned, "Drilling simulator courses need to have practice sessions to show how

shortcuts and bad practices damage equipment." Almost all participants strongly suggested that more simulator time and applications are required for all the drilling workforce.

Summary

Ten individual interviews with a drilling contractor's vocational training participants were conducted to collect data for this study. The answer to RQ1 regarding drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their learning showed that using drilling simulators in training was a valuable tool. Drilling simulator training helped to create a safe, low-cost, easy to operate, and hands-on-the-job training environment. It familiarized trainees with running and handling the rig equipment and increased their working experiences through developing drilling and well-control skills. It also assisted trainees with practice on a variety of problematic operation scenarios and developed a spirit of teamwork. Finally, it helped reduce nonproductive rig time.

The answer to RQ2 regarding drilling-rig vocational trainees' perspectives on the influence of drilling simulation technologies on their motivation to complete their education showed that drilling simulation training was a highly motivating factor that helped to develop the trainee's self-confidence as a result of using planned and safe training applications. It helped to develop the trainees' competencies through well-planned practices, encouragement, and professional supervision. Many trainees became eager to know what was next for them and to move forward with their education. They

began to have positive future expectations as more experience fosters greater anticipation of worker value and compensation.

In Chapter 5, I will interpret the findings presented using the scholarly literature. I provide the limitations of this study and make recommendations for future research based on its strengths, weaknesses, and current research. I will also discuss implications for positive social change and practice.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this qualitative study was to explore how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at the oilfield drilling rig's vocational training facility. The population of this research study was limited to one vocational training facility of a major Saudi Arabia-based drilling contractor company. The RQs allowed me to explore the participants' perceptions and training experiences regarding using the drilling simulator in their education and professional training settings. The use of a basic qualitative design provided in-depth data for identifying themes regarding the participants' experiences while using the drilling simulator. I identified the positive learning and motivational value of using the drilling simulation technology to educate and develop knowledge and professional skills for the drilling workforce at all occupational levels.

Ten participants completed semistructured interviews out of 15 who met the inclusion criteria. The interview questions were designed to address the two RQs:

RQ1: What are drilling-rig vocational trainees' perspectives on the influence of the use of drilling simulation technologies on their learning?

RQ2: What are drilling-rig vocational trainees' perspectives on the influence of drilling simulation technologies on their motivation to complete their education?

The key findings from the study indicated that the participants perceived drilling simulators in training to be a valuable tool. Drilling simulator training helped create a safe, low-cost, easy-to-operate, and hands-on-the-job training environment. It assisted in

developing the trainees' self-confidence by using planned and safe training applications. Many trainees were motivated and eager to know what was next for them and to move forward with their education as more experience created high expectations of worker value and compensation.

In this chapter, I discuss the findings and how they were interpreted in light of the conceptual framework. I focus on the results of the interviews, field notes, and reflective journaling and how they compared to the peer-reviewed literature in Chapter 2. I also discuss the study's limits and how I addressed trustworthiness difficulties. Additionally, recommendations for future research studies are made, and the chapter finishes with implications for constructive social change and a conclusion.

Interpretation of the Findings

Davis's (1985) TAM served as a guide for this basic qualitative study on how using simulation technologies influences trainees' learning, motivation, and perspectives about completing their education at the oilfield drilling rig's vocational training facility. The findings were examined and interpreted for each RQ using the conceptual framework as a lens and the literature review to extend knowledge on the use of drilling simulation technology in educational settings for vocational training purposes. I used the TAM's two critical constructs, PEOU and PU, to develop two groups of semistructured interview questions. One group was used to elicit responses regarding the ease of use of the drilling simulator and how this PEOU encouraged the trainees to understand and enhance their skills and performance. The second group of questions was designed to explore how

useful the simulator is and how this PU may improve the trainees' motivation and intention to complete their education.

Based on the data from the responses of the 10 interviews, the participants indicated their perception of Davis's (1985) TAM theory's two major constructs, PEOU and PU. The drilling vocational training participants used their direct experience and self-reflection of going through the drilling simulation training to provide detailed feedback to Davis's definition of the PEOU as "the degree to which a person believes that using a particular system would be free from effort" (p. 26). The PU is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1985, p. 26). The participants' perceptions confirmed the assumption based on the TAM that simulation technology is useful for their training. It is easy to use correctly, and they saw it as encouraging and motivating.

Research Question 1

The interview questions for RQ1 focused on how easy the use of the drilling simulator was and how this perceived ease and usefulness attracted trainees, encouraged them to understand, and enhanced their skills and performance during the simulator training and when they went back to their original work environment at the rig site. The themes that emerged from the interviews representing the answers for RQ1 were safe hands-on practices, drilling simulator ease of use, and drilling simulator learning usefulness. The research data indicated that all 10 participants agreed that the drilling simulator training programs were critical for their learning, as they improved their professional skills and performance using concrete, hands-on experience and reflective

observation. There have been similar studies completed by Akçayır and Akçayır (2016), Reyhan et al. (2018), and Chiang et al. (2014) on the effect of using simulations in other educational settings, which showed that using simulations may improve students' communication skills, critical thinking, professional skills, and professional accountability. Simulations also reduce students' concerns during practice and positively influence the decision to enter their profession, which will help fill in the current research gap in this area.

Hands-On Safe Practices

The participants agreed that using a drilling simulator provided a more convenient and safe training environment than using a drilling rig. Simulating multiple field scenarios enables practice and perfectly reproduces the on-the-job safe training environment while reducing overall training expenditures. P6 explained the value of hand-on simulations: "The thing you practice with your hand. . . . The student will be sitting on the console of the simulator; he knows how to deal with it." P7 emphasized the value of being able to restart the program to learn from mistakes: "Everything became evident. Using the simulator is all about learning. Innocent of any error. Hence, we will do everything for our own sake. No mistake is counted. . . . So, innocent mistakes, right? Simulating mistakes is essential."

The literature reviewed in Chapter 2 supports these results. In a study about simulation training for nursing and paramedic education, Cowling and Birt (2018) stated that using simulation in training health science students would improve the learners' safety, competency, and job skills compared with conventional educational training

methods. Sabalic and Schoener (2017) investigated how VR-based technologies can improve dental students' and educators' knowledge, attitudes, and practice. In an online poll, 121 students and dentists from 35 countries across Africa, America, Asia, and Europe responded anonymously. According to the survey results, dental students and educators strongly supported VR-based technologies because simulation training allows students to practice the treatment multiple times. Additionally, Kassem et al. (2017), in a study on building engineering education and training, concluded that virtual simulation environments helped increase the possibility of identifying and managing risk at different construction sites.

Drilling Simulator Ease of Use

All participants agreed that using the simulator was simple after receiving basic instruction and professional guidance from training instructors. Repetitive simulator practice also helped. The participants said that the drilling simulator's ease of use helped them gain job control, boosted their confidence by allowing them to practicing the driller role, familiarized them with handling and operating rig equipment, allowed them to practice problematic scenarios, and helped them cope with work stress while training in a professional and safe environment. Supporting evidence from the literature review on the effectiveness and ease of use of simulations in educational settings over the conventional methods was identified by Abulhassan (2016). Using a live well simulator computer-based drilling program that incorporated realistic, hands-on, and theoretical explanations was found to be a more effective solution than a traditional classroom environment alone.

P2 stated that using the drilling simulator was easier and better than using the standard drilling rig console to learn new skills: “Of course, it will be easier [practicing] with the simulator; it is better in terms of safety, in terms of saving money, and in terms of understanding more and more details.” P5 added,

> Learning from the simulator easier than learning at the rig. At the rig or the field of work, you may have more than one piece of equipment, so you may need three to four people to do the job at the rig. But on the simulator, you can deal with it on your own, and it is significantly easier than the rig.

Simulator training programs have compiled some of the rig equipment together so that one person can handle the control of the equipment settings. However, this requires more than one person at the rig site.

Drilling Simulator Learning Usefulness

Throughout the simulator training programs, each participant complimented its ease of use and highlighted how the simulator was useful for mastering the drilling operations’ applications and troubleshooting processes. According to the participants, the drilling simulator training programs improved their working experience, created a safe and low-cost training environment, enhanced their rig handling and operation sequences, developed a spirit of teamwork, improved their overall skills in the rig’s drilling and well-control applications, and eliminated the fear of failed practices. They all advised adding additional real-world problems to these training programs.

P4 explained the many benefits of the drilling simulator:

> The program's usefulness was many, but one of the most prominent benefits is to reveal the reactions of human errors in dealing with the downhole problem, the tests of the trainees are done through drilling simulators, but without any loss. One of the benefits of drilling simulation is that it returns to us without any accidents. Of course, the skills acquired are countless in this program, but the most prominent of them is the strengthening of information and the concept of the work of the traditional drilling rig. . . . We feel [the] simulator system enhances the skill's practical skill so that we spend less time in real life in a traditional life.

P3 valued the training and stated, "Yes. The simulator training program is useful. It developed my skills and gave me confidence."

The learning usefulness of the simulator training within other specialties such as nursing and pharmacy education was shown in the literature through studies by Kapucu (2017), Rossler et al. (2018), and Unver et al. (2018). The findings indicated that simulation training was useful for improving nursing students' skills beyond using a mannequin by increasing students' confidence and preparing them for real-life clinical settings. In addition, Fernandez (2017) and Kiryakova et al. (2018) showed that continuous simulation technology increased perception and understanding of learning outcomes and helped students acquire specific knowledge while performing different educational activities. In an older study by Hodgson and Hassard (2006), using a drilling simulator helped drilling crews cover the mechanical handling of the equipment, training development plans, and oil-well-control principles and procedures.

Participant responses, memo notes, reflexive journaling, and evidence from peer-reviewed literature all contributed to answering the first RQ about the drilling-rig trainees' perceptions of the influence of using drilling simulations on their learning. All participants had positive feedback demonstrated by their use of the drilling simulators. They agreed that drilling simulator training programs are essential for their learning and that they should complete training before exposure to the rig site's real environment, which would improve their professional skills and performance. They stated that using drilling simulator training provided them with a more convenient and safe teaching environment than using a drilling rig. Fernandez (2017) stated that using innovative approaches in education, such as simulation, VR, and AR, provided students with a more efficient learning environment to increase their perception and understanding of learning outcomes and acquire precise knowledge while performing educational activities.

Drilling simulations also maximize on-the-job training, save rig downtime, allow for varied field scenario simulations, replicate training, and lower overall training expenses. The participants indicated that the drilling simulator's ease of use helped them gain job control, boost their confidence by practicing the driller's role, familiarize themselves with handling and operating rig equipment, practice problematic scenarios, and cope with work stress while training in a professional and safe environment. In addition, these programs improved the trainees' skills in the rig's drilling and well-control applications by making these applications simple and easy to use. Similarly, Abulhassan (2016) stated that using a live well simulator computer-based drilling

program that incorporates realistic, hands-on, and theoretical explanations is more effective than a traditional classroom environment alone.

Research Question 2

RQ2 was designed to allow examination of the perceptions of drilling-rig vocational trainees regarding how using drilling simulation technologies affected their motivation and intention to proceed with and complete their education. Each of the 10 participants gave positive and encouraging feedback regarding how drilling simulator training improved their morale and inspired them to further their education and talents. P8 expressed,

> Sure. Too many. [Their] self-confidence has increased. . . . I'm not just working as an assistant driller; I work everything for the supervisor one thing. These simulators allow you to apply everything at once to teach you how to deal with this situation. I say I will be very encouraged. Because he sees himself applying something, and he will see himself in the situation, and he gets excited and says, "Why I didn't get to this thing?" [He] will be very encouraged. Sure, he'll continue [drilling education] because he saw himself progressing and saw himself on the simulator. I'm now, for example, I'm an assistant driller, and I learned all these things, and I think I can, but an assistant says, "Why don't I get more than that? Why don't I take a higher job? I mean, I did it [during simulator practice] here, right?" On the contrary, the simulator gave me a big morale boost.

The interview themes for RQ2 include drilling simulator motivational value and future expectations.

Drilling Simulator Motivational Value

Most participants perceived a significant motivational effect from the simulator training program, particularly at the beginning of their career training. They also had higher expectations about their future work development; however, they all agreed that hard work would be the only way to achieve this. The drilling simulation training program helped them develop self-confidence due to using well-planned and safe training applications. It also helped to enhance their experience of using drilling technology.

According to Douglas-Lenders et al. (2017), increased self-efficacy, learning confidence, learning motivation, and supervisor support for workers were observed while using experiential simulation-based learning, which was predicated on the improvement of the participants' leadership, communication, and safety awareness. To increase trainees' motivation by using AR simulations in vocational education and training, Bacca et al. (2018) found a positive correlation between student and motivation feedback. Learning outcomes, student success, and motivation are all linked. Using the AR application drew the trainees' attention and increased their motivation.

P3 was excited recalling his first simulation training program:

> I want to give you too many words. After completing the training, I looked up while lifting my chest [feeling proud] as working as a driller is like a big dream. Yes. Yes. It did encourage me and motivate me. It made me feel that I want to complete my training quickly, and I want to work hard until my dreams come true. It made me more confident, and I hoped that the negative people around me would not affect me and push me back.

Merging all data resources helped me answer the second RQ and conclude that most participants found the simulator training programs motivating. They could develop their competencies and enhance their drilling technology experience with planned and safe training applications.

Future Expectations

Drilling companies usually have an investment in the career development of their drilling workforce in both theoretical and practical training programs. Such developments usually create a positive future expectation; this was discussed by P4:

> Honestly, my future plans are unlimited. . . . Because our field is unlimited. . . . My ambitions are to be a drilling manager, but I know that I want to go higher and higher as a drilling manager. . . Our salaries are never low. . . . Of course, it affects positively; of course, it affects positively. Families will be happy for sure.

Everyone had high hopes for future advancement in their work, but all felt that substantial effort was the only route to success. The participants claimed they were excited to discover what was ahead of them following the drilling simulation training program. They all had high hopes for the future, as experience increased a worker's worth and income.

Limitations of the Study

While completing this study, I recognized three limitations. First, the study was conducted using convenience sampling instead of random sampling, which could have increased the risk of bias. The ability to generalize from a convenience sample is limited, as the sample may not accurately represent all drilling institutes' vocational trainees in

different settings and circumstances (see Creswell, 2009). However, other factors helped achieve a wide range of participants' perceptions; they had different levels of education, ranging from dropping out of high school to a master's degree. Their total number of years of experience and level of exposure to drilling simulators also varied, helping to broaden feedback regarding the study's topic.

The second limitation was the study's sample size. I contacted 15 individuals who met the study's criteria; however, only 10 participated. This study was limited by its inability to reach the anticipated sample size. However, after analyzing nine interview responses, I reached data saturation as no new themes emerged from individual interviews. Because drilling simulations were standard activities within the same organization, the participants who attended the same training shared similar impressions and experiences. Mason (2010) stated that while many factors affect sample size in qualitative studies, researchers generally use saturation as a guiding principle during data collection.

The third limitation was the difference in settings, such as the drilling vocational institute's procedures for simulation experiences, different types of simulators, how the simulation content was delivered, and the trainees' preparation for the simulation experiences. These cannot be controlled and may influence outcomes during the simulation experiences. Such conditions indicate that it is necessary to perform more studies to explore how using simulation technologies may influence trainees' learning, rig training motivation, and perspectives about completing their education at the oilfield drilling facilities.

Recommendations

This study focused on 10 participants' perceptions of their experiences while using the drilling simulator in oil-rig training. The participants were recruited from one partner organization, and their jobs were floorman, derrickman, trainee assistant driller, and assistant driller. I recommend future research studies that recruit participants from more than one organization and examine their perceptions from various other job levels (e.g., driller, night pusher, tool pusher, rig manager, etc.). During this basic qualitative study, I specifically tried to understand the positive impact of simulation technology on the learning and motivation of oil-rig trainees. I used the concepts of PEOU and PU, taking into account the participants' perceptions of the use of drilling simulation technology, which could help fill in the literature gap. It is possible that follow-up with descriptive quantitative or mixed-methods research would help evaluate students' learning development, motivation, and job skills enhancement in conjunction with PU for drilling education, which could extend or confirm the findings of this study. I recommend studies that cover future drilling simulation technologies, including VR or AR.

All the participants made one recommendation that could be considered a workforce request. In addition to the current well-control and stuck pipe training courses, based on the requests from all participants, I recommend and urge that drilling contractor training facilities' leaders put together different levels of drilling simulation training courses. Each level of these courses should cover the job activities and drilling processes of a specific drilling crew's position, starting from floorman, derrickman, assistant driller, the driller, night pusher, and tool pusher. Every course could be built based on each

level's requirements. The higher the level, the more compiled applications, problems, and troubleshooting should be included. Some simulators are too expensive to be used only for well-control courses and for a few drilling problems, such as a stuck pipe.

My original study plan was to interview 15 participants; however, due to the COVID-19 pandemic, the participants' compressed work schedules, and family responsibilities during their short days off, I could only interview 10. I recommend using focus groups in future studies to capture more rich and intensive data. Using focus groups may help in the collection of additional data from group discussions (see Ravitch & Carl, 2016).

Implications

This study was guided by Walden University's aim to provide a diverse community of career professionals with opportunities to transform themselves as scholar-practitioners and influence positive social change. Positive social change improves human and social conditions as well as society. Change occurs at the individual, family, community, and societal levels, propelled by good intentions, ideas, and behaviors. Human ethics is one of the essential motives behind social change; it should include kindness, compassion, and careful consideration.

My study explored how simulation technologies in educational settings can increase trainees' learning, motivation, and desire to finish their education at drilling vocational institutes. This study's findings have the potential to promote positive social change at the trainee level, the country's drilling rig workforce level, and the regional level. The implications of positive change include better learning and understanding of

drilling processes, motivating and encouraging current trainees to complete their vocational education programs, and attracting more future nationals to join the oil drilling industry, which will foster social responsibility and help create more job opportunities for Saudi youth. Creating job opportunities for Saudi youth is critical, considering approximately 40% are currently unemployed (Yamada, 2018).

With more trainees who decide to complete their education and stay within the industry, the high training costs per individual will decrease. Lower training costs will increase competitiveness and national employment levels, particularly among families of those who have drilling rig technical jobs. The growth of the drilling rig workforce in the country would extend to support the region's countries to achieve their national plans targeting the development of the local workforce within the drilling industry and building localized talent pools (Saudi Aramco, 2018).

Conclusion

This study explored the influence of simulation technologies on trainees' learning, motivation, and perspectives on completing their education at the oilfield drilling rig's training facility. My study demonstrated that the participants' involvement with the drilling simulation helped them progress, evoked a range of emotional responses, motivated them through the educational qualities of drilling simulation, and that their experiences varied in intensity. All participants provided positive feedback regarding the simulation technology and strongly believed they gained more knowledge, skills, and experience in different drilling applications compared to when they began engagement with the drilling simulation training.

The answers to the two RQs showed that using drilling simulators in training was an extremely valuable tool. It helped create a safe, low-cost, easy to operate, and hands-on-the-job training environment. It familiarized the trainees with running and handling the rig equipment and increased working experiences through developing a trainee's drilling and well-control skills. The drilling simulators also helped the trainees to practice a variety of operations and problematic scenarios, develop a spirit of teamwork, and reduce nonproductive time.

The participants' responses also showed that drilling simulation training was a significant motivating factor that helped to develop the trainee's self-confidence as a result of using planned and safe training applications. It assisted in development of their competencies through well-planned practices, encouragement, and professional supervision. Many trainees became eager to know what was next for them and to move forward with their education. They also had positive expectations for the future, as more experience increases the anticipation of worker value and compensation.

References

Abulhassan, A. (2016). The role of well control training in developing safe onshore and offshore oil drilling operations. *Interchange*, *47*, 375-389. https://doi.org/10.1007/s10780-016-9285-7

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Prentice-Hall.

Akçayır, M., & Akçayır, G. (2016). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, *20,* 1-11. https://doi.org/10.1016/j.edurev.2016.11.002

AlNajdi, S. M. (2022, April 4). The effectiveness of using augmented reality (AR) to enhance student performance: Using quick response (QR) codes in student textbooks in the Saudi education system. *Educational Technology Research and Development*, *70*, 1105-1124. https://doi.org/10.1007/s11423-022-10100-4

Awad, M. S., Abdullah, M. K., Ibrahim, R. H., & Abdulla, R. K. (2019). Nursing students' attitudes towards simulation technology in nursing education. *International Journal of Emerging Technologies in Learning*, *14*(14), 31-45. https://doi.org/10.3991/ijet.v14i14.10571

Bacca, J., Baldiris, S., & Fabregat, R. (2018). Insights into the factors influencing student motivation in augmented reality learning experiences in vocational education and training. *Frontiers in Psychology*, *9*, Article 1486. https://doi.org/10.3389/fpsyg.2018.01486

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, *37*(2), 122-147. https://doi.org/10.1037/0003-066X.37.2.122

Bhagat, K. K., Liou, W.-K., & Chang, C.-Y. (2016). A cost-effective interactive 3D virtual reality system applied to military live firing training. *Virtual Reality*, *20*, 127–140. https://doi.org/10.1007/s10055-016-0284-x

Birt, J., Stromberga, Z., Cowling, M., & Moro, C. (2018). Mobile mixed reality for experiential learning and simulation in medical and health sciences education. *Information*, *9*(2), 31-45. https://doi.org/10.3390/info9020031

Bogdan, R. C., & Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods* (5th ed.). Allyn & Bacon.

Bragg, J. E., Miller-Cribbs, J., Gordon, J., Gaudet, J., Hellman, C., & Munoz, R. T. (2017). Increasing self-efficacy and building hope through simulation-based education. *International Journal of Arts & Sciences*, *10*(2), 549-557.

Cai, S., Chiang, F.-K., Sun, Y., Lin, C., & Lee, J. J. (2017). Applications of augmented reality-based natural interactive learning in magnetic field instruction. *Interactive Learning Environments*, *25*(6), 778-791. https://doi.org/10.1080/10494820.2016.1181094

Capatina, A., Schin, G. C., & Rusu, D. (2017). Increasing academic brand awareness through virtual reality. *Revista De Management Comparat International*, *18*(2), 171-182.

Chang, R.-C., Chung, L.-Y., & Huang, Y.-M. (2016). Developing an interactive augmented reality system as a complement to plant education and comparing its

effectiveness with video learning. *Interactive Learning Environments*, *24*(6), 1245-1264. https://doi.org/10.1080/10494820.2014.982131

Chiang, T. H. C., Yang, S. J. H., & Hwang, G.-W. (2014). An augmented reality-based mobile learning system to improve students' learning achievements and motivation in natural science inquiry activities. *Educational Technology & Society*, *17*(4), 352–365.

Cowling, M., & Birt, J. (2018). Pedagogy before technology: A design-based research approach to enhancing skills development in paramedic science using mixed reality. *Information*, *9*(29), 29-44. https://doi.org/10.3390/info9020029

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). SAGE Publications.

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Pearson.

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems: Theory and results* [Doctoral dissertation, Massachusetts Institute of Technology]. MT Libraries. https://hdl.handle.net/1721.1/15192

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

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

Douglas-Lenders, R. C., Holland, P. J., & Allen, B. (2017). Building a better workforce, A case study in management simulations, and experiential learning in the construction industry. *Education + Training*, *59*(1), 2. https://doi.org/10.1108/ET-10-2015-0095

Drilling Systems. (2022, April 14). D2500 [Photograph of drilling simulator]. www.andreas.smith@drillingsystems.com

Fan, Y.-C., & Wen, C.-Y. (2019). A virtual reality soldier simulator with body area networks for team training. *Sensors*, *19*(3), 451-473. https://doi.org/10.3390/s19030451

Fernandez, M. (2017). Augmented-virtual reality: How to improve education systems. *Higher Learning Research Communications*, *7*(1), 1–15. https://dx.doi.org/10.18870/hlrc.v7i1.373

Frenzel, J. E., Skoy, E. T., & Eukel, H. N. (2018). Use of simulations to improve pharmacy students' knowledge, skills, and attitudes about medication errors and patient safety. *American Journal of Pharmaceutical Education*, *82*(8), 924–931. https://doi.org/10.5688/ajpe6644

Garcia, E. T., Ware, S. G., & Baker, L. J. (2019, May 19-22). *Measuring presence and performance in a virtual reality police use of force training simulation prototype* [Conference]. The 32nd International Florida Artificial Intelligence Research Society Conference FLAIRS Conference, Sarasota, FL, United States. https://par.nsf.gov/servlets/purl/10099541

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries.

Educational Technology Research and Development, *29*(2), 75-91. https://doi.org/10.1007/BF02766777

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, *18*(1), 59-82. https://doi.org/10.1177%2F1525822X05279903

Hattingh, H. L., Robinson, D., & Kelly, A. (2018). Evaluation of a simulation-based hospital pharmacy training package for pharmacy students. *International Journal of Educational Technology in Higher Education*, *15*, Article 39. https://doi.org/10.1186/s41239-018-0120-3

Hauser, R. J., & Shugan, S. M. (1980). Intensity measures of consumer preference. *Operation Research*, *28*(2), 279-320. https://doi.org/10.1287/opre.28.2.278

Ho, S.-C., Hsieh, S.-W., Sun, P.-C., & Chen, C.-M. (2017). To activate English learning: Listen and speak in real-life context with an AR featured u-learning system. *Journal of Educational Technology & Society*, *20*(2), 176-187.

Hodgson, R., & Hassard, P. (2006, July/August). Advanced drilling simulators offer realistic models to reduce crews' learning curves. *Drilling Contractor*, 50–54. https://www.iadc.org/dcpi/dc-julyaug06/July06-Simulators.pdf

Huang, H.-M., & Laiw, S.-S. (2018). An analysis of learners' intentions toward virtual reality learning based on constructivist and technology acceptance approaches. *International Review of Research in Open and Distributed Learning*, *19*(1), 91-115. https://doi.org/10.19173/irrodl.v19i1.2503

Hwang, G.-J., Wu, P.-H., Chen, C.-C., & Tu, N.-T. (2016). Effects of an augmented

reality-based, educational game on students' learning achievements and attitudes in real-world observations. *Interactive Learning Environments*, *24*(8), 1895-1906. https://doi.org/10.1080/10494820.2015.1057747

Jauhar, J., Ting, C. S., & Rahim, N. F. A. (2017). The impact of reward and transformational leadership on the intention to quit of generation Y employees in oil and gas Industry: Moderating role of job satisfaction. *Global Business & Management Research*, *9*(4s), 426-441.

Jenab, K., Moslehpour, S., & Khoury, S. (2016). Virtual maintenance, reality, and systems: A review. *International Journal of Electrical and Computer Engineering*, *6*(6), 2698-2707. https://doi.org/10.11591/ijece.v6i6.11468

Kapucu, S. (2017). The effects of using simulation in nursing education: A thorax trauma case scenario. *International Journal of Caring Sciences*, *10*(2), 1069-1074.

Karagozlu, D., & Ozdamli, F. (2017). Student opinions on mobile augmented reality application and developed content in science class. *TEM Journal*, *6*(4), 660-670. https://doi.org/10.18421/TEM64-03

Kassem, M., Benomran, L., & Teizer, J. (2017). Virtual environments for safety learning in construction and engineering: seeking evidence and identifying gaps for future research. *Visualization in Engineering*, *5*, Article 16, 1-15. https://doi.org/10.1186/s40327-017-0054-1

Kim, Y.-H., Hwang, K.-H., & Cho, O.-H. (2018). Simulation education with problem-based learning: Effect on nursing students’ communication apprehension. *Social Behavior & Personality: An International Journal*, *46*(1), 151–160.

https://doi.org/10.2224/sbp.6906

Kiryakova, G., Angelova, N., & Yordanova, L. (2018). The potential of augmented reality to transform education into smart education. *TEM Journal, 7*(3), 556-565. https://doi.org/10.18421/TEM73-11

Komperda, K., & Lempicki, K. (2019). Effectiveness of a medication reconciliation simulation in an introductory pharmacy practice experience course. *American Journal of Pharmaceutical Education*, *83*(4), 514–525. https://doi.org/10.5688/ajpe6628

Larcker, D. F., & Lessig, V. P. (1980). Perceived usefulness of information: A psychometric examination. *Decision Sciences*, *11*(1), 121-134. https://doi.org/10.1111/j.1540-5915.1980.tb01130.x

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications.

Liou, H.-H., Yang, S. J. H., Chen, S. Y., & Tarng, W. (2017). The influences of the 2D image-based augmented reality and virtual reality on student learning. *Journal of Educational Technology & Society*, *20*(3), 110-121.

Liu, W. C., Wang, J. C. K., & Ryan, R. M. (2016). Understanding motivation in education: Theoretical and practical considerations. In W. C. Liu, J. C. K. Wang, & R. M. Ryan (Eds.), *Building autonomous learners: Perspectives from research and practice using self-determination theory* (pp. 107). Springer. https://doi.org/10.1007/978-981-287-630-0

Liu, X., Zhang, J., Hou, G., & Wang, Z. (2018). Virtual reality and its application in military. *IOP Conference Series: Earth and Environmental Science*, *170*(3),

032155-032162. https://doi.org/1088/1755-1315/170/3/032155

Lu, S.-J., & Liu, Y.-C. (2015). Integrating augmented reality technology to enhance children's learning in marine education. *Environmental Education Research*, *21*(4), 525-541. https://doi.org/10.1080/13504622.2014.911247

Lu, S.-J., Liu, Y.-C., Chen, P.-J., & Hsieh, M.-R. (2018). Evaluation of AR embedded physical puzzle game on students' learning achievement and motivation on elementary natural science. *Interactive Learning Environments*, *28*(4), 451-463. https://doi.org/10.1080/10494820.2018.1541908

Martin, L., & Omrani, N. (2015). An assessment of trends in technology use, innovative work practices, and employees' attitudes in Europe. *Applied Economics*, *47*(6), 623-638. https://doi.org/10.1080/00036846.2014.978072

Mason, M. (2010). Sample size and saturation in Ph.D. studies using qualitative interviews. *Forum: Qualitative Social Research, 11*(3). https://doi.org/10.17169/fqs-11.3.1428

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design an implementation* (4th ed.). Jossey-Bass.

Meyer, D. Z., & Avery, L. M. (2009). Excel as a qualitative data analysis tool. *Field Methods*, *21*(1), 91-112. https://doi.org/10.1177%2F1525822X08323985

Namey, E., Guest, G., McKenna, K., & Chen, M. (2016). Evaluating bang for the buck: A cost-effectiveness comparison between individual interviews and focus groups based on thematic saturation levels. *American Journal of Evaluation*, *37*(3), 425-440. https://doi.org/10.1177/1098214016630406

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE.

Pitts, J. M. (1994). *Personal understandings and mental models of information: A qualitative study of factors associated with the information-seeking and use of adolescents* (Publication No. 9416154) [Doctoral dissertation, Florida State University]. ProQuest Dissertations Publishing.

Price, J. H., & Murnan, J. (2004). Research limitations and the necessity of reporting them. *American Journal of Health Education*, *35*(2), 66-67. https://doi.org/10.1080/19325037.2004.10603611

Ravitch, S. M., & Carl, N. M. (2016). *Qualitative research: Bridging the conceptual, theoretical, and methodological*. SAGE Publications.

Ravitch, S. M., Tarditi, M., Montenegro, N., Estrada, E., & Baltodano, D. (2015). Learning together: Reflections on trust, collaboration and reciprocal transformation from a Nicaraguan action research program. In L. L. Rowell, C. D. Bruce, J. M. Shosh, & M. M. Riel (Eds.), *Palgrave international handbook of action research* (pp. 791-805). Palgrave.

Reeves, T. C. (2006). Design research from a technology perspective. In J. Van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 52-66). Routledge. https://doi.org/10.4324/9780203088364

Register, S. J., Blanchard, E., Belle, A., Viles, A., Moore, S. P., MacLennan, P., & White, M. L. (2020). Using AIDET® education simulations to improve patient experience scores. *Clinical Simulation Nursing*, *38*, 14-17.

https://doi.org/10.1016/j.ecns.2019.09.005

Reyhan, F., Mete, A., Sayiner, F., & Celik, N. (2018). Evaluating the views of midwifery students about simulation education. *International Journal of Caring Sciences*, *11*(1), 239-245.

Robey, D. (1979). User attitudes and management information system use. *Academy of Management Journal*, *22*(3), 527-538. https://doi.org/10.5465/255742

Rossler, K. L., Hardin, K., Hernandez-Leveille, M., & Wright, K. (2018). Newly licensed nurses' perceptions on transitioning into hospital practice with simulation-based education. *Nurse Education in Practice*, *33*, 154-158. https://doi.org/10.1016/j.nepr.2018.10.004

Rubin, H. J., & Rubin, I. S. (2012). *Qualitative interviewing: The art of hearing data* (3rd ed.). SAGE.

Sabalic, M., & Schoener, J. D. (2017). Virtual reality-based technologies in dental medicine: Knowledge, attitudes, and practice among students and practitioners. *Technology, Knowledge, and Learning*, *22*(2), 199-207. https://doi.org/10.1007/s10758-017-9305-4

Sakakushev, B. E., Marinov, B. I., Stefanova, P. P., St. Kostianev, S., & Georgiou, E. K. (2017). Striving for better medical Education: The simulation approach. *Folia Medica*, *59*(2), 123-131. https://doi.org/10.1515/folmed-2017-0039

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed). SAGE.

Saudi Arabian Drilling Academy. (2016, July 18). Drilling academy to train over 4,000 Saudi nationals a year. *Arab News*.

https://www.arabnews.com/node/955426/economy

Saudi Aramco. (2018). *The Saudi Arabian Drilling Academy (SADA) holds a first graduation ceremony*: *ABQAIQ, September 17, 2018*. https://www.aramco.com/en/news-media/news/2018/sada

Schoch, K. (2016). Case study research. In G. J. Burkholder, K. A. Cox, & L. M. Crawford (Eds.), *The scholar practitioner's guide to research design* (pp. 227–244). SAGE Publications.

Schultz, R. L., & Slevin, D. P. (1975). *Implementation and organizational validity: An empirical investigation in implementing operations research/management science*. American Elsevier.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75. https://doi.org/10.3233/EFI-2004-22201

Spooner, M. T., Alex, J. E., Greer, J. A., Delorey, D. R., Kiser, R. A., Petersen, C., Polk, T., & Gunzelmen, K. (2019). Simulation training for operational medicine providers (STOMP): Impact of a comprehensive skills-based curriculum for military general medical officers. *Military Medicine*, *184*(5-6), e141–e146. https://doi.org/10.1093/milmed/usy346

Squires, D. (2017a). Augmented reality application classroom development: New technology and new media, education and intelligent classrooms. *i-Manager's Journal of Educational Technology*, *14*(1), 1-6.

Squires, D. (2017b). Working memory and augmented reality's trajectory: A literature

review of AR in education, online learning, workforce training, and working memory research. *i-Manager's Journal of Educational Technology*, *14*(3), 55-63. https://doi.org/10.26634/jet.14.3.13860

Stavroulia, K. E., Makri-Botsari, E., Psycharis, S., & Kekkeris, G. (2016). Emotional experiences in simulated classroom training environments. *The International Journal of Information and Learning Technology*, *33*(3), 172-185. https://doi.org/10.1108/IJILT-10-2015-0030

Suri, A., Patra, D. P., & Meena, R. K. (2016). Simulation in neurosurgery: Past, present, and future. *Neurology India*, *64*(3), 387-395. https://doi.org/10.4103/0028-3886.181556

Swanson, E. B. (1987). Information channel disposition and use. *Decision Sciences*, *18*(1), 131-145. https://doi.org/10.1111/j.1540-5915.1987.tb01508.x

Unver, V., Basak, T., Ayhan, H., Cinar, F. I., Iyigun, E., Tosun, N., Tastan, S., & Kose, G. (2018). Integrating simulation-based learning into nursing education programs: Hybrid simulation. *Technology & Health Care*, *26*(2), 263–270. https://doi.org/10.3233/THC-170853

Wang, P., Wu, P., Wang, J., Chi, H.-L., & Wang, X. (2018). A critical review of the use of virtual reality in construction engineering education and training. *International Journal of Environmental Research and Public Health*, *15*(6), 1204-1222. https://doi.org/10.3390/ijerph15061204

Watson, T. W. (1997). *Guidelines for conducting interviews*. United States Air Force Armstrong Laboratory. https://apps.dtic.mil/sti/pdfs/ADA328769.pdf

Wu, P.-H., Hwang, G.-J., Yang, M.-L., & Chen, C.-H. (2018). Impacts of integrating the repertory grid into an augmented reality-based learning design on students' learning achievements, cognitive load, and degree of satisfaction. *Interactive Learning Environments*, *26*(2), 221-234. https://doi.org/10.1080/10494820.2017.1294608

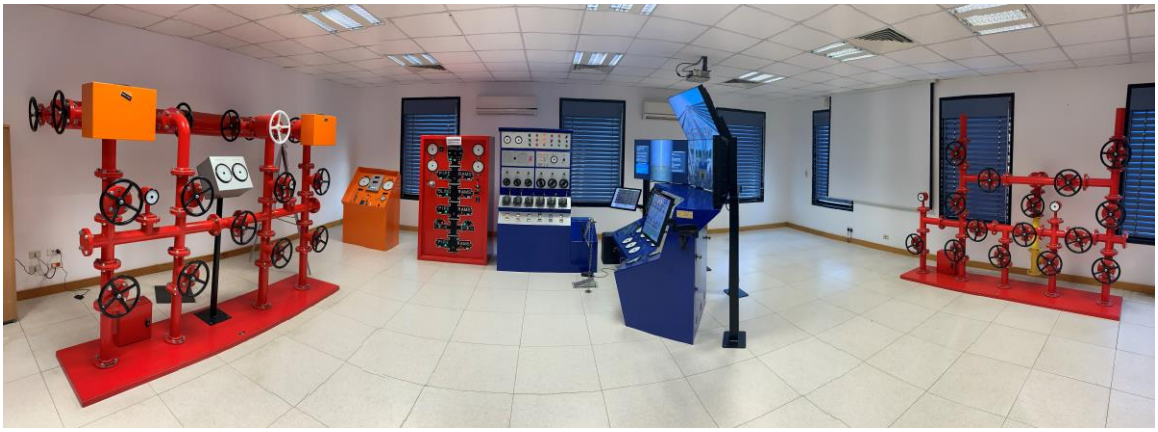
Yamada, M. (2018). Can Saudi Arabia move beyond "production with rentier characteristics"? Human capital development in the transitional oil economy. *The Middle East Journal*, *72*(4), 587-609. https://doi.org/10.3751/72.4.13

Yilmaz, R. M., & Göktaş, Y. (2018). Using augmented reality technology in education. *Çukurova Üniversitesi Eğitim Fakültesi Dergisi*, *47*(2), 510-537.

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). SAGE Publications.

Yoon, S., Anderson, E., Lin, J., & Elinich, K. (2017). How augmented reality enables conceptual understanding of challenging science content. *Educational Technology & Society*, *20*(1), 156–168.

Appendix A: Drilling Systems Company Business Development Manager's Permission to Use Drilling Simulator Picture (Figure 1)



Re: Drilling Systems Introduction

AS

Andreas Smith <Andreas.Smith@drillingsystems.com>
To: aabdelaziz@alamalsahara.co

Thursday, April 14, 2022 at 11:36 PM

This message is flagged for follow up.

Good evening and sorry for the delay.

I don't believe there should be any issues.

I do wish you good luck with your PhD thesis and would love to receive a copy wants complete to peer review.

Regards

Andreas

Andreas V. Smith
Business Development Manager – MENA
Drilling Systems

+973 35091552
andreas.smith@drillingsystems.com

drillingsystems.com Connect on LinkedIn

Drilling Systems is part of 3t Energy Group. Together we are Transforming Training with Technology.

From: aabdelaziz@alamalsahara.co <aabdelaziz@alamalsahara.co>
Sent: Thursday, April 14, 2022 10:54
To: Andreas Smith <Andreas.Smith@drillingsystems.com>
Subject: FW: Drilling Systems Introduction

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Good Day Andreas,

I'm following up on my request for permission to use the attached picture for PhD research purpose that I'm currently doing. I believe my dissertation will encourge all the drilling contractor companies to use drilling simulator as an essential training technology tool for all drilling workforce, not only for well control training but also for all drilling practices in general Please let me know when I can call you to explain more if you have any concerns. Thank you so much. I appreciate your support. Thanks,

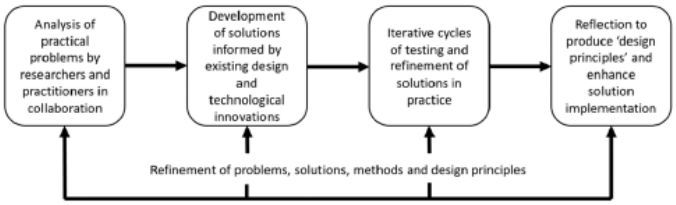
Regards

Appendix B: Author Permission to Use Design-Based Research Figure

Adel Abdel Aziz
Mon 5/11/2020 2:27 PM
To: treeves@uga.edu

Hello Dr. Reeves,

My name is Adel Aziz. I'm a PhD student at Walden University, and I'm currently writing my proposal. I'm seeking your approval to include your Figure about the Predictive and design-based research approaches in educational technology research (Reeves, 2006) as a supportive figure in my literature review discussions. Thank you so much.



Regards
Adel Abdel Aziz
Student ID: A00239921
P.h.D Education-LII

TR Thomas C Reeves <treeves@uga.edu>
Mon 5/11/2020 4:01 PM
To: Adel Abdel Aziz

Greetings Adel,

Yes, you have my permission. I wish you great success in your studies and your research.

Best wishes,
Tom

Thomas C. Reeves, Ph.D.
Professor Emeritus of Learning, Design, and Technology
College of Education
The University of Georgia
222 River's Crossing
850 College Station Road
Athens, Georgia 30602 USA
E-MAIL: treeves@uga.edu
Webpage: http://www.evaluateitnow.com/

Appendix C: Interview Guide

Interview Guide

Demographic Data

Participant Name: _____ Age: _____ Specialty: _____

Interview Opening/Purpose of the Interview

Thank you for coming today; this interview will help me explore how using drilling simulators in the educational settings at drilling rig training facilities could be a useful training tool and how it may impact you and the trainees' learning and motivation. The research results will help the drilling workforce community and encourage the use of more simulation technologies in oilfield drilling rig vocational training facilities.

Before we begin, I will be asking you to sign an informed consent that you are volunteering willingly to be part of my study and be interviewed. Your participation is voluntary. You can decline to answer a question at any time during the interview. Each interview is recorded as a backup. A copy of the transcript will be provided to you later to ensure that the transcript is an accurate description of what you said during the interview.

Terms of Confidentiality

The interview questions will focus on your perceptions and experiences about the influence of the use of drilling simulators in training. Confidentiality is the main ethical consideration for you, the participant. Confidentiality means using alphanumeric codes and changing or not disclosing other identifying facts.

Confidentiality Statement: Your interview records/transcript, including your details, will be protected and deleted from my personal computer and placed on an

encrypted removable hard drive for 5 years after the study is completed. Anyone who is not part of the study will not have access to your personal information.

Interview Format and Time

The interview consists of three groups of 12 open-ended questions (which should take around 45-60 minutes).

Interview Questions

Introduction (Rapport Building Questions)

1. Tell me about yourself. Your name, age, specialty.
2. Describe why and how you joined the drilling training program.
3. Explain how you feel about your training courses. What is your favorite course?

    Probing questions: What about the drilling simulator workshop? Is it one of your favorite courses? Why?
4. Explain why drilling simulation experience must be required as part of your learning courses.

Perceived Ease of Using Drilling Simulator

5. What does the use of the drilling simulator look and feel like to you and your colleagues?

    Probing question: Was it easy to understand and use?
6. Explain if and how it was easy to understand. How was it easy to operate?
7. While using the drilling simulator to learn a new skill, did you find it easier, harder, or the same compared to the conventional drilling rig console?

Perceived Usefulness (Learning & Motivation)

8. What was your experience with the drilling simulator training program? What did you do?
9. What do you think of the drilling simulator training program concerning:
    a. Program usefulness?
    b. Skills attained?
    c. Strengths? Weaknesses?
    d. Things liked? Things disliked?
    e. Things that should be changed or added to increase usefulness?
10. How do you think the involvement in the drilling simulator training program affected you with regards to the following areas:
    a. How it affected your self-confidence?
    b. Attitudes towards the drilling training program?

        Probing question: How that encourage/discourage you to continue and complete your drilling education?
    c. Any effect on your future ambitions?
11. What are your future expectations? What changes do you perceive in yourself concerning the following areas:
    a. Future work plans?
    b. Future income expectations?
    c. Lifestyle expectations or plans?

Interview Closing

12. Would you like to share any other information related to the drilling simulation training before we finish this interview?

End

Appendix D: Interview Invitation

Email Format for Interview Invitation

Emailed to the invited interviewee:

You are invited to participate in an online virtual interview using Zoom software. This interview will be part of a research study that I am completing towards my doctoral program. The purpose of the interview is to help me collect research data and then analyze how using drilling simulators may influence the trainees' learning and motivation. Please review the attached consent form and answer with “I consent” when you decide to participate. Thank you so much.

Appendix E: Code Book

Code	Meaning	Participants' quotes & interview questions
Have development	Drilling has granted job skills development	P1.Q2: "I joined ADC, and they start developing me with the A drilling program. I didn't seek [*sic*] for it. I gave them my CV, and they put me in the drilling program."
Bright future	A promising future	P4. Q2: "My entrance to the drilling industry was due to one of the many open positions that were open when there was a bright future."
More experience Different branches	Additional work knowledge Many services line	P2. Q2 "As for drilling, in particular, it is different and has many branches. I mean, I liked it in terms of specializations; it will be many and in terms of experience."
High rewards for hard workers	High pay for hard workers	P7. Q2: "The highest paying jobs in Saudi Arabia are thrown [*sic*] in the drilling industry." P9. Q2: "The opportunity for drilling is huge; huge [in the] industry. That's why, that's why everyone wants to contribute. Everyone wants to be in this industry."
Interesting subjects and visual training	Motivating topics with a strong emphasis on visuals	P9. Q3: Everything in the drilling was interesting, like especially now how to call the simulations. Okay, like you know [you] feel interested; like you will be engaged. You will feel like you know after you see that in the book. You will see it even when it comes to the work. I already have this experience, to be honest, now."
Hands-on experience	Experiential learning	P6. Q3: "I saw everything we were hearing about it. I saw my work. We worked with them; we put our hands with [*sic*] them better than studying and learned the names of equipment better than I studied it—I mean practiced the thing with my hand. I worked on [the] drilling simulator cyber and hand brake."
Realistic training	Training that is based on reality	P7. Q3: "Sure [the drilling simulator is my favorite] because the thing you're applying is practical, for example, doing my job better than sitting and listening because you're doing the thing, putting yourself in the job itself."
Gives real-life opportunity	Provides a chance to experience real-life situations	P3. Q4: "It [drilling simulator training experience] is required to practice on different job task. . . . When you train on the simulator, you will not be afraid at the rig site as you will have the background about these tasks before you see it on the ground." P8. Q4: "Originally, in the real situation, it's the same as the simulator."

Code	Meaning	Participants' quotes & interview questions
Real-life reactions	Real-world responses	P4. Q4: "The drilling simulation experience contains more than one drilling simulation, which also contains user reactions that absorb the downhole problem and the detection of any errors resulting from the reactions that may be on the real environment, which allows avoiding most of the problems that will occur on the group. It is important because it reveals the reactions of the person himself, the trainee himself, when he encounters a problem, so he knows what is weak in it."
More practice is required	Need more practice	P5. Q5: "After the instructor explained it, we sat down and used it twice. It was easy. With practice, we can understand, and it becomes easy without any difficulty."
Simulation practice results affect the feeling	The outcomes of simulation practice have an impact on how people feel	P7. Q5: "And all synchronized from all over you found your sense and interaction from different media, you know. It's not only by saying I like how we also have the sound, you know, the more I think . . . the more senses we include, the better the experience will be."
Similarity with the rig makes it easy to understand	It's simple to understand because it's similar to the rig	P7. Q6: "So easy to operate or to understand because the layout is exactly like real life [the rig], which is I think the main reason behind that simulation." P6. Q6: "The simulator was the same as the rig."
More practice makes it easy to operate	It becomes easier to operate with more practice	P10. Q6: "To be honest, most of us, we did not have enough time; we get to have, like, segments in our training when we do simulation. And I really want to do more. I really want to do, like, 5, 6 hours, but we didn't have the time."
A safe learning environment; not afraid of tools failure make it easier to operate	A secure learning environment that is unafraid of tools failure facilitates the operation	P3. Q7: "Because you are working in [a] hazardous environment with life threaten [*sic*] situations for the rig crew. . . . The whole atmosphere makes you feel fear, but with the simulator environment, you are completely confident that whatever happens there will be no dangerous situation, and you can repeat and learn."
Time and cost saving	Saving both time and money	P7. Q7: "I definitely think the simulator may [be] amazing; an amazing and amazing way to get knowledge before it goes in [to rig] . . . you can save a lot of time to be recalled [*sic*] everyone, instead of just leaving them. . . . It's not only cost effective, and time effective, and [it is] also environmentally friendly because you are saving all those transportations and also safety."

Code	Meaning	Participants' quotes & interview questions
Practice simulation makes more sense of actual work.	Actual work is made more understandable through practice simulation.	P4. Q8: "When we do the pick, the make-up of the pipe that's [*sic*] gives us the procedure to follow with, so it becomes exactly the correct work. And the practicing that we work means that not just that it teaches us how to pick up, but it tells us that this is good practicing [and] that that's the correct way that we benefit from the point of saving the equipment as well like saving the work safe to the people that are working with it."
Increase self-confidence.	Boost self-esteem.	P2.Q8: "Also, there is something else with regards to self-confidence. You will have self-confidence." P2-Q8 "This program made me feel more confident. I was already confident in myself; I was more confident in myself, and I even started explaining to the young people at the rig."
Save time; save the lives of fellow workers through working safely.	Working safely allows you to save time and save the lives of your coworkers.	P2. Q8: "You will have everything you will need to learn until you are aware of the situation until you have [the] principles of controlling the well, and that means saving the life [*sic*] of the people you have."
Useful actual examples.	Real-world examples that are beneficial.	P1. Q9: "Yeah. I gained more skills when I trained with the simulator. And one extra thing, for example, the instructor will not give you all the scenarios that [*sic*] what happened at the rig. But if you ask about a problem, he will give you more information about the problem, and he will tell you how you deal with it at the rig."
Better skills through a more theoretical and practical understanding of work scenarios and applications.	Improved abilities as a result of a more thorough theoretical and practical understanding of work scenarios.	P4. Q9: "Of course, the skills acquired are countless in this program, but the most prominent of them is the strengthening of information and the concept of the work of the traditional drilling rig. I mean, if someone from outside his specialization came and learned about the drilling simulator completely, he would understand the traditional drilling rig. This thing enhances his knowledge and understanding of it. We feel [the] simulator system enhances the skill's practical skill so that we spend less time in traditional life."
Strengths: safe environment for hands-on practices, but it should not have a negative effect.	A secure environment is conducive to hands-on practice. However, it should not have a detrimental effect and application.	P4. Q9: "There are strengths and weaknesses in safety. I mean, the strengths are related to the training program and its mistakes. These are the strengths and the trainee's development greatly [*sic*] in his understanding simulates reality. . . . The weaknesses [of the] simulator—it is maybe the belief of the trainee himself that there are no losses during his simulator training, which may affect his reaction. This needs to be considered while practicing."

Code	Meaning	Participants' quotes & interview questions
Weakness: limited applications.	Only a few applications.	P6. Q9: "About the points that I like to change as a simulator, I need the simulator to cover the whole operation . . . that passed by me while I am on the rig." P1. Q9: "The problem with our system itself [is that it] needs to be updated because it is lagging, and sometimes you have to switch it off and restart, and that takes training time also. Time is taken for one trainee; the instructor can make [time for] two if the program is good."
Positive effect.	Favorable influence.	P4. Q10: "It affected my self-confidence positively. Everything ([t the rig] was similar to the instructions that I trained on as well as my role." P9. Q10: "Simulator, on the contrary, this gives me a big morale boost."
Confident worker.	Self-assured employee.	P3. Q10: "It made me [simulator training] more confident. And I hope that the negative people around me will not affect me and push me back." P9. Q10: "Sure, too many; my self-confidence has increased."
Better positive attitudes. Encouragement	Encouragement for having more optimistic attitudes.	P3. Q10: "After completing the training, I looked up while lifting your chest [feeling so proud], as working as a driller is like a big dream. Yes. Yes. it did encourage me and motivate me." P7. Q10: "This [the simulator training] is definitely encouraging."
Looking at a better future through learning and gaining the required knowledge.	Looking forward to a better future through learning and acquiring the necessary skills and information.	P2. Q10: "Ambitions. I'm looking forward to being something. For example, I would like to hold a respectable position first, and secondly, I earn something that satisfies my life [*sic*] needs. I do not want, for example, to work roustabout for 15 years; this is too much. I want to grow and get promoted." P3. Q10: "It [simulator training] made me feel that I want to complete my training quickly, and I want to work hard until my dreams come true." P4. Q10: "Frankly, after completing this program, I no longer wanted to stop learning."

Code	Meaning	Participants' quotes & interview questions
Confidence—build required experience and positive expectations.	Build confidence and good expectations by gaining the necessary experience.	P9. Q11: "[A] person who will take this course's training program, they wouldn't be more competent; they will be in a position that they will forget how much money they will take [*sic*]. And each month after this program or after these courses he will be more, like, understanding each aspect around him. So, he will gain more experience. He will be in the future something that we will not; we cannot imagine he will be operation [supervisor]. Maybe it will be rig manager one day, so these courses would be pushing him to the maximum."
More experience equals higher positions equals income increase.	Increased experience equates to higher positions, which equates to an increase in pay.	P5. Q11: "In the drilling field, there are very, very large chances for development. Promotions increase your financial income." P8. Q11: "The more you get promoted, the more you earn. The more you earn, the more skills you will have. You will not be able to reach more and increase your income if you do not have these things."'
Higher income equals better lifestyle equals investment in projects that develop the society.	Increased income equates to a better standard of living and investment in social development programs.	P2. Q11: "Income? It will be better, and it will be enough for you; it will make you build a house, and you will live a good life. You will educate your children and buy the things you like—the things that the children need and like. And you will do many things, meaning other money. I can use the money to invest in other projects that will help my country."
More simulator training applications and durations are needed.	It is necessary to increase the number of simulator training applications and durations.	P2. Q12: "For the simulator, we need more training time. I will take an example when we complete a simulator training program, and we succeed in it. We need to have more training time to develop our skills."
Simulate the effect of bad drilling practices.	Simulation of the consequences of poor drilling procedures.	P4. Q12: "Drilling simulator courses need to have practice sessions to show how shortcuts and bad practices damage equipment."