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TOWARDS FAILURE-BASED INSTRUCTIONAL DESIGN:

A PHENOMENOLOGICAL STUDY OF THE PERCEPTIONS OF DRONE PILOTS ABOUT

THE USE OF SIMULATIONS TO PROMOTE FAILURE-BASED LEARNING

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
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Approved by:

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# ABSTRACT

## TOWARDS FAILURE-BASED INSTRUCTIONAL DESIGN: A PHENOMENOLOGICAL STUDY OF THE PERCEPTIONS OF DRONE PILOTS ABOUT THE USE OF SIMULATIONS TO PROMOTE FAILURE-BASED LEARNING

Nikisha Watson
Old Dominion University, 2021
Director: Dr. John Baaki

Simulations have become increasingly popular in many contexts, particularly for performance optimization, testing, and safety (Aldrich, 2003). By nature, simulations immerse the learner in an environment that is an approximate imitation of the situation or process to be learned (Baek, 2009). In the literature, there is a lack of qualitative research on the perceptions of learners regarding the use of failure-based learning in simulations. The idea of learning through failure experiences is not a new concept, yet, to date, no instructional design models have discussed how to employ failure strategically within education (Tawfik, Rong, & Choi, 2015).

This study utilized Tawfik et al.'s (2015) unified model of failure and learning systems design to create a drone flight simulation designed to focus on safely operating a drone while capturing high-quality aerial videography. Data collection included semi-structured interviews with 16 licensed drone pilots. This study illuminates the pilots' perceptions and understanding about employing a failure-based learning model in a drone flight training simulation. Key findings from a thematic analysis of the interviews were that learners find value in experiencing and learning from failure and that the failure experiences led to increased self-confidence and intrinsic motivation.

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This dissertation is dedicated to my loving family and friends. I am thankful to God for giving me the patience, health, and power of mind to complete this work. To my parents, Alix Bannis and Nicholas Jno-Baptiste, thank you for being my source of inspiration and light. To my sister, Delian A. Nicholas, who spent countless hours providing her time and energy to support me and our children, I am forever grateful. To my husband, Ryan A. Watson, who gave me strength and encouragement when I thought of giving up and who continually provided his moral, spiritual, emotional, and financial support, I am most thankful for the many sacrifices you made so that I could fulfill this dream. To our beautiful children, Naima, Rayna, and Xavier, your existence has given my life such meaning and purpose. I love you all and I am so blessed to be your mother.

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# CHAPTER 1

# INTRODUCTION

Failure is often viewed as a negative term with undesirable associations (Kallevig, 2015). Contextually, there are many reasons why failure is avoided in schools today, including the influence of the negative stigma associated with this term (Kallevig, 2015). Various studies have examined the effect that success and failure experiences play in enhancing learning (Ariño & De La Torre, 1998; Kapur & Bielcyz, 2011; Kolodner, Owensby, & Guzdial, 2004). Creating learning opportunities that promote failure-based learning has been the subject of much research in a wide variety of fields however, much of the empirical failure research is situated within the context of business management (Cannon & Edmondson, 2005).

The idea of learning through failure experiences is not a new concept, yet, to date, no instructional design models have discussed how to employ failure strategically within education (Tawfik et al., 2015). In secondary schooling and higher education, failure was indisputably avoided, with educators often citing accountability and accreditation as reasons for avoidance (Alfi, Assor, & Katz, 2004). These notions, however, fail to consider the fact that simulations inherently leverage failure as a motivator (Pivec, Dziabenko, & Schinnerl, 2003). Today, more instructors are moving towards exploring failure by reflecting on their own definition and framework of failure, by giving examples of their experience with failure, and by elaborating how they deal with and learn from failure (Jungic et al., 2020).

**Background**

To provide learners with meaningful, realistic learning experiences, in situations where the learning environment is not always conducive to real-world training, simulations are often used in various training settings (Rosser, 2007). Over the last two decades, the shift in education focused on the development of competencies (Stoof, Martens, Van Merriënboer, & Bastiaens, 2002). Simulation learning encompasses scenarios requiring authentic learning, where learners are motivated to develop applicable competencies by encountering learning experiences that simulate their real life or future professional practice (Herrington & Oliver, 2000; Honebein, Duffy, & Fishman, 1993). Simulations also utilize authentic failure experiences to enhance successful completion of varying levels and challenges (Pivec et al., 2003).

From coping skills (Alfi et al., 2004) to behavior modification (Ellis, Mendel, & Nir, 2006) to problem solving (Tawfik et al., 2015) to demonstrating competence or mastery (Morris, Croker, Zimmermna, Gil, & Romig, 2013), lessons learned from failure experiences have proven to be better motivators than lessons drawn from successes (Ellis et al., 2006; Sitkin, 1992). While simulations originally focused on nursing education, the use of simulations has moved well beyond health professions education (McGaghie, Issenberg, Petrusa, & Scalese, 2010). The objectives of most simulations are rooted in either procedural or declarative knowledge, or a combination of both. Within the simulated environment, the learner is constantly building knowledge on how the scenario works and what actions must take place in order to successfully complete the training, but it is from the feedback provided that learning takes place (Prensky, 2003). When a learner fails to complete a necessary action or task, they are typically forced to try again until they are successful. With each new attempt, the knowledge and experience are enhanced, and the learner is eventually allowed to move forward in the simulation. Therefore, the necessary link that helps learners plan to successfully complete what they are being asked to do is the failure experience (Snow, 2016).

Simulations use a model that depicts or mirrors some aspect of reality in form, if not necessarily in content (Aldrich, 2003). Simulations make "learning by doing" possible because it focuses on the learner's performance outcomes in a context that mirrors the real-world environment and demands more intuitive responses while taking into account the complexity of possible interactions across key variables such as time, lack of prior knowledge, and other constraints (Aldrich, 2005). The use of simulations in medical training allows learners to experience authentic situations that are near-impossible to replicate in the real world (Rosser, 2007). Simulation-based design inherently endorses failure as an intended part of the learning experience (Pivec et al., 2003). Although simulations are frequently used in medical research and development, its potential for failure-based learning has not been fully discovered. By rethinking our approach to how we delineate failure, we can provide learners with opportunities to discover, improve (Kallevig, 2015), retain (Schank, 1999) and apply the meaningful and necessary lessons drawn from that experience. Simulation-based learning not only has the potential to enhance training in medical fields, but also provides the opportunity to improve a variety of fields, including drone operations training, by virtue of its engagement, motivation, role playing, authenticity, and repeatability of failed strategies that can be modified and tried again with little to no risk (Corti, 2006).

An effective simulation requires an environment conducive to learning and introduces activities that foster mastery of new and previous skills and competencies. Debriefing and reflection activities after completion of simulation-based learning builds self-efficacy and supports self-regulation of behavior (Burke & Mancuso, 2012). Mindful selection of simulation complexity and structure matches course learning objectives and supports progressive development of metacognition (Burke & Mancuso, 2012). Tailoring the level of difficulty to learners' mastery level supports successful outcomes. Learning in simulation requires a psychologically safe environment (Rudolph, Simon, Dufresne, & Raemer, 2006). The drone industry continues to grow and expand each day, with more licensed drone pilots entering the field since the rollout of the Federal Aviation Administration (FAA) Reauthorization Act of 2018 (FAA Reauthorization, 2019). Drone flight training frequently employs the power of computer simulations to support and enforce the skills and competencies of flight pilots. Simulation-based learning allows learners to fail fast, often, and safely when learning to operate the drone.

## Conceptual Framework

This study was conducted using a phenomenological approach. Phenomenology is a methodological framework that seeks meaning in participants' narratives of the lived experiences of phenomena (Moustakas, 1994). The objective was to capture the perceptions and experiences of drone videography pilots participating in failure-based learning using a drone flight training simulation. The purpose of phenomenological study is to understand and describe a particular phenomenon comprehensively, to reach the essence of participants' lived experience of the phenomenon (Moustakas, 1994). The intent for this study was to understand the phenomena in the participants own terms using a qualitative research design. Qualitative research aims to develop theory by relying on those who have personal experience with the phenomenon in question and giving them an opportunity to share their own meaning and experiences (Creswell, 2003). It was important to assess what instructional scaffolds were used to engage learners when encountering failure during the simulation. As the aim of this proposed research was to understand how the use of simulation-based methods influence learner perception regarding failure-based learning, it was necessary to make meaning pertaining to learning from failure in an authentic simulated-learning environment. This study was framed using Kolb's (1984) Experiential Learning Theory (ELT) in which learning is characterized by: (a) a continuous process grounded in experience, (b) a process requiring the resolution of conflicts between dialectically opposed modes of adapting to the world, (c) a holistic process of adapting to the world, (d) transactions between the person and the environment, and (e) a process of creating knowledge.

## Purpose of Study

Within the context of a simulation-based learning environment, this researcher sought to examine the perspectives of drone videography pilots regarding failure-based learning. This study utilized Tawfik et al.'s (2015) failure-based learning model to examine the degree to which intentional failure is perceived as beneficial within simulations. The purpose of this study was to identify the ways in which the use of simulations influences the rationale for and the impact of failure-based learning, with respect to learner perceptions and experience.

### Research Questions

This study addressed the following research questions:

1. How do drone videography pilots perceive the use of failure-based learning strategies as part of the simulation training experience?
2. How does the drone pilot instructor perceive the use of intentional failure-based learning design in the simulation training activity?

## Definition of Terms

A multi-database search revealed no singular, agreed-to definition of computer simulations or failure. The following listing serves as a reference for operationally defined key terms and definitions used throughout this study:

- *Administration or Administrator*: Leaders in a college or university that includes the president, deans and associate deans and program coordinators who are responsible for the management of the college or university.
- *College*: educational institution or establishment.
- *Instructor*: All education professionals working in participating colleges or universities or training professionals working in corporate settings.
- *Failure*: A lack of success, or omission of occurrence or performance. Specifically, failing to perform a duty or expected action.
- D*rone*: An unmanned aircraft or ship guided by remote control or onboard computers (Merriam-Webster n.d.).
- *Simulation*: The imitative representation of the functioning of one system or process by means of the functioning of another (Merriam-Webster n.d.).
- U*niversity*: Educational institution designed for instruction, examination, or both, of learners in many branches of advanced learning, conferring degrees in various faculties, and often embodying colleges and similar institutions.

## Significance of the Study

While researchers have identified strategies for learning from failure (Edmondson, 2011) and studied whether learning from failure differed from learning from success (Baumard & Starbuck, 2005), a gap in the literature exists on learning design that affords opportunities for learners to encounter and overcome failure as part of the learning process. Studies from numerous domains, particularly business-related fields, recognize failure as an effective teaching tool (Cannon & Edmondson, 2005). The results of this study highlight the valued lessons learned from experiencing failure in training drone videography pilots. The question of the value in designing training and teaching experiences for learners that promote learning from failure is rooted in the notion that failure is beneficial, because it allows the learner to reflect on the experience for future problem solving in an authentic learning environment (Kapur & Bielczyz, 2011; Schank, 1999). A recent meta-analysis found only 62 articles within the past 10 years that empirically investigated productive failure and only 12 of these articles were robust enough to include in their meta-analysis with many of the works produced by the same author, Kapur, highlighting the need for more research in this area (Darabi, Arrington, and Sayilir, 2018).

Instructional designers seeking to design for simulation-based learning environments can use the results of this study to inform practices regarding how to use simulations to employ failure to promote learning. As key stakeholders in drone training education seek to better understand how to prepare learners for their professional careers, explorations into the use of simulations in the curriculum can provide evidence as to what non-traditional interventions significantly impact learner performance. Understanding the use and impact of failure-based learning in simulations is important for future studies in this field.

## Delimitations

This study was limited to Part 107 licensed, FAA certified drone pilots who had successfully completed or were currently enrolled in the drone videography course at a public research university in the southeastern region. One limitation of this study was related to the researchers' spousal relationship with the drone videography course instructor. In addition, this researcher's personal relationship to one of the participants outside of the context of this research had the potential to sway their responses. The small number of participants (N=16) was another limitation as the population of interest was limited to Part 107 licensed drone pilots. Transferability refers to the degree to which one can extend the interpretation of a specific situation or population to other settings than those directly studied (Maxwell & Chmiel, 2014). Results of this study might differ from pilots trained at other universities, from other programs, and at different levels of expertise. Potential biases might also interfere with the analyses of the content of the interviews and in the exploration of pilots' experiences.

Simulations are well-positioned as an advanced teaching tool in the 21st century. Though the use of simulations in various teaching and learning settings has increased, the progression of using simulations to engage learners with experiencing failure is undeveloped and this area is rich for further research. The findings in this study could have significant implications for the use of simulations and failure-based learning strategies. However, as this study was designed to focus solely on drone videography pilots, the scope is limited to this population and field of study. Lack of learning approaches to facilitate failure-based learning also inhibits implementation of this process. In the case of simulation-based learning, failure invites the opportunity to challenge traditional assumptions about the value of learning from failure versus learning from success. While the results of this study may lead to important considerations for implementing failure-based curriculum, the results will likely not be broadly generalizable to other learner groups or subject areas.

## Summary

Despite significant growth in the use of simulations for learning, no studies have addressed the effectiveness of this format for training drone videography pilots and the degree to which failure is employed. In addition, little research exists examining learner perceptions on the impact of failure-based learning strategies on learner learning outcomes. This study proposes to help fill these gaps in the literature.

The remaining chapters of this dissertation are organized as follows: Chapter II presents a literature review of previous studies examining the topic of simulations and leveraging failure, including the history, benefits, limitations, and impact of failure strategies. Chapter III describes the methods that were used in this qualitative study. Chapter IV reports the study's findings collected from interviews with the participants. Finally, Chapter V includes a discussion of the findings, implications, and recommendations for future research.

# CHAPTER 2

# LITERATURE REVIEW

The purpose of this study was to examine drone pilots' perception of the use of simulations to promote learning from failure. This chapter focuses on the literature surrounding simulations and failure-based learning. This chapter first defines theories of failure and provides a history of simulations and failure-based learning. Before considering this body of literature, it is important to note that little research exists on learning design that intentionally allows opportunities for learners to encounter and overcome failure as part of the learning process. The present discussion will focus primarily on findings and issues associated with simulations and failure-based learning.

## Historical Origins

Simulations afford the unique possibility of designing an authentic learning experience when it is impossible or impractical to foster such an experience in the physical world (Galarneau, 2005). Participating in an authentic learning environment results in more active and deep learning and improves intrinsic motivation of learners (Gulikers, Bastiaens, & Martens, 2005). Authentic environments provide a realistic context to authentic tasks (Herrington & Oliver, 2000). The function of both an authentic learning environment and an authentic task is to demonstrate relevance and to encourage learners to develop skills and competencies that are relevant for their future professional lives (Herrington & Oliver, 2000). Simulations incorporate scenario-based learning, which is rooted in the principles of situated learning theory (Lave & Wenger, 1991). Situated learning theory asserts that learning best takes place in the context in which it is going to be used (Lave & Wenger, 1991). Knowledge is best acquired and more fully understood when situated within its context (Kindley, 2002). These authentic tasks allow learners to be immersed in problem-solving situations that employ their skills. Cognition is assumed to be a social and situated activity where one learns a subject matter by doing what experts are expected to do in that field (Lave & Wegner, 1991). Legitimate peripheral participation should be understood as defining ways of belonging to a community of practice (Lave & Wenger, 1991). Learning therefore, is perceived as participation in a co-constructive process in which knowledge is not only constructed by the individual learner, but also involves the sociocultural setting and the activities of other individuals within that setting (Lave & Wenger, 1991).

Scenario-based learning strategies coupled with situated learning theory emphasizes the importance of context in establishing meaningful linkages with learner experience and in promoting connections among knowledge, skill, and experience. This learner-centered approach has encouraged the recent shift to implement scenario-based learning strategies such as games and simulations in training and education (Galarneau, 2005). The demand for experiential learning strategies is growing rapidly as these types of teaching and learning strategies offer a safe and effective way for learners to acquire new skills and competencies and apply what they have learned to real-life situations. Learners are placed in a context where they become transformed into active problem solvers and critical thinkers; where they must use their decision-making skills to solve problems or potentially suffer the consequences. Learners take time to think about these decisions, make a choice, and then experience the consequences of their decisions.

**Authentic Learning**

There are 10 characteristics of authentic learning activities that can be applied to simulations (Reeves, Herrington, & Oliver, 2002):

1. Have real world relevance and are not simply classroom based.

2. Provide complex tasks that take a significant amount of time to complete.
3. Have ill-defined problems that require learners to define tasks and sub-tasks to be completed through multiple interpretations.
4. Provide learners the opportunity to collaborate.
5. Provide learners the opportunity to examine the problem from different perspectives using a variety of resources.
6. Require learners to reflect on their social and individual learning experiences.
7. Require integration of content from several disciplines and lead to outcomes beyond the specific learning objectives.
8. Integrate assessment into the activities rather than employing external tests in an effort to be reflective of similar real-world assessments.
9. Lead to the creation of a polished product with value in their own right outside of simply earning a mark.
10. Allow competing solutions and a diversity of outcomes instead of one single correct answer.

Evidence indicates that success is preferred over failure, yet theorists have positioned varied evidence which suggests that the absence of failure experiences can result in decreased organizational resilience when faced with changing circumstances (Douglas & Wildavsky, 1983; Edmondson, 2004, 2011). During the last two decades, the shift in medical education focused on the development of competencies (Stoof et al., 2002). In healthcare, learning from failure requires substantial effort to create a foundation for new beliefs and behaviors throughout the organization, particularly where patients are being treated (Edmondson, 2004). Authentic learning prescribes that learners are motivated to develop applicable competencies by encountering learning experiences that simulate their real life or future professional practice (Herrington & Oliver, 2000; Honebein et al., 1993). Authentic learning strategies like simulations are commonly used in healthcare or corporate training environments, as well as in some educational settings, but are not typically designed such that learners intentionally experience failure.

**Simulations in High-Stakes Learning**

In popular culture, the Kobayashi Maru is a simulated training activity in the fictional Star Trek universe where the test-taker must decide whether to attempt rescue of the Kobayashi Maru crew, endangering their own ship and lives, or leave the Kobayashi Maru to certain destruction resulting in total loss of life on the ship. The simulation is designed to test the character of the learner by placing them in a situation in which they will certainly fail. In high-stakes learning environments where training involves protecting life, such as with the Kobayashi Maru, training activities are often designed to evaluate how trainees handle high-risk situations that ultimately result in failure (Dunlap & Lowenthal, 2010). In developing high-stakes simulation-based assessments, much has been learned about exam design, test administration and logistics, quality assurance, and psychometrics (Boulet & Swanson, 2004). The overarching goal is to provide an authentic, low-risk learning environment that allows for the construction of knowledge and meaning applicable to a real-life scenario. Simulations mimic real-world events and incorporate game-like features such as identity and immersion, where users feel like they are a character in the simulation and are engaged and motivated to succeed both by the events in the simulation and their score (Annetta, 2010). Instructors are increasingly turning to simulation activities to support clinical skill development (Motola, Devine, Chung, Sullivan, & Issenberg, 2013). The reasons for the increasing popularity of simulation-based training are clear: they can provide learners with realistic experiences with little risks; the tasks/scenarios can be designed to meet important needs, with increasing complexity introduced in a controlled way; skills can be practiced repeatedly, with tailoring to individual needs; and the likelihood of transfer from instruction to real-world situations is enhanced (Boulet & Swanson, 2004). If instructors can identify and implement those aspects of simulations that motivate learners and encourage learning, their impact on achieving learning outcomes would be increased (Garris, Ahlers, & Driskell, 2002). With increasing access to quality technology, instructors are progressively considering web-based or virtual simulations for learning as a way to augment or supplement learning done through laboratory simulation (Cant & Cooper, 2014).

**Theories of Failure**

To better understand failure and failure-based learning as it is used in this study, it is necessary to be familiar with the theories of failure that are applicable to learning design. Clifford's (1984) theory of constructive failure informed many future studies on failure. Sitkin (1992) expanded upon Clifford's theory and explored the value of failure and distinguishes systematic failure from which one can learn, from failure that does not foster learning. He argued that planning is not enough; for failure to be beneficial, the outcome of action must be uncertain (Sitkin, 1992). Therefore, it is important to recognize that failure is not the goal but learning from the experience is the ultimate goal (Sitkin, 1992). Cannon and Edmondson (2005) discuss the notion of failing intelligently as originally introduced by Sitkin (1992). Intelligent failures provide valuable new knowledge generated by the learner. Embracing opportunities to learn from failure encourages learners to not only be more engaged, but also builds schema, builds metacognitive thinking, and promotes transfer (Martinez, 2010; Sitkin, 1992). It is crucial that learners know how to accurately appraise what they know and understand and what they do not

(Martinez, 2010). It is also important to provide adequate practice with a variety of examples and problems which successfully facilitates the internal processes of retention and transfer. This learner-centered approach endorses self-regulated learning in which the learner is the primary arbiter in making judgments as to what, when, and how learning will occur (Hannafin, 1992).

Ellis et al., (2006) studied the effect of the type of after event reviews on performance improvement and causal attributions under conditions of earlier success and earlier failure. The researchers found that learning from failed experiences often has deeper impact from that of successful experiences (Ellis et al., 2006). Each scenario or after-event review type was thoroughly evaluated to provide a rich perspective on how success and failure influence learning experiences. Productive failure is the concept in which learning conditions are designed such that they may not maximize performance in the shorter term, but in fact maximize learning in the longer term (Kapur, 2008). Learners will not typically have all the information needed to be successful, therefore, they must generate or discover solutions to solve problems or meet objectives, using prior knowledge or trial-and-error as a result of an impasse (Kapur, 2008). Kapur examined whether or not there is a "hidden efficacy" in un-scaffolded, ill-structured problem-solving processes and whether or not it can be extracted using a contrasting-case mechanism (Kapur, 2008). Engaging learners in solving complex, ill-structured problems with limited to no support can be a productive activity in learning from failures (Kapur, 2008). The efficacy of productive negativity or failure was demonstrated in ninth-grade learners learning about the concept of variance (Kapur, 2013). One group of learners received direct instruction on how to calculate variance, while another group was allowed to form their own hypotheses and attempt to calculate variance using their own formulas (Kapur, 2013). The group who first experienced failure outperformed the other in terms of their conceptual understanding of variance and their ability to transfer the concept to new scenarios (Kapur, 2013).

**Productive Failure**

When designed to be followed by a productive response, failure is referred to as productive failure or productive negativity (Kapur, 2008, 2013; Kapur & Rummel, 2012). Learning through crises events is another identifiable aspect of the existing literature on learning from failure (Cope, 2011; Shepherd, 2003). Critical episodes and failure events can have heightened learning outcomes when compared with regular operational activities (Shepherd, 2003). Productive failure suggests that when the learner is confronted with a task, the previously encountered failure will be referenced, thus enabling better application of prior knowledge (Kapur, 2008). Further research on productive failure perspective found that when learner support was delayed during mathematical problem-solving, learners were able to perform better on transfer tasks when compared to those within the lecture and practice condition (Kapur & Bieclczyz, 2011). These studies give support in designing simulations with productive failure strategies.

**Failure, Simulations, and Games**

Blumberg, Rosenthal, and Randall (2008) examined the nature of the relationship between impasse and learning, as encountered during video game play, and found that in the video game context, problem-solving failures may provide enough incentive for progressing through tasks despite opportunities for failure. Learners who engage in games as part of their training display greater comprehension and exhibit positive changes in behavior (Breuer & Bente, 2010). Games demand learners make choices and attempt to solve problems, with great risk for failure, yet, that element of failure is to be desired and does not impair the game play experience (Breuer & Bente, 2010). In game play, failure is expected and appreciated as it instills a sense of accomplishment once the learner becomes successful (Kapp, 2012). Failure is not only an option in games, but also a good option, as allowing a learner to fail with minimal consequences encourages deeper understanding and exploration (Kapp, 2012). Kallevig (2015) explored the perceptions in higher education of failure and the use of gamification to address the fear of failure. Students in a higher education classroom felt that failure can be an effective learning strategy when followed by constructive feedback following the failure experience and when it is applied as part of a trial-and-error process and there are no consequences to the learner (Kallevig, 2015). In addition, more participants responded favorably that failure in game play can be a more positive learning experience than a negative experience (Kallevig, 2015).

Research published in the *International Journal of Gaming and Computer-Mediated Simulations* explore how both games and simulations provide low-risk, interactive opportunities for learners to fail before performing in a high-risk training or work environment. Comparable to games, simulations are especially suited to motivate learners to set higher personal standards for goal attainment by encouraging learner control over ill-structured scenarios ultimately leading to successful outcomes. While simulations and games have key similarities and differences, the intersection of games and simulations exists in their capacity to encourage learners to learn through their mistakes (Kapp, 2012). Simulations provide a safe environment for learners to fail. Much like with video or computer games, with simulations, failure is by design an expected and sometimes even necessary step in the learning process (Kapur, 2008; Plass, Homer, & Kinzer, 2015). The lowered expectation of consequences of failure in simulations encourages knowledge generation and exploration (Hoffman & Nadelson, 2009).

## Degree of Failure in Simulations

There are numerous ways to measure the quality of a course or training. Traditionally, course evaluations are based on course participants' and other key stakeholders' opinions of the quality of the course. With simulations often assessed only in terms of individual successes or failures, it is difficult to ascertain whether success or failure was due to a specific design choice or omission. Graafland, Schraagen, and Schijven (2012) presented the first consensus-based framework for the assessment of specific medical games. The framework consists of 62 items in five main themes, aimed at assessing a game's rationale, functionality, validity, and data safety. This information allows caregivers and instructors to make balanced choices when utilizing a game for healthcare training purposes.

## Unified Design Approach for Failure-Based Learning

Building on Kapur's (2013) work, Tawfik et al., (2015) assert that it is possible that learning systems that strategically employ failure may be able to generate additional benefits when compared with successful problem-solving models. The researchers acknowledge that to date, no models have discussed how to employ failure strategically within instructional design. Given this gap, the researchers first present failure-based research from various theoretical frameworks: perturbations (Piaget, 1977), impasses (VanLehn, 1988), failures (Kapur, 2012), script deviations (Schank, 1999), and errors (Gartmeier, Bauer, Gruber, & Heid, 2008, 2010), which allow them to offer four failure-based principles for learning systems design which served as a guide for this study. These principles are as follows:

1. Allow learners to identify failure.
2. Design learning environments to intentionally encounter failure.
3. Support inquiry into failure for analogical transfer.

4. Support solution generation to resolve failures.

Figure 1 depicts Tawfik et al.'s (2015) unified model of failure. This unified model of failure and learning systems design incorporates a hands-on approach in recognizing the value of failure and the role it plays in instructional design.

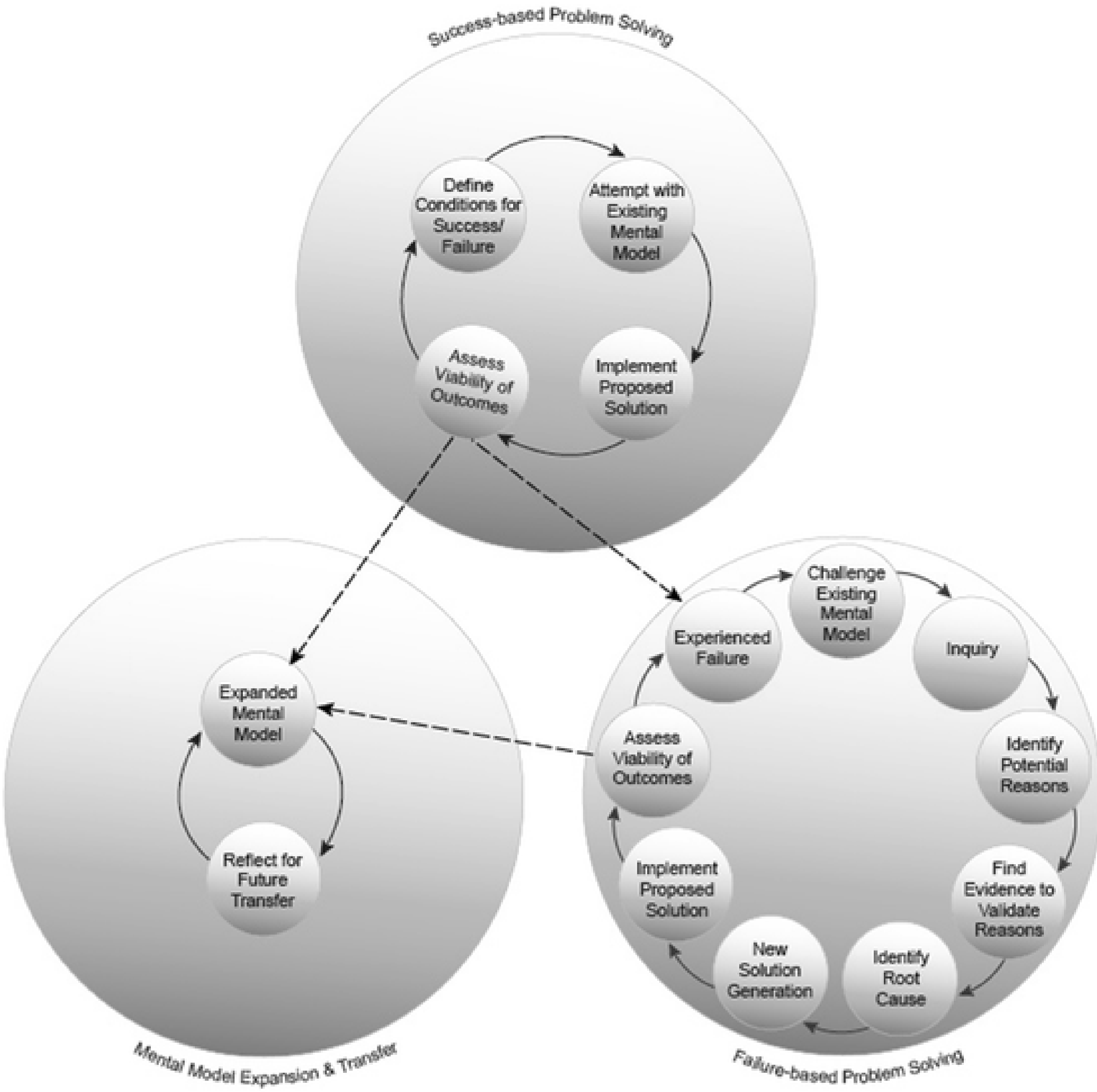


*Figure 1.* Unified model of failure. (Tawfik et al., 2015)

Understanding how to employ failure strategically is an important step in supporting knowledge generation and higher order thinking (Tawfik et al., 2015). The researchers suggest that intentional exposure to failure integrated into learning systems allows the learner to identify causal processes and employ this new knowledge to resolve the problem (Tawfik et al., 2015). For the unified model of failure and learning systems design approach to work, it is crucial that the learner can first identify and define the learning experience as a failure experience. The learner must classify the experience as being deviant from their expectations (Schank, 1999). The researchers outline theoretical perspectives and empirical research to lead the discussion on failure-based instructional design guidelines that can be incorporated into future learning systems. The most important element of employing this unified model is how the learner addresses the failure and garners meaning from the experience as they progress towards a solution. Tawfik et al., (2015) recommend the following guidelines to employ failure explicitly during learning design.

**1. Allow learners to identify failure.**

Instructional designers should define the conditions for failure and identify different failure perspectives. To promote cognitive flexibility, learners should be prompted to address the conditions for success and failure prior to problem-solving and should also be given the opportunity to redefine the success and failure from an alternative perspective (Tawfik et al., 2015).

**2. Design learning environments to intentionally encounter failure.**

Instructors and instructional designers should create failure-based question prompts and generate failure-based causal models and other models for failure to provide a series of failure-based narratives that learners could access as just-in-time resources (Tawfik et al., 2015). The question prompts should be designed for learners to discuss and/or encounter failures that they might otherwise overlook. This helps to promote better engagement in the failure-based problem-solving cycle (Tawfik et al., 2015).

**3. Support inquiry into failure for analogical transfer.**

Instructors and instructional designers should provide prompts for the learner to reflect on their experience and misconceptions. Reflection on failure encourages learners to identify opportunities for transfer (Kapur & Bielczyz, 2011). In addition, embedded prompts encourage learners to reflect on individual introspection. Learners can also be asked to identify reasons for failure states as well as artifacts of the failure context. This encourages a systemic perspective of failure that allows learners to demarcate the appropriate conditions for transfer (Tawfik et al., 2015).

**4. Support solution generation to resolve failures.**

Instructors and instructional designers should allow learners the opportunity to generate, debate, select, apply, and evaluate solutions to resolve root causes to breakdowns of the micro-failures (Tawfik et al., 2015).

**Simulations and Scenario-Based Design**

Simulation design occurs in many overlapping contexts and involves unique scenario-based design. Applications in the literature range from business, medical, and corporate settings with a newfound focus shift on various avenues of educational settings. From the instructional design perspective, three approaches in scenario-based strategy form the foundation for moving to the use and value of scenarios: in simulations inherent problems with prediction, the need for practical systems thinking, and strategy as a continuous learning process (van der Merwe, 2008). Designing scenario-based activities such as simulations and games can be time consuming, and research shows that it typically takes between six and nine months to complete, but the product results in an authentic learning experience which can both challenge and motivate learners (van der Merwe, 2008). Much like games, simulations promote success through failure by involving challenging scenario-based tasks and conflicts, thus ensuring the development of key skills or knowledge through repetition and experimentation in an engaging environment (Barab, Gresalfi, & Ingram-Goble, 2010; Charsky, 2010). Carroll (2000) proposed five technical challenges of scenario-based design of information technology:

1. Scenarios evoke reflection in the content of design work, helping developers coordinate design action and reflection.
2. Scenarios are at once concrete and flexible, helping developers manage the fluidity of design situations.
3. Scenarios afford multiple views of an interaction, diverse kinds and amounts of detailing, helping developers manage the many consequences entailed by any given design move.
4. Scenarios can also be abstracted and categorized, helping designers to recognize, capture, and reuse generalizations, and to address the challenge that technical knowledge often lags the needs of technical design.
5. Scenarios promote work-oriented communication among stakeholders, helping to make design activities more accessible to the great variety of expertise that can contribute to design, and addressing the challenge that external constraints designers and clients often distract attention from the needs and concerns of the people who will use the technology.

van der Merwe (2008) proposed five heuristics for scenario-based learning strategies that instructional designers can apply to simulations: promote construction of knowledge, scaffold and differentiate learner learning, support collaboration and learner control, present content in a variety of contexts to promote transfer, and when possible, identify motivational problems and provide opportunities to enhance retention and transfer.

The goal for using simulations in drone videography training can be different from those in other subject matter areas in other training and educational settings. For example, early exposure to flight operation skills helps integrate learners' knowledge in basic skills with practical concepts. This integration enhances learners' understanding and interest in developing more challenging competencies (van der Merwe, 2008). Skills-based scenarios require learners to demonstrate acquired skills, abilities, attitudes, and basic understanding of complex tasks (Carroll, 2000). The implementation of authentic tasks and assessments in a simulation, can better prepare professionals to perform in the true working environment. Well-designed failure-based scenarios can teach learners important concepts, competencies and skill sets that require they accomplish a specific task or learning goal.

**Simulations and Experiential Learning**

This study utilized Kolb's (1984) experiential learning theory as a framework for the importance of direct experience and reflective observation. The theory of experiential learning is depicted as a four-stage model focusing on concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). More advanced than games, simulation activities provide a higher level of quantifiable realistic "uncertainty" and require that learners actively seek information to successfully meet learning goals (Jeffries, 2005). Through experiential learning and continuous interaction with the simulation, the learner acquires and values new knowledge and becomes more engaged in learning (Bandura, 1991). Many instructors inadvertently and sometimes deliberately shelter learners from the complexity and dynamicity required of ill structured problems, therefore inadvertently overlooking the benefits of failure (Tawfik et al., 2015). Instructional systems should balance when it is appropriate to provide support and when to allow learners to face some of the complexity of the domain in productive ways (Reiser, 2004).

Simulations are often used to enhance curriculum. Active learning in a simulated environment helps learners intercede in a way that is responsive and dynamic with little risk, depending on the degree of problem solving and intervention (Aldrich, 2005). Like games, simulations afford learners the opportunity to continuously repeat the scenario until the desired outcome is attained. Repeated engagement allows learners to apply forethought, thus modifying their approach in response to their next attempt (Galarneau, 2005). Negative experiences are deleterious to self-efficacy and reduce motivation by making goals seem unattainable (Bandura, 1991). However, when learners demonstrate mastery, it is important to increase the scenario difficulty level, ensuring that learners are optimally challenged to enhance critical thinking skills and metacognitive growth (Bandura, 2001). These outcomes can be reinforced by using failure-based learning strategies.

Strong interest and engrossment in authentic learning activities is sparked by challenging goals (Bandura, 2001). Wilkerson, Avstreih, Gruppen, Beier, and Woolliscroft (2008) sought to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. The researchers found that immersive training in a virtual environment was a powerful tool to train first responders for high-acuity, low-frequency events (Wilkerson et al., 2008). The infrequent nature of these such events leads to less collective experience, limited opportunities for practice, and as a result, little empirical research (Wilkerson et al., 2008). The practice needed for knowledge retention is also inhibited by few authentic training opportunities. For example, drones offer great risk and underwriting challenges. One of the greatest risks is due to radio frequency interference which can result in loss of control of the drone, and in the worst-case scenario, loss of life. Using simulations as part of the teaching method in drone training provides opportunities for practice and supports learner attentiveness and retention. Adding a failure-based scenario within a simulation that is aligned with the curriculum, supports the progression of learner metacognitive skills, and optimizes critical thinking and the ability to apply new knowledge and behaviors (Tawfik et al., 2015).

**Current Research on Simulations and Game Design**

Experiential learning theory provides a basis for the integration of gameplay and learning (Kiili, 2005). Not only do simulations and games share several important characteristics, but most games are also built on simulations and incorporate them as part of their basic architecture (Honey & Hilton, 2011). Computer simulations and games have great potential to support failure-based learning strategies, by allowing learners to explore natural phenomena that they cannot and probably would not want to directly observe. Boyle et al., (2016) found that most games investigated from 2009 to 2014 did not integrate advanced gaming mechanics in a way that aligned with learning outcomes. They invite more research that investigates what gaming features are most effective at supporting learning and engagement (Boyle et al., 2016). Studies on the effectiveness of simulations and games for learning tend to focus on assessing conceptual understanding alone. This study aimed to investigate failure as an effective learning and engagement strategy during drone simulation training. Lameras et al. (2016) reviewed 165 papers which specifically reported on how learning and gaming mechanics can be integrated into effective games. The authors found that very few of these papers employed frameworks that linked learning and gaming elements such as failure, with empirical evidence (Lameras et al., 2016). Several game-design models and frameworks have surfaced to help game creators and evaluators better describe the relationships between the game mechanics and instructional strategies more explicitly (Arnab et al., 2014; Cain & Piascik, 2015; Carvalho et al., 2015; Pedro et al., 2015; Starks, 2014).

Interactive computer simulations with complex representations and sophisticated graphics are not widely used in the traditional classroom and research in this area is limited. Lane and Tang (2000) explored the effectiveness of simulations for teaching statistical concepts in comparison to the effectiveness of a textbook. Their results support the increasing use of simulations in education and training. The researchers found that training by simulation led to better performance than training using a traditional textbook approach (Lane & Tang, 2000). Participants trained with the simulation were more able to recognize the key elements of ill-defined problems embedded in various real-world situations and apply the relevant statistical principles (Lane & Tang, 2000).

Gauthier and Jenkinson (2018) investigated how explicit game design strategies can promote productive negativity, or learning from failure, which has been recognized as a chief mechanism in both gaming and learning. The authors describe the theoretical framework underpinning their game using the Activity Theory Model for Serious Games (ATMSG), a conceptual model that supports a detailed and systematic representation of educational games based on pedagogical objectives (Gauthier & Jenkinson, 2018). While simulations are not always games, this study is one of the first to successfully make direct comparisons between learners' interactions in a simulation and a non-simulation application to provide concrete and actionable game design recommendations (Gauthier & Jenkinson, 2018). They found that the serious game resulted in significantly more productively negative experiences, while the interactive simulation allowed for greater exploratory or experimental behaviors (Gauthier & Jenkinson, 2018). The authors recommend three game design strategies to enhance the occurrence of desired simulation or game-flow loops (e.g. productive negativity) with respect to the ATMSG framework: 1) including additional game mechanics on the primary game-flow axis may limit the exploratory nature of the application but does not impede overall productive interactions from occurring; 2) integrating two or more primary-axis mechanics in a game-flow loop increases the frequency of interaction with this loop; and 3) game-play loops that involve mechanics that fall off the primary-axis (i.e. non-mandatory mechanics) occur less frequently than those which involve primary-axis (i.e. mandatory) mechanics (Gauthier & Jenkinson, 2018).

**Summary**

Simulations open a world of possibility for learners. Review of the current literature provides a foundation for the research question posed in this study and will help guide future research considerations. This study aimed to investigate how failure, as a specific simulation design strategy, can promote positive learning outcomes. Chapter 3 is a discussion of the research design, setting, participants, data sources and analysis.

# CHAPTER 3

# METHODOLOGY

This chapter introduces the methodology and research design for this study. A qualitative methodology framed by a phenomenological approach was chosen to understand the perspectives of drone videography pilots regarding the use of failure-based learning within a simulation training experience. The research design was guided by the following questions:

1. How do drone videography pilots perceive the use of failure-based learning strategies as part of the simulation training experience?
2. How does the drone pilot instructor perceive the use of intentional failure-based learning design in the simulation training activity?

## Research Design

Phenomenology is the study of "phenomena": appearances of things, or things as they appear in our experience, or the ways we experience things, thus the meanings things have in our experience (Giorgi, 2018). A phenomenological study describes the meaning of the lived experiences for several individuals about a concept or the phenomenon (Creswell, 2003). The overall purpose is to understand how participants make sense of their lived experiences (Merriam & Tisdell, 2015). A phenomenological approach was most appropriate for this study as it had the purpose of describing the central theme that emerges from the lived experiences of persons who share an experience (Creswell, 2003; Kline, 2008). Phenomenology shares some features with grounded theory and uses similar techniques to collect data, but instead focuses on understanding how human beings experience their world. This gives researchers the opportunity to better understand the subjective experiences of participants. This study explored the experiences of drone videography pilots about their perceptions of the use of failure-based learning strategies in drone videography simulation training. This researcher utilized Tawfik et al.'s (2015) unified model of failure and learning systems design to verify the degree in which failure is explicitly employed in the simulation design, using the model as a design framework. Few studies have considered the development of failure-based learning in relation to training and higher education. The overarching goal of this study was to bring some clarity to the use of failure-based learning within simulations.

**Research Setting**

The setting of this research took place at a public research university's drone school program in the southeastern region. The drone videography course is designed to give learners flight training as well as an understanding of the FAA regulations associated with the use of drones in preparation for the FAA Remote Pilot License Exam. The drone training setting can have a significant impact on the phenomenon of simulation usage as each university is unique and has its own set of parameters. A comprehensive understanding of the central phenomenon can best be developed by allowing the researcher to focus on the meaning each participant holds related to the use of simulations in the classroom by asking general, open questions and collecting data in the environment where each learner completes their drone training.

**Target Population and Sample**

A phenomenological framework requires a comparatively similar group of participants who have experience with the same phenomenon (Creswell, 2003). Purposeful sampling is commonly used in qualitative studies. The selection of the university and participants for this study was a purposive and convenience sampling (Palys, 2008). While purposive sampling is typically used in qualitative studies, a convenience sampling method is applicable to both qualitative and quantitative studies, although it is most frequently used in quantitative studies

(Etikan, Musa, & Alkassim, 2016). A range between five to 25 participants, is a recommended sample size for most qualitative research, with a minimum of six participants (Creswell, 2003; Morse, 1994). The participant sampling pool for this study was limited to drone pilots who had an active Part 107 license and were either currently enrolled in or had successfully completed the drone videography course at the university. The sample did not include students enrolled in the drone videography course at the time of the study that had failed their Part 107 license exam.

**Participant Recruitment and Selection**

Since its inception of the drone videography program in 2018, the university has successfully produced over 60 licensed drone pilots since the time of the program's first commencement. Many of these pilots have gone on to work for high-ranked companies and other successful multimedia production houses. A list of the email addresses of current students and alumni was generated from the drone videography course instructor with permission. An invitation to participate in the study was sent to pilots who had an active Part 107 license. At the time of this study, there were 16 students enrolled in the drone videography course however, three of these students could not be invited to participate in the study as they had failed the Part 107 exam and therefore were ineligible to participate. Twelve licensed former students were also invited to participate in the research. Individuals who fit the study's criteria were contacted via email to discuss informed consent and to schedule a date for completing the simulation exercise. An informed consent form, as shown in the Appendix, was required for each pilot prior to participating in the study.

Of the 25 pilots asked to participate, 16 (64%) pilots participated in the study. These participants were willing to participate and were quick to respond to the recruitment process. All participants were made aware that the data collection process was for research purposes only.

Participants were also informed of the safety measures put in place in response to the ongoing Covid-19 pandemic. Once selected, each participant was assigned a participant number in the order of acceptance into the study, running from P01 through P16. These unique identifiers were for the purpose of research only. The names of participants were removed from the transcripts.

**Participant Demographics**

Out of 16 participants, eight were women while the other eight were men. The interview sample comprised 10 current students and six former students. All the participants had an active FAA Part 107 license at the time of the study. Table 1 provides data on the categories of participants according to gender and enrollment status.

Table 1

*Demographics of Study Participants*

| Participants | Currently Enrolled | Former Student |
|---|---|---|
| Male | 6 | 2 |
| Female | 4 | 4 |

The final sample consisted of 16 individuals who capture the diverse experiences of drone pilots as they describe their roles as current students and their experiences with career success after commencement. The selected participants for this study met all inclusion criteria needed to evaluate the phenomenon, representing a broad range of skill level, age, and experience.

## Data Collection

This researcher used the AeroSIM$^{RC}$ radio control training simulator software to design and develop a drone flight training simulation using the Tawfik et al., (2015) unified model of failure and learning systems design. The model outlines four instructional design principles for failure-based learning: 1) allow learners to identify failure, 2) design learning environments to intentionally encounter failure, 3) support inquiry into failure for analogical transfer, and 4) support solution generation to resolve failures. Simulations are an important part of drone training. Simulations offer authentic scenarios that can guide users through all aspects of responsible drone use. The simulation design for this study applied real-world applications of drone technology. Dr. Andrew Tawfik verified the implementation of the four instructional design principles for failure-based learning in the simulation design for this study. The drone videography course instructor conveyed that the best learning experiences occurred when learners were tasked to solve problems, not just to fly the drone. Given this information, the educational objectives for the simulation activity were formulated in the context of the unified model of failure-based learning framework. It was important that Dr. Tawfik verify that all model elements were present in the simulation design. He was also invited to indicate whether any modifications should be made to the content. Dr. Tawfik reviewed the interview protocol to provide content validity.

## Verification and Validation of the Simulation

Validation and verification are two important steps in designing a simulation project. A simulation model is valid only if the model is an accurate representation of the actual system (Law, 2009). One validity method used for this study was face validity, which typically involves evaluating the degree of resemblance of the simulated environment to the real-world to determine whether it measures what it is purported to measure. In this study, the drone videography course instructor was consulted on a regular basis as the subject-matter-expert, to ensure that the simulation developed was a close approximation to the actual system. It is important to note that each time design decisions were made, the validity of the simulation was reexamined as part of an iterative process. To achieve high validity, a seven-step approach for conducting a successful simulation study was used to finalize the simulation design (Law, 2009).

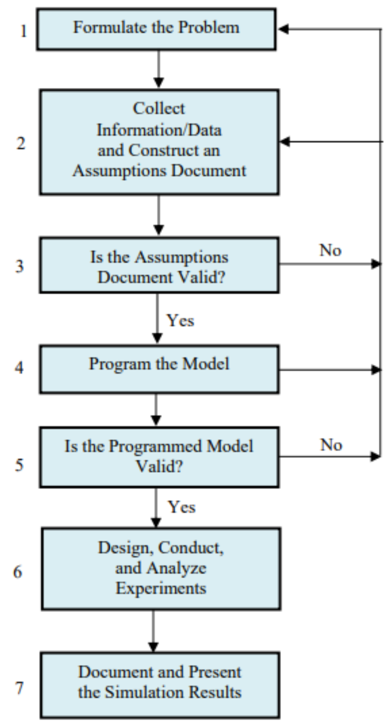


*Figure 2*. A Seven-Step Approach for Conducting a Successful Simulation Study (Law, 2009)

The simulation underwent several iterations before it was finalized. Step six of the seven-step approach for conducting a successful simulation study proved most challenging as the initial designs were so difficult to complete, that even the instructor was unable to successfully fly the drone shortly after takeoff. This proved to be quite interesting as the level of difficulty impacted the decision on the overall design. Great care was needed to ensure that the failure-based design proved useful to the advancement of student learning outcomes. After three design iterations, the simulation design and development were complete. With model validation successfully complete, final improvements were made to the overall research design.

Before any flight, pilots must ensure that the drone is in optimum state and that the flight can be executed with an acceptable operational risk. The FAA requires a preflight assessment including risk mitigation actions so that small, unmanned aircraft will pose no undue hazard to other aircraft, people, or property in the event of a loss of control or other safety hazards (as per FAA NPRM RIN 2120–AJ60). The simulation design ensured that the drone was in the desired optimal state to execute a successful flight. Participants were informed that the simulated drone was safe and reliable with no technical safety hazards. Table 2 presents a list of failure scenarios implemented in the simulation design.

Table 2

*List of Failure Scenarios in the Simulation*

| Failure Scenario | Area of Influence |
|---|---|
| Severe weather | Difficult maneuverability, UAV performance, Lack of stability, Flight safety |
| Power failure | Collision, Loss of control, Lack of footage, Flight safety |

Once the simulation design was finalized, Dr. Andrew Tawfik verified the use of the unified model of failure and learning systems design to ensure it was accurately implemented to the degree needed for the model's intended purpose and application for this study. The objective of Dr. Tawfik's model verification was to ensure that the implementation of the model was appropriate. All four guidelines to employ failure explicitly during learning design were incorporated into the simulation design.

## Data Gathering Process

In this phenomenological study, the major data gathering methods involved observations during completion of the simulation activity, and in-depth interviews with participants. The purpose of a phenomenological interview is to describe the meaning of a phenomenon that several individuals share (Marshall & Rossman, 2014). Research data collection was completed in the Fall 2020 semester. After completion of the simulation activity, the one-to-one interviews with each participant were audio and video recorded and notes were taken during the interviews. The interview questions explored pilot perceptions and the process of building their skillset over time. Pearson and Smith (1985) outline three questions for the debriefing process in experience-based learning: What happened? How did the participants feel? What does it mean? This structure was used to help guide the development of the interview protocol. The semi-structured format allowed for more flexibility in getting clarification or asking more probing follow-up questions during the interview.

To build trustworthiness and increase validity, the researcher asked for clarifications about the pilots' experiences during the interview. After listening to the recorded interviews, and checking for accuracy, the interviews were transcribed to a Word document and shared with each individual participant for review. Once each participant validated their transcription, the researcher began the coding process to identify the common themes. To ensure that the data collected from the semi-structured interviews reflected the participant's perspective accurately, the researcher allowed the participants an opportunity to review the final report once for further input, corrections, and clarification. Peer review of the analysis occurred regularly throughout the research process to provide credibility and validation of accurate interpretation of the data (Guba & Lincoln, 1994). These discussions with fellow PhD candidates, colleagues, and other higher education faculty were noted for consideration. This researcher also used triangulation of data sources including interviews, observations, and member checking during the data collection phase.

## Impact of 2020 COVID-19 Pandemic on Data Collection

The 2020 COVID-19 (Coronavirus) pandemic caused several disruptions to this study. Data collection was originally planned to begin during the Spring 2020 semester with participants enrolled in the advanced drone videography course at the university. On March 17, 2020, the state university system determined that all in-person activities be canceled or postponed to reduce introduction of the virus into new communities and to slow the spread of infection. Because of this new requirement, data collection was postponed to the Fall 2020 semester. The initial protocol was limited to participants enrolled in the Fall 2020 drone videography course at the university. Due to the uncertainty with response to COVID-19 and the looming potential for face-to-face courses to be once again moved to remote instruction at any time during the semester, the decision was made to expand the participant sampling pool by revising the inclusion criteria and increasing the recruitment effort. This would allow for the research to continue without disruption, regardless of the status of remote and face-to-face instruction at the university.

### Changes to Participant Recruitment

Amendments to the research information sheet, participant interview protocol, and information letter were created and approved to reflect the changes to remove references to the advanced drone videography course requirement, to clarify recruitment criteria, and to update the change from face-to-face interviews to a virtual interview format. To participate in the study, participants were required to be enrolled in or have successfully completed the drone videography course at the university and must be a licensed drone pilot with FAA Part 107 certification. While the study was no longer associated with the advanced drone videography course, the context of the study remained the same. There was no change to the methodology.

**Safety Measures**

On August 7, 2020, the university implemented “Phase II” in response to the Coronavirus pandemic. Phase II allowed for up to 50% of staff returning to the campuses, based on space configuration. It also allowed for courses to be delivered through a combination of face-to-face, hybrid, and online instruction, and some points of service would open on campus. The university continued to support this research and provided an on-campus classroom to complete the research. All protocols and procedures outlined in the university’s Return-to-Campus plan published on August 21, 2020 were followed. All faculty, staff and students were required to complete the Return to Campus COVID-19 Assessment. In addition, the university required students, faculty, staff, and visitors to wear face coverings inside university facilities on campus including, but not limited to, classrooms, conference rooms, shared workspaces, academic and administrative buildings, lobbies and lounge areas, research facilities, residence halls, student unions, performance spaces, retail spaces, museums, libraries, and dining facilities. The simulation activity was designed as a practical experience that could only be administered on this researcher's computer. Participants were required to complete the simulation activity in-person, on-campus, in a classroom similar to the one used for the drone videography course.

**ODU Return to Research – Stage 3 In-Person Human Subjects Research**

On October 7, 2020, this researcher secured approval to restart in-person human subjects research from the Old Dominion University (ODU) Education Human Subjects Review Committee. The simulation activity would take place in-person as planned, in compliance with

ODU, the university, and Centers for Disease Control and Prevention (CDC) guidelines and recommendations in response to COVID-19. The researcher, instructor, and study participants wore face coverings at all times. Hand sanitizer was available on site for the duration of the simulation portion of the study. No more than three individuals were present during the simulation activity, and all individuals remained at least six feet apart as per CDC guidelines. The workstation included the researcher's laptop computer and drone remote controller, which was cleaned and sanitized before and after each participant session. Food or drink consumption was not allowed, in order to mitigate the removal of face-coverings during the activity. All research materials were stored in a secure, confidential location, for protection of the research data.

Following the simulation activity, the semi-structured interviews were conducted virtually for each participant using Zoom through ODU's enterprise account which has appropriate security measures in place for the protection of research data. The interview schedules included information on the virtual meeting location, and most convenient date and time for each participant. Interviews were both audio and video recorded with participant consent. In-person data collection for the simulation activity took place from October 23, 2020 through November 14, 2020. On November 23, 2020, due to the recent increase in COVID cases throughout the country, and given the response from Richmond by instituting additional restrictions to control community transmission, the Old Dominion University Office of Research decided that any in-person human subjects data collection that was approved in Stage 3 would be placed on hold. At that time, all face-to-face data collection for this study had already been completed. In the weeks that remained prior to the end of the Fall 2020 semester, scheduling of appropriate time for virtual interviews was most appropriate for this study, given the unprecedented circumstances surrounding the COVID-19 pandemic. Virtual interview meetings occurred during the second week of data collections, and transcriptions were complete within 24 hours of each collection.

## Data Analysis

Data was analyzed consistent with Husserl's (1970) phenomenological philosophy. Analysts first conduct and report an interview that focuses on a bracketed topic and question, and then organize and analyze the data to facilitate development of structural meanings and essences (Moustakas, 1994). During the analysis phase, the phenomenological analysis starts with bracketing the researcher's subjectivity which serves to clarify preconception throughout the study (Moustakas, 1994). This researcher started by bracketing everyday knowledge of drone pilots and drone videography to take a fresh look and be present to the data each day, careful to set aside prejudgments towards the phenomenon to see the data as it appears in its own context. For example, though tempted to do so, this researcher refrained from completing the simulation activity and assumed the phenomenological attitude to describe what was present for consciousness from the participant's first-person perspective.

During the simulation activity, observations were documented in the form of field notes to complement the associated audio and video recorded interviews. These field notes provided important context to the interpretation of interview data and helped to remind of situational factors that were important in data analysis. Field notes allowed this researcher to maintain and comment upon impressions, environmental contexts, behaviors, and nonverbal cues that may not be adequately captured during the interview. Next, field notes were revisited to extract the significant statements pertaining to the phenomenon.

Interviews were conducted using Zoom during October and November 2020. One major advantage of Zoom is the ability to securely record, store, and transcribe sessions without recourse to third-party software. This feature is particularly important in research where the protection of highly sensitive data is required. Other important security features include user-specific authentication, real-time encryption of meetings, and the ability to backup recordings to online remote server networks often referred to as “the cloud,” or local drives, which can then be shared securely for the purpose of collaboration. When the participant reached a point that he or she had said all that could be said following the research question prompts, one or more follow-up questions were asked. After conducting the follow-up interviews, the final steps were to first edit the audio transcription for each interview to ensure accuracy, then read through each transcript to gain an overall understanding of each session.

Finalized interview transcripts were uploaded to NVivo for qualitative analysis. Nvivo is a qualitative data analysis (QDA) computer software package produced by QSR International. This software program is primarily used for qualitative and mixed-methods research for the analysis of unstructured text, audio, video, and image data. The tool allowed this researcher to work effectively with the different types of data, focusing on all the main categories and themes easily recorded in one source. The 16 interviews were analyzed using the line-by-line method (Donalek & Soldwich, 2004; Moustakas, 1994). Each transcript was examined by looking for the main categories which described the essential meaning of participants’ experience. Responses were compared to identify patterns and extract relevant statements. Trends that formulated meanings to reflect common patterns that participants felt most strongly about were identified. Thematic data coding ensured theme emergence was evident. As new themes emerged, previous transcripts were read for deeper analysis. The developing data was evaluated through systematic coding and identified both importance and occurrence of the codes, converting the clusters into a more concise representation of the data that captured the pilots' experience and understanding.

## Data Coding

Through the process of analysis, 224 statements were identified as significant to the study. Data analysis began with open coding, with data broken down line-by-line, closely examined and compared for similarities and differences. Open coding lead to axial coding and selective coding occurred when there were no new open codes, or when codes relate only to the core categories that began to emerge (Urquhart, 2012).

### Open coding

All interviews were coded manually during open coding. This researcher reviewed the initial groupings of meaning through the context of the participant's complete response to the research questions. Careful examination and elimination of redundant codes followed to allow for better grouping (Moustakas, 1994). Field notes compiled during the simulation activity were a useful complementary source of information to facilitate this process, due to the gap in time between an interview, transcribing, and coding. To conceptualize the data, this researcher began to identify patterns, comparing different participant's views, situations, actions, accounts, and experiences. Clustered patterns were highlighted and then named depending on the subject matter (Long, Strauss, & Corbin, 1993). This helped to generate meaning with the evolving clusters. Action codes were generated, reviewed, and modified utilizing the constant comparative methodology (Charmaz, 2000). These groupings were originally organized into 17 open codes.

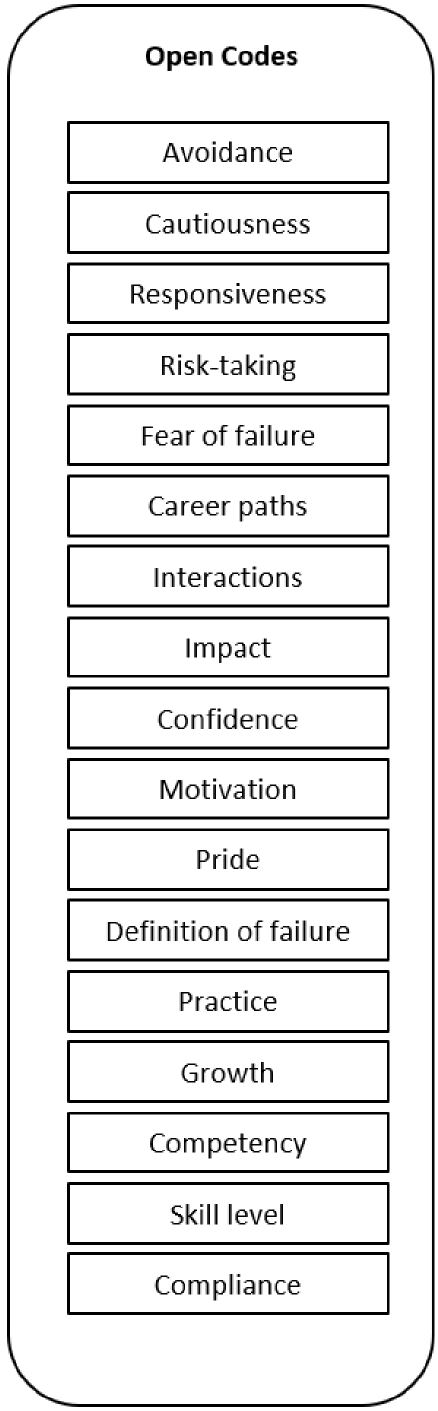


*Figure 3*. Open Codes.

**Axial Coding**

Open coding led to axial coding which consisted of identifying relationships among the open codes (De Vos, 2005). NVivo 10 software was used to manage and code the data in this study. Following open coding, transcripts were uploaded into computer software NVivo, for further analysis. Participants were assigned a unique identifier from P01 through P16. Specific features of the NVivo software includes the capacity to extract phrases, words, and references for further clustering of data, which was helpful to not only avoid the use of redundant units of data, but to also look for deeper links and connections. When clusters overlapped, this revelation was evident due to the software's structure, highlighting significant cluster differences. This process resulted in identifying more precise categories surrounding the phenomenon (Simon, 2011). There were five distinct axial codes that emerged from the manual and NVivo analysis.

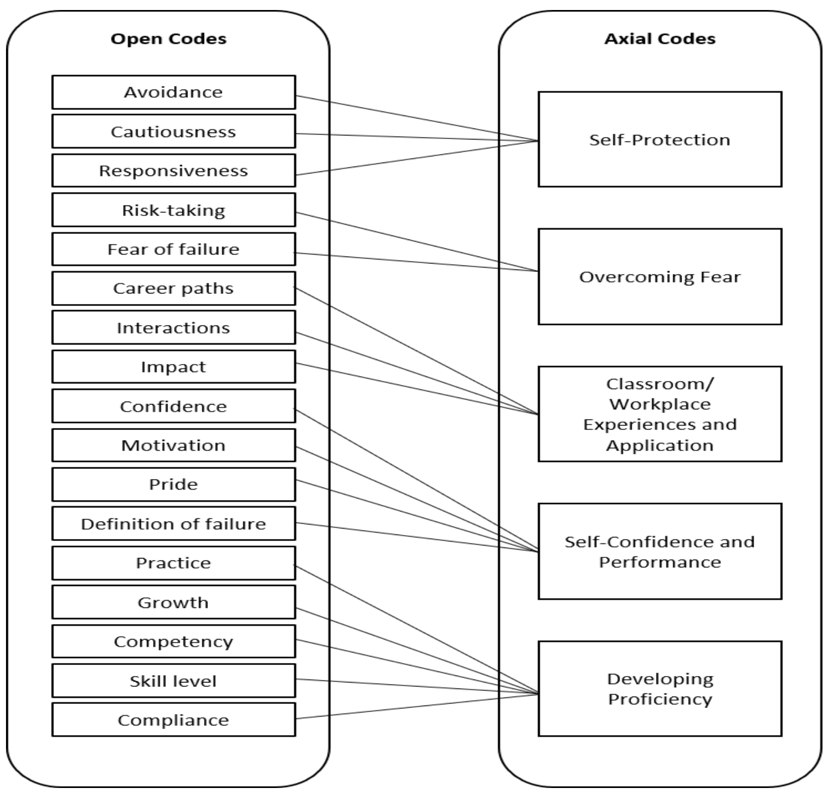


*Figure 4*. Axial Codes.

**Selective Coding**

Selective coding began to occur when there were no new open codes and when codes related only to the core categories that began to emerge (Urquhart, 2012). Selective coding with constant comparative analysis techniques was used to explore the interrelationship of categories and identify overarching categories of interest. This process was used to understand the underlying variables that include all the data. There were three selective codes that emerged from the analysis, with two distinctions in the selective codes: individual-focused codes, and classroom or workplace-focused codes. Individual-focused codes pertain to improving the participants' knowledge, skills, and competencies independent of the classroom or workplace. Classroom or workplace codes pertain to learning that occurs through a traditional classroom, or through the workplace.

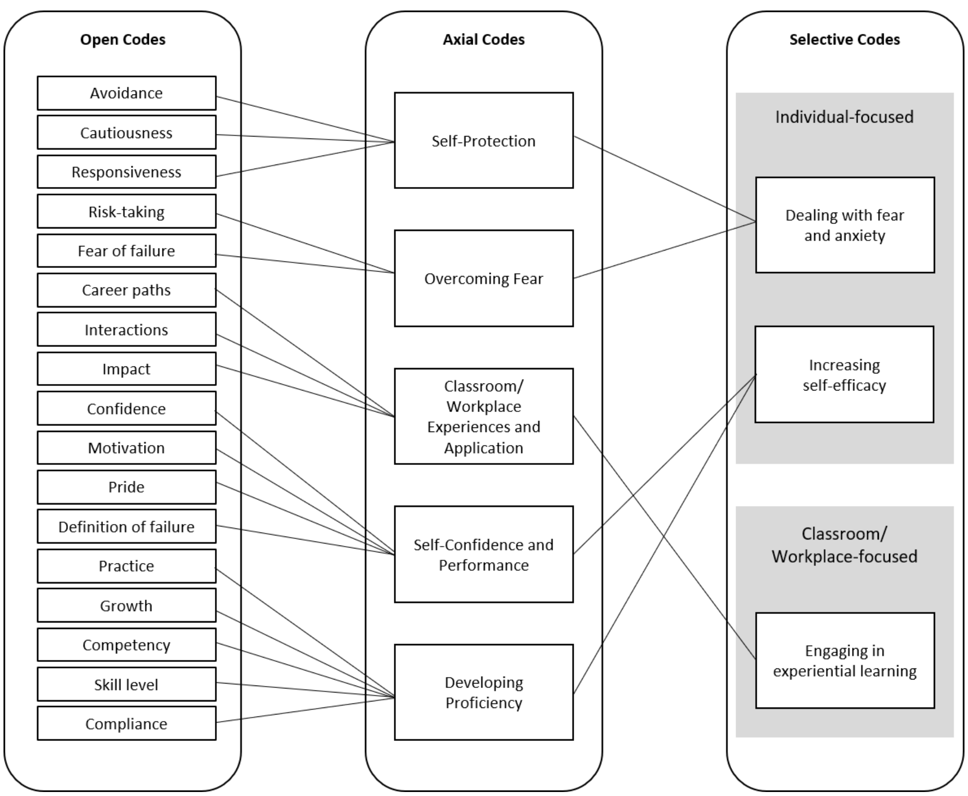


*Figure 5*. Selective Codes.

## Data Validation

The validity of a questionnaire or survey is defined by the degree to which the instrument measures what it is intended to measure and face validity confirms that the instrument appears to measure the concept being tested (LoBiondo-Wood & Haber, 2010). For this study, this concept was addressed by requesting other researchers test-run the instrument to ensure the questions were relevant, clear and unambiguous (Rattray & Jones, 2007). Validity of qualitative research refers to the trustworthiness of the data interpretation (Glesne & Peshkin, 1991). For this study, trustworthiness was defined against four categories: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985).

## Reliability and Validity

Credibility was established using memos, member checking, peer debriefing, and observation to ensure that the participants had the relevant experience to discuss the phenomenon this researcher sought to explore (Lincoln & Guba, 1985). Credibility was certified by providing the individuals' transcripts to each participant to validate the results. Participants were each given the opportunity to schedule a second meeting after the initial interview, once the initial analysis had been carried out, so that they could confirm the accuracy of the interview analysis. Though transferability is limited with this study, the different experiences of each pilot granted a clearer understanding of the phenomenon of failure-based learning in drone simulations and can contribute to a higher quality in this study and future studies. Dependability was established by triangulating the data sources, meticulously handling, and maintaining interview records and field notes, and by using member checking. Confirmability refers to the themes and findings of the study being derived from the participant voices and supported by the data collected (Lincoln & Guba, 1985). Confirmability was addressed using peer debriefing and bracketing the researcher's role and assumptions. The use of memos also helped ensure accountability to any theories that emerged by aiding reflection and assisting during the research process (Birks & Mills, 2011). Dependability and confirmability were also strengthened by presenting an in-depth description of how the study progressed and evolved, the decisions that were being made, and any issues that occurred during the interviews or over the course of the study. This information was presented to PhD candidates, colleagues, and other higher education faculty who have experience with qualitive coding and data analysis. These external audits helped to confirm the accuracy of the codes, to support the research findings, to confirm the validity of interpretations, and to identify and reduce the potential for researcher bias.

**Member Checking**

The most useful measure adopted to ensure that findings were close to the participants' meanings was to member check the details (Merriam & Tisdell, 2015). Interview transcripts were sent to the participants to review to complete member checking. Participants were asked to review the transcription notes for any inaccuracies in communication. The quick turnaround for transcript creation in Zoom allowed for the implementation of member checking and data validation, prior to data loading into the NVivo software.

**Reflexive Journaling**

Journal reflections were completed each day during data collection. The use of field notes in addition to reflexive journaling provided organizational clarity and consistency to the research analysis phase. Journal notations captured rich descriptions that were useful to the study after interviews were complete. This was a useful strategy for this study to transform the full-scope view of information from each participant into a cohesive package of perceptions, encapsulating the experiences, mindsets, biases, and emotional states of both this researcher and the participant (Janesick, 2007).

## Evidence of Trustworthiness

In this study, trustworthiness was addressed according to four categories: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Triangulation methods were also useful to collect opinions, perceptions, and experiences of the sample of participants represented in this study. Using memos, member checking, peer debriefing, and observation ensured that the participants had the relevant experience to discuss the phenomenon. Sharing data with the participants through member checking further validated the degree of trust in the descriptions of their experiences along with the use of journaling (Moustakas, 1994). Participants were each given the opportunity to review their interview transcripts and to schedule a second meeting to discuss the accuracy of the interview. No participants expressed interest in scheduling a second meeting. Transcription of all interviews occurred promptly after interview activities were completed in a systematic manner. The use of memos, field notes, and reflexive journaling also helped the researcher stay accountable to any theories that emerged (Birks & Mills, 2011).

Though phenomenological research aims to gain an in-depth description of the experience of a specific group, the findings from qualitative research are typically less generalizable to other populations, contexts, and time (Johnson, 1997). Data on the demographics of the participants and their roles as current and former students helped to obtain a thick description from the participants selected. Job duties of former student participants established a connection between the research questions and other contextual descriptions. The interview questions were open-ended, and topically focused to ensure there was a limited amount of inconsistency in the analysis of data.

## Role of the Researcher

Before data collection began, steps were taken to ensure that this researcher entered the study with a mindful perspective, using phenomenological reduction to acknowledge and reduce any influence surrounding role, relationship, and other biases. As the spouse of the participating instructor for this study, this researcher considered this spousal relationship as an important factor concerning student participation and outcomes. Peshkin (1988) discussed the importance of researchers being aware of their own positionality so as not to insinuate the researcher is completely objective. Therefore, this researcher acknowledges that the relationship to the instructor had the potential capacity to skew, influence, block, and/or misconstrue what transpired from the study. In the case where this researcher has a personal relationship to one of the research participants outside of the context of this research, it is conceivable that this relationship also had the potential to influence or sway the participant's responses. Member checks, peer reviews, and exercising reflexivity were used to monitor subjectivity to enhance the quality and rigor of this qualitative research (Peshkin, 1988). In addition, the epoché process was used to identify and acknowledge any a priori thoughts on the topic and helped to ensure that preconceived biases did not overshadow the essential descriptions (Husserl, 1970).

### Phenomenological Reduction and the Researcher's Role and Relationship Dynamic

Phenomenological reduction is brought to realization through the epoché process. This process requires the researcher to bracket, or suspend, their beliefs and interests in the phenomenon (Husserl, 1970). The epoché process was used to navigate the social dynamics and to suspend this researcher's existing assumptions throughout the course of the study. This method ensured this researcher applied an unbiased approach to conduct the interviews.

At first, the instructor's presence appeared to carry some influence on student-professor dynamics. However, once the simulation activity had begun, pilots adjusted into the professional student-professor dynamic. The currently enrolled students particularly seemed to enjoy participating in the study most. They reported it made them feel "excited," and were visibly happy to see the instructor arrive and were reluctant to leave without discussing the course and their upcoming assignments. All pilots reported in follow-up interviews that they had not changed their behavior considerably, because of the instructor and this researcher's spousal relationship.

## Ethical Considerations

Following the methods as outlined in this chapter was crucial in ensuring the validity and reliability of the study. Institutional Review Board (IRB) approval was requested in writing from Old Dominion University. The main ethical principles that were considered in coordinating this study were respect for persons, confidentiality, and beneficence /non-maleficence. Informed consent was sought from each participant. This researcher provided details of the nature and purpose of the research, the potential subjects, who would have access to the data, and the proposed outcome of the research. A written guarantee was given to the participants that the data collected would remain confidential. The risks to human subjects associated with this study were minimal. All participants were over 18 years of age and were not expected to demonstrate any impaired mental capacity, as determined by their ability to perform the responsibilities of drone videography professionals.

## Limitations of the Study

Limited generalizability and transferability were key limitations in this study. Results of this research might differ from pilots trained at other universities, from other programs, from other instructors, or at different levels of expertise. This study was limited to a targeted population of drone videography pilots. The study was further limited by the choice of the university, as well as the number of participants and their individual characteristics. Every university is diverse and complex, as are the learning environments within these settings. Therefore, the data gathered was dependent upon these contexts. Consequently, the context of the simulation also limited the generalizability of the findings. Because this study was intended to focus on drone pilots, the scope was limited to this population and field of study. The role of the researcher and other biases may have also interfered with the content of the interviews and ultimately, the current student experiences. While the findings of this study could have implications for the use of simulations and failure-based learning strategies and how these elements impact instructional design, the results may not be broadly generalizable to other learner groups or subject areas.

## Summary

This study sought to understand the perspectives drone videography pilots regarding the use of failure-based learning within a simulation training experience. The study was guided by two research questions:

1. How do drone videography pilots perceive the use of failure-based learning strategies as part of the simulation training experience?
2. How does the drone pilot instructor perceive the use of intentional failure-based learning design in the simulation training activity?

The participants (N=16) were current and former licensed drone videography pilots who were currently enrolled in or had successfully completed the drone videography course at a public research university in the southeastern region during the Fall semester of 2020. Semi-structured interviews provided data regarding the 16 pilots' perceptions about the use of failure-based learning strategies as part of the simulation training experience. The research design used Tawfik et al.'s (2015) unified model of failure and learning systems design to create a drone flight simulation designed to focus on safely operating the drone while capturing high-quality video. Dr. Andrew Tawfik verified the degree in which failure exists in the simulation design based on the unified model for failure-based learning.

The goal of this chapter was to outline the methods that were used to answer the research questions proposed in this study. The findings fill specific gaps in the literature around the effectiveness of simulations for training drone videography learners and the degree to which failure is employed. The remaining chapters of this dissertation are organized as follows: Chapter 4 report the study's findings and discuss the limitations. Chapter 5 includes a discussion of the findings, implications for implementing simulations and designing failure-based curriculum, and recommendations for future research.

# CHAPTER 4

# FINDINGS

While many studies from numerous domains recognize failure as an effecting teaching tool, little literature or previous research exists on intentional learning design that affords opportunities for learners to encounter and overcome failure as part of the learning process. This study explored drone pilot's perceptions about their flight skills within the context of a simulation designed to employ a failure-based learning model. A qualitative approach was used to design this study. The data were extracted and analyzed using phenomenological methodology. To better understand learner perception on the impact of failure-based learning strategies, this study addressed the following research questions:

1. How do drone videography pilots perceive the use of failure-based learning strategies as part of the simulation training experience?
2. How does the drone pilot instructor perceive the use of intentional failure-based learning design in the simulation training activity?

The phenomenological framework pursues a genuine understanding of the nature or meaning of the participants' experiences (Crotty & Crotty, 1998). Data collection involved the simulation exercise, participant-observation, and semi-structured interviews. Observations focused on how the use of failure in simulation is realized in practice. Interviews with both the participants and the instructor sought to explore overall learner perceptions with emphasis on the degree to which failure is perceived as beneficial within simulations. This chapter presents the findings of the research as derived from interview data with 16 licensed drone pilots who are currently enrolled in or have successfully completed the drone videography course at the university. Using a phenomenological approach, this study provides rich insight into the experiences of licensed drone pilots, capturing key findings from the participants perceptions of failure with respect to drone videography. Table 3 provides data on the results of the participants simulation exercise according to failure component.

Table 3

*Participant Simulation Results*

| Participants | Failure Component |
|---|---|
| 01 | Crashed at landing site |
| 02 | Crashed at landing site |
| 03 | Crashed at landing site |
| 04 | Did not crash, Lack of stability in drone footage |
| 05 | Did not crash, Lack of stability in drone footage |
| 06 | Crashed at landing site |
| 07 | Did not crash, Lack of stability in drone footage |
| 08 | Crashed at landing site |
| 09 | Did not crash, Lack of stability in drone footage |
| 10 | Overrunning during take-off, Collision with building |
| 11 | Crashed at landing site |
| 12 | Crashed at landing site |
| 13 | Crashed at landing site |
| 14 | Crashed at landing site, Power failure |
| 15 | Crashed at landing site |
| 16 | Crashed at landing site |

## Emerging Themes

The resulting codes were grouped together according to conceptual similarities. The data was continuously refined through several coding cycles and resulting codes were clustered and validated with the source text to identify experiences common to all participants. These patterns generated themes that produced a structure useful to move towards converging ideas that answer the research question (Moustakas, 1994). Integrating the participant voices provided context to the significant amount of source material. The next step involved creating central themes. The analysis first highlighted categories from the interview questions, ultimately finding themes common to the phenomenon (Finlay, 2009). Focusing on the participants experience provided an objective view to obtaining the analysis (Moustakas, 1994). The analysis led to the emergence of three major themes representing the phenomenon: (1) building confidence in a low-stakes environment to increase self-efficacy, (2) reflecting on impact of failure experiences to overcome fear and anxiety and to promote intrinsic motivation, and (3) influence of experiential learning experiences on safety and performance-based culture.

Each of the 224 significant statements were linked to a formulated code and can be directly traced to a resulting theme. The following discussion is designed to present each theme in further detail. Direct quotes from interview transcripts are presented to best represent the voice of the participants and how they perceive and understand the phenomenon.

### Theme One: Building confidence in a low-stakes environment to increase self-efficacy

The first major theme expressed the participants holds the significance that 100% of the pilots placed on the importance of hands-on learning and the value that a simulated hands-on learning experience brings to increasing self-efficacy. Evident in this theme is the suggestion that the failure-based simulation training had an overall positive influence on participants' self-confidence, with 87% reporting either an increase or no change in their level of self-confidence, and only 13% reporting a decrease in self-confidence. In the drone videography course, students can often begin handling and even flying a drone as soon as the second day of class. Though the pilots expressed an appreciation for having an immediate opportunity for hands-on training, they each felt intimidated during their initial flight. Participant 06 offered:

> I'm very hands on. I like to just experience it. And I've certainly learned that you can learn a lot by failing. Just that it would put me in a bit of a more difficult setting to challenge myself because I don't think I would immediately go out and fly a drone like around a bunch of buildings like that I find my comfort zone within like open fields, when it comes to flying. It's like there's less things to hit. So definitely putting myself into that simulation was useful and kind of like a learning experience.

All 16 respondents supported the idea that students enrolled in a drone videography course could benefit from participating in a hands-on simulation training exercise as an initial introduction to flying a drone. Participant 15 shared:

> I actually had never gotten a fly a drone until the semester when I took the class with [the instructor]. That's about all my experience, I've got is just flying with him in class. I'm a very hands on visual learning person. So like with [the instructor], he would always take us out every week, once a week. So that was the best way for me to learn was to just be able to have my hands on the controller of flying. I like to use the simulation, just because I was in a very controlled environment. So I like being in that controlled environment and being able to almost mess around a little bit more. Whereas when you're out in the field with a

> real drone, you can't just like screw around with controls and kind of just mess with things. Yeah, so it was nice to be able to do that in the simulation and kind of test it to see…what can I do, what can I not do.

Participant 12 has been flying drones for the past 11 months. He expressed the sense of reassurance and confidence-building that the simulated learning experience also provided to more experienced pilots:

> So I would say it seems like a very helpful learning tool, especially for people who are scared to fly. Because I know I was very scared to fly at first because crashing a real drone is not fun. I would say it was kind of like a peace of mind to know that if I did fail, it wasn't like costing a ton of money or hurting anyone so it kind of made me more confident. I would say in that I could practice movements with the controls without any fear of consequence.

Participant 04, a fourth-year masters student considered by the drone videography instructor as one of the most skilled drone pilots, has only been flying drones for the past three months. Still, he substantiated other more experienced pilot's claims by confirming the value the other pilots placed on hands-on learning and building confidence in a simulated learning environment. He offered a unique perspective during the interview as he had just completed a flight that day in which the real-life conditions were very similar to that of the simulation design in this study.

> I've only had experienced some flying for about two months, two or three months because I started in August. Besides, the only experience I have with any kind of videography is strictly with like handheld cameras. I think that's definitely why I was able to pick up the drone…I think I typically prefer like a much more hands-on approach.

When asked about his first impression of the simulation exercise he completed, he shared:

> I guess I was a little nervous, because I've never done anything like that before. So I definitely was just like, Okay, I hope I don't like crashes or anything like that. But I was just more kinda nervous excited. I think a cool thing about it was you kind of get to experience things that you normally wouldn't do…like today.

Participant 04 shared that he had just completed a real drone flight prior to the interview. He described that what he had experienced during his flight that day was “eerily similar” to the simulation exercise. He shared:

> I was actually flying in downtown and I was like, I can…do like the simulation obviously just because I wouldn't be able to get any over these buildings or anything like that. If I do crash [in the simulation], yeah, I know I'd have more leeway towards like any crashes or anything like that. So today was probably the worst I've ever filmed using it. And then a whole time I was thinking about like the simulation. I was like, wow, this is like same exact thing to happen. I was like, okay, at least have some preparation. But it was it was funny how it played out.

When asked about his overall impression of the simulation exercise he completed, given what he had experienced during his real drone flight that day, he shared:

> Yeah, I think it was definitely a good experience like I see how it can be used to implement like future trainings. I would say the drone course is like a lot more scary. Just because I remember like the first day we all did it. We were like, oh, wow, like this thing can go like super fast and you don't even like feel it like so it definitely learn how to control it…whereas what the simulation. Like I said previously, you feel much safer, just because it's not like a real piece of

> equipment, per se, like if you fail, you don't worry about like paying for anything like I think you feel more comfortable. With the simulation, but the same time and in person course like does make you feel more prepared. Once you have to go out and fly like yourself. I think I feel a little bit more confident when it comes like weather conditions. It was bizarre is almost identical.

Self-efficacy is the belief in one's own capabilities to produce clear levels of performance around certain tasks (Bandura, 1991). This notion is supported across many studies in various disciplines (Ding, Brinkman, & Neerincx, 2020; Stocker, Burmester, & Allen, 2014; Zimmermann et al., 2015). Self-efficacy can be measured in degrees of confidence (Bandura, 2006). Self-efficacy is often reported by some researchers as level of confidence (Saied, 2017). In this study, participants were asked whether their confidence had been affected since using the simulation and in what way. Fourteen of the 16 participants reported either positive or no change in their confidence level. Six participants reported an increase in confidence, while eight reported no change, and two participants reported a decrease in confidence. Participant 15 reported an increase in self-confidence as a drone pilot. She offered:

> I would probably say I'm a little bit more confidence and that I know now that I do fly very cautiously and knowing that, okay, this is how things can change. And even in a controlled environment. So being in an uncontrolled environment, just out in the real world. I now know how things can be affected. A little bit, yeah. It would definitely give me a little bit more confidence and at least how I fly anyway.

Participant 12 shared a similar experience in her increase in confidence level:

> Yeah…so I would say I feel more confident as far as handling the turbulence in the drone and sort of just like taking a break and like readjusting. And confident and the way I move the controls and everything you just get a better sense of just this simple movements too.

Two participants reported a decrease in their self-confidence after completing the simulation training exercise. Participant 06 reported a decrease in confidence, stating:

> I think I have had a little bit less confidence because I kind of realized like, oh, wow, like this could all happen. And so like I've been more cautious than anything.

Participant 13 had a similar experience. She offered, “Oh yeah, I feel like I need to practice more.”

### Theme Two: Reflecting on impact of failure experiences to overcome fear and anxiety and promote intrinsic motivation

The second theme demonstrates what the 16 pilots reported as important traits of a successful drone pilot. 100% of the participants expressed that the use of intentional failure during the simulation exercise could lead to increased levels of confidence in their ability to execute successful flights and make skillful in-flight decisions when facing challenging tasks or other variable conditions.  Field notes taken during each recorded interview noted that the participants had spent some time reflecting on their experience with the simulation prior to the scheduled interview. This theme describes how pilots recognize the need for practice and repetition as part of a reflective exercise to overcome fear and anxiety. Those who had a previous failure experience, such as crashing the drone, recalled that experience as such a lasting impression, but ultimately found support, confidence, and motivation when reflecting on this experience. Failure should encourage learners to reflect on their misconceptions and revise their understanding (Tawfik et al., 2015). In this study, it was imperative that the drone pilots reflect on the conditions and the decision-making processes that resulted in the failure and the assumptions in reasoning that impacted the unforeseen outcomes (Tawfik et al., 2015).

Participants were asked during their interviews to describe how any of their thoughts, skills, and attitudes changed since completing the simulation. They were also asked to describe how did using the simulation give them any ideas about doing things differently when flying the drone. A consistent thread in all the participants responses expressed that their own time outside of class or work to practice flying led to more experience, thus allowing them to overcome fear and anxiety with handling the drone.

Participant 01 captured this theme when he suggested:

> I think [the simulation] would be worthwhile as a starting point…maybe the first week or two of flying…but I still think you need the physical hands-on risk of losing a drone because…once you get used to it there's no fear…you can crash on purpose, and it won't matter.

When asked if the simulation had given him any ideas about doing things differently, he offered:

> Really the only thing I can think of that I could have done differently was to land as soon as I started noticing an issue instead of trying to push on to complete the flight. My fear factor of crashing in a video game is almost nothing…but for somebody who…doesn't have it life experience like that it could be very beneficial. If I were the instructor, I would want to have…the failure-based training idea, just this is going to happen to you at some point be prepared. You

> know was it Star Trek, was it Kobayashi Maru, they're the no-win situation right…I feel like, that would be a good thing to face as a student.

Participant 03, a very confident and successful professional drone pilot, stated:

> When I compared it to when I first learned to fly a drone. It felt like I had like a similar experience. I'm very surprised to know that it was actually made or designed for engineer to fail. I was really anxious that I would crash and another thing is that I was afraid that the controller wasn't really responsive to my commands. I wish we had something like that, especially in…the beginning of the semester before we actually got to flying a real drone because students get like a little intimidated flying drones.

He offered additional thoughts on the intentional use of failure components in the simulation:

> I'm not gonna lie…a moment or two, I felt like, I know how to fly a drone better than that. Like I did not know that you're intentionally like, changing conditions. And so I was a little disappointed in myself. And I felt like, no, I can do better than that. So I was surprised that like I crashed once or twice, especially like with things that I did not like intentionally do. With tweaks here and there, it can become more accurate and it can become more useful. Especially when like the stakes are not really high. You can mimic conditions like wind without actually getting to experience like flying a real drone in wind. And so, it could be like really useful to learn how to control a drone in similar conditions. Using like a very powerful tool like that [simulation] to do like things like dangerous things but at lower stakes, just to gain more experience and be like, very skillful and flying drones at different conditions. Like there's nothing to lose in fly again you

> can crash again as much as much as you want. It can be really useful and really like enhances your skills. It is really beneficial and useful just to know…what I would do if I'm flying in like a very bad condition. Now, how comfortable I am or how like confident I am to just like land the drone safely and just like get the composition I want and do the move that I want in like these really bad conditions without like crashing. And it really tells you, like a lot about yourself and how to handle stress and how you handle like problems that you face.

When asked how the intentional use of failure impacted motivation and learning, Participant 13 summated this theme best when she reported, “I would say it motivated me to need to do better. I don't like failing...so the idea that I wasn't doing well at something that I thought that I would at least be like a decent and I was like, well, I'm not even at a decent level. I felt like I need to get back out there and practice. And you know, it's never enough just to be like, Okay, I know the skills like you need to constantly be honing them and fine tuning them, you know.” While Participant 13 also reported a decrease in confidence, she recognized a need for more practice to improve upon her skills as a pilot. She credited the simulation as a contributor to her desire to make more time practice to fine tune her flight skills.

When asked to describe how the intentional use of failure impacted learner motivation, all participants responded positively. Participant 11 said:

> I think in the moment, it kind of it motivated me to try harder because I felt like, I know this is like meant for me to fail. I was like, oh man, I don't want to let down my professor. With…not landing correctly or something like that. So I was motivated to just try as hard as I could just get it right…so it definitely motivated me.

Participant 15, a less experienced pilot, reported, “actually, it didn't impact me negatively at all. I was actually almost kind of having fun with it!” This final statement captured the overall positive reaction that many participants expressed as they reflected on their perspectives on the use of failure-based learning strategies used in the simulation designed for this study.

### Theme Three: Influence of experiential learning experiences on safety and performance-based culture

The third theme describes the impact of experiential learning experiences on pilots’ real-world application of safety and performance. Drone pilots are required to follow specific guidelines and to obey the laws and rules of flying as outlined by the FAA. Descriptive categories surfaced as participants discussed their experiences with how they perceived the use of failure-based learning within the simulation. Drone pilots are inspired to maintain safety and integrity through reputation of compliance with FAA regulations. Each participant engaged in this study demonstrated a legal commitment to the profession, with strict adherence to the laws. This performance-based culture is heavily influenced by the experiential learning outcomes presented in the drone videography course. All 16 participants described placing high value associated with the instructor and interactions within the drone course. Through informal observations noted during the simulation exercise, combined with the shared experiences explained by the participants regarding the formal drone course instruction, the voice of the drone instructor was apparent as numerous participant examples highlighted the importance of drone safety and the performance-based culture concerning drone pilots. Participant 08 illustrated this view with her statements on her interactions with the drone videography instructor:

> Anytime when I'm doing something with [the instructor] and he's like, Come on, man. He's like right [gestures to] shoulder and he like he just puts that pressure on me and like I want to earn his respect and I want to like make him proud so much. Yeah, I failed and it like it hurts. I guess I just feel like I definitely need more practice. I hadn't flown in a couple months before the drone simulation and I just realized that…but I did feel rusty and I felt like, oh, this is like a wake up call, like I need to be able to keep on top of this stuff and know my knowledge. And continue to practice. And so that he can call me any day and be like, hey, I need you to fly this tomorrow. Can you do this, and I feel…accountable and, you know, reliable. Yeah, in the future, it gave me a lot of like ideas, like to do in downtown because I've kind of avoided that area, like I'll get shots but it'll be…further away I don't feel comfortable, but now with that simulation, I'm like, I think it's possible. I think I can do it. And I mean, so many other people have done it.

Participant 08 also shared her personal experience with being a female drone pilot. She said:

> Yeah…I guess I always get nervous and being a girl. I feel like people just question me and they don't really I don't know, they invalidate like my abilities. Sometimes I feel like if I'm out there flying alone, they're gonna be like, what is she doing. Who does she think she is, and so…I feel like I can definitely go into the city now.

Experiential learning first engages learners in the experience and then encourages reflection about the experience to develop new skills and attitudes (Kolb, 2014). Failure generates an additional inquiry process at the point of failure that may not exist during a successful experience (Tawfik et al., 2015). While experiential learning generally focuses on the learning to be gained from experience, it is also important to consider ‘‘negative knowledge’’ that results from failure experiences and how to use these experiences as learning opportunities (Gartmeier et al., 2010). It is evident that the mental model generated by the drone pilots consisted of both success and failure experiences (Jonassen, 2011; Kolodner et al., 2004; Schank, 1999). All participants described some level of impact on safety and performance, experienced through interaction with the simulation. To illustrate this point, Participant 04 stated:

> I think it was a really good thing for me to experience to see that and know okay this is, it's a controlled environment. I can be a little bit more maneuverable I can be a little bit more almost aggressive. I have a tendency to lean towards overly cautious. So, for me, just being able to mess around a little bit and not have really any repercussions. I think that's a good learning experience.

Participant 02, a senior currently enrolled in the drone videography course, presented similar sentiments as a new pilot, sharing:

> I am currently enrolled in the mass communications degree and…the reason I’m taking [the drone videography course] is mainly to build my skills and to just be more versatile out in the field once I start working. It was also good that [the instructor] was there too because it [the simulation] felt like…actual in-person fly days. But I don't…see it as a substitute because I feel like you could really get the feeling of the simulation down and the controls of the simulation and once you're out on the field with an actual drone um suddenly the stakes are higher. So in terms of just getting the raw controls…it would help if it was like a supplementary but I don't think it could replace um in person flying.

**How does the drone pilot instructor perceive the use of intentional failure-based learning design in the simulation training activity?**

The second research question explored how the drone pilot instructor perceived the use of intentional failure-based learning design in the simulation training activity. The drone videography instructor was interviewed as part of the data collection process for this study. The instructor provided a reflection that highlighted his experience on how he perceived the pilot's interactions with the simulation. By participating in the validation and verification process for the simulation, he understood the use of the unified model of failure and learning systems design in this study and thus provided a series of unique question prompts designed for the pilots to discuss encountered failures that they might otherwise overlook (Lorch et al., 2011). Though experiential learning techniques are an integral part of the drone videography course, failure was not an integral part of the learning experience. As a result of this study, the instructor recognized potential benefits and opportunities for deeper learning from failure-based experiences. Drone flying naturally affords the use of failure-based learning models. By allowing the flexibility and manipulation of certain parameters within the simulated learning environment, the pilots are able to demarcate the appropriate conditions for transfer for future drone flights in the classroom or their workplace (Tawfik et al., 2015). The instructor found the simulation exercise to be most useful for generating mental models on safety and performance in real-world applications. He offered:

> When you're in the field, your instructor can't tell you what exactly is about to happen when you're at the mercy of the environment. I would say that [the simulation] probably increased their respect for the ability for what can possibly happen to them. Quite a few of them have wrecked on the landing…you can have

> a good flight, but if you wreck (shrugs). And your drone falls, you know, 100 feet and breaks into a million pieces and your memory card is damaged and you know you don't [have the final footage]. That's a failed flight. I think that the simulation overall definitely gave them a sense of respect for the potential hazards of drone flying. Such that they'll be extra careful and a few of them did say to me that the simulation has made them think a little bit more while they're out in the field. And that's what we want.

Another interesting point of discussion arose during the instructor interview. While one might consider the lack of drone crash incidents a success, the instructor supports the notion of productive failure contending that support for students should be delayed, increasing the likelihood that failure will be encountered (Kapur & Bielczyz, 2011). He asserted:

> This semester has actually been the first semester where we didn't have a crash. We've lost at least one drone per semester, which is not a bad number considering the number of flights that we have. Any drone pilot will tell you that when you have a crash it does something to you, like it makes you think twice, be it a computer simulation or in real life, it does something to your mind where you're like, I want to make sure that that doesn't happen again. And so as a person who's crashed a few times in real life, I can honestly say that with a with a lot of confidence. A few semesters ago, I had probably what I would consider to be the best class that we've had across the board as far as content creation and they all passed their [Part 107] test the first go round. But they had some crashes! This particular class, I'd say, not as innovative, but they were careful and they didn't crash and as an instructor you're happy with that. I think I could probably live

> with one crash a semester. We don't like to ever have one, but I probably [could] live with a crash that semester with a really innovative class that they went after it. First of all let me just also say we've never had an injury or property damage from any of these crashes, they'd never been people. Got to have a respect of what can happen, but you can't have a fear of flying to the point where you just, you're not able to exercise creativity.

The instructor disclosed that given the results of this study, he plans to continue to use the simulation in future iterations of the drone videography course.

> I think I'd probably do it the same way once a semester. Make sure that somebody has a crash in a simulator just again, nobody's invincible. I've crashed a few times, never injured anybody never damaged any property. But it can happen to everyone and everyone needs to be cognizant of that. So probably a simulation where…everyone crashes, at least once would definitely be useful to my course. One person suggested that I was going to suspend his [drone] checkout privileges, because he crashed the simulator. And I thought that was really funny. So I think for some of the less confident ones, they might take it a little too personally and not be able to bounce back as quickly as some of the other ones will, so I suppose that could be a negative. But again, like that's part of the process. You have to be able to accept that it can happen to you. And if that happens to you, you can't quit, [you] like have to learn from it and get back out there.

## Summary

The purpose of this study was to examine the perspectives of drone pilots regarding the use of failure-based learning within the context of a simulation training activity. This chapter presented the findings and analyses of the data obtained from the individual interviewees on their perceptions of how drone videography courses can use simulations to help students embrace failure. Thematic analysis revealed that participants have strong beliefs about the characterization of failure in their field. Three descriptive themes emerged as the 16 participants discussed their experiences with how they perceived the use of the simulation training exercise to promote failure-based learning: (1) building confidence in a low-stakes environment to increase self-efficacy, (2) reflecting on impact of failure experiences to overcome fear and anxiety and to promote intrinsic motivation, and (3) influence of experiential learning experiences on safety and performance-based culture. The themes signify ways in which the participants find value in experiencing and learning from failure. The results of this study provide a comprehensive review of the transcriptions obtained during the analysis phase. Eight participants expressed an increase in self-confidence after completing the simulation, having had many opportunities to internalize success, making it easier for them to embrace the idea of participating in challenging or difficult performance training exercises, even when faced with ultimate failure. Two pilots however, felt the opposite was true. One participant for instance, said “I think I have had a little bit less confidence because I kind of realized like, oh, wow, like this could all happen.” These contrasting statements demonstrate the importance for learners to reflect on the larger context in which failures occur. A discussion of this concept and the study findings is presented in the final chapter.

# CHAPTER 5

# DISCUSSION

The purpose of this phenomenological study was to understand drone pilots' perceptions of the use of simulations to promote failure-based learning. This study utilized the unified model of failure and learning systems design to create a drone flight simulation designed to focus on safely operating the drone, while capturing high-quality aerial footage. The literature on simulations has little to offer on failure-based learning. This study findings attempts to fill that gap by endorsing failure as an intentional part of the instructional design process when developing simulation-based learning experiences. This chapter includes a discussion of these findings as related to the literature on failure-based learning design, and what implications may be valuable for use by instructors and instructional designers. This chapter concludes with a discussion of the limitations of the study, recommendations for future research, and a brief summary.

Numerous theories arise in the literature on failure. While previous research has not directly explored how failure is promoted in simulation-based learning design, various studies have examined the effect that success and failure experiences play in enhancing learning (Ariño & De La Torre, 1998; Kapur & Bielcyz, 2011; Kolodner et al., 2004). One stream of studies focuses on constructive failure. For instance, Sitkin (1992) found that failure is not the goal, but learning from the experience is the goal, while Edmondson (2004) found that the notion of intelligent failure encourages learners to not only be more engaged, but also builds schema, metacognitive thinking, and promotes transfer. Scholars have also focused on productive failure (Kapur, 2008). These studies attend to engaging learners in solving complex, ill-structured problems as a productive exercise in learning from failures, finding that those who first experienced failure outperformed the other in terms of their conceptual understanding and ability to transfer the concept to new scenarios (Kapur, 2013).

The findings of this study highlight the perceptions of 16 licensed drone pilots at a large, public university, and supports the use of failure-based learning design in simulations. Three main themes were identified: (1) building confidence in a low-stakes environment to increase self-efficacy, (2) reflecting on impact of failure experiences to overcome fear and anxiety and to promote intrinsic motivation, and (3) influence of experiential learning experiences on safety and performance-based culture. While their career paths and experiences include some variation for each drone pilot, each of the three themes were relevant factors in motivating the participants interviewed for this study. Relative literature is utilized to help develop meaning around the themes that emerged.

## Attributes of the Simulation

For this study, it was important to ensure that the simulation learning experience supports Reeves et al., (2002) 10 characteristics of authentic learning, in addition to three core characteristics:

1. The simulation is immersive, involving the individual at a deeper learning level. (Wilkerson, et al., 2008).
2. The simulated experience replicates the school or work environment and focuses on real job behaviors and performance outcomes.
3. The knowledge generated is immediately applicable.

### The simulation is immersive, involving the individual at a deeper learning level.

The simulation design included a realistic cityscape, much like the layout of the city where students attend the university. The simulated visuals included clouds in the sky, sunshine, a flag blowing in the wind, black and white painted streets, skyscrapers of various heights, and a bridge connecting one hub of the city to the other. The sound design included wind blowing through the air and the sound of the drone propellers. The hand-held drone remote control is an almost exact model of the DJI Phantom 5 remote control the pilots use to operate real drones. All of the pilots found it valuable for the simulation to be hands-on and five of the 16 participants expressed how impressed they were with the authentic representation of the simulation design. Participant 03 shared, “I thought it controlled really well. It was accurate to a good extent.” Participant 07 commented, “I thought it was really smooth, felt really realistic,” while Participant 08 stated, “This looks so real, so this is just like when we fly for class.” Participant 10 shared similar sentiments stating, “I thought you did a good job recreating the experience.” Participant 11 was pleasantly surprised by the simulation design stating, “This is pretty cool. I wasn’t expecting it to be just like the real thing.” Participants were encouraged to think out loud once in the training simulation. Participant feedback paired with the instructor’s performance reviews suggests that immersive training in a simulation environment has the potential to be a powerful tool to train drone pilots (Wilkerson et al., 2008).

**The simulated experience replicates the school or work environment and focuses on real job behaviors and performance outcomes.**

Throughout the drone videography course, learners are taught various drone maneuvers and are later asked to perform these maneuvers to obtain footage of an object in question. This type of experience was recreated for the simulation activity. At the time of the study, six of the 16 drone pilots were currently employed, and these pilots indicated that the skills used in the simulation, were also used on projects for their real-life work. Participants were given a detailed orientation to the simulation and the objectives of the scenario. Participants were then given a minimum of five minutes but not more than 10 minutes to become acclimated to the drone remote control and the simulation environment. All participants agreed that enough time was given to be comfortable with the simulation environment. Once the simulation training scenario began, the pilots were asked to execute specific drone maneuvers to capture video footage of a city object for a client. Participants were encouraged to think out loud. The instructor played the role of the client as was performed in the drone videography course. Each participant's simulation flight was recorded within the simulation. The recordings provided a full view of actions taken by the participants within the simulated environment.

Participant 08 works as a photographer and drone-videographer for her own studio. She obtained her Part 107 license in 2018 and has maintained active status since. She often performs drone videography for wedding events and other similar venues. She shared, "I do this type of stuff for my job all the time." During the simulation activity, it became clear that Participant 08 grew frustrated with the failure-based design. She remarked, "Ok, I swear I can do this. Oh my goodness, I feel like I would do so much better in person. What in the world? I'm gonna blame it on the program." Upon completion of the simulation, each pilot participated in a semi-structured virtual interview conducted by this researcher. This interview probed participants' general reactions in addition to their assessments of realism and applicability to on-the-job performance. Participant 08 confirmed that although she became frustrated, she found the simulation activity beneficial. She said:

> I still felt frustrated because it made me feel like something was wrong with it. I was afraid to not do the moves right. I need more practice. I hadn't flown in a couple months before, so I felt rusty. I haven't flown since. I thought it was cool to have something like this now. It's a game changer.

This comment reflects the sentiments of five participants about how the authenticity of the simulation exceeded their expectations and made an impression on the applicability of their real-world experience.

**The knowledge generated is immediately applicable.**

Learner situational awareness is considered a prerequisite for the safe operation of aviation systems (Sarter & Woods, 1991). When teaching and learning drone videography, situation awareness is enhanced with the use of simulations (Endsley, 1997; Sarter & Woods, 1991). In the aviation domain, maintaining a high level of situation awareness is one of the most critical and challenging features of the job (Endsley, 1997). After completing the simulation activity, pilots were asked briefly to recall what had occurred during their flight. By comparing the real recorded simulation run and the perceived situation, the pilot's situation awareness was determined (Sarter & Woods, 1991).

Five participants expressed a desire to go out and complete a drone flight immediately upon completing the simulation, citing how the simulations' design impacted the pilot's desire to hone essential skills that were deficient during the simulation activity. Five of the 16 participants recognized a need for more practice, acknowledging that they had not flown in some time due to COVID-19 related lockdown restrictions. Two pilots requested to check out a drone for a practice flight immediately after completing the simulation. One participant expressed apprehension with having to complete a real flight later that day for work. Two of the pilots essentially failed the simulation in that they had crashed the drone prior to encountering the intentional failure aspect. These pilots were given a second attempt to complete the simulation. Four of the pilots passed the simulation as these pilots did not crash the drone and were able to successfully avoid crashing the drone which was one of the intentional failure aspects to complete the simulation.

## Interpretation of Findings

The first theme, building confidence in a low-stakes environment to increase self-efficacy, highlights the way in which the pilots engaged with the simulation. Self-efficacy theory suggests that self-efficacy increases with positive feedback, where the learner is inspired to perform better in the future (Schunk, 1991). A well-designed simulation activity will challenge learners to the degree in which they can expand their knowledge base without overwhelming them (Li, Cheng, & Liu, 2012). If users feel that they cannot successfully navigate the simulation, then they may not give the effort that is required. Fundamentally, they understand that they are going to be challenged, but they must believe they possess the tools to meet the challenge and successfully overcome it (Wilkerson et al., 2008). This study's findings support the assertion that learners are often motivated to learn because they know they possess the skills needed to accomplish the task and are being given the opportunity to build upon these skills (Schunk, 1991). As such, this researcher takes the position that failure-based learning models can provide learners with real world obstacles and problems that they may face to expand their skills and knowledge, while keeping them engaged in the simulation learning process. Given that 100% of the participants reported favorable impressions from the simulation experience, related to their attitude towards fear and anxiety with future flight operations, this researcher asserts that further efforts should be made to implement the use of simulations involving failure-based learning strategies in drone flight training. Developers of simulations for drone flight training should attempt to include conditional scenarios that include elements of intentional failure in compliance with the unified model of failure and learning systems design (Tawfik et al., 2015).

The participants shared their insights on how the simulation provided an opportunity to fail safe and fail fast. Positive feedback upon completing the simulation reinforced the expression of strong self-efficacy. Although the simulation experience had a different effect on two pilots, the other 14 participants responded positively regarding their perceptions of their skills and subsequent level of confidence. Given this information, this researchers' theory about using simulations to promote failure-based learning was well supported. The results imply that failure-based learning strategies involving the use of simulations might be most suitable for high-stakes training such as drone flight operations. Although this study focuses on the influence of the failure-based learning framework on a specialized set of learners, it would be helpful to understand the effect of this learning system in other high stakes learning environments. It is conceivable that the perceived benefits of using simulations to promote failure-based learning in this study shows how failure can be framed as productive for learning in other specialized high-stakes fields such as security, engineering, and medicine.

The notion of risk associated with learning from failure appears to be more palatable in low stakes learning environments. By using simulations to lower the stakes and thus increasing the opportunity to take risks, teaching and learning can inherently embrace the inevitability of learning from failure. This study demonstrated that failure as productive for learning, was a significant part of the participants' experience. A design approach that then encourages the learner to recover from failure might enhance self-efficacy, which may better support the overall learning experience (Schunk, 1991). In this study, participants cited enjoyment of the overall challenge of the simulation, often describing it as a "fun" and "creative" experience. Participants reported a preference for hands-on learning and thus appreciated the proactive and progressive failure-forward approach to learning as opposed to the traditional "failure is not an option" catch phrase. The favorable responses to the simulation activity demonstrate the effectiveness of the design in challenging the learner without overwhelming their cognitive capacity (Sibbald, Wang, & Caners, 2019). Giving learners an opportunity to fail helps them build capacity to solve problems and resolve errors as they would in real–world situations (Tawfik et al., 2015). If we desire to help learners recognize the value of failure in the learning process, we must first reflect on how failure is framed. We must be willing to fail ourselves first.

The emphasis on self-reflection and reflexivity played a central role in the evolution of the second theme. This theme, reflecting on impact of failure experiences to overcome fear and anxiety and to promote intrinsic motivation, centers on reflexiveness in turning the failure experience into learning. Awareness of what approaches are suboptimal or what actions are to avoid during a problem-solving process should assist individuals' notion of certainty in their professional practice (Gartmeier et al., 2008). Regarding the simulation design in this study, the primary goal of the embedded failure experience was to afford an opportunity for the learner to not just encounter failure, but to also engage in constructing schema from that experience in order to obtain high levels of future problem-solving skills. After an individual constructs an initial hypothesis and parameters for failure, the instructional system should allow learners to negotiate and redefine the success and failure from an alternative perspective (Tawfik et al., 2015). The interview responses showed how pilots emphasized the importance of reflection about their experiences and perceptions with the instructor and with their peers. At the conclusion of the study, the instructor shared that through the remainder of the semester, several student participants continued to discuss the simulation design and how the activity helped promote critical thinking and motivation. This supports previous literature on the deeper impact of learning from failed experiences as opposed to from that of successful experiences (Ellis et al., 2006).

Reflection upon failures have instructional benefits when employed strategically within the instructional design of the learning system (Tawfik et al., 2015). The literature also emphasizes the importance of analogical transfer after learners have recovered from a failure event (Gartmeier et al., 2010). Findings from the study point to pilots perceiving the aspect of intentional failure in the simulation design as a key motivator to reduce fear and anxiety with drone flight operations. The perceptions documented in this study also suggested that pilots' experiences and opinions about failure influenced their sense of self-efficacy constructively. While 100% of the respondents supported the belief that students enrolled in a drone videography course would likely benefit from participating in a hands-on simulation training as an initial introduction to flying a drone, they also reported that using a failure-based scenario approach would not be appropriate for an initial introduction. The 16 participants expressed concern with the adverse effects that such a scenario might have on levels of confidence and self-efficacy if used too early. This is further defined by the pilots as their genuine response to fear and anxiety with their very first flight, as well as after a failure encounter. Twelve of the participants in this study specifically mentioned that regular usage of the drone promotes proficiency in executing successful flights. Five participants acknowledged the need for more practice and three participants reported a willingness to take more risks with operating the drone. Participant 13 said, “So it kind of made me realize like, okay, don't be afraid...just push it, go faster, turn wider, or whatever that is, you know. So that's something I'm going to work on.”

The results of this study align with the literature on reflection. The nature of reflection that learners employ on failure experiences influences the quality of their learning, yet the practice of reflection is always a challenging task for learners (Schön, 1987). When asked to describe how they define failure, participants responses can be described as simply not obtaining a desired result, or not trying. Debriefing at the end of the simulation exercise allowed pilots to discuss and evaluate the variables within the simulation design. Failure-based question prompts during the interviews were designed for the pilots to discuss the failures they encountered and the variables they may have overlooked during the initial debriefing. This opportunity for reflection after completing the simulation exercise also appeared to have a positive impact on intrinsic motivation. Exposure to failure allows the learner to identify causal processes and employ this new knowledge to resolve the problem (Jonassen, 1997).

There are three aspects that could prompt a balanced approach to reflective reasoning: individual introspection; artifacts of the failure context; and systemic perspective of the failure (Hong & Choi, 2011). Regarding individual introspection, after completing the simulation exercise, participants were asked to reflect on the experience and be prepared to discuss during the follow-up interview. Participants provided their own definitions of failure and their reactions upon learning that the simulation was designed to fail. During the interviews, all the participants reported favorable impressions from the simulation experience, related to their attitude towards fear and anxiety with future flight operations. In terms of artifacts of the failure context, participants were directed to reflect on the simulation components that were relied upon to perform the simulated flight. With regard to systemic perspective of failure, participants were asked to reflect on the ways in which they expected to fail prior to completing the simulation, as well as the larger context in which drone flight failures occur in real-world situations. Participants indicated that completing the simulation training exercise further expanded their understanding of the skills necessary for both pre-flight and in-flight decision-making and process judgment. Understanding of causal-related events is important because they reveal how success or failure solutions are contingent on decision-making (Jonassen, 2011). These findings support research-based assertions that learners are more likely to demonstrate exploratory behaviors when they are intrinsically motivated (Trevino & Webster, 1992).

The literature on simulations discusses how instructional designers can use simulations to compress time to help the learner make a decision, implement it, and experience its consequences all within the same exercise (Maria, 1997). The third theme emanating from the data illustrates this concept. The third theme, influence of experiential learning experiences on safety and performance-based culture, reveals the power of experiential learning and the impacts on the learner. Participants shared experiences support the profound idea that simulations may be a better way to train and may accelerate promoting and evaluating learning failures. Eight of the pilots interviewed spoke of efforts to engage in continuous improvement opportunities to maintain professional knowledge on drone safety laws and guidelines.

Situation awareness is formally defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley, 1997, p. 258). Participant responses also supported the notion that those who have experienced failure are more likely to have positive knowledge outcomes due to increased awareness and resilience (Endsley, 1997). Maintaining situation awareness is a crucial part of a drone pilots' job however, lack of learning approaches to facilitate failure-based learning inhibits deeper application of this process. Enhancing situational awareness through better simulation designs remains a challenge. In this study, failure invited the opportunity to enhance situational awareness and challenge traditional assumptions about the value of learning from failure versus learning from success. It is true that given the performance-based culture of drone flight operations, failure represents one of the more difficult, complex issues to attempt. Nonetheless, both the participants and the instructor endorsed a positive connection between learning from failure with the disposition to think critically or build critical thinking skills when attempting to safely operate a drone. These themes reveal important implications for the lack of instructional strategies and attributions related to the learning outcomes of failure.

## Research Implications

Is designing for failure-based learning more difficult than traditional instructional design projects? A gap in the literature exists because learning design often focus on templates of successful problem-solving to support students (Tawfik et al., 2015). A recent study explored primary students' collaborative problem-solving competency in project-based learning with productive failure instructional design in a seamless learning environment (Song, 2018). The findings imply that productive failure instructional design can be conducive to developing primary students' collaborative solving competency in science learning in a seamless learning environment. Though Song's (2018) study utilized the design principles undergirding productive failure (Kapur, 2008), Tawfik et al.'s (2015) claim remains true that to date, no models have discussed how to employ failure strategically within instructional design.

This study adds to the conversation about the influence of a unified model of failure and learning systems design and how to employ failure strategically in teaching and learning (Tawfik et al., 2015). The results indicate that this framework can be particularly helpful for drone pilots with varying skills and background knowledge. More specifically, the design appeared to enhance the pilots' self-efficacy with regard to their perception of skills and challenge. How well learners can recover experiences and knowledge from long term memory is highly dependent upon how the material was interpreted in the first place (Norman, 2013). Instructional designers are responsible for setting parameters in place to encourage storage and retrieval of critical information. Establishing predictability and control over how what appears in instructional materials and how the depicted information is represented has historically been high on the research agenda (Winn & Snyder, 1996). When designing with failure in mind, instructional designers are not only tasked with bridging these gaps, but they also face the challenge of providing opportunities for learners to build schema and participate in meaningful, authentic learning activities while employing a failure-based strategy. When designing for high-stakes learning environments, instructional designers should seek opportunities to encourage risk-taking, placing emphasis on the inherent necessity of failure. This researcher takes the position that a high-stakes learning environment that values failure is more likely to nurture skillful decision-making and problem-solving.

Some might be skeptical of the findings based on the nature of self-reports, but participants' claims about the realism and accuracy of the simulation controls support this simulation's face validity. The implications of self-reporting can be mitigated by measuring participants 'presence' within the simulation as researchers use tools and objects representing the real-world scenario and can also watch for physiological measures and physical behaviors that seem to indicate a participant's presence or lack thereof. Dole and Ju (2019) recommend establishing an ecological validity threshold somewhere around 80% when designing simulations. Additionally, they suggest researchers declare before running a study how they will identify participants with low presence, and either exclude these participants from their analyses, include presence as a covariate, or attempt to experimentally manipulate it. If participants fail to take a simulation seriously, it can hardly be claimed that the study's results apply to the real world (Dole & Ju, 2019). The more immersive the simulation, the more present study participants tend to feel inside it (Dole & Ju, 2019). The results of this study show that 100% of the participants demonstrated an immersive and active learning experience while engaging with the simulation and each were highly motivated by the design output. Through observations, field notes, and interviews, all participants expressed positive impressions of the simulations' fidelity.

Research has presented how failure was beneficial for well-structured problems (VanLehn, 1988), decision-making problems (Tawfik & Jonassen, 2013), and ill-structured problems (Gartmeier et al., 2010; Kapur, 2012). For each problem type, aspects such as dynamicity and complexity are different, thereby changing the nature of how failure may be employed within the problem (Tawfik et al., 2015). As noted previously, educators may unconsciously shelter students from the complexity required of ill-structured problems, therefore inadvertently overlooking the benefits of failure (Tawfik et al., 2015). Instructional designers seeking to employ failure-based learning strategies are often challenged to obtain support for such strategies by the instructors. It is important to consider identifying the most appropriate form and time to employ a failure-based strategy to then demonstrate the meaningful impact from failure interactions. As demonstrated in this study, instructors can benefit from knowing the value learners place on their effort to allow them to encounter failure scenarios in a safe, low-stakes environment. This researcher asserts that by lowering stakes and increasing opportunities to experience the intrinsic necessity of failure, instructors can enhance teaching and learning experiences by promoting autonomy, building capacity, and increasing engagement. As an instructional design practitioner, this researcher contends that instructional designers are then charged with the responsibility of promoting the unified model of failure-based learning that serves as a conduit for employing failure as a strategic way to engender learning.

Learners are the direct beneficiaries of utilizing failure-based learning strategies in instructional curriculum. As demonstrated in this study, they find assurance in engaging with intentional failure in a low-stakes environment. Instructors working with instructional designers, especially those who teach in high-stakes problem solving environments such as emergency medicine, first responders, and aviation, should build time and strategy into their designs to encourage failure scenarios. These failure-based scenarios can occur at different times and in different settings throughout the curriculum. The intentionality of these failure encounters needs to be built into the learning and development process, including the assessments (Tawfik et al., 2015).

The inducement of failure must be an intentional aspect of the learning experience rather than just a byproduct (Tawfik et al., 2015). Learners tend not to question their initial problem space once they have constructed it; instead, they pursue the most efficient problem-solving path, therefore potentially bypassing opportunities for deeper learning from failure (Jonassen, 2011). Instructional systems that force learners to encounter failure through delayed support may thus be an important instructional design characteristic (Tawfik et al., 2015). In situations where a failure is not perceived to offer opportunities for interaction, instructional designers can act as advocates to encourage engagement from the instructor to take full advantage of the opportunity to experience failure in a low-stakes environment. Learners should also advocate that they value experiencing intentional failure encounters. Though factors that contribute to task or problem complexity may to some extent differ from one high-stakes setting to another, the instructional design must respect the limits of human working memory and facilitate the development and automation of cognitive schemas through evidence-based principles and guidelines (Leppink, Lee, & Hanham, 2019). This research has potential implications for simulation and game designers, as well as instructional designers. All designers, however, should expand their focus on the different strategies that can be used to find the right balance to employ intentional failure within a simulation in terms of ease of use, engagement, and representation of reality.

"To fail is to learn: we learn more from our failures than from our successes" (Norman, 2013, p. 64). Norman (2013) suggests that designers need to fail as an essential part of exploration and creativity. "It doesn't matter where our knowledge comes from. What matters is the quality of the end result" (Norman, 2013, p. 112). The act of learning is a process in which information continuously builds upon more information. When learners are fully engaged in practicing concepts, they are actively thinking about the information being presented while transferring this information into their working memory. Self-questioning, selective attention, and other encoding techniques occur as the learners process specific information they find relevant, while simultaneously ignoring other irrelevant information. In the context of design implications for simulations, it is the responsibility of the designer and instructor to produce lessons designed to encourage the learners to use rehearsal and encoding techniques. The instructional tasks should also allow learners to practice concepts in which they have some prior knowledge. When applying failure-based learning strategies, learners would then repeat the key concepts in various ways using multiple modes, until encoding takes place. Eventually, all of this information is stored in the learner's long-term memory where it is permanently stored until retrieval of learned information is needed. When implanting failure-based learning, the goal for instructional designers and instructors is to bridge the gaps and provide opportunities for learners to build schema and participate in meaningful, authentic learning activities.

Given the results of this research, this researcher submits that allowing learners to encounter errors in traditional educational contexts may better prepare learners for the complexity of problem-solving within any domain. By using simulations to make use of failure to create more complex schema, learners can potentially develop skills and acquire knowledge with little to no risk. When learners engage with failure to build schema, this can enhance relevant knowledge for the learner. It is just as important to distinguish the kind of problem to be solved, and not just direct learners to thinking about solving the problem. Failure-based learning goes beyond using prior experiences or case studies, but thinking about the nature of the problem, then determining the best strategies for that type of problem. In teaching and learning, it is impossible to think without emotion, learn without motivation, and comprehend and appraise without volition. Cognitive apprenticeship is one such example of how failure-based learning can be embedded into student-centered instruction. In this example, the instructor usually begins with guided modeling then intermittently decreases their support and guidance. Ultimately, the learners must review what they have successfully completed, set against what is considered a failure, then have an opportunity to analyze and reflect.

## Research Limitations

Limitations for this study include factors typical of phenomenological research. This study offered a preliminary view encompassing the essence of how drone pilots experience and understand the use of simulations to promote failure-based learning. Previous research had not explored the interactivity between drone pilots and failure-based learning in a simulation context. While phenomenological investigation focuses in on the essence of the lived experience of a specific population, other aspects of the interactivity are not fully explored (Wagner, 1984).

The field of education would benefit from an empirical investigation as to whether differences in failure stories remain across different problem types and domains (Tawfik & Jonassen, 2013). This study produced limitations that were narrow in scope (Creswell, 2003).

Regarding the study sample, three primary limitations exist. First, the number of participants in the study (N=16) was small. A larger group of participants may have produced different or additional themes. Second, data for this study were collected from Part 107 licensed drone pilots who were either college students enrolled in the drone videography course, or who had successfully completed the drone videography course at the university with the same instructor. The results can only be applied to the population examined and is not transferable to other drone pilots. Third, the study focused exclusively on a specific university's current and former students whose drone flight experiences occurred in the same location and with the same instructor. The results may be applicable to this field, state, and country only.

The results are also limited by how participants interpreted the interview questions. The primary qualitative data collection techniques included virtual interviews and field notes. Though the results indicate that the failure-based simulation may balance the challenge and skill perceptions of the drone pilots, it is possible the same simulation could have different impacts on pilots with different background knowledge or who received training from a different instructor. Baek (2009) discusses digital simulation in teaching and learning on context and the need for interactive and experiential methods of teaching and learning. He poses the question "Is simulation-based learning good for all disciplines in education?" This researcher takes the position that though the findings may not be generalized beyond this study, these findings could help other researchers begin to explore the phenomenon in other disciplines. Therefore, this research asserts that simulation-based learning can be good for all disciplines in education. This study can be enhanced by more differentiated analysis of those who have experienced failure in a broader selection of disciplines, investigating the context both during and beyond the failure process. Future research on targeted demographics within drone flight operations could also add to the findings in this study. The findings could also be strengthened by quantitative research as subsequent statistical analysis may offer more evidence to strengthen the data.

## Recommendations for Future Research

A noticeable shift toward studies of failure-based learning have begun to change our thinking about failure, but little research has been done so far to conceptualize why and how failure should be employed. There remains a need to examine the perceptions of both educators and learners at various stages of the failure process. In any practice, individuals experience both success and failure and learn from both, but historically, teaching and learning practices leave little room for learners to experience failure, and in fact, tend to avoid implementation of strategies that encourage learning from failure (Darabi et al., 2018). Future research is needed to understand the dimensions of failure in terms of learning and impact.

In this study, the first theme exposes a connection between failure and self-efficacy. Future studies should investigate this relationship in more complex ways. The unified model of failure and learning systems design was used as a framework to explicitly employ failure during the design of the simulation for this study (Tawfik et al., 2015). Further research is needed to understand the full impact of failure-based learning models on drone pilots' self-efficacy and skill development. Future research should also investigate how pilots with different knowledge levels and training may interact with the scenario. In addition, other instruments could be used to understand the experience associated with the simulation. For instance, a flow scale may be helpful to understand the effect of the simulation on components such as attention, focus, and curiosity (Trevino & Webster, 1992).

Researchers can investigate a variety of constructivist teaching methods and approaches to provide implementation examples that are effective not only in workplace training settings but also in education settings. An important facet for future consideration is the emotional aspect of the learner. Future research in failure-based learning could benefit by testing the impact on emotion for individuals that employ the failure-based model (Tawfik et al., 2015). Studies have shown that motivation and emotion is sometimes a negative issue as students transition towards ill-structured problem-solving strategies (Henry, Tawfik, Jonassen, Winholtz, & Khanna, 2012; Hung, 2011). To better prepare learners to be successful practitioners, instructional activities should afford opportunities for learners to encounter failures as one way to promote success (Tawfik et al., 2015).

This study's findings are best understood through the context of the 16 pilots and the instructor interviewed for the investigation. Transferability can be determined by considering the detailed descriptions specific to the current settings and situations. This study offers a foundation from which to build on as future studies continue to explore the evolving phenomenon of failure-based learning. Future research should also explore how instructors experience and understand their students' failures. Though the drone instructor was interviewed as part of this study, much of the research focused on the pilots' voice as it explored the experiences of the participants. Themes evolving in data from studying drone flight instructors could be compared to this study's findings to further develop a framework for comprehending and describing this phenomenon.

The findings might also have application to other high stakes teaching and learning environments. For example, application areas like military, first responder, aviation, and police training, share challenges with the inability to collect real-world data outside of a scenario in which an individuals' physical or mental safety is at risk. While using simulations for teaching and learning are commonplace in these disciplines, gathering more information on failure-based learning in these areas through further research can help enhance the findings of the present study. Finally, the results of such studies could be integrated to build instructional design models that intentionally make use of failure as a tool for teaching and learning.

## Conclusion

This study presented a picture of 16 licensed drone pilots whose stories developed a foundational knowledge on how drone pilots experience and understand the use of simulations to promote failure-based learning. This offered three themes: (1) building confidence in a low-stakes environment to increase self-efficacy, (2) reflecting on impact of failure experiences to overcome fear and anxiety and to promote intrinsic motivation, and (3) influence of experiential learning experiences on safety and performance-based culture. The results supported theories from numerous domains suggesting that failure is a fundamental aspect of the learning process (Tawfik, et al., 2015).

Instructors and instructional designers have a responsibility to use their knowledge, skills, and experience to give learners the context which is needed to formulate or retrieve images in relation to the subject to be learned (Kenny, Zhang, Schwier, & Campbell, 2005). The goal is to maximize learning; therefore, it is important to understand the mental activities necessary for processing information and images when working with failure. Much remains to be done to articulate the use of failure for instruction to determine its proper place in the broader framework of teaching and learning settings. As demonstrated in chapter two of this study, review of the literature reveals a continued lack of consensus in the field on the most appropriate settings for failure-based learning and how to strategically employ failure-based learning strategies in the education environment.

Failure represents one of the more difficult, complex topics to attempt. There is no doubt that those who have experienced failure are likely to have positive learning outcomes due to increased knowledge and resilience, however lack of learning approaches to facilitate failure-based learning inhibits implementation of this process. By giving learners the opportunity to make mistakes and learn from their mistakes, any experiential learning experiences can be transformed into a highly effective teaching and learning experience (Yerushalmi & Polingher, 2006).

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# APPENDIX A

## INFORMATION LETTER

Hello awesome drone pilot:

My name is Nikisha Watson. I am a doctoral student in the Instructional Design and Technology program at Old Dominion University. I am conducting a research study as part of the requirements of my doctoral degree and I'd like to invite you to participate! This study will highlight the benefits of simulations and failure-based learning strategies that emphasizes the valuable lessons learned from experiencing failure.

If you decide to participate, you will be asked to meet with me to complete a practicum experience and follow-up virtual interview about your experience. You will be asked questions about your experience with using the drone simulation training. The interview will be both audio and video recorded to accurately reflect what is discussed. We will be utilizing Old Dominion University's enterprise Zoom account for the virtual interviews. The recordings will only be reviewed by members of the research team who will transcribe and analyze them. They will then be destroyed.

Participation is confidential. The results of the study may be published or presented at professional meetings, but your identity will not be revealed. Participation, non-participation or withdrawal will not affect your grades in any way. If you have any questions, please feel free to contact me at, nwats001@odu.edu or my faculty advisor, Dr. John Baaki, jbaaki@odu.edu if you have study related questions or concerns.

Thank you for your consideration!

*Nikisha Watson*

## APPENDIX B

## RESEARCH INFORMATION SHEET

Towards failure-based instructional design:

A phenomenological study of the perceptions of drone videography pilots about the use of simulations to promote failure-based learning

**PRIMARY PRINCIPAL INVESTIGATOR:**
John Baaki, PhD
Assistant Professor
Instructional Design & Technology
Department of STEM Education & Professional Studies
Old Dominion University
College of Education
Education Building
43rd and Hampton Boulevard #4125
Norfolk, VA 23529
jbaaki@odu.edu

**PRINCIPAL INVESTIGATOR:**
Nikisha Watson, Graduate Student
Instructional Design & Technology
Old Dominion University
Darden College of Education
STEM Education & Professional Studies
Norfolk, VA 23529
(727) 641-7797
nwats001@odu.edu

**DESCRIPTION:**

You are invited to participate in a research study that will explore a drone pilot's understanding about the evolution of their flight skills during their studies, while incorporating the use of a simulation designed to employ a failure-based learning model. The purpose of this study is to investigate how drone videography courses can use simulations to help students embrace failure. This proposed study will address the following research questions:

1. How do drone pilots perceive the use of failure-based learning strategies as part of the simulation training experience?
2. How does the drone pilot instructor perceive the use of intentional failure-based learning design in the simulation training activity?

**STUDY PROCEDURES:**

If you decide to participate in this research study, you will be asked to participate in a semi-structure interview which will be both video and audio recorded using Zoom. Your participation in this study is voluntary and you are free to withdraw your participation from this study at any time. The virtual interview should take approximately one hour to complete.

**BENEFITS:**

As a participant in this research study, you may not directly benefit from this research; however, we hope that your participation in the study may benefit other people now or in the future.

**RISKS:**

There are several ways in which we will try to minimize risk associated with potential exposure to COVID-19. Participants will complete the simulation activity in person at the university. During the simulation, we will try to reduce the time participants are exposed to the researcher. We will follow all protocols and procedures outlined in the Return-to-Campus plan published on August 21, 2020. All faculty, staff and students should have filled out the Return to Campus COVID-19 Assessment. Anyone who comes to campus is required to follow the university's guidelines for wearing face coverings, maintaining physical distancing, hand washing, disinfecting spaces and other posted mitigation measures. The researcher, faculty, and student participants will wear face coverings at all times. Hand sanitizer will be available on site for the duration of the simulation. No more than three individuals will be present at all times during the simulation, and all individuals will be at least six feet apart at all times. If a participant is suspected to be positive for COVID-19, there may be last minute changes to how research procedures for the simulation activity are performed. At the conclusion of the simulation activity, participants will follow-up with a virtual interview at a later date and/or time. The virtual interviews will take place via Zoom through Old Dominion University's enterprise account. The virtual interviews will be both audio and video recorded.

**COSTS:**

There will be no costs to you for participation in this research study.

**COMPENSATION:**

You will not be paid for taking part in this study.

**CONFIDENTIALITY:**

I will do my best to protect the confidentiality of the information gathered from you but I cannot guarantee 100% confidentiality. Your confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties. All information collected about you during the course of this study will be kept in confidence by the principal investigator. The principal investigator will keep raw and developed data secured and will limit access to the data to the principal investigator and other study researchers. At the conclusion of this study, the researchers may publish their findings. Information will be presented in summary format and you will not be identified in any publications or presentations.

**VOLUNTARY PARTICIPATION /WITHDRAWAL:**

If you decide to participate in this study, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time.

**QUESTIONS:**

If you have any questions about this study now or in the future, you may contact Nikisha Watson at nwats001@odu.edu or (727) 641-7797 or Dr. John Baaki at jbaaki@odu.edu or at (757) 683-5491 or you may contact Dr. Laura C. Chezan, current chair of the Darden College of Education and Professional Studies Human Subjects Review Committee at lchezan@odu.edu or 757-683-7055.

**I voluntarily agree to participate in this research program.** □ Yes □ No

I understand that I will be given a copy of this signed Consent Form.

Name of Participant (print):

Participant Signature:

Date:

Name of Witness (print):

Signature:

Date:

Person Obtaining Consent:

Signature:

Additional Note: A copy of the signed, dated consent form must be kept by the Principle Investigator(s) and a copy must be given to the participant

# APPENDIX C

## PILOT INTERVIEW PROTOCOL

Towards failure-based instructional design:

A phenomenological study of the perceptions of drone videography pilots about the use of simulations to promote failure-based learning

**PRIMARY PRINCIPAL INVESTIGATOR:**
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Introductory Protocol

You have been selected to speak with me today because you have been identified as someone who has a great deal of experience with drone videography on this campus. This study is limited to participants who have completed a drone videography course at the university, and who have also obtained FAA Part 107 certification. This research project as a whole focuses on the use of a failure-based simulation for drone training, with particular interest in understanding how students are engaged in this activity, and whether we can begin to share what we learn about making a difference in undergraduate education. This study does not aim to evaluate your techniques or experiences. Rather, I am trying to learn more about failure-based teaching and learning, and hopefully learn about instructional design practices that help improve student learning.

To facilitate notetaking, I would like to both video and audio record our conversations today. We will be using Zoom to facilitate this virtual interview. For your information, only researchers on the project will be privy to the recording which will be eventually destroyed after they are transcribed. In addition, you must sign the form devised to meet our human subject requirements. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary and you may stop at any time if you feel uncomfortable, and (3) we do not intend to inflict any harm. Thank you for your agreeing to participate. I have planned this interview to last no longer than one hour.

Interview Questions

1. Tell me about yourself, what is your major (if still a student), where are you from and how long have you been a student in this drone program?
2. Tell me about how you like to learn. What is your go to strategy for studying the material?
3. How do you define failure?
4. What was your first impression of the simulation used in the course?
5. What do you like most about using this simulation for learning?
6. What do you like least about using this simulation for learning?
7. What was your reaction once you learned that the simulation was designed to fail?
8. What were the ways, if any, did you expect to fail?
9. In what ways have any of your thoughts, skills, and attitudes changed since you completed the simulation?
10. Describe your experience on completing the simulation training.
11. How did the intentional use of failure impact your motivation and learning?
12. The goal of using simulations for learning is to mimic an authentic learning environment in order to help students gain the necessary skills in a safe environment. What is your reaction to that in relation to this course?
13. Has your confidence been affected since using the simulation? In what way?
14. How did using the simulation given you any ideas about doing things differently?
15. Is there anything else you'd like to share?

# APPENDIX D

## INSTRUCTOR INTERVIEW PROTOCOL

Towards failure-based instructional design:

A phenomenological study of the perceptions of drone videography pilots about the use of simulations to promote failure-based learning

**PRIMARY PRINCIPAL INVESTIGATOR:**
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**PRINCIPAL INVESTIGATOR:**
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Instructional Design & Technology
Old Dominion University
Darden College of Education
STEM Education & Professional Studies
Norfolk, VA 23529
(727) 641-7797
nwats001@odu.edu

Introductory Protocol

Good morning. Thank you for agreeing to participate in this study. This research project as a whole focuses on the use of a failure-based simulation for drone training, with particular interest in understanding how students are engaged in this activity, and whether we can begin to share what we learn about making a difference in undergraduate education. This study does not aim to evaluate your teaching techniques or experiences. Rather, I am trying to learn more about failure-based teaching and learning, and hopefully learn about instructional design practices that help improve student learning. To facilitate notetaking, I would like to audio tape our conversations today. Please sign the release form. For your information, only researchers on the project will be privy to the recording which will be eventually destroyed after they are transcribed. In addition, you must sign a form devised to meet our human subject requirements. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary and you may stop at any time if you feel uncomfortable, and (3) we do not intend to inflict any harm. Thank you for your agreeing to participate. I have planned this interview to last no longer than one hour.

Interview Questions

1. In regard to failure-based learning, describe the characteristics of the simulation activity can be identified that can support students in an explicit and scaffolded manner in this aspect?
2. Explain in detail the effects of the developed simulation activity on students learning of drone flight techniques?
3. Describe the design characteristics for a realistic and effective failure-based learning simulation activity that enables drone videography students to recognize the functionality of drone flight preparedness and safety knowledge in work placement sites?
4. What impact do you believe this failure-based simulation activity had on learner performance and behavior? Why or why not?
5. In a failure-based learning context, how does the design of the simulation help to facilitate learning and assess competence, which usually involves instruction and participant feedback as part of the overall simulation-based learning experience?
6. Is there anything else you’d like to share?

# CURRICULUM VITAE

**Nikisha Watson, M.S.**
nwats001@odu.edu

## EDUCATION

2015 – 2021 **Old Dominion University** Norfolk, VA
Doctor of Philosophy-Education in Instructional Design & Technology

2012 – 2014 **University of Tampa** Tampa, FL
Master of Science in Instructional Design & Technology

2002 – 2006 **Xavier University of Louisiana** New Orleans, LA
Bachelor of Science in Biology Minors: Chemistry; Philosophy

## PROFESSIONAL EXPERIENCE

2018 - Present **ConnectWise, Inc.** Tampa, FL
Manager, Learning and Development

2014 – 2018 **Pasco-Hernando State College** New Port Richey, FL
Senior Instructional Design Coordinator/Adjunct Faculty

2010 – 2014 **School District of Hillsborough County** Tampa, FL
Secondary Education Teacher

2009 – 2010 **Operation PAR, Inc.** St. Petersburg, FL
Care Coordinator

2008 – 2009 **Healthy Start at Johns Hopkins All Children's Hospital** St. Petersburg, FL
Community Health Educator

2007 – 2008 **Pinellas County Schools** Gulfport, FL
Secondary Education Teacher

## PROFESSIONAL ORGANIZATIONS:

- Association for Educational Communications and Technology (AECT)
- Association for Talent Development (ATD)
- Golden Key International Honor Society
- Phi Kappa Phi- Collegiate Honor Society
- Phi Sigma Tau- International Honor Society in Philosophy