12-2023

The Effects of an Equine Riding Simulator as an Objective Feedback Modality on Learning Outcomes for Rider Competency on Performance Skills in Equestrian Riding Fundamentals

Kelli Munns
Utah State University, kelli.munns@usu.edu

Recommended Citation

Munns, Kelli, "The Effects of an Equine Riding Simulator as an Objective Feedback Modality on Learning Outcomes for Rider Competency on Performance Skills in Equestrian Riding Fundamentals" (2023). *All Graduate Theses and Dissertations, Fall 2023 to Present*. 13.
https://digitalcommons.usu.edu/etd2023/13

THE EFFECTS OF AN EQUINE RIDING SIMULATOR AS AN OBJECTIVE FEEDBACK MODALITY ON LEARNING OUTCOMES FOR RIDER COMPETENCY ON PERFORMANCE SKILLS IN EQUESTRIAN RIDING FUNDAMENTALS

by

Kelli Munns

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Career and Technical Education

Approved:

Brian K. Warninck, Ph.D. Major Professor	M. Rose Judd-Murray, Ph.D. Committee Member
Michael L. Pate, Ph.D. Committee Member	Kerry A. Rood, MS, DVM, MPH Committee Member
Debra M. Spielmaker, Ph.D. Committee Member	D. Richard Cutler, Ph.D. Vice Provost of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2023

ABSTRACT

The Effects of an Equine Riding Simulator as an Objective Feedback Modality on Learning Outcomes for Rider Competency on Performance Skills in Equestrian Riding Fundamentals

by

Kelli Munns, Doctor of Philosophy

Utah State University, 2023

Major Professor: Dr. Brian K. Warnick
Department: Applied Sciences, Technology and Education

Simulation-based learning is a highly effective approach for teaching complex motor skills in various fields. Using simulation allows learners to have deliberate practice for real-world scenarios in a controlled environment that will reduce risk, improve welfare-minded practices, decrease strains on resources, and standardize instruction and assessments. This mixed-methods experimental study examined the effects of different feedback modalities provided during the simulated-based practice of riding seat skills. The research also addressed the relationship between participants' feedback literacy, perceptions, and improvement scores. The study was designed, implemented, and analyzed using the adapted conceptual framework of Carless' 3P Model of the Learner Experience of Feedback. The data sets were analyzed using a triangulation convergence design method. The researchers analyzed the quantitative and qualitative data separately, transformed and merged the results, and used the findings to make interpretations. The study collected quantitative data from auto-training deviation scores provided by the Racewood Eventing Simulator and closed-ended questions from an exit survey. The qualitative data was collected from open-ended questions from an exit survey. The two feedback modalities implemented in this study were verbal feedback from an instructor and visual, kinematic feedback from the Racewood Eventing Simulator. Participants were stratified based on Skill Level and then randomized into one of four study groups. The Racewood Simulator seat scores were analyzed using a generalized linear mixed model to identify improvement across three practice sessions. An initial priori coding framework adapted from the 3P model was used to thematically code the participants' responses to identify perceptions and feedback literacy characteristics.

The study determined that the multi-modality feedback from the instructor and simulator resulted in significant improvement from Session 1 to Session 3 and that participants from Skill Level 1, in all study groups, resulted in significant improvement from Session 1 to Session 3. Perceptions of the Racewood Eventing Simulator as an instructional tool for practicing riding motor skills were very positive throughout all participants' responses. Participants had varying perceptions of the feedback experience based on the practice session feedback modality and their feedback literacy factors.

(198 pages)

PUBLIC ABSTRACT

The Effects of an Equine Riding Simulator as an Objective Feedback Modality on Learning Outcomes for Rider Competency on Performance Skills in Equestrian Riding Fundamentals

Kelli Munns

This study examined the effects of different feedback modalities provided during simulated-based practice on performance and perceptions. In addition, the research also addressed the relationship between participants' feedback literacy, perceptions, and improvement scores. The purpose of this research was motivated by the emerging equine simulation technology that provides feedback on movement and coordination during complex motor skill acquisition. Selecting an effective feedback approach for simulation-based practice in motor skill learning is contingent on the complexity of the performance skill and the learner's experience. However, the learner's feedback literacy can result in contradictory performance and perceptions despite the feedback approach experienced. Feedback literacy is a concept that identifies a learner's ability to uptake feedback.

This mixed-methods study used the conceptual framework of Carless's 3P Model of the Learner Experience of Feedback. Seventy-five participants completed the study, consisting of three 10-minute practice sessions with a pre/posttest and an exit survey at the end of their third session.

The study demonstrated that the combination of instructor- and simulator-mediated feedback had the most significant impact on improvement scores by the completion of three practice sessions. Regardless of feedback modality, the novice participants had the most significant improvement score impact by the completion of three practice sessions. When an instructor provided feedback, participants had more positive perceptions of the practice experience. The study supported that the higher the participant's feedback literacy, the more they engaged in practice, appreciated feedback, and improved on performance scores, regardless of feedback received. The lower a participant's feedback literacy, the more negative they were about the experience and their perceived improvement, and the higher likelihood of disengaging during practice, regardless of feedback received.

The results indicate that a multi-modality approach to feedback in simulation-based motor skill practice is effective. The findings also support that feedback literacy influences a learner's engagement during practice, and instructor feedback can mitigate the negative influences of low feedback literacy. Conclusions from this research suggest that using a horseback riding simulator has the potential to improve riding seat skills and supports an equine welfare-minded approach to learning in equestrian sports.

ACKNOWLEDGMENTS

First and foremost, I want to thank Dr. Brian Warnick for his support, enthusiasm, and belief in this journey. The best advice I got for starting a doctorate program was to choose a chair who sincerely supported my vision and goals for pursuing a Ph.D. and without a doubt, I chose right. Thank you, Dr. Warnick, for being a great mentor and a great human being. I want to thank my doctoral committee members. Dr. Judd-Murray, I cannot express my gratitude enough for the honesty and support every woman deserves and needs in this journey. Dr. Pate, thank you for the patience and encouragement as I embarked on the statistical maze my data presented as well as enduring my humor. Dr. Rood, thank you for being a champion of this innovation from the early conversations almost 8 years ago. Dr. Speilmaker, thank you for the work you put into this doctoral program and for setting a standard I aspired to meet. Through much of this journey I have used your words and expectations to guide what I did.

I would also like to acknowledge and thank my colleagues in the Equine Program for their support and contributions. Judy Smith and Sarah Andersen, you were both essential in the completion of the research. Thank you for giving me your time and efforts. Dr. Karl Hoopes, thanks for being a great colleague and advocate of my efforts. Dr. Dirk Vanderwall, thank you for giving me opportunities to be great and creating the way to be the first U.S. university to implement an equine simulator.

Last, but never least, Charlotte and Bud. Thank you for seeing this through with me. My accomplishments are not done in isolation. We are in this together and it makes everything that much better.

Kelli Munns

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

CHAPTER I

INTRODUCTION

Background Information

The role of feedback in learning has evolved to become an instrumental and dynamic function of instruction and learning. Historically, instructional feedback was solitary and definitive, serving as a means to represent the learner's conclusive knowledge or task ability (Hattie & Timperley, 2007). An excellent example of this is providing students feedback about their learning through a test score or grade. As new learning paradigms started emerging in the 1900s, instructional uses of feedback shifted to a more communicative and iterative form on the learning gaps and how to close them (Giordano, 2005 McDowell et al., 2009). A good example is providing students feedback through formative assessments to gauge their current level of understanding and advise on remediation efforts (Black & William, 1996; Bloom, 1968; Sadler, 1989). Feedback can be a terminal input of a learner's knowledge and skill. However, a more considerable consensus in the literature and research is to provide feedback to elicit action for remediation and redress misconceptions and misunderstandings (Hattie & Clarke, 2018; Hattie & Timperley, 2007; Kulhavy, 1977; Kulhavy et al., 1985). When feedback operates in this way, it serves as a function of the dialogue between learner and instructor to collaborate, co-construct, and explore solutions to problems (Boud & Molloy, 2013; Carless & Boud, 2018; Vygotsky, 1978). Feedback oriented in this way fits well in an instructional approach from a social constructivist lens.

In motor skill acquisition, feedback plays an integral role in the instructional designs of deliberate practice. The purpose of deliberate practice is to perform repetitive motor skill actions to develop accurate motor pathways, automate movement, and build expertise (Baechle et al., 2022; Ericsson et al., 1993). To reach intended competencies, develop a frame of reference to exemplar execution, and improve the efficacy of the practice, augmented feedback (i.e., external source) is provided by an instructor or technology to guide the efforts of the individual (Anderson et al., 2019; Sharma et al., 2016). Although individuals can rely on intrinsic (i.e., vestibular senses) feedback to self-correct and inform practice, novice learners' intrinsic feedback is typically not refined or advanced enough to guide remediation efforts (Sharma et al., 2016).

There are several characteristics of motor skill-augmented feedback. First, augmented feedback has various forms (i.e., verbal, haptic, auditory, visual) and modalities (i.e., instructor, simulation; Petancevski et al., 2022; Sigrist et al., 2013). Likewise, the information provided by augmented feedback addresses one of two categories, knowledge of performance (KP) and knowledge of results (KR). KP informs the learner about the influence of their action execution (i.e., strategies, techniques, motor movement[s]), and KR informs the learner about the results of their actions (i.e., improvement scores). Last, the timing of the augmented feedback occurs at various stages of practice. Feedback can be provided at the end of practice (i.e., terminal), which is typical of KR, and it can be provided during practice (i.e., concurrently; Lauber & Keller, 2014; Petancevski et al., 2022; Weeks & Kordus, 1998).

Based on the complexity of the motor skill and learner characteristics, the type of feedback, when and how often to provide the feedback, and the modality that delivers the feedback are essential factors to consider during instructional practice. Complex motor skills require coordination of several movements in several degrees of freedom, high cognitive demand and domain knowledge, extensive, deliberate practice, and influence by external stimuli (Ackerman, 2007; Franklin, 2020; Wulf & Shea, 2002). The learners' experiences vary from novices (i.e., beginners) to experts (i.e., professionals). Experience is distinguished based on domain knowledge, time spent doing the task, perceptual speed, and psychomotor abilities (Ackerman, 2007; Cecilio-Fernandes et al., 2020; Guadagnoli & Lee, 2004; Wulf & Shea, 2002). Between novices and experts, there have been varying results on the best approaches to providing feedback during practice. For example, novices in the early stages of motor skill learning benefit from approaches that include information about how to do the task versus feedback correcting performance factors (Zhou et al., 2011).

For complex motor skills in fields that have complications in providing deliberate practice (i.e., flight, medical, driving), technology has been leveraged through simulation-based learning (SBL) to provide a reliable solution for educational programs. SBL uses technology to situate a learner in a realistic environment where deliberate practice, evaluation, and remediation can occur without reality's risks and concerns (Brabeck et al., 2010; Casutt et al., 2014; El Hussein & Ha, 2023; Ziv et al., 2003). Learning complex motor skills through SBL is also enhanced when the simulation technology can provide additional feedback. For example, simulation can provide objective and quantifiable measures of kinematics that are difficult for instructors to observe and articulate. Instructors can use the simulator feedback to discuss solutions and clarifications while encouraging participants to engage in deeper meanings and cognitive orders (Jaszczur-Nowicki et al., 2021).

Problem Statement

Emerging equestrian simulation technology offers a solution to improving the motor skills and competencies of riders. However, despite the evidence from other fields and sports using simulators to enhance performance, research, and educational programming, the use of horseback riding simulators for improving riding fundamentals is minimal. Riding simulators have been researched for jockey training (Walker, Applegate, et al., 2016), therapeutic uses (Dominguez-Romero et al., 2020), to examine fidelity to the actual horse (Clark et al., 2021; Walker, Martin, et al., 2016), and examining differences and impacts of riders (Clark et al., 2022); however, using it specifically for instruction of general riding fundamentals for equestrian education has not been shown. Furthermore, the U.S. equestrian community needs to be faster to integrate this technology. The equestrian industry relies extensively on expert opinion and uses approaches steeped in tradition versus evidence-based practices (Egan et al., 2019; Lord, 2019). Egan et al. studied perceptions of using innovative technology in equine practices. They found that equine community members had some consensus that technological innovations could be helpful. However, their resistance to using it was attributed to needing strong evidence of the innovation efficacy, a high benefit compared to the cost and time ratio, endorsement and use from high-level experts, and transparency of how the technology does what it claims to do. This research aimed to provide evidence for the efficacy of using a horseback riding simulator for complex motor skills in riding fundamentals.

Research in improving complex motor skill acquisition through feedback during practice has supported various approaches and modalities. Developing a practical feedback approach includes multiple factors, including the instructor's pedagogical style (Hatala et al., 2014; Petancevski et al., 2022; Sigrist et al., 2013; Wulf et al., 2010). What needs to be better explored in motor skill acquisition outside of skill levels (Ackerman, 2007; Cecilio-Fernandeset al., 2020; Guadagnoli & Lee, 2004) is what learner characteristics influence their uptake of feedback for improvement. This research examined the nuanced factors of learners' feedback literacy and the impact of feedback uptake and improvement in motor skill acquisition.

Purpose and Objectives

Using the social constructivist approach to feedback and conceptualizing the study through the 3P Model of the Learner's Experience with Feedback (Carless, 2019b), this study aimed to identify factors of a learner's feedback literacy to understand the influence feedback modality has on practicing a complex motor skill. The concept of feedback literacy was selected for this study because the research supports the instructor- and simulator-mediated feedback approaches in SBL for complex motor skill acquisition. However, there needs to be more research examining learner factors that integrate into how and why these approaches yield positive results. This study examined how an equine simulator, using different applications of feedback modalities, could benefit the complex motor skill acquisition of riders and explore their feedback literacy. The research will help provide insight into how SBL of complex motor skills can improve feedback practices while simultaneously providing the equine community with alternative solutions to improving riding skills that are more effective, safe, and support the equine welfare of the ridden horse.

The following research objectives were established to focus on the study's aims and methods.

1. Identify the effects of different feedback modalities during simulated-based practice on the rider's seat balance and stability performance.
2. Examine if relationships exist between the rider's perception of their feedback experience and factors that influence feedback literacy.
3. Identify the effects of different feedback modalities and the influence of individual feedback literacy factors on riders' perception of improved seat balance and stability.
4. Examine the rider's perception of a horseback riding simulator as an instructional tool to improve seat balance and stability.

Research Questions

Research in complex motor skill acquisition in SBL has demonstrated that learners have significant performance improvements when multi-modalities of feedback are implemented (Magill, 1994; Sigrist et al., 2013; Wicken, 2002; Wulf et al., 2001). Feedback research studies also demonstrated that when individual feedback literacy is high (Carless & Boud, 2018; Sutton, 2012; Winstone & Carless, 2019), feedback is dialogical (Carless, 2019b; Nicol, 2010) and uptake of feedback is improved, resulting in improved learning (Oppici et al., 2021; Sharma et al., 2016). This study aimed to determine how the feedback modality provided during an equine simulation-based practice influences participants' motor skill performance (i.e., seat stability and balance) and perceptions, focusing on factors in feedback literacy. The following research questions guided the focus of the study.

1. How does the feedback modality experienced during practice affect the performance of seat stability and balance?
2. What is the rider’s perception of their feedback experience while using a horseback riding simulator to improve seat stability and balance?
3. What is the rider’s perception of their improvement while using a horseback riding simulator to improve seat stability and balance?
4. What is the rider’s perception of using a horseback riding simulator as an instructional tool to improve seat balance and stability?

Research Design

This research study was a triangulated mixed methods experimental design. The target audience for this study was physically healthy adults, 18 years or older, who are horseback riders or have the motivation to be horseback riders. The quantitative instrument (i.e., Racewood Eventing Simulator seat deviation scores) provided statistical results on the impact of the feedback modalities. At the same time, a qualitative opened-ended survey instrument provided data on the participant’s experience and perception of the intervention and simulation-based practice (Curry et al., 2009). The quantitative research was a randomized controlled experiment with a 4x3 mixed factorial design. It accounted for the stratified randomization of participants into one of four study groups (between subjects) and the repeated measures across three practice sessions (within-subject). The qualitative research was a survey design using open-ended questions that thematically coded the responses using an initial priori coding framework.

Significance of Study

Understanding the best practice for instructional feedback approaches and factors that influence a learner's ability to uptake feedback is essential in all fields of education. Particularly, examining individual learner factors in SBL for complex motor skill acquisition relating to feedback literacy may provide insight into why specific feedback modalities generate a higher impact than others. Feedback literacy is a complex concept that involves factors from a learner's past experiences, personal perceptions, and a general responsibility to act on feedback. Research has demonstrated that factors and theories, like cognitive load (Buchner et al., 2021; Wulf et al., 1998), multiple resource model (Wickens, 2002, 2008), and guidance hypothesis (McKay et al., 2022; Wulf & Shea, 2004) validate approaches for multi-modality feedback in motor skill learning, but what is not well understood is the influence of the learner's feedback literacy. The results from this study stand to fill the gap in SBL for complex motor skill learning to provide a more inclusive understanding of the learner's active role with feedback to improve performance.

In addition to contributing to the research on feedback approaches for SBL of motor skill acquisition, the insights from this study will also contribute to the equine industry's use of simulation as an instructional tool. Equine simulation is slow to assimilate into equestrian sports, except for horse racing which has led the movement in equine simulation development (Racewood, n.d.). However, with equine sport's waning social license (Campbell, 2021; Furtado et al., 2021) and the evolving scientific evidence that bolsters the need to move to more welfare-minded practices of the ridden horse

(MacKechnie-Guire et al., 2020), the concept of using horseback riding simulators for riding fundamentals should be considered by all teaching and training programs. As this study focused on the use of a horseback riding simulator to improve the performance of a skill that, when mastered, contributes to safer practices and decreases physical detriment to the horse (Kang et al., 2010; Münz et al., 2014; Olivier et al., 2017; Terada, 2000: Williams & Tabor, 2017), the results will serve to inform those stakeholders in the equine industry how to improve and develop the integration of SBL into horseback riding educational programs.

Assumptions

Riding horses has various styles and purposes, including the saddle used. Unfortunately, no consensus or governing authority exists on what practices, approaches, or treatment is most appropriate. This study assumed that the target population was concerned and motivated to address the fundamental riding skill of seat stability and balance from a biomechanically synchronized approach. This approach meant that balance and stability were a more complex motor skill than the ability to stay mounted in a manner that was comfortable for the rider. Another assumption was that the participants would answer truthfully in their skill placement assessment and survey responses.

Delimitations

A delimitation of this study is the equestrian simulator used. Although this study explored how motor skill acquisition in SBL was affected by feedback modality, the simulator and motor skills are specific to the sport of equestrianism. Therefore, it is unknown if the results of this study would apply to other subjects and fields using simulation in motor skill acquisition.

Definition of Terms

Equestrian(ism): The individual committed to riding a horse and the collective act of riding a horse for sport.

Balance: The symmetry of movement along the mediolateral or anteroposterior axis of an equine's back that is the same from zero or centered. Balance in horseback riding is synonymous with the symmetry of movement on both sides of the center (Olivier et al., 2019).

Complex motor skill: Wulf and Shea (2002) define complex tasks as those that contain multiple independent body movements with various degrees of freedom needed to coordinate a task, require a high cognitive demand and domain knowledge, and external conditions impact the execution of the task.

Lateral Balance: The left to right, or mediolateral, symmetry of a rider's seat (Olivier et al., 2019).

Longitudinal Balance: The front-to-back, or anteroposterior, symmetry of a rider's seat (Olivier et al., 2019).

Presage: Carless (2019b) defines presage as all the factors that learners possess from their prior experiences and the factors involved with the instructor's teaching context of a feedback experience. Presage factors directly influence Process factors and subtly influence Product factors.

Process: Carless (2019b) defines Process as all the factors a learner engages or disengages with while emerging in the feedback experience. These factors include whether they engage, sense-make, dialogue, and manage their emotions while receiving feedback. Process factors directly influence Product factors and more subtly influence Presage factors.

Product: Carless (2019b) defines the Product as the resulting impact of the learner's presage and process factors, including the instructor's teaching context, like the design and implementation of the learning/feedback experience. The Product can be quantitative scores, improved strategies, the use of feedback to contribute to feedback spirals, and using the feedback experience to continue to explore ongoing puzzles.

Seat: The seat of a rider is considered the "movement of the rider's pelvis [to] follow and compensate for the horse's trunk movements allowing the arms and legs to act independently to follow the horse's head and neck motion and to give aids to the horse" (Hobbs et al., 2020, p. 9).

Simulation-based learning (SBL): Creating an experiential learning environment that implements a simulator and simulated scenario that reflects a reality where learners can engage their knowledge and skills in a real-life situation (Barsuk et al., 2012; Lateef, 2010).

Stability: The ability of a rider to move in biomechanical synchrony with the horse in all directions (i.e., left, right, front, and back) so that slight motion occurs from the rider's seat (Lagarde et al., 2005). The ability to synch with the horse means that a rider's seat is moving in and with the exact motion of the horse, which gives the illusion of that rider not moving.

CHAPTER II

LITERATURE REVIEW

Social Constructivism

A paradigm describes a person's "basic assumptions, beliefs, norms, and values" that influence how they see the world (Kivunja & Kuyini, 2017, pp. 26-27). *Constructivism* is a paradigm that places the learner at the center of the cognitive process to construct and build upon knowledge from the amalgamation of new experiences and prior understanding (Kivunja & Kuyini, 2017). Many philosophers, theorists, and psychologists contributed to the present understanding and utility of constructivism and constructivism types (i.e., cognitive, radical, and social constructivism).

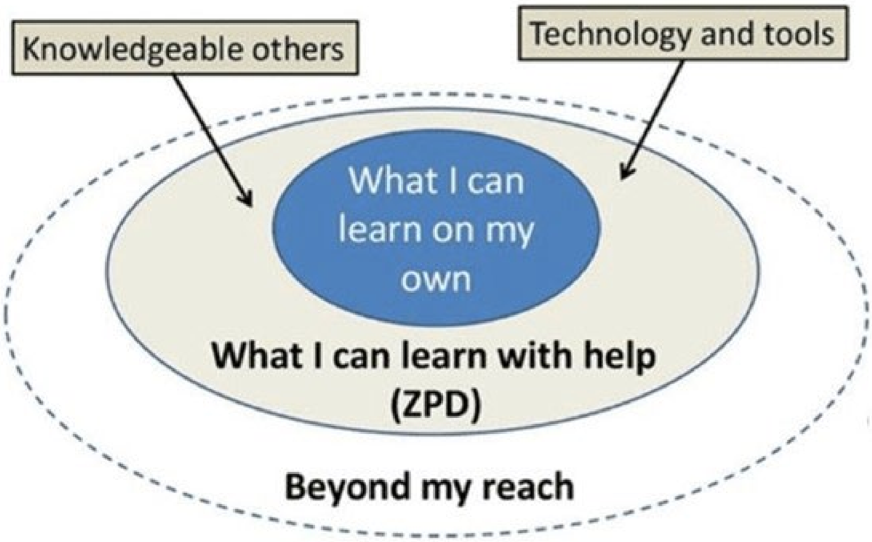
Notably, Immanuel Kant, Jean Piaget, and John Dewey were foundational to the present concept of constructivism. Kant, a German philosopher, was one of the first to postulate that individuals learn through worldly experiences by their innately engendered cognitive schema (e.g., the ability to memorize; Kant & Smith, 1979). Piaget, a Swiss philosopher who studied development in children, builds upon the idea of a cognitive schema and suggests it becomes more complex due to biological development (e.g., maturation) and experiencing the world (McLeod, 2022). Dewey, an American philosopher, asserts that knowledge develops through the organism and the environment via inquiry, action, and experiences. Dewey's constructivism is transactional and "that knowledge concerns not an external, mind or organism independent reality, but rather the relationship between the activities of the organism and the consequences these activities bring about" (Vanderstraeten, 2002, p. 238). In summary, constructivist theorists believe that learning occurs by individuals actively constructing new understanding and meaning as they experience the world and reconcile that with their prior knowledge and experiences.

These ideas and concepts of constructivism lay the groundwork for social constructivism. *Social constructivism* is a separate thread that goes beyond the interplay of the individual and the environment by considering the significant influence that social-cultural norms and the use of language has on a learner. Social communities and the language used allow meaning to be attached to learning and collaborative endeavors to deepen understanding of the world (Vygotsky, 1978). Learning and development are deeply interwoven with the social contexts where meaning is applied, which is why what an individual knows is a transformative process and not transactional like the behaviorist would describe it (Palincsar, 1998).

Vygotsky's contributions are central in the underpinning of the delineation of social constructivism from constructivism learning theory. Within Vygotsky's social constructivism, he developed the zone of proximal development (ZPD) to explain how learners improve and expand their cognitive schema. The more knowledgeable individuals provide a process to scaffold information and learning so that the learner can co-construct new knowledge and skills (Vygotsky, 1978). Learners have three schemata of cognition (see Figure 1). There is the primary schema of current knowledge and skills that a learner can use independently; an intermediary schema that represents the knowledge and skills a learner can understand and do with help from a more

Figure 1

Zone of Proximal Development



Note. From "Lev Vygotsky's Sociocultural Theory of Cognitive Development," by S. Mcleod, 2023, *Simply Psychology* (https://simplypsychology.org/vygotsky.html). Copyright 2013 by Steve Wheeler, University of Plymouth.

knowledgeable individual; and an inaccessible cognitive schema of what they are not capable of understanding or doing, nor could they know or do even with assistance (Vygotsky, 1978). The intermediary schema is what Vygotsky defines as ZPD. This area is where a learner can be cognitively stretched, with guidance, to make the information and skills something they can do independently. Once the ZPD is mastered, the process starts again, and the individual can expand into more complex and sophisticated knowledge.

Theoretical Framework

The theoretical framework that underpins this study is social constructivist learning theory and its orientation within the feedback process. This study's design, implementation, and analysis are under the epistemological assumptions of social constructivism that an individual generates knowledge through the interdependence of social and cultural practices (Hattie & Timperley, 2007; von Glasersfeld, 1995). The function of feedback practices, approaches to motor skill acquisition, and situating learning in simulation-based environments are all operationalized through the lens of social constructivism.

Feedback

Feedback Origins

Feedback methods and models emerged through the work on improving formative assessment practices. As emerging cognitive learning theories developed in the mid to late 1900s, assessment practices began diversifying from standardized testing to testing as an ongoing informative process (Giordano, 2005; McDowell et al., 2009). Specifically, this informative assessment process gained prominence when Scriven (1967) discussed the concept of "formative evaluations" for identifying areas where a program curriculum could improve.

Later, Bloom (1968) furthered the implications of formative assessments through his mastery learning theory that used formative evaluations as a diagnostic tool for helping students with academic success (Black & William, 1996). Bloom et al. (1971) believed that once an instructor developed their learning expectation and taught the relevant information, a formative evaluation's "purpose is to give students information, or feedback, on their learning" (Guskey, 2005, p. 3). Sadler (1989) expanded the idea by officially coining the term' formative assessment.' Sadler also explained how formative assessments differ from other assessments by providing specific feedback informing the learner on how to close the learning gap to achieve a learning goal (McDowell et al., 2009). As the development of formative assessment practices persisted, it became apparent that feedback stood out as a defining characteristic in improving learning.

Defining Feedback

Initially, feedback was based on behaviorism principles and implemented as a one-way statement of providing results about the learner's correctness (e.g., test score, grade; Hattie & Timperley, 2007; Sadler, 2010). However, Kulhavy (1977) states that just because corrective feedback has been provided, it does not mean that it "reinforces" changes in the learning or behavior because this type of feedback does not assuage a learner's misunderstanding (pp. 212-216). So, for feedback to be effective in improving learning, it must operate within an instructional and remedial function (Hattie & Timperley, 2007; Kulhavy, 1977; Kulhavy et al., 1985).

Feedback as an instructional component can correct incorrect information; provide insight into the weaknesses of the student's learning process; and improve the student's internal self-regulatory response to remediation, assessment, and efficacy (Hattie & Timperley, 2007, p. 90). In addition, the feedback closes a learning gap by informing the learner where they are, where they need to be, and what next steps are needed. Finally, feedback structure should require action from the learner to compare what they presently know with what they are experiencing in the learning and remediate that into new knowledge.

Feedback Situated in Social Constructivism

When operationalized through the social constructivist lens, feedback becomes the instructor and learner discourse around improvement. As Carless (2019b) explains, “Feedback needs to be conceptualized as a dialogical process that involves coordinated teacher-learner and peer interaction as well as active learner engagement” (p. 52). Situating feedback in this context aligns well with Vygotsky’s (1978) theory of social constructivism since a “more *knowledgeable* other” is an essential part of knowledge construction.

Instructor Role

The instructor may perform several roles (e.g., expert, facilitator, coach, consultant, advocate) in the learning setting to encourage learner agency and cooperation (Carless, 2020). Instructors are not imparting feedback as a passive transfer of information but providing it to help empower and co-construct knowledge with the learner (Amineh & Asl, 2015). The instructor’s disposition should motivate the learner to engage in the feedback process. Instructors’ actions and facilitation in the feedback should also reduce the power struggle so that a learner can trust the instructor and a collaborative relationship can exist. As Boud and Molloy (2013) affirm, “[p]ower relations profoundly influence trust and indeed other features of the learning milieu” (p. 709). Suppose a learner has a relational issue (e.g., mistrust, imbalance of power relations) with the instructor. In that case, there is a high likelihood of the student resisting collaboration, having a negative emotional response to feedback (e.g., becoming defensive, feeling anxious), and rejecting the feedback entirely (Boud & Molloy, 2013;

Carless, 2006; Ryan & Henderson, 2018; Yang & Carless, 2013).

Orienting feedback as a social practice requires instructors to be transformative in their thought and ideas, being open to new ways of solving problems in collaboration with the learner, especially since every learner will come with a variety of prior knowledge and experiences (Akpan et al., 2020; Boud & Molloy, 2013). Therefore, the instructor being the more knowledgeable individual, should impart their expertise by providing questions to promote inquiry, help scaffold tacit knowledge, clarify feedback (i.e., frame of reference, sense-making), and help the learner restructure previous experiences with present ones (Hattie & Timperley, 2007). Along with these notions, an instructor should also encourage the learner's agency to seek out other sources of feedback (e.g., peers, technology, and self-evaluation; Boud & Molloy, 2013; Carless, 2019a; Lipnevich & Panadero, 2021).

Learner Role

In the framework of social constructivism, the learner's choice to actively participate in the feedback process is vital to their success. Lipnevich and Panadero (2021) stated:

> In contrast to the earlier conception where "feedback was done" to the student, in the most current models the learner is not only at the center of the feedback process, but is now an active agent that does not only process feedback, but responds to it, can generate it, and acquires feedback expertise to engage with it in more advanced ways. (p.2)

Through this understanding, students need to take responsibility in the feedback process and "seek information, make sense of it and undertake subsequent tasks, to enable the translation of newly constructed knowledge into practice" (Molloy et al., 2020,

p. 528). If students fail to interact with the feedback and the instructor, the feedback process becomes null.

However, learners struggle to take accountability for the feedback process because past experiences with feedback have been "teacher-generated inputs" and fail to be an impetus for learner action (Molloy et al., 2020, p. 528). Learners may understand what the feedback means concerning their work or performance. Nevertheless, the instructor did not require that the learner engages with the feedback to remediate, make improvements, and be allowed to "try again." As a result, when individuals have opportunities to engage with the feedback, some will lack the understanding and experience to engage with it (Winstone et al., 2019).

Feedback Literacy

Adding to the learner's role in feedback is their ability or inability to effectively use feedback as a learning process, defined as "feedback literacy." Sutton (2012) coined the term and stated:

> Becoming feedback literate is part of the process that enables learners to reach the standard of disciplinary knowledge indicated in module and programme learning outcomes, subject bench marks etc.; that assists learners in forming judgements concerning what counts as valid knowledge within particular disciplines; and that helps them develop the ability to assess the quality of their own and others' work. (p. 33)

As depicted in Figure 2, Carless and Boud (2018, pp. 1316-1320) proposed four interconnected conditions that lead to students acting on the feedback they receive.

1. Appreciate feedback: Students will value all forms of feedback and, in return, identify their responsibility in implementing the feedback;

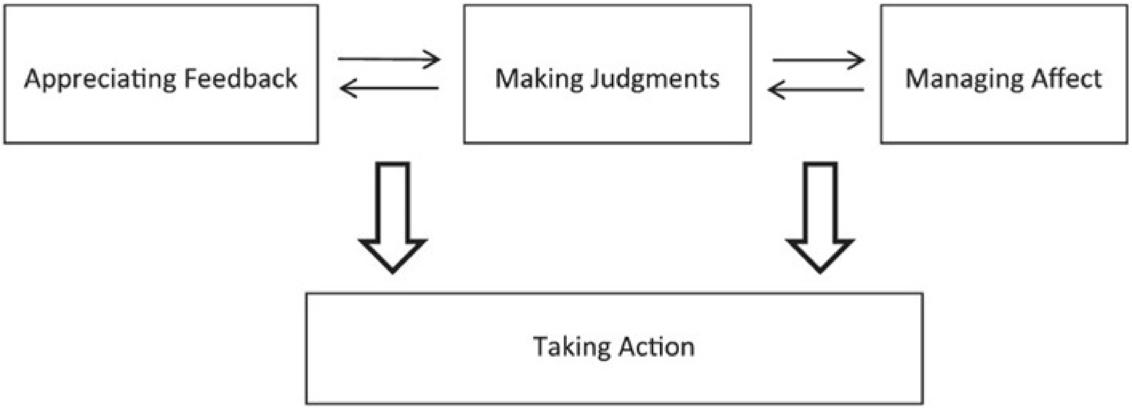
2. Making judgments: the ability to make judgments about the quality of their

work and improve the ability to self-evaluate over time;

3. Managing affect: withholding negative emotions (i.e., defensiveness) when receiving feedback and actively seeking feedback; and
4. Taking action: making sense of the feedback to improve learning and understanding.

Figure 2

Features of Student Feedback Literacy



Note. From “The Development of Student Feedback Literacy: Enabling Uptake of Feedback,” by D. Carless and D. Boud, 2018, *Assessment & Evaluation in Higher Education, 43*, 1315-1325. (https://doi.org/10.1080/02602938.2018.1463354). CC BY-NC-ND 4.0.

If any of these conditions are lacking from a learner, the result is a low level of feedback literacy. Even if the instructor uses evidence-based best practices in the learning environment to support learner success, a low level of feedback literacy means the learner will likely make little progress. For effective learning through the feedback process, learners must develop the skills and aptitudes to become feedback literate.

Motor skill Acquisition

The motor skill acquisition is learning specific bodily movement(s) to accomplish a performance task. There are two levels of motor skill acquisition tasks: simple and complex. Wulf and Shea (2002) defined complex tasks as those that contain more than one degree of freedom in body movement (i.e., multiple independent body movements needed to coordinate a task; Franklin, 2020), require multiple practice sessions to achieve expertise, require a high cognitive demand, and external conditions (i.e., weather, other individuals, terrain, external movement) impact execution. An excellent example is the complex motor skill tasks required in sports (Yamamoto et al., 2019).

Simple tasks, in contrast, require one coordinated movement, low cognitive demand, minimal time to move from novice to expert, and are not influenced by external conditions (Wulf & Shea, 2002). An example of a simple motor skill would be typing on a keyboard. In motor skill acquisition, the factors that deem a skill complex are also why a complex motor skill requires "more time, practice, and feedback" to achieve mastery or expertise (Cecilio-Fernandes et al., 2020, p. 768).

Acknowledging that factors from the learner's expertise also influence task complexity is important. For example, the "functional task difficulty" concept explains how a task's complexity will decrease as individuals work towards expertise (Guadagnoli & Lee, 2004, p. 213). The complexity of the task characteristics is reduced for experts because they are more efficient in motor movement, quicker in their response times, require a lower cognitive demand, improved muscle memory, and have an increase of procedural and tacit knowledge (i.e., proceduralization; Cecilio-Fernandes et al., 2020, p. 768; Wulf & Shea, 2002). Guadagnoli and Lee presented an excellent example of functional task difficulty by explaining that if external conditions change in golfing, like high winds during a "75-yard pitch shot to a green over a pond of water," this increases the difficulty of the task (p. 213). However, it is still much easier for the expert than the beginner. Specifics of situations like this illuminate the fact that task complexity can be subjective based on the performer's previous experiences.

Feedback in Motor skill Acquisition

Since learning a complex motor skill is different than a simple skill, it is important to identify what factors are imperative to the learner's success. In motor skill acquisition, because of the inherent nature of proprioception (i.e., a person's ability to know their body's position in relation to the world around them, Merriam-Webster, n.d.), a learner will need deliberate practice that includes feedback about their intrinsic body movements and their body movement within the spatial environment (Todorov et al., 1997). Deliberate practice "occurs when an individual intentionally repeats an activity in order to improve performance" (Campitelli & Gobet, 2011, p. 280). Deliberate practice is needed in motor skill acquisition to develop accurate motor pathways, automate movement, and build expertise (Baechle et al., 2022; Ericsson et al., 1993).

Feedback during practice is classified based on the source providing it. *Augmented feedback* comes from an extrinsic or outside source (i.e., instructor, simulator, peer). If it is from the learner's internal sensory and perception (i.e., vestibular senses), it is considered intrinsic feedback (Sharma et al., 2016). *Intrinsic feedback* is not always beneficial for novice learners because they have yet to develop enough skill, nor a frame of exemplar execution, to know what sensory input to recognize. However, as an individual receives augmented feedback to improve a motor skill, so will their ability to use intrinsic feedback (Anderson et al., 2019; Sharma et al., 2016). For example, when a beginner is first learning to downhill ski, they need more sensory experience on how to stay balanced while going over bumpy snow. Hence, they need augmented feedback to inform them how to keep their balance. Once they become proficient at skiing over bumpy terrain, they rely on their intrinsic feedback to guide their movements to maintain balance.

Two categories comprise augmented feedback: knowledge of results and performance. Knowledge of results (KR) is the feedback received about the overall performance (Lauber & Keller, 2014; Weeks & Kordus, 1998). Knowledge of performance (KP) can be “descriptive or prescriptive” feedback that informs the learner about specifics areas of the execution of their motor skills. KP can be provided during (i.e., concurrent) or after (i.e., terminal) the performance (Magill, 1994; Petancevski et al., 2022, p. 2). For example, in firearm shooting, KR would be feedback discussing the shooting score, while KP would be feedback about characteristics of the shooting performance, such as pitch and aim deviations (Sigrist et al., 2013).

Augmented feedback can also come from various modalities: verbal, haptic, auditory, visual, or any combination (i.e., multimodal; Petancevski et al., 2022; Sigrist et al., 2013). Verbal feedback is language, such as feedback verbally provided by a sports coach. Haptic feedback refers to a tactile or sensory mechanism that helps inform the motor skill’s motion, such as a resistance from a paddle in a rowing simulation. Auditory feedback is sound specific to the task, such as the hoofbeat sequences of a horse. Visual feedback is any visual representation of the motor skill, including a video of the learner, kinetic information of motion displayed as graphs or charts, or feedback from a mirror.

In the literature on augmented feedback, there has been a focus on which characteristics of augmented feedback best serve the improvement of motor skill acquisition. Studies examining terminal and concurrent feedback have shown varying results on whether one is more effective. Simple motor skill task learning is more effective when there is a reduction of concurrent and terminal feedback (Wulf & Shea, 2002; Yamamoto et al., 2019), while complex motor skill task learning can improve by continuous, concurrent feedback (Wulf & Shea, 2002; Wulf et al., 1998).

In complex tasks, especially for novice learners, concurrent feedback is beneficial in helping reduce the cognitive load, reducing the development of incorrect motor movement patterns, and helping to inform the learner in transforming knowledge into action (Wulf et al., 1998). However, in simple tasks, continuous, concurrent feedback creates a dependency on feedback, which reduces the development of intrinsic feedback and perceptual planning skills (Chang et al., 2007; Winstein et al., 1994; Wulf & Shea, 2002). In a study examining the effects of concurrent and terminal visual feedback on an individual's ability to improve in a complex motor- skill task, Yamamoto et al. (2019) found that concurrent visual feedback was effective for low-skill levels. Sigrist et al. (2013) examined terminal feedback with various concurrent feedback to see the effects on a complex rowing task. In the findings, the terminal feedback was significant in teaching the complex rowing skill compared to other concurrent feedback modalities. The result forces the learner to rely on their intrinsic feedback to develop the rowing motor movement skill based on terminal feedback from the previous practice. The concurrent feedback degraded and distracted this process, resulting in decreased learning.

In a study examining concurrent and terminal feedback in improving a joint mobilization skill, both groups had similar effectiveness in performance and retention tests on this motor-task skill (Chang et al., 2007). Wulf et al. (1998) found that 100% concurrent feedback on a complex Salomon ski-simulator task was more effective than no or 50% feedback.

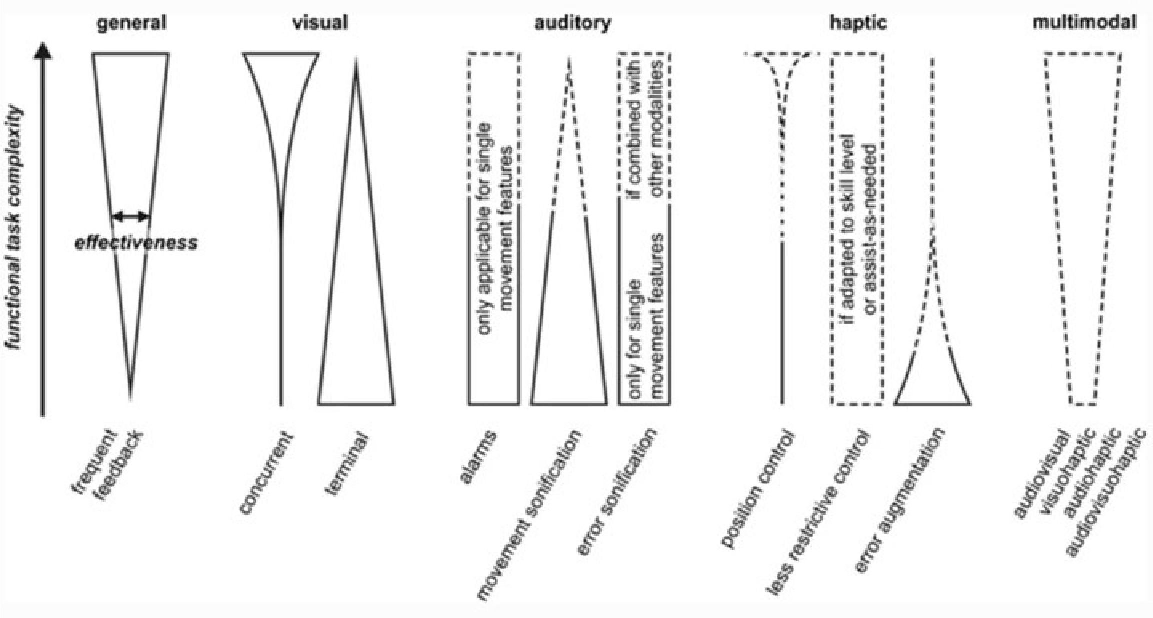
The type of feedback, KR or KP, has varying degrees of influence on learner performance. It is stated in the literature that KR on motor skill acquisition can be a repeat of what a more experienced learner already knows from their intrinsic feedback. Whereas KP is new information the learner needs to know (Zubiaur et al., 1999). However, suppose a learner is new to the motor skill, which indicates they lack intrinsic feedback. In that case, KR is likely still helpful and possesses some effectiveness in the initial learning of the motor skill task (Magill et al., 1991; Zubiaur et al., 1999). KP is also helpful, especially in a prescriptive manner, for novice learners to help provide them with information on how to improve their motor skills (Petancevski et al., 2022).

Sharma et al. (2016) used a simple ball-throwing task with participants' non-dominate arms to determine if KP or KR was more effective in learning. The results demonstrated that while KP and KR feedback improved results for participants, KP was the most improved. Additionally, Oppici et al. (2021) conducted a systematic review to examine the effects of KR, KP, and a combination of KR/KP in motor skill learning. Among the 19 studies selected, a combination of KR/KP was more effective than KR or KP alone.

Sigrist et al. (2013) reviewed the motor skill feedback literature. They concluded that different modalities have different effects based on the learner's experiences, the timing of feedback (i.e., concurrent or terminal), and task complexity (see Figure 3). An important finding in Sigrist et al.'s review is that small amounts of feedback and terminal visual feedback are more effective for simple-motor skill acquisition, which contrasts with complex motor skill learning where a high frequency of concurrent visual feedback as well as the use of multimodal feedback strategies is beneficial. Specifically, multimodal augmented feedback strategies can improve complex motor skill acquisition (Sigrist et al., 2013; Wickens, 2002). Furthermore, supported by Wickens (2002, 2008) multiple resource model, complex tasks require multitasking of different sensory requirements, so providing feedback through multiple modalities allows the learner to

Figure 3

Task Complexity



Note. "Augmented Visual, Auditory, Haptic, and Multimodal Feedback in Motor Learning: A Review," R. Sigrist, G. Rauter, R. Riener, & P. Wolf, 2013, *Psychonomic Bulletin Review*, *20*(1) 21-53. (https://doi.org/10.3758/s13423-012-0333-8). Copyright 2012 covered by CC 4.0 by the Psychonomic Society, Inc.

process information according to the best-suited “processing structure” (Wickens, 2008, p. 450).

It is common practice for augmented feedback in motor skill acquisition to be provided verbally through an instructor or coach (Petancevski et al., 2022; Sigrist et al., 2013). An advantage of verbal feedback is that the language used to provide feedback can be individualized better to fit a learner’s understanding or current cognitive schema. For example, Wulf et al. (2010) stated “that a simple change in the wording of instructions can have a significant impact on performance and learning” (p. 78). The verbal feedback from an instructor aligns with the social constructivist feedback approach by providing dialogue, scaffolding, and a more knowledgeable other that is essential in ZPD. However, examining the feedback approach in motor skill acquisition through the social constructivist lens is limited in the literature (Concannon et al., 2019).

Simulation-Based Learning

Simulation-based learning (SBL) implementation can be a valuable tool for student learning and assessment of critical performance competencies required in their field of study. SBL creates an experiential learning environment that implements a simulator or simulated scenario that reflects a reality where students can engage their knowledge and skills (Barsuk et al., 2012; Lateef, 2010). Research suggests that SBL can improve students’ performances compared to traditional paper- or lecture-based instructional methods (Tian et al., 2015). It also allows learners to master a learning competency that may be challenging to experience before entering the workforce or undergoing the actual situation (e.g., flying emergency landings; Ruiz et al., 2014). For example, in a systematic review, several studies suggested that using SBL in nursing "created a learning environment that contributed to greater knowledge, skills, safety, and students' confidence" (Cant & Cooper, 2016, p. 65).

The need for SBL is multi-faceted from concepts surrounding welfare reasons (e.g., animal welfare), safety concerns (e.g., learning medical procedures on live patients), and the need for deliberate practice. In some instances, like riding horses or traditional medical training practices, the animal's welfare comes into question. For example, in some surgical training programs, anesthetized animals are used to train and assess future surgeons. In a study conducted at the University of Toronto, Martin et al. (1997) used a bench model simulation versus an anesthetized animal to compare the assessment of technical skills. The results indicated no statistical difference between the two assessment models, demonstrating that the bench model had the same efficacy in assessing the technical skills as the live animal (Martin et al., 1997). Using simulations can allow for more welfare-minded practices without compromising the effectiveness of the training. As Ziv et al. (2003) stated, "Simulators can provide models of human physiology and metabolic responses as well as (and sometimes better than) animals typically used for training purposes" (p. 786).

SBL is also valuable for developing skills in an artificial reality that would be dangerous to perform in real time. An example of this is emergency flight procedures. Flight simulators have a high enough fidelity to real airplanes that the Federal Aviation Administration (FAA) uses flight simulators for specific certifications and check rides in place of real airplanes (Federal Aviation Administration [FAA], 2020). Future medical professionals need experience with complex procedures that would be dangerous and unethical if replicated or practiced on a live human or animal. However, without practice and demonstrated competency, they pose a risk to their future patients (El Hussein & Ha, 2023). Even if the trainee is working under the supervision of a professional, risk should be “minimized to the degree possible by medical pedagogy” (Ziv et al., 2003, p. 785). Practicing and failing to produce an optimal result in real-life scenarios is dangerous; however, SBL can provide a safe learning environment for practice, learning, and mastering skills before having to do them in reality. Another area of SBL is using driving simulators to improve driving performance and reduce the risks involved with vehicle crashes. Casutt et al. (2014) studied older adults’ cognition and on-road driving performance using a simulator. They found that performance improvement was much better for the simulator-trained group than for the instruction-only group.

SBL also plays an integral part in reducing some aspects of resources (i.e., live animals, airplanes) and associated expenses, which gives way to the feasibility of deliberate and repeated practice. Simulation technology can be initially costly to purchase. However, the return on investment is associated with the cost-to-benefit ratio by providing more opportunities for learners to practice and remediate errors for specific skills (Lateef, 2010). According to Brabeck et al. (2010), “deliberate practice involves attention, rehearsal, and repetition and leads to new knowledge or skills that can later be developed into more complex knowledge and skills” (para 2). The branches of the Military services are good examples of using simulation technology as a cost-effective but beneficial solution for practice. For example, the Puget Sound Naval Shipyard &

Intermediate Maintenance Facility uses simulation to teach students to paint Navy ships, a crucial skill required for proper vessel maintenance. Teaching with an actual painting scenario costs the Navy 125 dollars in consumables per student per session, including several hours spent for the seaman to suit up instead of practicing painting. Using the painting simulation significantly reduces the waste of these resources (Maxfield, 2019).

Simulator Feedback in Motor Skill Acquisition

Incorporating a simulator to deliver feedback on the motor skill acquisition process has proven to be an effective strategy in several areas. Examining research in the various fields, studies using SBL have confirmed improved motor skill acquisition. For example, SBL scenarios that have proven beneficial include the use of a haptic dental simulator (Al-Saud et al., 2017), the use of a haptic laparoscopic surgery simulator (Zhou et al., 2011), concurrent, visual simulated feedback on racket movement in target shot hitting in table tennis (Todorov et al., 1997), simulation-based verbal, visual, and written feedback on restorative dental procedures (Baechle et al., 2022), accuracy of rifle shooting, and welding techniques of novices (Hadinejad-Roudi et al., 2021). The more complex a task is, the more the learner can profit from simulator-mediated, concurrent feedback. However, it is important to acknowledge that feedback, when delivered continuously and concurrently in complex motor skills (i.e., sport skills), can detract from important "perception-actions" of an individual to adapt skills based on variable of unpredictability (i.e., environmental factors; Arsalan et al., 2021; Tissera et al., 2022).

Using simulator feedback, regardless of the type provided (i.e., haptic, visual, auditory), can be highly effective in motor skill acquisition when coupled with verbal feedback from an expert (Hatala et al., 2014). González and Šarabon (2022b) conducted a study using real-time visual kinematic feedback to reduce the force on a rider and found that the visual kinematic feedback, combined with an expert coach, reduced shock forces in comparison to the expert coach only group. Cecilio-Fernandes et al. (2020) found that using feedback provided from simulator help screens and verbal instruction from an expert yielded higher quality transthoracic echocardiogram images. An important consideration of using an expert in providing feedback with simulator-mediated feedback is that the expert can adapt feedback based on the characteristics of the learner's knowledge, skill, and aptitude at the time of learning. Verbal instruction can provide inquiry prompts that encourage the learner to actively participate in what the simulation feedback means instead of solely focusing on getting better results (Jaszczur-Nowicki et al., 2021). This idea aligns with the feedback literature that multimodal feedback is better than unimodal feedback (Magill, 1994; Sigrist et al., 2013; Wickens, 2002) and demonstrates the social nature of feedback in the learning process (Carless & Boud, 2018; Vygotsky, 1978).

Equestrian Education

According to the American Horse Council Foundation Economic Impact Report (2017), the equine industry is a $122 billion industry that includes six sectors based on horse usage: racing, competition, recreation, equine therapy, rescues/sanctuaries, and utilitarian. The primary function of horses in the equine industry is riding, and the demand and service of riding instruction are evident in all six industry sectors. Jockeys must receive official training, meet physical fitness requirements, and participate in continuing education to receive and maintain licensing to race and train horses on sanctioned tracks (Horseracing Integrity and Safety Authority, n.d.). In addition, several show associations provide training certifications, clinics, and continuing education opportunities for all riders, trainers, coaches, and show officials (United States Equestrian Federation, n.d.). Across the U.S. are thousands of riding programs and lesson schools. For example, in just the state of Maryland, there are over 700 facilities that offer horseback riding lessons (Maryland Horse Council, 2023). Of American colleges and universities, 63 offer 2- or 4-year degrees with titles that specify equine in the name (DataUSA, n.d.). Since the title of degree awarded identifies programs, several more equine programs are likely not accounted for because they operate under broader degree titles. For example, Utah State University has an undergraduate program with an equine emphasis attached to a broader degree awarded as an Animal, Dairy, and Veterinary Sciences B.S. (Utah State University, 2023.).

Traditionally, riding programs use expert instructors to deliver education on riding fundamentals. Instructors use their best judgment to address gaps, provide helpful feedback, and deliver meaningful instruction to help riders achieve the required skills (Brandt, 2004). However, not every nuance of a rider's ineffectiveness is observable, leaving an instructor making assumptions about how to rectify the riding situation (Davis & Maurstad, 2017). Instructing riders can also be complicated by a horse's present emotional state, the riding environment, the confidence of the rider, and a horse's sensitivity to riding cues (Davis & Maurstad, 2017). With beginning and novice-level students, the inherent risk of horses is also an added responsibility in ensuring the learning situations remain safe (Hancock et al., 2007). Instructors may need help identifying the individual's physical and proprioceptive limitations.

Equestrian Complex Motor Skills

Equestrianism is a sport rifled with complex motor skill, mainly due to the high biomechanical demands between the horse and rider (González & Šarabon, 2020, 2022a, 2022b; Hobbs et al., 2020). The rider's responsibility is to sit balanced but independent of the horse. Hobbs et al. explained the independent seat as the "movement of the rider's pelvis [to] follow and compensate for the horse's trunk movements allowing the arms and legs to act independently to follow the horse's head and neck motion and to give aids to the horse" (p. 9). A proper riding seat requires a lot of muscle coordination to stabilize the rider while their base of support (i.e., the horse) is moving and to maintain this stability while communicating with the horse using various physical body cues (Williams & Tabor, 2017). Maintaining a stable seat is also related to horse and rider biomechanical synchrony (Lagarde et al., 2005). Biomechanical synchrony is challenging since the horse has "large vertical and longitudinal accelerations and decelerations" (Hobbs et al., 2020, p. 14) that transmit to a rider. These movement forces and patterns are different for every gait and the transitions between gaits, adding to the physicality required for the rider to execute a simultaneous change as the horse changes (Byström et al., 2009; Williams & Tabor, 2017). The motor function to maintain postural control and stability is a skill that differentiates the expert from the novice riders (Kang et al., 2010; Münz et al., 2014; Olivier et al., 2017; Terada, 2000). Beginning and novice riders manage the influence of the horse's motion by poor motor responses that prompt gripping and stiffening, compromise postural control, and reduce the ability to provide isolated physical cues for effective communication (Williams & Tabor, 2017).

Additionally, learning riding skills can be challenging because of proprioception. Once mounted on a horse, the horse's motion influences the rider's pelvic motion with the same physiological responses of balancing as they would off a horse (Hilliere et al., 2018). The similarity between these motor movements causes the rider to struggle with the proprioception of their body's positioning to the horse's movement since the rider is not in control of activating that response. An example is when a rider's proprioception tells them they are sitting perfectly upright with their torso, but the reality is that they are leaning slightly forward.

According to Jones (2015):

> Horse sports place unusually steep demands on the human proprioceptive system. All athletes have to control muscle contraction, but riders have to contract their muscles while simultaneously keeping them relaxed.... Equestrians need precise gradation of muscle tension to cue horses in smooth, gentle ways. Our brains need to sense not only our own joint angles, muscle lengths, tendon tension and postural balance, but also our horse's joints, muscles, tendons and balance. (para. 4)

The complex physical demands on riders will likely provoke significant dissonance, which must be resolved for proprioception to accurately identify what their body is doing and how to adapt motor coordination when influenced by a horse's motion (Olivier et al., 2017). Ultimately, individuals learning horseback riding competencies face a challenge of their proprioception issues, particularly in balance, that could further complicate the learning curve in achieving learning goals.

Equine Simulation

Equine simulators serve several capacities, including therapeutic interventions, in training jockeys, and as a tool for teaching riding concepts (W. Lee et al., 2018; Walker, Martin, et al., 2016; Olivier et al., 2017). A riding simulator in an academic or professional training program would be beneficial in a multitude of ways: It can support welfare-minded practices by not physically or mentally exposing horses to unskilled riders (Clayton & Hobbs, 2017; Dyson, 2017; Kieson & Abramson, 2017; Lesimple et al., 2010), allowing novice students to begin to build certain motor skills without the variables and risks of a horse (Demarie et al., 2013), provide specific feedback to address and correct rider proprioception (Olivier et al., 2017), and reduce costs and safety concerns associated with equine care and inherent risk (Thompson et al., 2015).

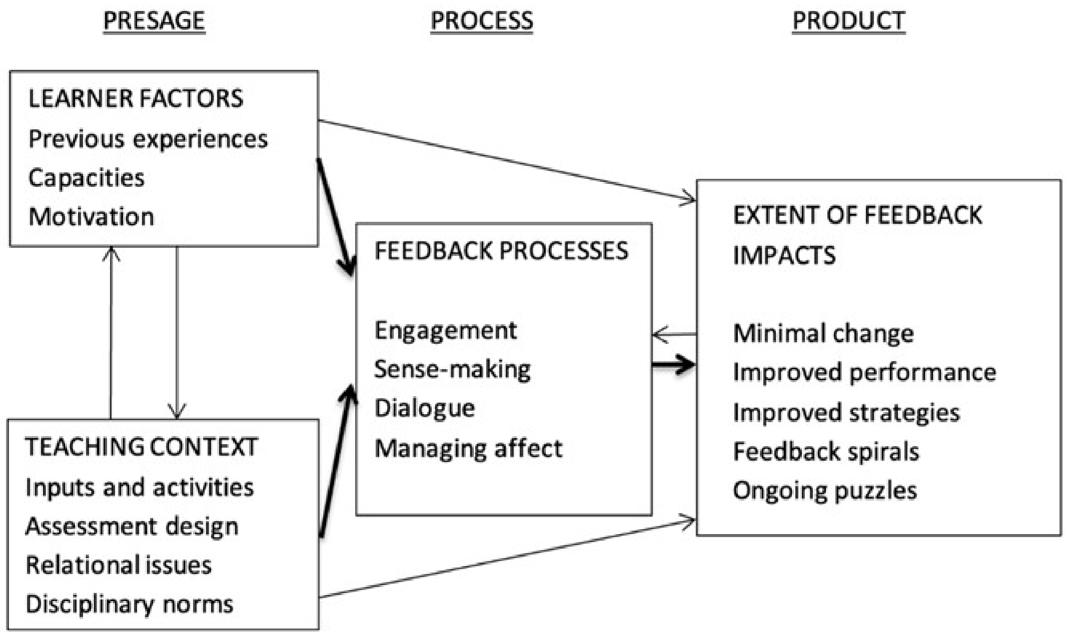
Universities in Sweden, the Netherlands, and the United Kingdom have all included advanced technology of horseback riding simulators in their programs (L. Edwards, personal communication, September 17, 2021). In addition, several public and private training and equine therapy facilities worldwide have used various high- and low-tech riding simulators (Equicizer, n.d.; Fortis, n.d.; Racewood, n.d.). One of the most integrated uses of a horseback riding simulator is by the British Racing School and Horse Racing Authority. In order to obtain various levels of professional licensure, jockeys in the program must pass three fitness tests, one of which is completed on a high-tech simulator, and various skill competencies as outlined in the licensure requirements (British Horse Racing Authority, 2019; British Racing School, n.d.).

Conceptual Framework

Using a social constructivist lens to capture the experience of feedback in motor skill acquisition through SBL, it is essential that influential factors based on previous research and literature are considered and accounted for in this research. To account for the elements of feedback literacy that interplay in an individual's response to feedback and the impact on their learning, Carless (2019b) created the 3P Model of the Learner Experience of Feedback (see Figure 4), an adaptation from Biggs' (1993, 1999) 3P Model of Learning and Teaching. This conceptual model is an appropriate choice based on the theoretical framework of social constructivism.

Figure 4

3P Model of the Learner Experience of Feedback



Note. From "Learners' Feedback Literacy and the Longer Term: Developing Capacity for Impact," by D. Carless (2019b). In M. Henderson, R. Ajjawi, D. Boud, & E. Molloy (Eds), T*he impact of feedback in higher education: Improving assessment outcomes for learners* (p. 53). Springer International. (https://doi.org/10.1007/978-3-030-25112-3_4). Reprinted with permission (Appendix G).

The three main elements (i.e., Presage, Process, Product) are linear in design but have interactional effects that “represent some of the temporal and development aspects” of feedback uptake (Carless, 2019b, p. 52). The first element is Presage, which involves the factors already established within the learner and learning environments. For example, learner factors are prior experiences, dispositions to change and adapt, appreciation of receiving feedback, and desire or motivation to use feedback. Learning environment factors (i.e., teaching context) involve content, pedagogy, relationships between teacher and peers, and specific disciplinary cultures. The second element is Process, which represents how the learner engages with the feedback (e.g., managing emotional responses, processes, interpreting, reflecting, and interacting with others). The last element is Product, which results from what the learner does with the feedback during the Process. For example, Product is when a learner improves their knowledge or skills, develops/expands a learning process strategy, builds upon current understanding, and continues an iterative process of long-term understanding and perspective changing (i.e., feedback spirals and ongoing puzzles; Carless, 2019a, 2019b).

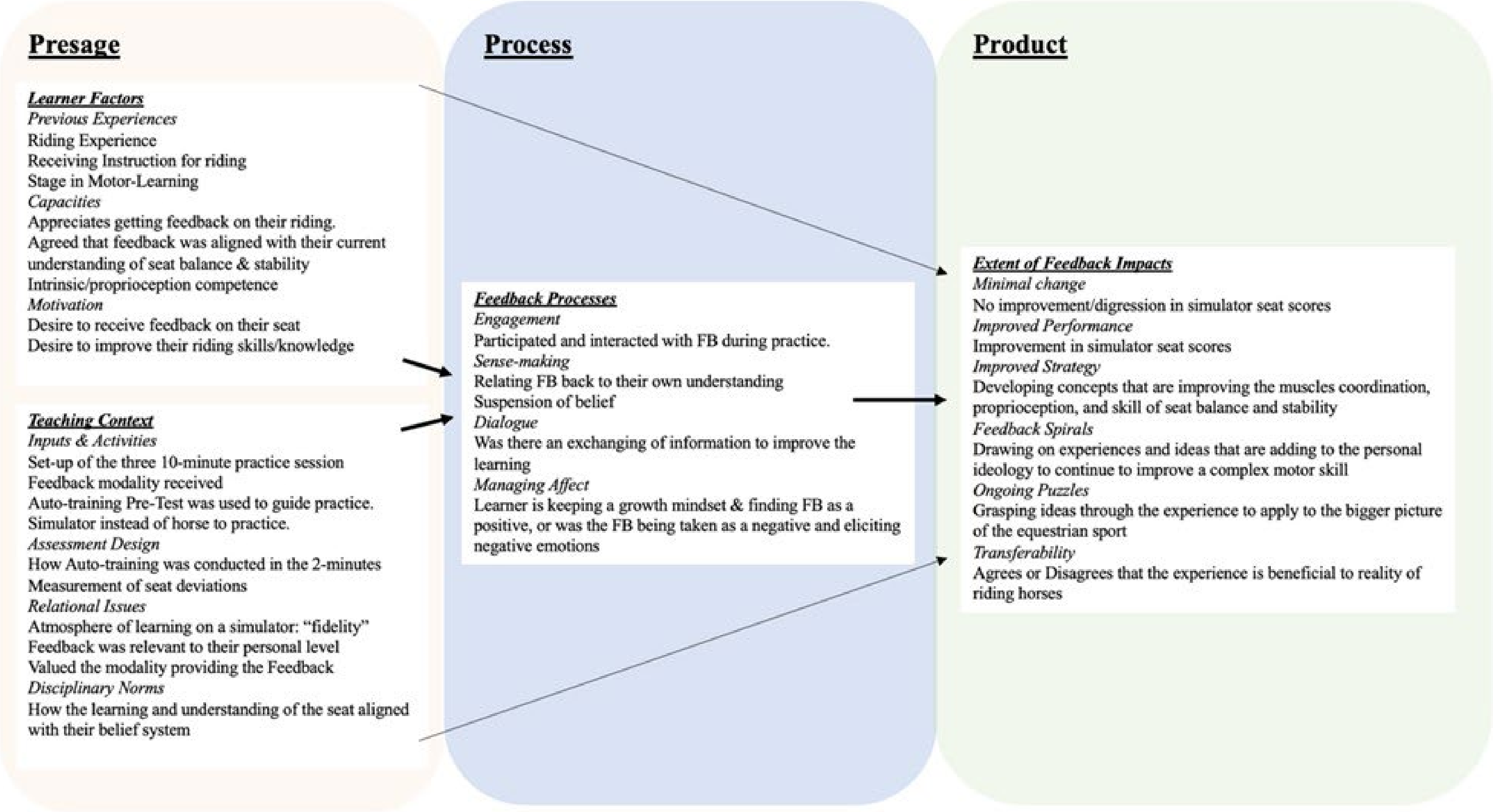
The 3P Model of the Learner Experience of Feedback supports the social nature of feedback (e.g., relational issues and dialogical factors between learner and instructor) and includes the factors that keep the learning process learner-centered, such as the student’s agency and prior experiences. Another highly influential component of the model is the inclusivity of the factors contributing to feedback literacy. Feedback literacy is vital in answering the study’s research questions because it will help illuminate why a learner may or may not engage in the feedback process. For example, a learner may have had an intensely negative affective response to the learning experience because they allowed themselves to get frustrated by the feedback they received. In return, they quit using the feedback and exerting effort, resulting in low to no improvement. An example in practice would be if a learner has recreationally ridden horses on trails for several years but decides to take up competitive dressage riding. Although they have learned to stay on the horse (i.e., not fall off), they must have the disciplinary norms of equestrianism to grasp that staying mounted does not equate to having a balanced and independent seat. Not understanding the difference results in dissonance in their ability to execute the correct motor movement because they assume the motor movement they have done not to fall off was sufficient and appropriate.

This model also considers that improvement is not just a quantification of better scores. In the Product phase of the learner's experience with feedback, it underscores that along with quantifiable improvements, learner improvement can result from improving strategies, the continuation of feedback spirals, and adding to the ongoing puzzles of learning about the subject. For example, a learner may not have improved performance at the end of a learning intervention. However, they did develop a better strategy to utilize that will lead to improved performance which is a viable indication of improvement in learning (Carless & Boud, 2018).

Figure 5 represents how this study overlies on the 3P Model of the Learner Experience of Feedback framework. This framework includes essential elements of the theories surrounding SBL and motor skill acquisition as they relate to the themes of the model. Specifically, the study's design included the Presage, Process, and Product

Figure 5

Adapted 3P Model



Note. This is the 3P Model of the Learner Experience of Feedback interpreted through the elements in this study. Adapted " Learners' Feedback Literacy and the Longer Term: Developing Capacity for Impact," by D. Carless, in M. Henderson, R. Ajjawi, D. Boud, & E. Molloy (Eds), T*he Impact of Feedback in Higher Education: Improving Assessment Outcomes for Learners (p. 53),* 2019b, New York City, NY: Springer International Publishing AG. (https://doi.org/10.1007/978-3-030-25112-3_4). Copyright 2019 by Springer Nature. Reprinted elements at various study points. The Presage represents the aspects of the participants' previous experiences with horseback riding (i.e., skill level) and feedback, as well as the study design to deliver the feedback intervention (i.e., practice sessions, pre/posttests administration, the disciplinary norms of complex motor skill learning (e.g., equestrian sport), and the pedagogical approach of the instructor). What a learner did during the practice sessions represented the Process. The Process is what a learner does with the feedback they have received: engage, sense-make, dialogue, and emotional responses. Finally, the Product represented the quantitative and qualitative findings. Quantitatively, the Product measured the improvement in the stability, lateral, and longitudinal seat scores. Qualitatively, learners discussed whether or not they improved their strategy, the iterative process of feedback spirals, or their understanding of the ongoing puzzle within the equestrian sport.

This conceptual model enhances how nuanced and intricate factors influence a learner's feedback uptake.

Summary

Several educational training programs have adopted simulation technology to advance the learning of complex motor skill acquisition while simultaneously increasing safety, improving welfare, and reducing costs. The existing literature and prior research have highlighted effective ways to implement feedback to improve performance and learning in motor skill acquisition during simulated practice (Al-Saud et al., 2017; Baechle et al., 2022; Hatala et al., 2014; Zhou et al., 2011). In performance fields where the identification of the learner's deficiencies are difficult to observe (i.e., activated motor coordination for balance in horseback riding (J.-N. Lee & Kwack, 2014; Williams & Tabor, 2017), arc geometry and hand motion/speed in welding (Hadinejad-Roudi et al., 2021), simulated feedback can offer specific and concrete measurements to inform practice and improvement.

Combining verbal feedback from an instructor is a common practice in motor skill acquisition, and by combining it with simulation feedback, performance is significantly enhanced (Al-Saud et al., 2017; Cecilio-Fernandes et al., 2020). However, a gap exists in the literature on the relationship between the feedback process and learner aptitude to use the feedback in SBL of motor skill acquisition. Theories and considerations from areas like cognitive load (Buchner et al., 2021; Wulf et al., 1998), multiple resource model (Wickens, 2002, 2008), and guidance hypothesis (McKay et al., 2022; Wulf & Shea, 2004) have attributed to the success or failures of certain aspects of the feedback modalities. However, the ability to learn and improve depends on the learner's uptake of feedback, which depends on several factors of a learner's social and personal constructs, providing insight into why feedback modalities affect learner motor skill acquisition.

CHAPTER III

METHODOLOGY

The purpose of this study was to evaluate how feedback during simulated-based practice influences performance outcomes related to complex motor skill acquisition. Feedback can be delivered in different modalities and this study specifically examined instructor-mediated feedback (i.e., verbal), simulator-mediated feedback (i.e., visual), and a combination of both (i.e., multi-modality). Additionally, further investigation in the study extended into examining effects of rider skill level and perceptions of feedback and simulation-based practice on performance. This chapter discusses the methodology used to conduct the research.

Research Objective and Questions

Research in complex motor skill acquisition (Magill, 1994; Sigrist et al., 2013; Wicken, 2002; Wulf et al., 2001) demonstrated that feedback received from multi-modalities is effective in improved performance. Feedback research studies also demonstrated that when individual feedback literacy is high (Carless & Boud, 2018; Sutton, 2012; Winstone & Carless, 2019), feedback is dialogical (Carless, 2019b; Nicol, 2010) and feedback provided KR and KP (Oppici et al., 2021; Sharma et al., 2016), uptake of feedback is improved, resulting in improved learning. The objective of this study was to determine how the feedback modality provided during simulation-based practice influences participants performance and perceptions of motor skill acquisition (i.e., seat stability and balance).

The following research questions guided the focus of the study.

1. How does the type of feedback modality experienced during practice affect the performance of seat stability and balance?

   Null Hypothesis: There is no significant difference between control and treatment groups of performance in a rider's lateral balance, longitudinal balance, and seat stability.

2. What is the rider's perception of their feedback experience while using a horseback riding simulator to improve seat stability and balance?
3. What is the rider's perception of their improvement while using a horseback riding simulator to improve seat stability and balance?
4. What is the rider's perception of using a horseback riding simulator as an instructional tool to improve seat balance and stability?

Research Design

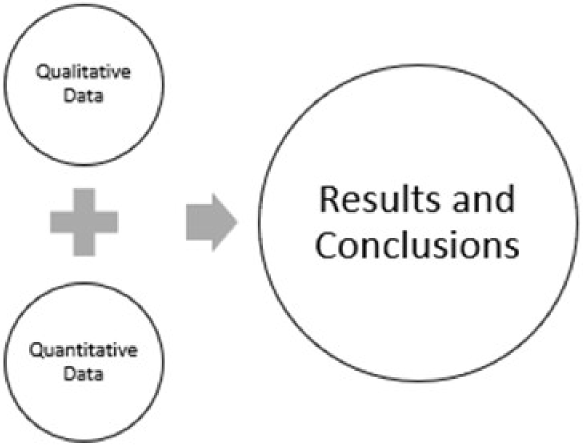
All methods were approved by Utah State University's Institutional Review Board (IRB# 12750). This research study used a mixed methods design to examine the effectiveness of feedback modalities on complex motor skill acquisition, while focusing on the impact simulation-based practice had on rider performance and perception. Mixed methods is an approach that expands and validates the understanding of the research questions from two data sources (Creswell, 2015; Morse, 1991). Plano Clark (2019) described mixed methods as a way for researchers "to describe contextualized outcomes, to identify relationships and explain the mechanisms behind those relationships, or to generate and test hypotheses and theories" (p. 107). In this study, quantitative and qualitative data were essential in understanding the complexity of the relationship of motor skill acquisition to the participant's learning experience with feedback and simulation-based practice.

Triangulation Mixed Method Experimental Design

A triangulation mixed method experimental design was the approach used to mix quantitative and qualitative data (see Figure 6). This mixed method approach was employed to deepen the quantitative results with qualitative explanations that provided how the findings occurred through the lens of the participant's experience (Creswell & Plano Clark, 2011; Malterud, 2001). Both quantitative and qualitative methods occurred in the same phase and the interpretations were used to "validate, confirm, or corroborate quantitative findings with qualitative findings" to help answer the research questions (Creswell & Plano Clark, 2011, pp. 64-65).

Figure 6

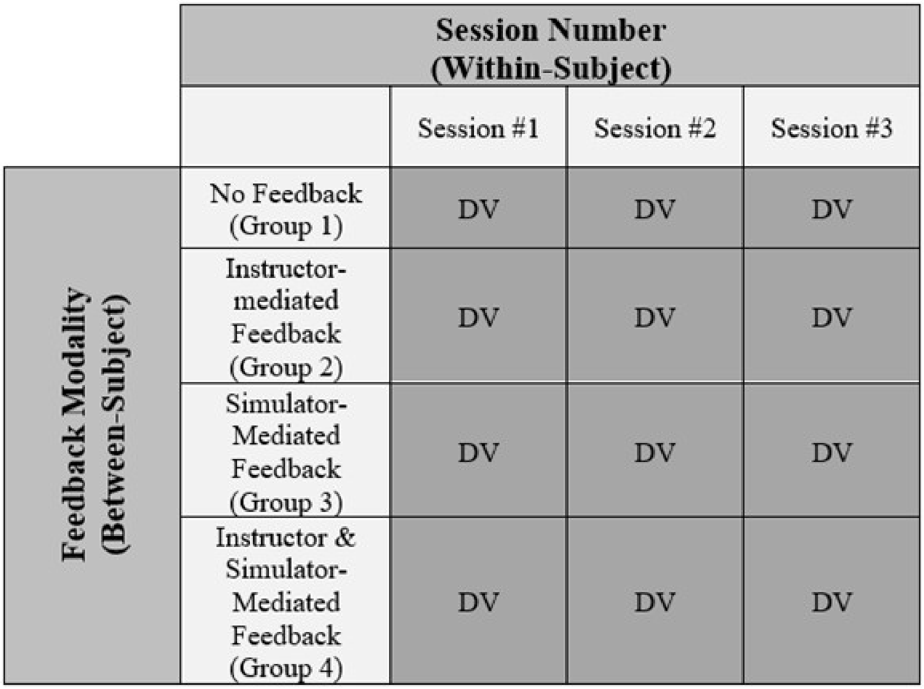
Study Design: Triangulation Design



The quantitative instrument provided statistical results on the impact of the feedback modalities while the qualitative instrument provided data on the participant's experience and perception of the intervention and simulation-based practice (Curry et al., 2009). The quantitative research was a randomized controlled experiment with a 4x3 mixed factorial design (see Figure 7). This study design accounted for the stratified randomization of participants into one of four study groups (between-subjects) and the repeated measures across three practice sessions (within-subject). The qualitative research was a survey research design using open-ended survey questions. Both data sets were collected concurrently, analyzed separately, and the results were triangulated to develop conclusions and interpretations of the research questions (Creswell, 2015).

Figure 7

4x3 Mixed Factorial Research Design



		Session Number (Within-Subject)		
		Session #1	Session #2	Session #3
Feedback Modality (Between-Subject)	No Feedback (Group 1)	DV	DV	DV
	Instructor-mediated Feedback (Group 2)	DV	DV	DV
	Simulator-Mediated Feedback (Group 3)	DV	DV	DV
	Instructor & Simulator-Mediated Feedback (Group 4)	DV	DV	DV

Independent Variables

The independent variables were the feedback modalities: no feedback, instructor-mediated feedback, simulator-mediated feedback, and both instructor- and simulator-mediated feedback; and practice sessions: Session 1, Session 2, and Session 3. Participant skill level was an extraneous variable that was controlled through stratified randomization to assuage the threat to internal validity. Skill level was also analyzed as a covariate to determine any effect on outcomes.

Dependent Variables

The dependent variables were the measures on three different observational seat scores (i.e., lateral balance, longitudinal balance, and overall stability). Lateral balance is the symmetry of the side-to-side movement. A laterally balanced seat is one that has the same movement to the left as right from center. Longitudinal balance in the symmetry of the front to back movement. A longitudinally balanced seat is one that has the same amount of forward movement as backwards movement from center. Stability is the overall movement front, back, left, and right. A stable seat has as little movement possible in all directions.

Participants

Research Population

The study target population was individuals interested in or currently participating in horseback riding. Participants were recruited from the Utah equestrian community and from the student population in Utah State University's College of Agriculture and Applied Science (CAAS). The rationale for recruiting students from CAAS was that several would have an interest in riding horses or are currently horseback riders since this college includes two equine programs, the Intercollegiate Horse Show Association equestrian teams, and the National Intercollegiate Rodeo Association rodeo team.

Sampling Strategy

The sample size calculation was provided using a *priori* power analysis through G*power (Faul et al., 2007). To detect an effect of $\eta^2 p = .04$ with 80% power in a between-subjects ANOVA (four groups, alpha = .05), G*Power calculations estimated a total of 73 participants ($N = 73$) across four groups.

Recruitment

Participants were recruited through an informational flyer that was posted on Facebook accounts of the horse community in Utah through Utah State University's Equine-Human Science's Facebook account, *USU Equine Experience*. The Facebook accounts that posted the recruitment flyer were Utah Horse Council, Utah Dressage Society, Wasatch Range Eventing of Area IX, Utah Hunter Jumper Association, Utah All Breed Association, and USU Equine Experience. Students in CAAS were also emailed the flyer through their university emails from the college listserv. The flyer discussed the study purpose and protocol, risk and benefits associated with participation in the study, requirements, dates, location, link to Qualtrics survey, participation interest survey, and contact information of the principal investigator and graduate student researcher.

Inclusion Criteria

To meet the inclusion criteria of this study, participants had to be between 18 and 65 years of age, have a genuine interest (motivation) in horseback riding, have the physical capability to get on and off a horse-riding simulator with the assistance of a mounting block, weigh 180 pounds or less, and not possess any contraindications (see Appendix A).

Informed Consent Form

An informed consent form was given to the participants before the study began through the enrollment survey that was accessed through Qualtrics survey software. The form provided participants with full disclosure of the nature of the study. It outlined the procedures of the study as well as the benefits and risks. Participation was voluntary in nature and the participants could leave the study at any time without penalty. Upon completion of all three sessions, participants were compensated with a $10 Tango Card. Participants were also informed on how their Personally Identifiable Information (PII) was kept confidential and protected.

Enrollment

Participants were screened for eligibility through a participation interest survey accessed through Qualtrics survey software. The participation interest survey included questions regarding all the inclusion criteria. If the participant met the inclusion criteria, the survey ended with collecting the participant’s email to be used to send a link to the enrollment survey, also provided through Qualtrics survey software. If any of the questions were answered that violated the inclusion criteria, the participant’s survey ended with a message that they did not meet the inclusion criteria.

The enrollment survey began by asking consent to the Informed Consent

Document. If participants agreed to the Informed Consent Document, the next questions asked participants to acknowledged that participation in the study was voluntary, provide demographic information, and answer a series of questions about horseback riding experience to determine skill level. Skill level questions were adapted from the Intercollegiate Horse Show Association (IHSA) Rider Placement Worksheet (IHSA, 2019). The questions categorized riders based on their experience riding, time spent riding with a professional instructor, and competition history.

Data Collection

Data collection took place during summer 2022. In full compliance with the Institutional Review Board (IRB) guidelines, participant data was protected and confidential. All participants were assigned a research identification code that was used in lieu of the participant's name. Group 1 participants were coded as a 100 number, Group 2 as a 200 number, Group 3 as a 300 number, and Group 4 as a 400 number. The research identification code and participants' electronic data were stored in a password protected file in Qualtrics survey software and BOX, a cloud-based content management system, that only the committee chair and lead researcher had access to. Physical documents were kept in a locked file cabinet. All de-identified documents and data sets will be kept for use in future research studies and stored electronically on an encrypted cloud server that is password protected through USU's IT system.

Instructor Description

The instructor responsible for the instructor-mediated feedback was an equine professional in the Utah State University Equine-Human Science program. She held a B.S. in Equine Science and Management, a M.S. in Agricultural Extension and Education, a *Certified Therapeutic Riding Instructor* certification from the Professional Association of Therapeutic Horsemanship International (PATH, Intl), and was an *Equine Facility Manager Assistant Certifier* through the Certified Horsemanship Association (CHA). She was also an active competitor in the United States Eventing Association.

The instructor was selected for her expertise in equitation science principles, instructional experience in horseback riding lessons, and her pedagogical alignment with the social constructivist approach. She received training to understand the sensor feedback screens and operational cueing of the Racewood Eventing simulator.

Simulator Operator

The simulator operator was the graduate student researcher. She was responsible for placing the Racewood Eventing simulator in the correct mode for the participants and instructor (auto-training, instructional, or screens off), calibrating the saddle and sensors, and reviewing the auto-training results (i.e., pre- and post-test) with the participants. She was trained by the Racewood team on the full operation and functionality of the simulator, including interpreting results and feedback analyses.

Instrument

Racewood Eventing Simulator Instrument

The instrument used to measure the performance of the dependent variables (i.e., lateral balance, longitudinal balance, and stability) in this study was the Racewood

Eventing simulator’s pressure sensors that are positioned underneath the saddle (see Appendix B). The pressure sensors are designed to sense movement of the rider’s seat through four inflated air bags that are embedded in the Korrector Pad (see Figure 8). Pressure from the weight of a rider sitting in the saddle is applied to the Korrector Pad, air flows through pipework to a NXP differential pressure sensor where the signal voltage is produced, amplified, and transferred to the Galil motion controller analogue input. The Galil controller sends the signal to the Unity software in the Racewood Eventing Simulator’s computer system and the signal is output as a data score. The deviation score is represented as a measurement of voltage (V). It should be noted that the score is not a

Figure 8

Korrector Pad

Note. This is the Korrector Pad on the Racewood Eventing Simulator where the four inflated sensor air bags are embedded. A saddle is placed on top of this Korrector Pad and calibrated by the simulator operator.

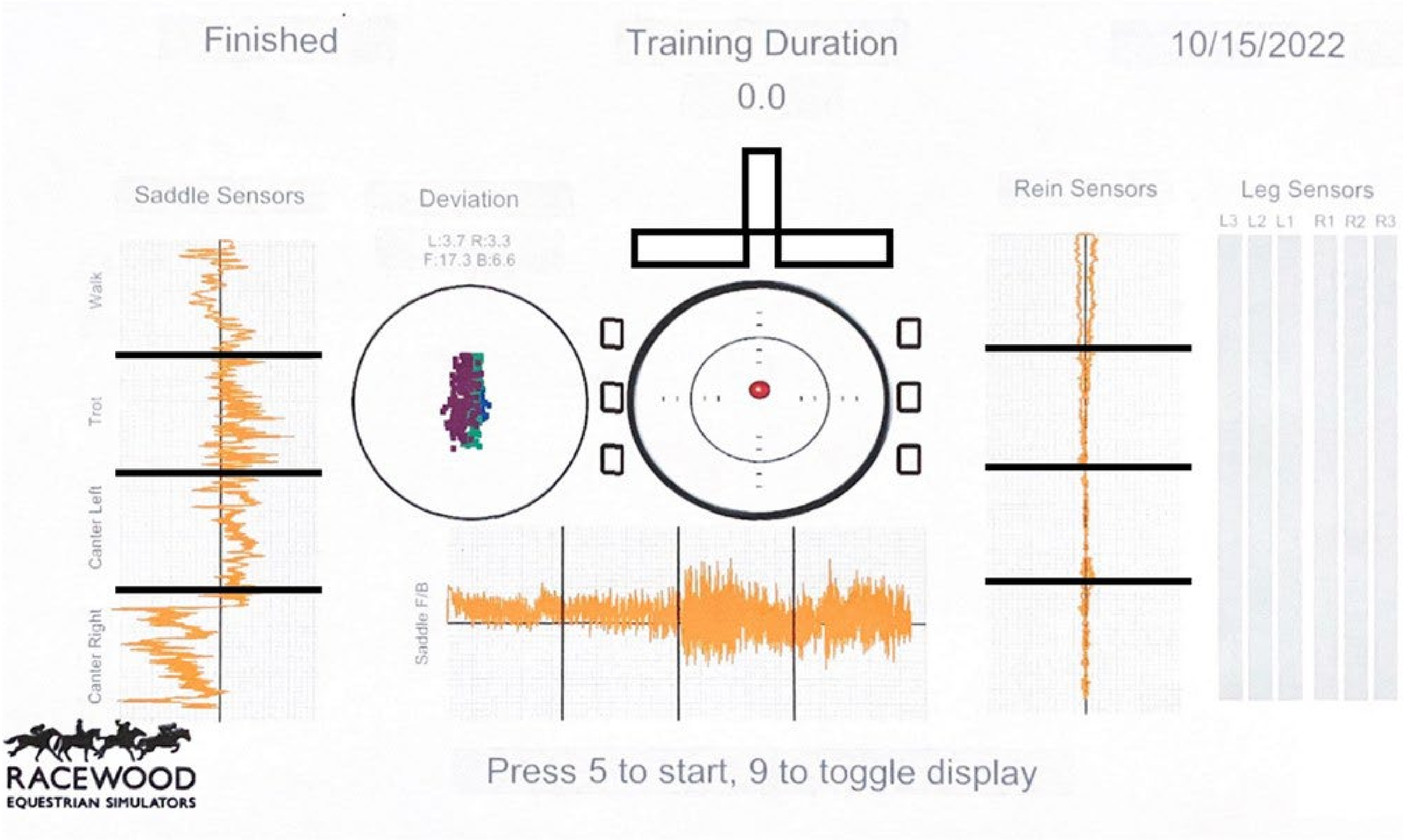
direct measurement of voltage since the NXP differential pressure sensor is amplified by the instrumentation and operational amplifiers in combination with resistors and a potentiometer to offset the zero value (A. Armstrong, personal communication, March 15, 2023).

Seat deviation scores. Figure 9 shows the entirety of the visual metrics and data that are collected during the Racewood Eventing Simulator's Auto-Training session. The seat deviation scores were collected as quantitative data. The deviation scores are a quantitative measurement of a rider's average seat deviations from center (i.e., 0) in four different directions: left, right, front, and back (see Figure 10). The stability score was calculated by adding together all four scores, which represented the overall movement of the seat. The lateral balance score was an indicator of how much symmetry was present in the side-to-side movement of a rider. The lateral balance score was the absolute value of the left deviation score subtracted from the right deviation score.

The longitudinal balance score was an indicator of how much symmetry there was in the movement from front to back. The longitudinal balance score was the absolute value of the front deviation score subtracted from the back deviation score. For all three variables (i.e., lateral balance, longitudinal balance, stability), the measurement of improvement was determined by calculating the difference of the pretest and the posttest scores, by subtracting the posttest from the pretest. Positive scores represented improved performance ($x > 0$), a score of 0 represented no improvement ($x = 0$), and a negative score represented a decline in performance ($x < 0$).

Figure 9

Auto-Training Session Results



Finished

Training Duration
0.0

10/15/2022

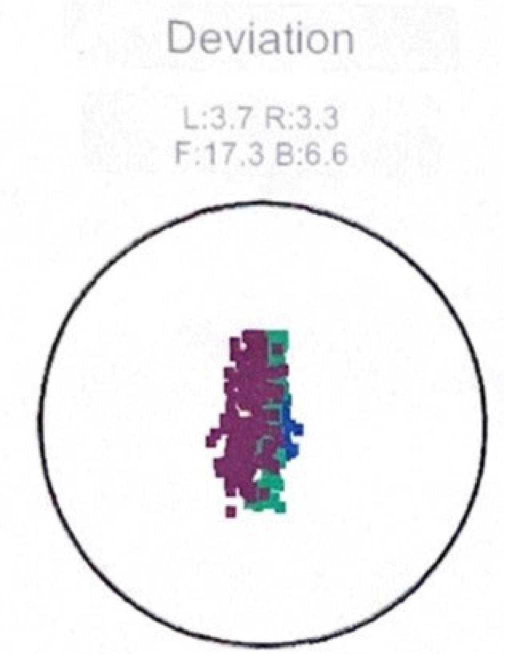
Deviation
L:3.7 R:3.3
F:17.3 B:6.6

Press 5 to start, 9 to toggle display

Note. This is how the kinematics from the rider' s two-minute Auto-Training session are presented from the simulator screens as well as a physical print out.

Figure 10

Deviation Seat Scores



Note. This is the deviation score output that is produced at the end of the Auto-training sessions. L represents the deviations to the left of center, R represents the deviations right of center, F represents the deviations to the front of center, B represents the deviations to the back. The deviation scores are produced by the sensors in the Korrector Pad.

The Racewood Eventing simulator was calibrated by the Racewood engineers to ensure score validity and reliability.

Survey instrument. An exit survey (see Appendix C) was used to collect quantitative and qualitative data on constructs from the conceptual framework and the participant's experience and perception of the intervention and simulated-based practice. The survey used a combination of closed-ended questions (e.g., Likert scales and multiple choice) and general open-ended questions. The exit survey was completed in a paper-format so that filtering of questions could be manually performed by the researchers. Filtering was required so that participants only answered questions relevant to their feedback intervention. An electronic format of the survey would have required the participant to navigate filtering options, and since filtering occurred in every section, an electronic delivery would have been more complicated and confusing for the participants (Jenn, 2006).

The closed-ended questions were developed to address the contextual factors from the three themes (i.e., Presage, Process, and Product) of the conceptual model (Carless, 2019b). The Likert scale response options were based on a five-point scale, balanced with the same amount of negative and positive anchors, and anchors were selected to match Likert indicator statements. Multiple choice questions allowed for participants to select all options that applied, including a write in option (i.e., Other [please specify]) for options not listed. To reduce misinterpretation, questions were written in broad language, omitting the use of study jargon (Champagne, 2014; Jenn, 2006). To improve face validity, open-ended questions were grouped by the 3P constructs of Presage, Process, and Product, and organized to replicate the flow of the conceptual model (Dillman et al., 2014; Jenn, 2006).

The main emphasis of using the survey instrument was to capture qualitative data through open-ended questions. O'Cathain and Thomas (2004) state that even when closed-ended questions are crafted through guidance of pilot studies and focus groups, closed-ended questions are indicative of the researcher's agenda. Rouder et al. (2021) explain that open-ended responses are useful in understanding the "why" of the results and, potentially, reframing the narrative of the quantitative findings. The open-ended questions were structured to capture nuanced details of the participants' experiences that were not exposed in the closed-ended questions, reveal data about the complexity of the relationship between feedback literacy and simulation-based practice, add depth to the quantitative findings, and reveal emerging issues not anticipated by the study. Opened-ended questions were intentionally placed at the end of the survey since they were general in character (Jenn, 2006), meant to stand-alone as their own section of the survey tool (O'Cathain & Thomas, 2004; Rouder et al., 2021), and gave the participant an opportunity to justify any choices made in the closed-ended questions (Singer & Couper, 2017).

The survey was reviewed for face and construct validity by the research team. Adjustments to the survey were made based on the feedback provided.

Procedures

Based on the skill level placement from the enrollment survey, participants were grouped into skill categories: Skill Level 1 (beginners and pre-novice), Skill Level 2 (novice and limited) Skill Level 3 (intermediate and open). Then the participants in each skill category were randomly assigned to a study group. The study groups were Group 1 (control), Group 2 (instructor-mediated feedback), Group 3 (simulator-mediated feedback), and Group 4 (instructor- and simulator-mediated feedback). This was done to keep each group equally balanced with participants from every skill category. Randomization was completed through a *Random Group Generator* online tool (Tarr, 2023). Once participants were assigned to a group, they were assigned a research identification code and emailed instructions to sign up for three training sessions using a Calendly online scheduler link. In addition to signing up for training sessions, the email included a link to a YouTube video that described the basics of the Racewood simulator.

The training sessions were held at the USU Sam Skaggs Family Equine Education Center in Wellsville, Utah. Participants began the first session with the simulator operator introducing the process of the training sessions, explaining study terms (i.e., seat stability, longitudinal seat balance, lateral seat balance, feedback, and function and anatomy of the seat in horseback riding), and reviewing simulator function information from the YouTube video. Any of this information was only repeated in session two and three if requested by the participant.

Each session started with a pretest using the *Auto-training* function provided in the Racewood Riding simulator software. The Auto-training is a 2-minute session that records front, back, left, and right balance deviations, leg and rein pressure over time, and lateral and longitudinal graphs within the three horse gaits (i.e., walk, trot, and canter) (see Figure 9). Front, back, left, and right deviation score data were collected. During the 2-minute session, the simulator moved automatically through all three horse gaits in 30 second intervals, including both canter leads. There was no cueing required from the participant. At the end of the Auto-training, the results were reviewed by the participant and simulator operator to evaluate performance and inform the direction of the practice.

After the pretest, the participants engaged in a 10-minute practice session in the *Instruction* function on the simulator. Group 1 was the control and received no augmented feedback (e.g., no verbal instruction from the instructor or visual kinematics from the simulator screens) during practice. Group 2 had instructor-mediated feedback (i.e., verbal feedback from the instructor only, the visual kinematics from the simulator screens were turned off during the practice) during practice. Group 3 had simulator-mediated feedback (i.e., visual kinematics from the simulator screens were turned on, no verbal feedback from the instructor) during practice. Group 4 received both instructor- and simulator-mediated feedback (i.e., verbal feedback from the instructor and visual kinematics from the simulator screens were turned on and simultaneously presented) during practice. Riders in Group 1 and Group 3 had the autonomy to ride the simulator in any gait, for any length of time during the ten-minute practice sessions. Riders in Group 2 and Group 4 collaborated with the instructor to determine what sequence and length of time to spend in each gait during the ten-minute practice session. The instructor did not have access to the visual kinematics on the simulator screens while instructing Group 2 but did while instructing Group 4.

At the end of the ten-minute practice session with or without augmented feedback, participants completed a posttest by repeating the same Auto-training session as they did in the pretest. At the end of session three, the last session, riders completed an exit survey to capture their perceptions and attitudes of the entire experience as well as answer questions that aligned with factors in the 3P model of the Learner's Experience with Feedback (see Appendix C).

Data Analysis

Quantitative Analysis

The quantitative data was comprised of three separate observational seat scores (i.e., dependent variables): seat stability, lateral seat balance, and longitudinal seat balance for each participant. The three scores were analyzed separately with a *generalized linear mixed model* (GLMM). In the model, group (feedback modality), skill level, session, and their interactions were fixed effects while subject was a random effect. Feedback modality contained four levels, namely, no feedback, instructor feedback, simulator feedback, and both feedbacks. Covariance error structure was heterogeneous compound symmetry to account for the correlations of the repeated measures on each subject over sessions.

The quantitative data analysis was conducted using PROC GLIMMIX in SAS/STAT by SAS Institute Inc. (Cary, NC, USA). Post hoc pairwise comparisons among treatment levels were conducted with Tukey-Kramer method to adjust multiplicity. The alpha level was set to 0.05 to determine statistical significance. This analysis specifically addressed research question one.

The quantitative data from the closed-ended survey questions were exported to Microsoft Excel. The data set was organized into two data sets: study groups and skill levels. Both data sets were analyzed in Microsoft Excel Data Analysis ToolPak (v.16.72) for descriptive statistics for individual items. To fully represent the 3P Model, the items were also analyzed by the Presage, Process, and Product contextual factor groups (see Table 1). Analyzing the survey data by grouping multi-items based on contextual factors added scope and robustness to the participant perceptions, which is otherwise difficult to capture on individual item analysis (Gliem & Gliem, 2003; Spector, 1992). The data were analyzed using Cronbach’s alpha in SPSS (v.28) for post-hoc reliability and to examine correlations between the conceptual framework constructs. These survey data sets were analyzed to answer research questions two, three, and four.

Table 1

Items Used to Measure Contextual Factors

Item	Scale
Presage	
My previous experience with receiving feedback on performance-based tasks helped me utilize the information from the auto training (pre and post-test scores)	5 pt Likert
My previous experience with receiving feedback on performance-based tasks helped me utilize the feedback from the instructor	5 pt Likert
My previous experience with receiving feedback on performance-based tasks helped me utilize the feedback from the simulator	5 pt Likert
What was your level of motivation when it came to improving your horseback riding seat?	5 pt Likert
How would you rate the effectiveness of the training session format (pretest, review, instructional time, post-test, review) in helping you work through improving your seat	5 pt Likert
Process	
How would you rate your engagement with the instructor feedback being given during the instructional portion of the training?	5 pt Likert
How would you rate your engagement with the simulator feedback being given during the instructional portion of the training?	5 pt Likert
How would you rate your overall engagement with the general riding of the simulator to improve your seat stability and balance?	5 pt Likert
How would you rate your understanding of the auto-training results (pre and post-test) you received from the simulator?	5 pt Likert
How would you rate your understanding of the feedback you received from the simulator?	5 pt Likert
How would you rate your understanding of the feedback you received from the instructor?	5 pt Likert
The results of the auto-training pretest helped me improve during the practice portion of the training.	5 pt Likert
Reviewing the results of the auto-training pretest with the Simulator Operator [Kelli] helped me improve during the practice portion of the training.	5 pt Likert
The results of the auto-training pretest helped me utilize the feedback I received during the practice portion of the training.	5 pt Likert
Reviewing the results of the auto-training pretest with the Simulator Operator [Kelli] helped me utilize the feedback I received during the practice portion of the training.	5 pt Likert
Product	
How much do you agree with this statement: The simulator feedback is useful in improving my seat balance.	5 pt Likert
How much do you agree with this statement: The instructor feedback is useful in improving my seat balance.	5 pt Likert
How much do you agree with this statement: Even though I did not receive any feedback during my 10-minute practice time, the simulator is useful in improving my seat balance.	5 pt Likert
How much do you agree with this statement: The simulator feedback improved my strategies for improving my seat balance.	5 pt Likert
How much do you agree with this statement: The instructor feedback improved my strategies for improving my seat balance.	5 pt Likert
How much do you agree with this statement: Even though I did not receive any feedback during my 10-minute practice time, the simulator improved my strategies for improving my seat balance.	5 pt Likert

Qualitative Analysis

The open-ended questions in the surveys provided qualitative data. The data were first analyzed with open exploration using the conceptual 3P Model as an initial priori coding framework. Once open exploration was completed, adaptation of the framework was developed that included emerging themes specific to the study, and a codebook was produced for thematically coding (Braun & Clarke, 2006). The initial codebook was used by the researcher and a second coder to group code 20% of the data to substantiate and clarify definitions and exemplars of codes, including adding in operative words that were exclusive to specific themes. A second coding session occurred with the data set for IRR until a 0.8 Cohen's Kappa was achieved using the modified codebook. The remainder of the data was coded by the researcher. Once all data was coded, the coded segments were extracted, grouped, enumerated (counted), and codes were displayed in a matrix, which helped depict "conceptual overtones" and study outcomes (Miles & Huberman, 1994).

Triangulation

To further examine the perceptions of feedback factors and performance, a convergence of data from both methods was conducted. Quantitative results were used to select participants if they had digressed (i.e., a negative score) or improved (i.e., a positive score) in all three seat scores during session 3. Qualitative results were used to select participants who conveyed negative coded response in both Presage and Process categories. Once selected, all coded responses, seat improvement scores, and exit survey mean scores were used to create a Triangulation Matrix and identify patterns of feedback modality, feedback literacy, and performance on seat scores.

CHAPTER IV

RESULTS

This mixed methods study aimed to examine how feedback modalities impacted the performance of motor skill outcomes and the perceptions of riders using a horseback riding simulator in practice. Results were gathered from one sample population (*N* = 75). The enrollment survey was the resource for collecting demographic information, and a series of questions adapted from the IHSA Rider Placement Assessment (IHSA, 2019) used to determine skill level. A skill level stratum first grouped participants, and then each group level was randomized into one of four treatment groups. Participants performed three practice sessions that began with a pre-test and ended with the identical` post-test conducted in the Racewood Eventing simulator's Auto-Training function. The intervention was applied during the ten-minute practice session in the Racewood Eventing simulator's *Instruction* function. All participants completed an exit survey after the third and final session to provide data on perceptions of the feedback process and simulator use that aligned with the three constructs (i.e., Presage, Process, Product) of the 3P conceptual model and to provide individual experiences not captured from closed-ended questions or the results from the Racewood Simulator pre- and post-tests.

This chapter presents the results of the study. Relevant quantitative and qualitative data, tables, and figures are used to present the results. The following subheadings organize the chapter: (a) demographic data, (b) skill level, (c) quantitative results, (d) qualitative results, (e) triangulation results, and (f) summary. The research questions were as follows.

1. How does the type of feedback modality experienced during practice effect the performance of seat stability and balance?
2. What is the rider’s perception of their feedback experience while using a horseback riding simulator to improve seat stability and balance?
3. What is the rider’s perception of their improvement while using a horseback riding simulator to improve seat stability and balance?
4. What is the rider’s perception of using a horseback riding simulator as an instructional tool to improve seat balance and stability?

Demographic Data

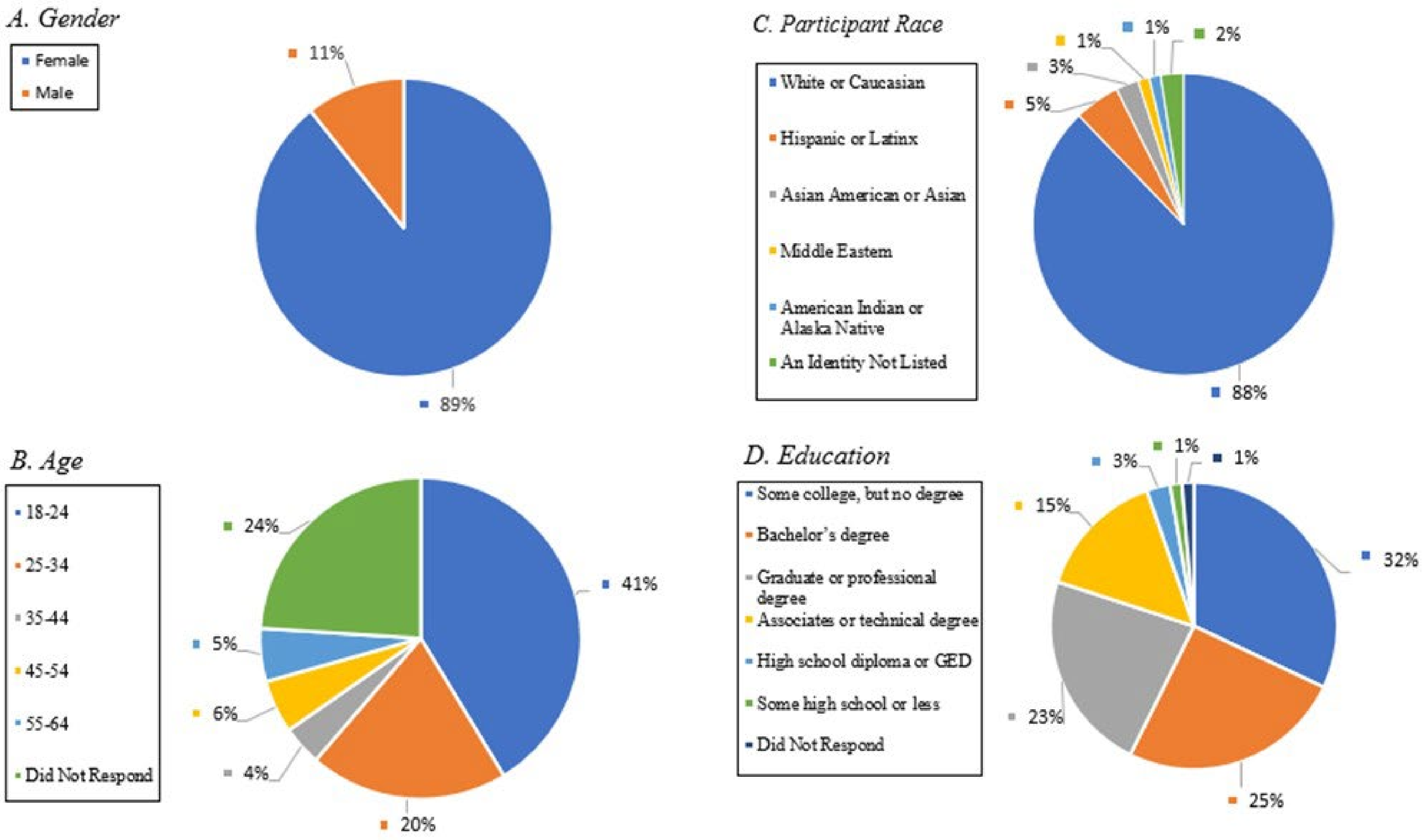
Figure 11 contains the demographic data from the study participants. The study was predominantly female (89.3%), with the remainder of the participants identifying as male (10.7%). All participants agreed through the interest survey to be at least 18 years of age, and through the Informed Consent in the enrollment survey, confirmed to be between the ages of 18 and 65. Most participants were in the age category of 18-24 years of age (41.3%), and the remaining in the age categories of 25-34 years of age (20%), 35-44 years of age (4%), 45-54 years of age (5.3%), 55-64 years of age (5.3%), while 18 participants chose not to respond (24%). Ethnic diversity for the study was represented predominantly by participants of the White or Caucasian race. Most participants were college educated.

Skill Level

Stratified random assignment was used in this experimental mixed methods study. Before randomization into a treatment group, participants were grouped into a skill level stratum through a series of dichotomous questions adapted from the IHSA Rider

Figure 11

Study Participant



Placement Assessment (IHSA, 2019). Participant responses placed them in one of six skill level categories: beginner, pre-novice, novice, limited, intermediate, and open. A second grouping occurred to refine groups into three skills since the largest difference between the similar categories was based on competition wins or assignment (e.g., the only difference between intermediate and open was intermediate participants did not have to show in the professional divisions, where open participants did). Skill level one consisted of participants from beginner and pre-novice categories; skill level two consisted of participants from novice and limited; skill level three consisted of participants from intermediate and open. Table 2 contains the skill levels in each study group.

Table 2

Study Group by Skill Level

	Skill level			
Study group	1	2	3	Total
1	8	7	3	18
2	7	8	3	18
3	10	8	2	20
4	7	7	5	19
Total	32	30	13	75

Quantitative Results

Simulator Observation Scores

Observed scores for the dependent variables were non-normally distributed and correlated due to the time-series design. This violated the assumption of the general linear model. Therefore, the generalized linear mixed model (GLMM) fit the quantitative data collected. The PROC GLIMMIX procedure in SAS/STAT by SAS Institute Inc. (Cary, NC, USA) was used to enter predictor variables as either fixed or random effects. Fixed effects were selected for subjects. Random effects were selected for Group, Skill Level, and Session. The distribution selected by the model was Gaussian, and the estimation technique was Restricted Maximum Likelihood. A three-way interaction model examined interaction effects between Groups, Skill Level, and Sessions. This procedure analyzed the overall model fit (see Table 3). The dispersion parameter (Chi-square/*df* = 1) demonstrated the model is adequate for all three data sets. The model was significant (-2LL = AIC and BIC).

Table 3

Overall Model Fit Statistics

Lateral Model Fit		Longitudinal Model Fit		Stability Model Fit	
-2 Res Log Likelihood	924.76	-2 Res Log Likelihood	1205.90	-2 Res Log Likelihood	1053.17
AIC	932.76	AIC	1215.90	AIC	1061.17
AICC	932.98	AICC	1216.23	AICC	1061.39
BIC	942.03	BIC	1227.49	BIC	1070.44
CAIC	946.03	CAIC	1232.49	CAIC	1074.44
HQIC	936.46	HQIC	1220.53	HQIC	1064.87
Generalized Chi-Square	189.00	Generalized Chi-Square	188.99	Generalized Chi-Square	189.00
Generalized Chi-Square / DF	1.00	Generalized Chi-Square / DF	1.00	Generalized Chi-Square / DF	1.00

Lateral Balance

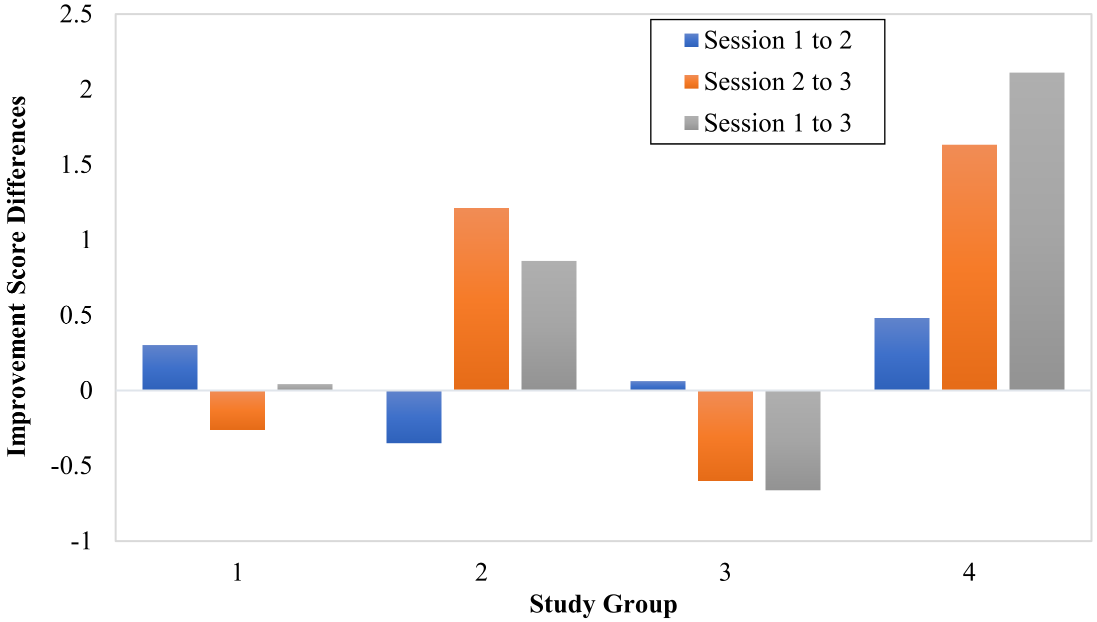
Main effect for Group (*F* (3,126) = 1.36, *p* = 0.257), Skill Level (*F* (2,126) =

1.47, $p = 0.234$), and Session Type ($F(2,126) = 1.32$, $p = 0.271$) were nonsignificant for lateral balance.

Interaction effects between Group and Session for lateral balance improvement scores were examined. Figure 12 illustrates the lateral balance improvement score differences between Sessions for each Group. *F*-tests for Groups 1, 2, and 3 demonstrated no statistically significant differences between Sessions on lateral balance seat improvement scores. A significant interaction was shown for Group 4 ($F(2, 126) = 5.01$, $p = .008$). The post hoc pairwise comparison between Sessions for Group 4 revealed that the difference between Session 1 and Session 3 was significant with a moderate effect size ($t(126) = 2.94$, adj. $p = 0.01$; $d = 0.52$). Differences between Session 2 and Session 3

Figure 12

Lateral Balance Improvement Score Differences Between Sessions for Study Group



Note. Improvement scores are shown for each Study Group and represent the difference between the sessions least square means.

scores were close to being significantly different (*t* (126) = 2.22, adj. *p* = 0.07; *d* = 0.40) (see Table 4). On average, Group 4 Session 1 scores were 2.11 higher than Session 3 scores, which demonstrated that lateral balance was better in Session 3. Notable, the post hoc pairwise comparison for the interaction effect of Group 1 and Session revealed that Session 1 and Session 3 differences were nonsignificant (*t* (126) = 0.05, adj. *p* = 0.999), which demonstrated that there was nearly no change in seat improvement scores from Session 1 to Session 3 for individuals in Group 1. The participants' Session 1 scores for Group 1 were only 0.04 higher than their Session 3 scores.

Table 4

Tukey-Kramer Post Hoc Pairwise Comparison of Group 4 Between Sessions for Lateral Balance

Group	Session	_Session	Estimate	Standard error	*DF*	*t* value	Pr > |*t*|	Adj P
Group 4	1	2	0.4800	0.8025	126	0.60	0.5508	0.8214
Group 4	1	3	2.1095	0.7179	126	2.94	0.0039	0.0109
Group 4	2	3	1.6295	0.7331	126	2.22	0.0280	0.0712

The interaction effect between Session 1 and Skill Level for lateral balance was significant (*F* (2, 126) = 4.54, *p* = .012). The post hoc pairwise comparisons on the interaction found the specific difference between Skill Level 1 and Skill Level 3 for Session 1. During Session 1, Skill Level 1 scored 2.36 higher on average than Skill Level 3 (*t* (126) = 2.73, adj. *p* = 0.02; *d* = 0.49), which demonstrated Skill Level 1 was less laterally balanced in Session 1. No statistically significant difference existed between Skill Levels 1 and 2 or Skill Levels 2 and 3 during Session 1 (see Table 5).

Table 5

Tukey-Kramer Post Hoc Pairwise Comparison of Session 1 Between Skill Levels for Lateral Balance

Session	Skill level	skill level	Estimate	Standard error	*DF*	*t* value	Pr > |*t*|	Adj P
Session 1	1	2	1.4095	0.6461	126	2.18	0.0310	0.0783
Session 1	1	3	2.3646	0.8653	126	2.73	0.0072	0.0195
Session 1	2	3	0.9551	0.8711	126	1.10	0.2750	0.5180

Interaction effects between Skill Level and Session were examined. In the interaction of Skill Level and Session on lateral balance, we saw a significant difference for Skill Level 1 across sessions (*F* (2, 126) = 6.57, *p* = .002). The post hoc pairwise comparisons on the interaction of Skill Level 1 and Session found the specific difference between Session 1 and 3 to be statistically significant with a moderate effect size (*t* (126) = 3.62, *p* = 0.001; *d* = 0.64). On average, these participants scored 2.0 higher in Session 1 than Session 3, which demonstrated that lateral balance was better in Session 3. No statistically significant difference was demonstrated for Skill Level 1 between Session 1 and 2 or Session 2 and 3 (see Table 6). *F-tests* for Skill Level 2 and Skill Level 3 demonstrated no statistically significant difference between Sessions on lateral balance seat improvement scores. Figure 13 illustrates the lateral balance improvement score differences between Sessions for each Skill Level.

Longitudinal Balance

Main effect for Group (*F* (3,126) = 1.01, *p* = 0.392) and Skill Level (*F* (2,126) = 0.30, *p* = 0.734) were nonsignificant for longitudinal balance. Session Type (*F* (2, 126) = 3.99, *p* = 0.021) was significant for longitudinal balance.

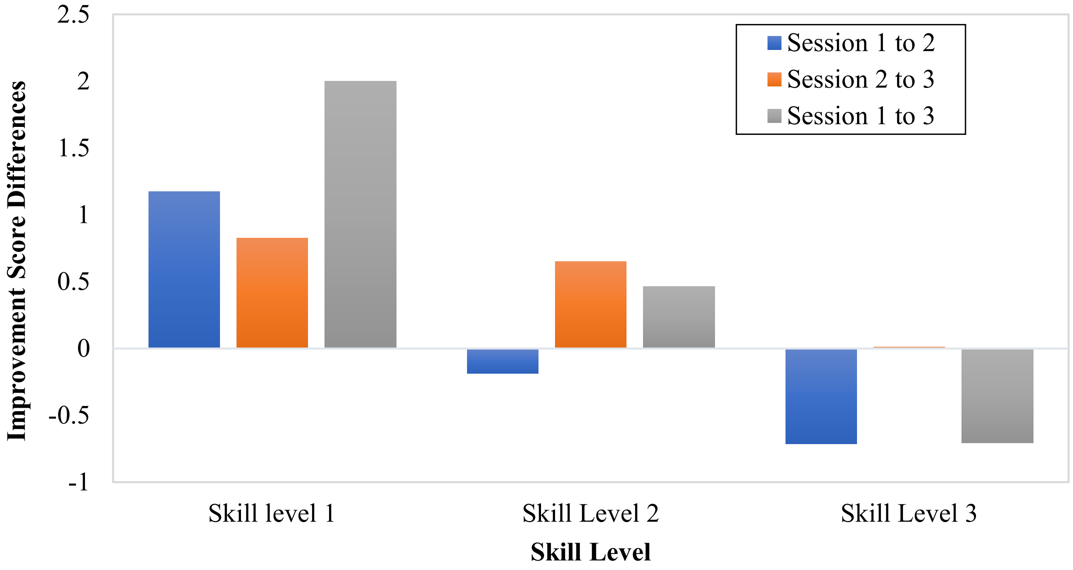
Table 6

Tukey-Kramer Post Hoc Pairwise Comparison of Skill Level 1 Between Sessions for Lateral Balance

Skill	Session	_session	Estimate	Standard error	*DF*	*t* value	Pr > |*t*|	Adj P
Skill 1	1	2	1.1746	0.6172	126	1.90	0.0593	0.1419
Skill 1	1	3	2.0004	0.5521	126	3.62	0.0004	0.0012
Skill 1	2	3	0.8258	0.5638	126	1.46	0.1455	0.3114

Figure 13

Lateral Balance Improvement Score Differences Between Sessions for Skill Level

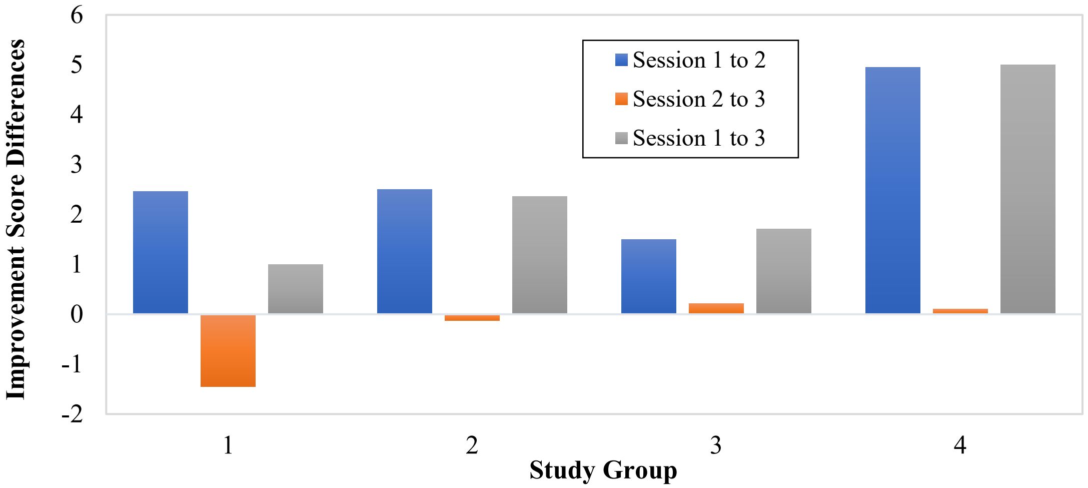


Note. Improvement scores are shown for each Study Group and represent the difference between the sessions least square means.

Interaction effects between Group and Session for longitudinal balance improvement scores were examined. Figure 14 illustrates the longitudinal balance improvement score differences between Sessions for each Group. *F*-tests for Groups 1, 2, and 3 demonstrated no statistically significant differences between Sessions on

Figure 14

Longitudinal Balance Improvement Score Differences Between Sessions for Study Group



Note. Improvement scores are shown for each Study Group and represent the difference between the sessions least square means.

longitudinal balance seat improvement scores. A significant interaction was shown for Group 4 (*F* (2, 126) = 4.45, *p* = .014). The post hoc pairwise comparison between Sessions for Group 4 revealed that the difference between Session 1 and Session 2 scores was significant with a moderate effect size (*t* (126) = 2.55, adj. *p* = 0.032; *d* = 0.45). On average, Group 4 participants' Session 1 scores were 4.96 higher than their Session 2 scores, which demonstrated longitudinal balance was better in Session 2. Group 4 Session 1 and 3 scores were also significant with a moderate effect size (*t* (126) = 2.92, adj. *p* = 0.011; *d* = 0.52). On average, Group 4 participants' Session 1 scores were 5.05 higher than their Session 3 scores, which demonstrated longitudinal balance was better in Session 3. No statistical difference was found for Group 4 between Sessions 2 and Session 3 longitudinal improvement scores (see Table 7).

Table 7

Tukey-Kramer Post Hoc Pairwise Comparison of Group 4 Between Sessions for Longitudinal Balance

Group	Session	_session	Estimate	Standard error	*DF*	*t* value	Pr > |*t*|	Adj P
Group 4	1	2	4.9552	1.9439	126	2.55	0.0120	0.0320
Group 4	1	3	5.0543	1.7283	126	2.92	0.0041	0.0113
Group 4	2	3	0.09905	1.3507	126	0.07	0.9417	0.9970

The interaction effects between Skill Level and Session for longitudinal balance were examined. Figure 15 illustrates the longitudinal balance improvement score differences between Sessions for each Skill Level. *F-tests* for Skill Levels 2 and 3 demonstrated no statistically significant differences between Sessions on longitudinal

Figure 15

Longitudinal Balance Improvement Score Differences Between Sessions for Skill Level

Note. Improvement scores are shown for each Study Group and represent the difference between the sessions least square means.

balance seat improvement scores. A significant interaction was observed for Skill Level 1 across Sessions (*F* (2, 126) = 5.89, *p* = .004). The post hoc pairwise comparisons on the interaction of Skill Level 1 and Session found significant differences with moderate effect sizes between Session 1 and 2 (*t* (126) = 2.53, *p* = 0.034; *d* = 0.45) and Session 1 and 3 (*t* (126) = 3.43, *p* = 0.002; *d* = 0.61). On average, these participants scored 3.7823 points higher in Session 1 than in their Session 2 longitudinal improvement scores and 4.5628 points higher in Session 1 than in their Session 3 longitudinal improvement scores, which demonstrated that participants had more longitudinal balance in Session 2 and Session 3. No statistical difference was found for Skill Level 1 between Sessions 2 and 3 (see Table 8). Notable, the post hoc pairwise comparison for the interaction effect of Skill Level 3 and Session revealed that Session 1 and 3 differences were nonsignificant (*t* (126) = 0.04, adj. *p* = 0.999), which demonstrated that there was nearly no change in longitudinal improvement scores from Session 1 to Session 3 for individuals in Skill Level 3. Skill Level 3 participants' Session 1 longitudinal improvement scores were only 0.08 higher than their Session 3 longitudinal improvement scores.

Table 8

Tukey-Kramer Post Hoc Pairwise Comparison of Skill Level 1 Between Sessions for Longitudinal Balance

Skill	Session	_session	Estimate	Standard error	*DF*	*t* value	Pr > |*t*|	Adj P
Skill 1	1	2	3.7823	1.4950	126	2.53	0.0126	0.0336
Skill 1	1	3	4.5628	1.3291	126	3.43	0.0008	0.0023
Skill 1	2	3	0.7804	1.0388	126	0.75	0.4539	0.7334

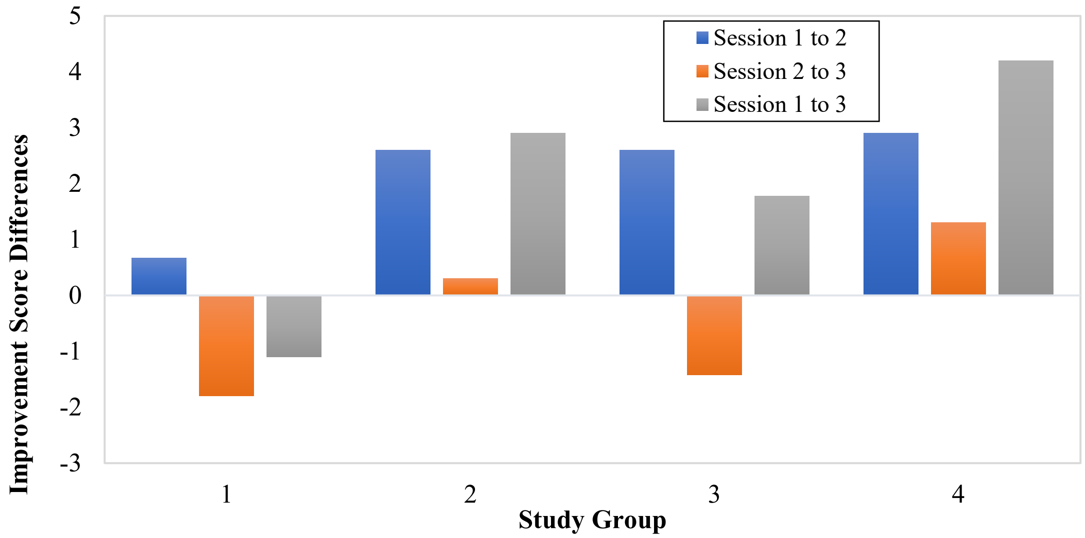
Seat Stability

Main effect for Group (*F* (3,126) = 1.06, *p* = 0.37) and Skill Level (*F* (2,126) = 1.82, *p* = 0.17) was nonsignificant for seat stability. Main effect for Session Type (*F* (2,126) = 4.11, *p* = 0.019) was significant for seat stability.

Interaction effects between Group and Session for seat stability improvement scores were examined. Figure 16 illustrates the seat stability improvement score differences between Sessions for each Group. *F*-tests for Groups 1, 2, and 3 demonstrated no statistically significant differences between Sessions on seat stability improvement scores. A significant interaction was observed for Group 4 (*F* (2, 126) = 5.05, *p* = .008). The post hoc pairwise comparison between Sessions for Group 4 revealed that the difference between Session 1 and Session 3 scores was significant with a moderate effect

Figure 16

Seat Stability Improvement Score Differences Between Sessions for Study Group



Note. Improvement scores are shown for each Study Group and represent the difference between the sessions least square means.

size (*t* (126) = 3.11, adj. *p* = 0.007; *d* = 0.55). On average, for Group 4, Session 1 scores were 4.22 points higher than their Session 3 scores, which demonstrated stability was better in Session 3. No statistical difference was found for Group 4 between Session 1 and 2 seat stability improvement scores or Session 2 and 3 seat stability improvement scores (see Table 9).

Table 9

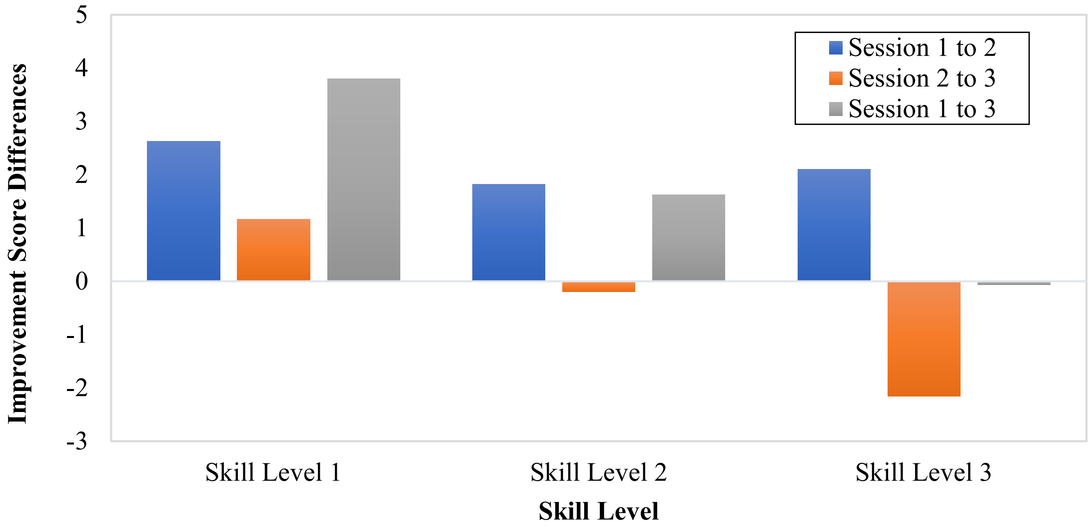
Tukey-Kramer Post Hoc Pairwise Comparison of Group 4 Between Sessions for Seat Stability

Group	Session	_session	Estimate	Standard error	*DF*	*t* value	Pr > |*t*|	Adj P
Group 4	1	2	2.8943	1.3674	126	2.12	0.0363	0.0905
Group 4	1	3	4.2210	1.3573	126	3.11	0.0023	0.0065
Group 4	2	3	1.3267	0.8483	126	1.56	0.1203	0.2651

Interaction effects between Skill Level and Session for seat stability were examined. Figure 17 illustrates the seat stability improvement score differences between Sessions for each Skill Level. *F-tests* for Skill Levels 2 and 3 demonstrated no statistically significant differences between Sessions on seat stability improvement scores. A significant interaction was observed when we looked at Skill Level 1 across Sessions (*F* (2, 126) = 6.84, *p* = .002). The post hoc pairwise comparisons on the interaction of Skill Level 1 and Session found statistically significant differences with moderate effect sizes between Session 1 and Session 2 (*t* (126) = 2.50, *p* = 0.036; *d* = 0.45) and between Session 1 and Session 3 (*t* (126) = 3.62, *p* = 0.001; *d* =0.65). On average, these participants scored 2.63 points higher on Session 1 than on Session 2, and 3.79 points higher on Session 1 than on Session 3. Participants in Skill Level 1 were the

Figure 17

Seat Stability Improvement Score Differences Between Sessions for Skill Level



Note. Improvement scores are shown for each Study Group and represent the difference between the sessions least square means.

most unstable in Session 1. No statistical difference was found for Skill Level 1 between Session 2 and Session 3 (see Table 10). Notable, the post hoc pairwise comparison for the interaction effect of Skill Level 3 and Session revealed that Session 1 and 3 differences were nonsignificant (t (126) = -0.03, adj. p = 0.999), which demonstrated that there was nearly no change in seat improvement scores from Session 1 to Session 3 for individuals in Skill Level 3. Skill Level 3 participants' Session 1 scores were only 0.06 lower than their Session 3 scores.

Exit Survey

The exit survey closed-ended questions were categorized by the contextual factors from the 3P model (see Table 1), and two data sets were produced to represent the Groups and Skill Levels (see Appendix D).

Table 10

Tukey-Kramer Post Hoc Pairwise Comparison of Skill Level 1 Between Sessions for Seat Stability

Skill	Session	_session	Estimate	Standard error	*DF*	*t* value	Pr > |*t*|	Adj P
Skill 1	1	2	2.6318	1.0516	126	2.50	0.0136	0.0360
Skill 1	1	3	3.7879	1.0438	126	3.63	0.0004	0.0012
Skill 1	2	3	1.1561	0.6524	126	1.77	0.0788	0.1832

Cronbach's alpha was used to determine post-hoc internal consistency of the 3Ps contextual factors and confirm the reliability of the statistical assumptions (see Table 11). The Presage category had five items ($\alpha = .79$), the Process category had ten items ($\alpha = .74$), and the Product had four items ($\alpha = .68$) Cronbach's Alpha was interpreted based on recommendations from DeVellis and Thrope (2021), and determined that Presage and Process were acceptable, and Product was questionable. The Product item reliability score ($\alpha = 0.68$) could be raised by the removal of question 23 ($\alpha = 0.71$). Further analysis was conducted on two Product Likert scale questions (i.e., question 22 and question 25) not included in the initial analysis of the four Product items because only participants from Group 1 answered those two items, which resulted in too few cases to run the analysis. The Cronbach's alpha for those two Product items was a score of .78 and considered acceptable.

A Pearson *r* correlation coefficient was used to analyze the relationship between the Presage, Process, and Product survey scores for all participants who responded to the exit survey (see Table 12). There was a significant strong positive relationship between Presage and Process, $r([73-2]) = .74$, $p = <.001$. There was a significant strong positive

Table 11

Cronbach's Alpha for Presage, Process, and Product

Contextual factors	*n*	Cronbach's α
Presage	5	.79
Process	10	.74
Product	4	.68
Product (no-feedback)	2	.78

Table 12

Correlation Between Presage, Process, and Product for all Participants

Contextual factors	Presage	Process	Product
Presage	.		
Process	.74**	.	
Product	.75**	.77**	.

Note: **Correlation is significant at the .01 level (two-tailed).

relationship between Presage and Product, *r*([72-2]) = .75, *p* = <.001. There was a significant strong positive relationship between Process and Product *r*([72-2]) = .77, *p* = <.001.

Another Pearson *r* correlation coefficient was used to analyze the relationship between the Presage, Process, and Product survey scores based on Study Groups for the participants who responded to the exit survey (see Table 13). There was a significant strong positive relationship between Presage and Process, *r*([73-2]) = .74, *p* = <.001. There was a significant strong positive relationship between Presage and Product, *r*([72-2]) = .75, *p* = <.001. There was a significant strong positive relationship between Process and Product *r*([72-2]) = .77, *p* = <.001.

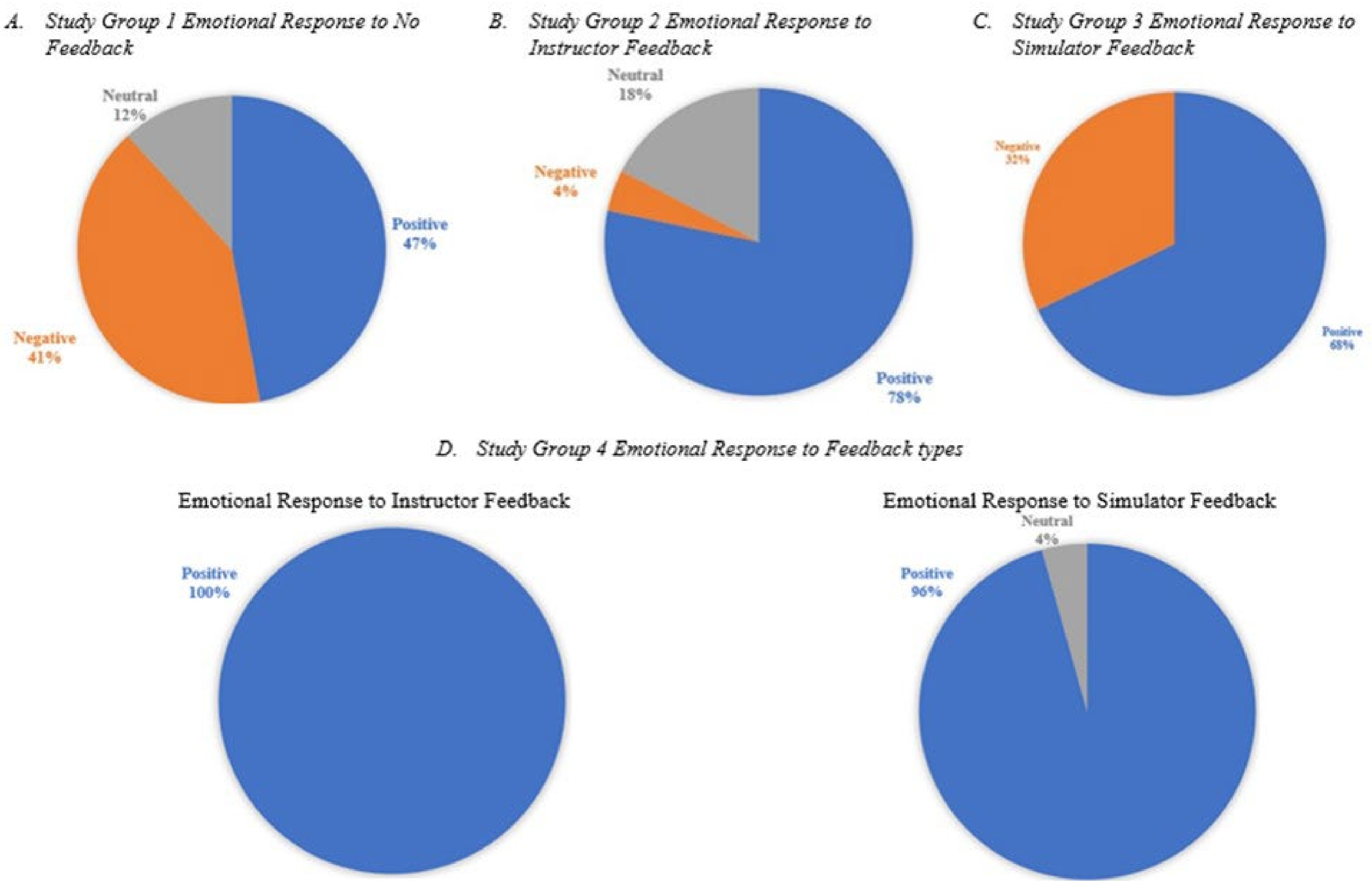
Questions 17, 18, and 19 asked participants to identify their emotional response to the feedback they experienced during practice. Figure 18 captures the emotional responses of participants based on Group. The emotional responses were captured from the question in the exit survey. The emotional responses were grouped by positive and negative emotions based on the PANAS-X developed by Watson and Clark (1994). Groups 2 and 4 responded more positively than Groups 1 and 3.

Qualitative Results

The researcher gathered data from open-ended questions presented in the exit survey. Participants that completed the exit survey were also those who completed all three sessions of the simulator study ($N = 74$). Only one participant who completed the study did not complete the exit survey. Survey data was thematically coded using an adapted initial priori coding framework from the 3P Model of the Learner Experience with Feedback. These codes were defined and operationalized into a codebook (see Appendix E) that was used to assign meaning to participant responses (DeCuir-Gunby et al., 2011). The initial codebook was reviewed and revised during group coding with the researcher and a second coder using 20% of the survey data. This allowed “reviewing and revising the codes in context” (DeCuir-Gunby et al., 2011, p. 143). Using the modified codebook, the researcher and second coder individually analyzed an additional 20% ($n = 15$) of the survey data to determine interrater reliability (IRR). The second coding session was analyzed in SPSS (v.28) for IRR using Cohen’s Kappa (κ). Kappa values were interpreted as indicated in Table 13, based on recommendations from McHugh (2012). Based on this interpretation, inter-rater reliability was strong ($\kappa = .803$; $p < .001$). The remaining data was coded by the researcher.

Figure 18

Emotional Responses by Group



A. Study Group 1 Emotional Response to No Feedback

B. Study Group 2 Emotional Response to Instructor Feedback

C. Study Group 3 Emotional Response to Simulator Feedback

D. Study Group 4 Emotional Response to Feedback types

Table 13

Kappa Score Interpretations

Kappa score (κ)	Level of agreement
0-.20	None
.21-.39	Minimal
.40-.59	Weak
.60-.79	Moderate
.80-.90	Strong
Above .90	Almost Perfect

Any portion of the response data (i.e., part of a sentence, whole sentence, entire response) that captured the essence of the code was labeled and extracted into the respective thematic code category in an Excel workbook (DeCuir-Gunby et al., 2011).

3Ps Model of the Learner Experience of Feedback

Instructors providing feedback is an essential component of the learning process but is complicated by individual feedback literacy and the complexities of factors that interplay on feedback uptake (Carless, 2019b; Carless & Boud, 2018). Carless conceptualized this through the 3P Model of the Learner Experience of Feedback. The results from the open-ended questions were thematically coded and organized based on an adaptation of this model to better understand the participants' feedback experiences and perceptions. The coded data was categorized based on a positive or negative connotation of the theme, counted, and displayed in a matrix (see Table 14). Based on the matrix, the collective responses were overall positive. The Process theme had the most responses. Overall, Group 2 was generally more positive in perceptions and Group 1 was generally more negative.

Table 14

Matrix for Qualitative Coded Themes

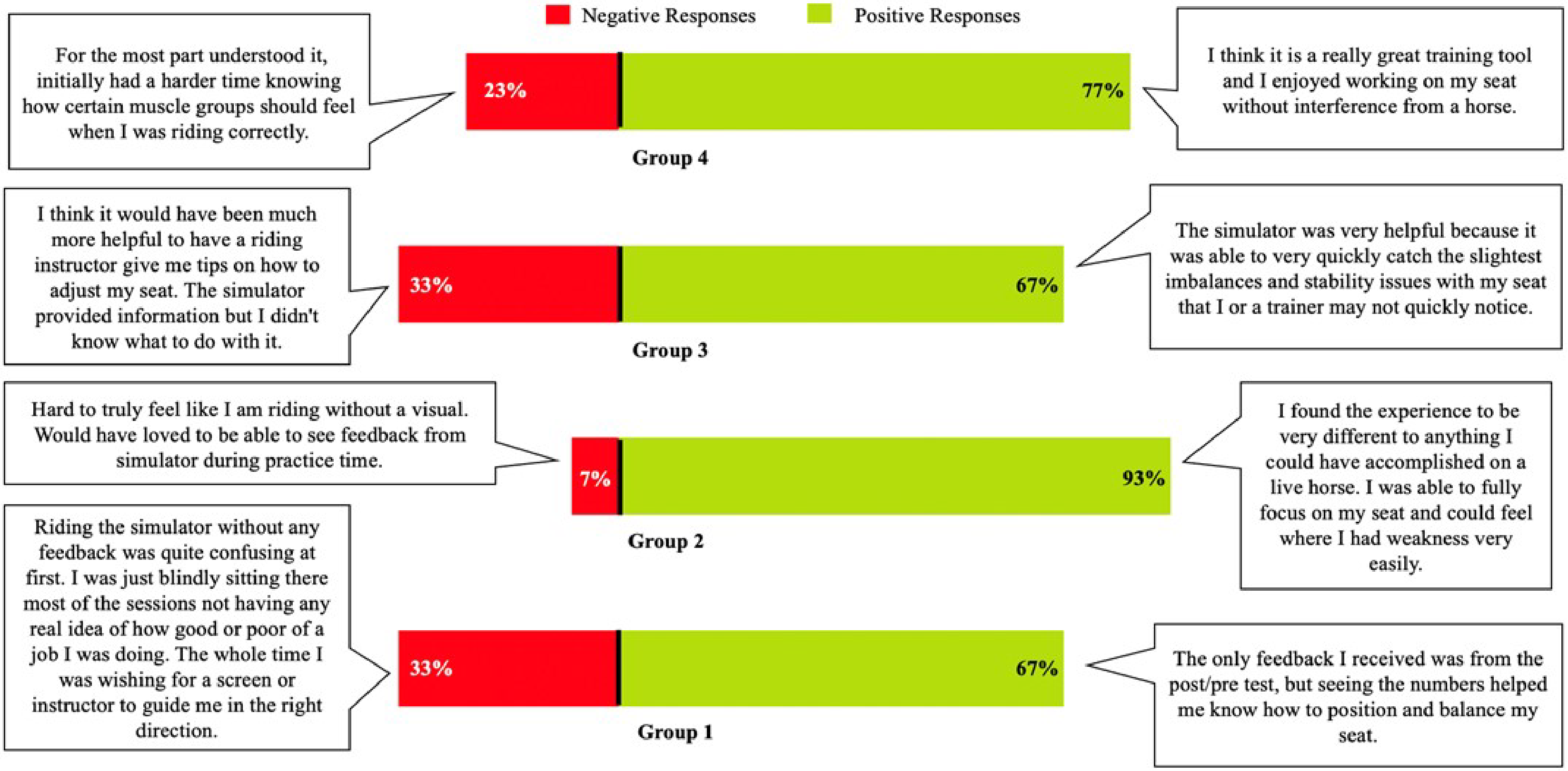
Study group			1	2	3	4	Total [Themes]	Exemplar of response
Preage coded responses	+	n	12	10	12	10	44	I feel like the feedback from the pre/posttest would have been more helpful if I had previous riding experience to know what fixes [to make]
		%	67%	83%	67%	77%	72%	
	-	n	6	2	6	3	17	I always tried to give myself a task (Ex, walk on transitions and lead changes) vs. just sit and hyper focus on my seat, since I was alone with no screen and no help.
		%	33%	17%	33%	23%	28%	
Process coded responses	+	n	14	14	16	17	61	I enjoyed the 10-minute practice because it allowed me to focus on my results and improve based on feel.
		%	64%	82%	67%	77%	72%	
	-	n	8	3	8	5	24	It pointed out WHAT I was doing wrong, but I didn't really know HOW to improve it.
		%	36%	18%	33%	23%	28%	
Product coded responses	+	n	13	11	14	16	54	It was great to ride the simulator and see how changes in my position affected my stability being a beginner rider, it helped me to be more confident in my riding and recognize how I should be seated.
		%	86%	100%	93%	100%	95%	
	-	n	2	0	1	0	3	Perhaps good for people with poor core stability, but I don't think it would benefit me due to the small, nuanced differences in movement.
		%	14%	0%	7%	0%	5%	
Transfer-ability coded responses	+	n	7	8	3	9	27	I feel like it could be easily translated to a real horse now that I know my general deviations.
		%	88%	89%	50%	90%	82%	
	-	n	1	1	3	1	6	I believe the fidelity of what a real horse feels like compared to what the simulator feels like makes it difficult to improve on simulator feedback alone.
		%	12%	11%	50%	10%	18%	
Total [study groups]	+	n	46	43	45	52		
		%	73%	88%	71%	85%		
	-	n	17	6	18	9		
		%	27%	12%	29%	15%		

Presage

Figure 19 shows the percentages of negative and positive Presage responses based on Group and includes exemplar comments. The Presage theme included the nuanced factors of previous experience, capacities, motivation, inputs and activities, assessment design, relational issues, and disciplinary norms. The themes that were the most frequently mentioned by participants were *relational issues* and *capacities*.

Figure 19

Presage Coded Responses by Study Group



For the most part understood it, initially had a harder time knowing how certain muscle groups should feel when I was riding correctly.

I think it is a really great training tool and I enjoyed working on my seat without interference from a horse.

I think it would have been much more helpful to have a riding instructor give me tips on how to adjust my seat. The simulator provided information but I didn't know what to do with it.

The simulator was very helpful because it was able to very quickly catch the slightest imbalances and stability issues with my seat that I or a trainer may not quickly notice.

Hard to truly feel like I am riding without a visual. Would have loved to be able to see feedback from simulator during practice time.

I found the experience to be very different to anything I could have accomplished on a live horse. I was able to fully focus on my seat and could feel where I had weakness very easily.

Riding the simulator without any feedback was quite confusing at first. I was just blindly sitting there most of the sessions not having any real idea of how good or poor of a job I was doing. The whole time I was wishing for a screen or instructor to guide me in the right direction.

The only feedback I received was from the post/pre test, but seeing the numbers helped me know how to position and balance my seat.

Relational Issues experienced by participants were expressed as perceptions of relevancy of the instructor's or simulator's feedback. For the instructor, there was an appreciation of the feedback that helped adjust the rider without compromising other issues. "[The instructor] worked hard to figure out how to get me more balanced, yet still riding correctly" (Participant 201). Others appreciated the simulator since it was objective and provided abstract feedback. "What I love about the simulator feedback is that it is completely impartial - it is literally what you are doing in the moment with your body and there are no opinions involved" (Participant 301). "The simulator was very helpful because it was able to very quickly catch the slightest imbalances and stability issues with my seat that I or a trainer may not quickly notice" (Participant 315). Participants appreciated both feedback modalities, even if they had a preference of one feedback modality over the other. "I was able to get unbiased corrections from the simulator while receiving suggestions from the instructor about HOW I might fix things." (Participant 419). "I was able to see on the simulator how following what the instructor said (shoulders back, etc.) brought me more balance and stability. It was SO great/helpful to have instructor and simulator feedback" (Participant 412)"

Capacities were conveyed as phrases that expressed a general appreciation of receiving feedback, feedback aligning with their belief system and priorities, and/or existing skills to engage with the feedback (i.e., self-monitoring, strategies). Some participants expressed a lack of capacity to engage with the feedback received. "Some disconnection, had to use own body for feedback" (Participant 113). "The simulator provided information, but I didn't know what to do with it" (Participant 318). A participant who did not receive feedback during practice felt loss as to what to do while practicing:

> "Riding the simulator without any feedback was quite confusing at first. I was just blindly sitting there most of the sessions not having any real idea of how good or poor of a job I was doing. The whole time I was wishing for a screen or instructor to guide me in the right direction." (Participant 127)

One participant mentioned the discourse that occurred between what resulted in improvement but conflicted with their belief of riding. "I did feel like it encouraged being a bit stiffer than I'd want to be" (Participant 128). Another expressed needing a horse's feedback to inform their changes for improvement to occur. "A real horse will change if I do something differently, whereas the simulator stayed the same, so I would immediately revert back to what felt normal instead of what felt right" (Participant 329). Riding is a physical activity, and one participant was not sure of the muscles required. "For the most part understood it, initially had a harder time knowing how certain muscle groups should feel when I was riding correctly" (Participant 418).

Other participants had positive perceptions of feedback and their capacities. Several participants identified the benefit to focus on the seat, something that was difficult to do on a real horse. "I found the experience to be very different to anything I could have accomplished on a live horse. I was able to fully focus on my seat and could feel where I had weakness very easily" (Participant 212). Another was able to use riding concepts in the absence of feedback to incorporate into improving seat scores:

> I always tried to give myself a task (Ex, walk on transitions and lead changes) vs. just sit and hyper focus on my seat, since I was alone with no screen and no help. It usually ended with better results. (Participant 112)

One participant related the feedback to aligning with their personal experience and understanding of their seat balance and stability. “I felt the simulator results matched my personal results with past riding experience” (Participant 309).

Process

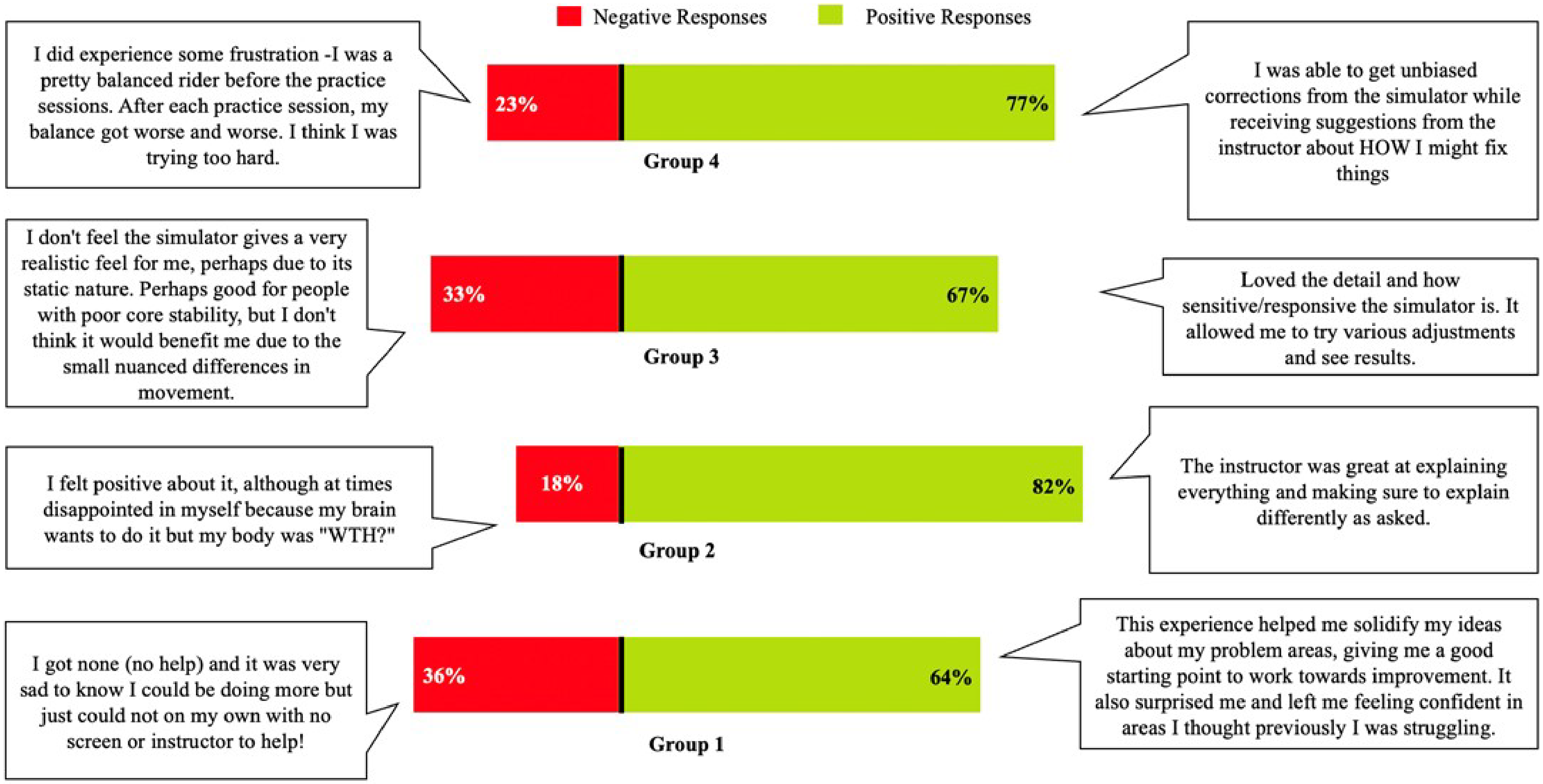
Figure 20 shows the percentages of negative and positive Presage responses based on Group and includes exemplar comments. Nuanced factors coded for Process included: *engagement, sensemaking, dialogue, and managing affect*. Most of the coded responses were ascribed to Process. Participants shared their perception of the feedback process by referring to what they did during the practice sessions. *Engagement* was articulated as participating and interacting with feedback as it was given during the practice session(s).

Participants that had instructor only feedback had positive references to engaging. “Very positive. All specific feedback, and immediate results were seen” (Participant 202). “Interesting to see how things could change and areas I could improve” (Participant 215). “[The instructor] helped me visualize the movement of the horse and how I move with it. She was able to fine-tune and make sense of what the simulator feedback was” (Participant 219). Participants with simulator only feedback and both feedback modalities mention engagement through helpfulness. “Very helpful in understanding my balance” (Participant 302). “The simulator was so helpful! I loved that it showed actual data real time then showed the product of my adjustments to my seat” (Participant 316). “Overall it was super helpful to get a feel of what sitting more stable feels like” (Participant 401). “When I could see my feedback real time, it was incredibly helpful” (Participant 424).

Sensemaking referred to a deeper level of engagement where the participant was working out what the feedback meant in relation to their improvement. One participant

Figure 20

Process Coded Responses by Study Group



I did experience some frustration -I was a pretty balanced rider before the practice sessions. After each practice session, my balance got worse and worse. I think I was trying too hard.

I was able to get unbiased corrections from the simulator while receiving suggestions from the instructor about HOW I might fix things

I don't feel the simulator gives a very realistic feel for me, perhaps due to its static nature. Perhaps good for people with poor core stability, but I don't think it would benefit me due to the small nuanced differences in movement.

Loved the detail and how sensitive/responsive the simulator is. It allowed me to try various adjustments and see results.

I felt positive about it, although at times disappointed in myself because my brain wants to do it but my body was "WTH?"

The instructor was great at explaining everything and making sure to explain differently as asked.

I got none (no help) and it was very sad to know I could be doing more but just could not on my own with no screen or instructor to help!

This experience helped me solidify my ideas about my problem areas, giving me a good starting point to work towards improvement. It also surprised me and left me feeling confident in areas I thought previously I was struggling.

appreciated how the feedback was able to tell them where they were and how getting better could be achieved. “I really liked riding the simulator, as it allowed me to see where I needed to improve and what I needed to focus on. I had a very positive experience with the feedback as it helped me to see what I was doing and how I could improve” (Participant 311).

Dialogue referenced the exchange of information. The exchange could be from the instructor and participant or the changes of sensor screens from the simulator as the participant adjusted. Participants had perceptions about dialogue from the simulator, the instructor, and/or the lack of having any dialogue.

One participant who had no feedback during practice explains the desire for discussion and instruction. “I really liked when the results of my simulation were discussed, but I would greatly have benefitted from more discussion and especially real-time instruction during my practice sessions” (Participant 103). Another, who was also in the control group, expressed that their progress could be impacted if they had help. “I got none (no help) and it was very sad to know I could be doing more but just could not on my own with no screen or instructor to help” (Participant 112). A participant from Group 2 engaged the instructor in dialogue to improve understanding. “I really enjoy data and understand graphs (engineer) and the instructor was great at explaining everything and making sure to explain differently as asked” (Participant 207).

A participant from the simulator-only group mentioned that the exchange of visual feedback while adjusting was helpful. “Loved the detail and how sensitive/ responsive the simulator is. It allowed me to try various adjustments and see results”

(Participant 310). A participant from Group 4 expressed that the exchange of information from the instructor, simulator, and her adjustments resulted in improvement. “I was able to see on the simulator how following what the instructor said (shoulders back, etc.) brought me more balance and stability. It was SO great/helpful to have instructor and simulator feedback” (Participant 412).

Managing affect was an emotional response that was triggered from feedback that resulted in accepting or rejecting the feedback itself. One participant expressed a positive effect because of objectivity the simulator feedback offers. “It is refreshing to have purely objective riding results in a mostly subjectively trained sport” (Participant 127).

Others mention the positive affect based on their outcomes. “It was really fulfilling to be able to watch my riding balance and stability improve as each session progressed” (Participant 213). “Positive. Very educational and has motivated me to keep working and improving my seat” (Participant 413). In contrast several participants expressed the feeling of frustration based on poor results. “I did experience some frustration -I was a pretty balanced rider before the practice sessions. After each practice session, my balance got worse and worse. I think I was trying too hard” (Participant 329). “Receiving feedback from the instructor makes me want to seek their approval, and when I’m not able to achieve the goal perfectly for them I get frustrated” (Participant 419). Two participants mention frustration from a lack of feedback. “A little frustrating not knowing how I was doing until I tested, but even just that was super useful” (Participant 125). “Frustrating trying to fix my deviation without an instructor teaching how to fix it” (Participant 327).

Product

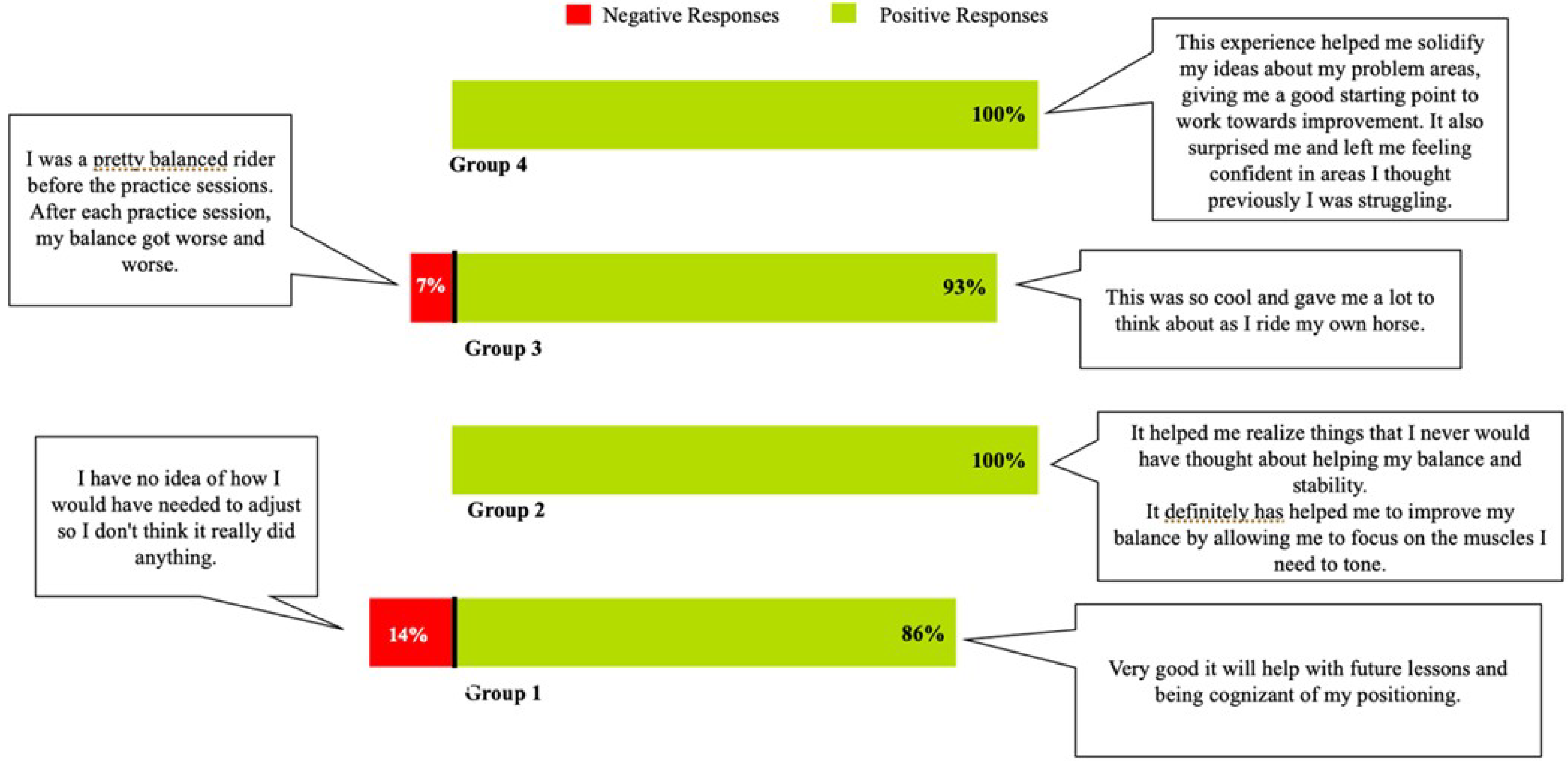
Figure 21 shows the percentages of negative and positive Presage responses based on Group and includes exemplar comments. Nuanced factors coded for Product included: *improved strategies, feedback spirals, and ongoing puzzles*. All the text coded for these themes were linked to a perception about the participant's result of participating in the practice sessions.

Improved strategies were responses that mention how new information created new approaches for working towards improvement. "I definitely have identified areas of my riding to improve on and have learned strategies to do so" (Participant 409). One participant identified that a physical need to create tone was a strategy that resulted in improving. "It definitely has helped me to improve my balance by allowing me to focus on the muscles I need to tone" (Participant 205).

Participant responses that coded for *feedback spirals* were individual and related to any indication on how a personal feedback loop could be closed. One participant felt the experience help them identify what to work on and what problems were resolving, ultimately helping close a feedback loop. "This experience helped me solidify my ideas about my problem areas, giving me a good starting point to work towards improvement. It also surprised me and left me feeling confident in areas I thought previously I was struggling" (Participant 115). Another identified ambiguous concepts that were made clear through the experience and resulted in their improvement. "It helped me realize things that I never would have thought about helping my balance and stability (Participant 222).

Figure 21

Product Coded Responses by Study Group



This experience helped me solidify my ideas about my problem areas, giving me a good starting point to work towards improvement. It also surprised me and left me feeling confident in areas I thought previously I was struggling.

I was a pretty balanced rider before the practice sessions. After each practice session, my balance got worse and worse.

This was so cool and gave me a lot to think about as I ride my own horse.

It helped me realize things that I never would have thought about helping my balance and stability.
It definitely has helped me to improve my balance by allowing me to focus on the muscles I need to tone.

I have no idea of how I would have needed to adjust so I don't think it really did anything.

Very good it will help with future lessons and being cognizant of my positioning.

Participants that reflected on the experience and how it could translate to a larger, more complex concept of equestrianism were sharing about *ongoing puzzles*. One participant reflected on how a simulator could be beneficial to sitting the trot for novice riders. “I would especially be curious to know how complete novices learning to ‘sit the trot’ could be helped” (Participant 218). Another participant saw the simulator experience as a springboard to discussing with others on how to improve. “At the very least, it opens up thinking and conversations to how myself and others can better ourselves as riders” (Participant 424). Another idea was how the simulator could be another source of help. “The simulator could be a really good tool if implemented along with all of the other tools in the tool bag” (Participant 127).

Transferability

An emerging theme (transferability) that was incorporated into the framework after the open coding phase. Transferability was defined as a perception that relayed the connection between the simulator experience and the actual act of riding the horse. Among the responses, 37% responded with a positive perception of the transferability of the simulator experience to riding a real horse, while 7% had a negative perception.

Two participants who had a negative perception of the simulator’s transferability had also included responses that conflicted to the concept. Each mentioned that the experience was helpful for riding, but the simulator itself presented aspects of low fidelity to the actual horse. “Although horse like, it is not completely true to ride, however, having a stable platform to build muscle memory to advance my skills beats trying to do this on Mr. Spooky” (Participant 214). “Different - because a real horse would give feedback…Very good it will help with future lessons and being cognizant of my positioning" (Participant 113).

Negative perceptions were coded for four other participants. One participant did not see the fidelity of the simulator due to their perception of their equestrian discipline. "I thought it was a cool idea. However, don't know how realistic it is for real life. I show reiners so it wasn't exactly what is real for my discipline" (Participant 105). Another participant stated that their ability to "cheat" on the simulator made them feel that "this simulator approach may not translate to a variety of horses or be effective at all" (Participant 306). The other two participants attributed the lack of transferability to "…the abstract nature of the simulator may have contributed to the experience feeling less "authentic" (Participant 418) and because "the simulator [does not] gives a very realistic feel for me, perhaps due to its static nature" (Participant 316).

All other participant responses were positive towards the transferability of the simulator and simulator experience. Most noted was a reference to being able to know what to do once they rode a horse again. "It was great. I feel like it was useful going back and riding my horse and a lot of the things I work on while riding (ex. needing to sit back more) showed in the simulator." (Participant 207). "I think it was a great checkpoint to review my riding off the actual horse. I believe it can help me when riding an actual horse." (Participant 420)

Triangulation

The results from both methods were triangulated to further explain the relationship between feedback modality, factors of feedback literacy, and seat scores. An area of interest was examining performance improvement score (i.e., quantitative results) and Presage, Process, and Product perceptions. Participant data was individually selected for the following areas: (1) two or more categories of negative responses, (2) all three seat improvement scores digressed in Session 3, (3) all three seat improvement scores improved in Session 3, and (4) all three seat improvement scores improved in Session 3. Then, all data was collected for each participant (i.e., Study Group, Skill Level, coded responses, seat improvement scores, and exit survey mean scores; see Appendix F). A Pearson *r* correlation coefficient was used to analyze the relationship between the Presage, Process, and Product survey scores for the selected participants (see Table 15). There was a significant strong positive relationship between Presage and Process, $r([31-2]) = .80$, $p = <.001$. There was a significant strong positive relationship between Presage and Product, $r([31-2]) = .68$, $p = <.001$. There was a significant strong positive relationship between Process and Product $r([31-2]) = .89$, $p = <.001$.

Table 15

Correlation Between Presage, Process, and Product for Triangulated Selected Participants

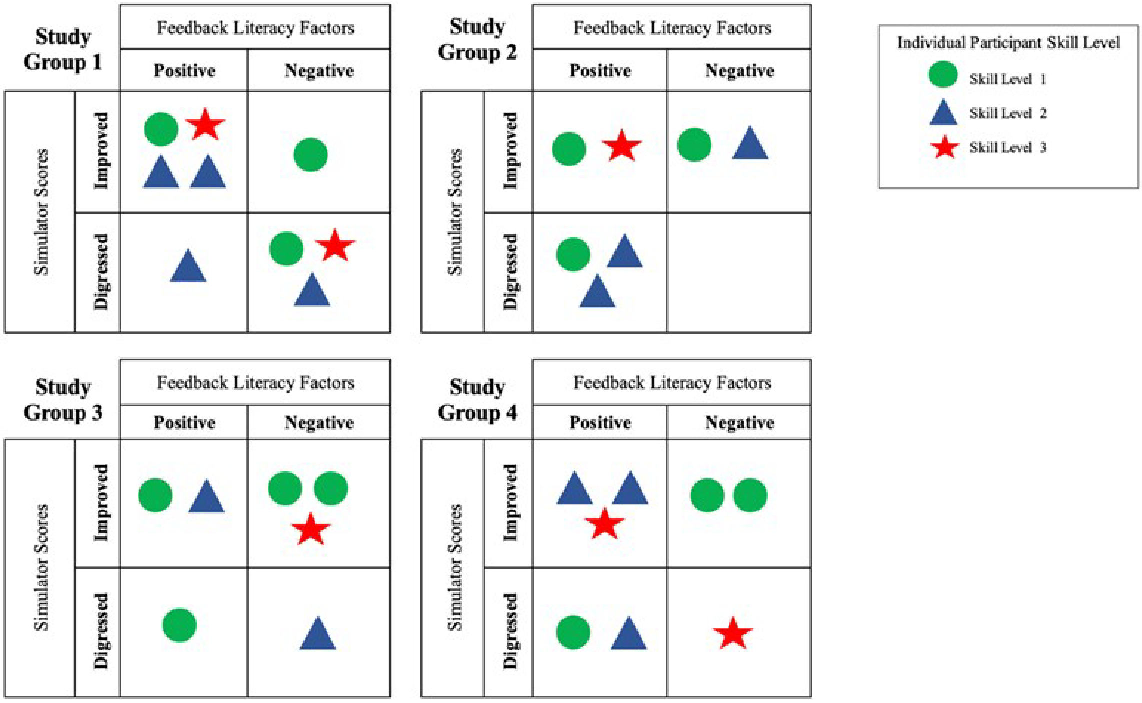
Contextual factors	Presage	Process	Product
Presage	.		
Process	.80**	.	
Product	.68**	.89**	.

Note. **Correlation is significant at the .01 level (two-tailed).

Figure 22 embodies the triangulated data for the 31 selected participants. Each participant is denoted in their Study Group by a symbol that represents their respective skill level, and placed in the quadrant that signifies their feedback literacy and improvement scores.

Figure 22

Triangulated Data from the Participant Subset



Note. Each Study Group is represented with participants (*n* = 31) that were selected based on the criteria for the data triangulation. The shapes represent the individual participant and their respective Skill Level. The quadrants represent the converged quantitative improvement scores from the simulator and the coded responses from the qualitative data. Participants were grouped by their coded feedback literacy responses being either positive or negative feedback and grouped if they improved or digressed in Session 3 on their seat improvement scores.

Chapter Summary

Performance and perception of improving a motor skill through simulated practice with different feedback modalities were analyzed. Participants represented various levels of previous experience and skill, and this was a covariant considered in the quantitative analysis. Perceptions of the experience were attributed to factors of a learner's feedback literacy through the conceptual framework.

Study Group (i.e., feedback modality applied) and Skill Level had statistical significance when the interaction of practice session was included. When the combined instructor- and simulator-mediated feedback was applied, participants had a statistically significant improvement by the end of the three sessions. Regardless of feedback modality, statistically significant improvement was found with Skill Level 1 by the completion of Session 3.

Across all Groups and Skill Levels, the overall participant perception was positive toward using an equine riding simulator as an instructional tool to improve performance and strategies. Perceptions of the simulation-mediated feedback to improve performance and strategies were slightly higher for those who also received instructor-mediated feedback in Study Group 4 than those with only simulator-mediated feedback in Study Group 3. Perceptions of the instructor-mediated feedback to improve performance and strategies were similar for Study Group 4 and Study Group 2. Perceptions from the no-feedback group (i.e., Study Group 1) were lower than all other groups (i.e., Study Groups 2, 3, & 4) for the simulator to improve performance and strategies.

Contextualizing the participants' perceptions demonstrated different results based on Presage, Process, and Product factors. Quantitative and qualitative results are integrated and guided by Carless' 3P (2019b) conceptual model to explain the nuances of feedback uptake of various feedback modalities during simulated practice on riding seat competencies.

CHAPTER V

DISCUSSION

This study examined the effects of feedback modalities on a learner's perception and performance in simulation-based practice through the 3P Model of the Learner Experience of Feedback conceptual framework. In addition, an extended factor of skill level was also considered and analyzed. This chapter will explain the results from the quantitative and qualitative findings and how the analysis from the previous chapter answers the four research questions.

Purpose of Study

Complex motor skill acquisition is vital in developing and mastering competencies in performance outcomes. Many factors are involved in achieving expertise in complex motor skills, but, as the literature demonstrates, the most important are deliberate practice and feedback approaches. The need to practice complex motor skills in specific fields presents significant concerns for human and animal welfare issues, learner safety, and high program/learner resource allocations. For example, in the medical field, it has been a long-withstanding practice to allow specific training to be conducted on human patients, usually under the supervision of a licensed professional, or to use animal subjects (i.e., anesthetized rats for surgery procedures; Martin et al., 1997). However, the risk and welfare of these exercises to the human and animal subjects are of a significant and unethical grade (El Hussein & Ha, 2023; Ziv et al., 2003). Other motor skill competencies are simply dangerous. For example, learning specific flight procedures is innately unsafe to replicate for novice pilots (Santos et al., 2022).

Also, practice can be costly when real-life resources are required. For example, in equestrian sports or flight programs, using a horse or plane to practice, whether purchased, leased, or rented, is a high-cost incurrence. The cost of training in a Full Motion Flight simulator for an Airbus or Boeing is $600/hour. In contrast, using an actual Airbus or Boeing 737 costs approximately $3,200 and $8,380 an hour, respectively (Lazic et al., 2022, p. 3632). Training programs, like the military, demand many resources to get soldiers trained and prepared for deployment. For example, the Army's 3-2 Stryker Brigade Combat Team in Washington saves the Army $44 every ten minutes in the virtual wartime simulation compared to the live training (McCullough, 2014). As a result, simulation technology has assuaged risk, ethical concerns, and resource demands while providing a reality-like learning environment for repeated deliberate practice so learners can achieve mastery.

Incorporating proper feedback with simulation technology makes for an irrefutably effective instructional tool for motor skill acquisition. In the literature, learning complex motor skills can be impacted by the timing of feedback, KP/KR, and type of feedback modality. However, despite the unanimity of these feedback approaches in simulation and the supporting theories like cognitive load, guidance hypothesis, and multiple resources, the replication of study results are inconsistent throughout the literature. For example, Cecilio-Fernandes et al. (2020) found that providing concurrent expert feedback with visual feedback from a simulator led to improved retention compared to providing only concurrent simulator or instructor feedback. Likewise, Sigrist et al. (2013) found that in a rowing task, participants that received terminal visual feedback outperformed those who received concurrent visual, haptic, and auditory feedback.

In addition to these inconsistent findings, the current studies and literature demonstrate motor skill improvement and learning only by performance scores and do not consider the characteristics that impact an individual's ability to uptake feedback. The concept known as a *performance plateau* is an example of motor skill acquisition occurring but not reflected in improved performance scores (Anderson et al., 2021; Magill & Anderson, 2018). Performance plateaus are temporary performance stalls or declines because of changes in strategies and methods to improve motor skills. Performance plateaus are an excellent example of how relying on performance scores will mislead researchers and practitioners in identifying whether or not motor skill learning and improvement are occurring. Feedback literacy research in non-performance fields (i.e., writing) suggests that learners have characteristics that influence how well they uptake and use feedback, directly impacting learning outcomes. At the time of this study, feedback literacy characteristics have yet to be examined in motor skill acquisition research.

Considering motor skill acquisition through simulation and the ambiguity of identifying learner feedback factors, this study was designed as a mixed methods to examine how feedback modalities in simulated-based practice affect a learner's performance and perceptions. The following research questions were used to guide the investigation.

1. How does the type of feedback modality experience during practice affect the performance of seat balance and stability?
2. What is the rider's perception of their feedback experience while using a horseback riding simulator to improve seat balance and stability?
3. What is the rider's perception of their improvement while using a horseback riding simulator to improve seat balance and stability?
4. What is the rider's perception of using a horseback riding simulator as an instructional tool to improve seat balance and stability?

This study was conducted to inform professional equestrian stakeholders about the effectiveness of the emerging equine-simulator technology and stakeholders in performance-based teaching programs of ways to improve simulator-based practice on the motor skill acquisition by addressing feedback modalities and the factors of learner feedback literacy.

Study results are supported by findings in the literature, give rise to the benefits of using simulators in developing horseback riding skills, and illuminate the factors that make feedback uptake complex and nuanced for individuals. Findings will be interpreted through the theoretical lens of social constructivism and presented in alignment with the 3P conceptual model based on the respective research questions they answer.

Research Question 1

Research question 1 was, "*How does the type of feedback modality effect the performance in a rider's seat balance and stability?*"

Feedback Modality

This study demonstrated that Group 4 had statistical significance in their improvement on all three observational seat scores (i.e., lateral seat balance, longitudinal seat balance, and seat stability) in Session 1 compared to Session 3. Furthermore, these findings demonstrated that improvement was the highest at Session 1, and after the third practice session, significant improvement was no longer occurring. This suggested that participants acquired the most impact on performance by completing three practice sessions when both feedback modalities were provided.

These results are consistent with the literature that verbal feedback from an instructor combined with a second feedback modality result in significant improvement of complex motor skill performance when compared to no feedback or unimodality feedback (Cecilio-Fernandes et al., 2020; Frikha et al., 2019; Giannousi et al., 2017; Martínez et al., 2016; Wickens, 2002; Wulf et al., 2010). The simulator feedback provided objective visual kinematic measures of the participant's seat deviations that was informative to both the participant and instructor. The simulator feedback allowed the participant to better understand the elusive nature of their seat balance and stability through a concrete visual representation, especially if proprioception or intrinsic feedback were lacking. The participants can use real-time visual feedback to understand better how their body movement translates to seat balance and stability measures.

The instructor could utilize their expertise to help the participants make physical adjustments through different strategies to improve balance and stability while maintaining the correct riding position (e.g., the instructor helps fix a left deviation by having the rider weight the right seat bone and maintain a centered torso versus allowing the rider to lean weight to the right which places their torso off centered). The instructor and participant could also discuss misunderstandings, improvement strategies, what the simulator sensor feedback indicates, and how to assuage proprioception issues. One function of the instructor over the simulator is the ability to provide feedback based on the learner's cognitive schema. For example, suppose the instructor detects that the participant is struggling (e.g., the practice experience, current understandings, negative emotions, physical limitations). In that case, they can provide the appropriate feedback to support the learner's limitations, keep the learner engaged, or adjust the strategy being used to better fit the learner's current situation. It is worth noting that the instructor also uses the simulator feedback to inform, complement, and validate the feedback they provide (Martínez et al., 2016).

Skill Level

Examining the covariant of skill level within the study, study groups, and session numbers, Skill Level 1 had statistical significance in their improvement on all three observational seat scores (i.e., lateral seat balance, longitudinal seat balance, and seat stability) in Session 1 compared to Session 3, irrespective of feedback modality presented. This identified that improvement scores were the highest at Session 1, and by the completion of the third practice session, improvement scores were significantly lower indicating that the practice sessions effectively stabilized and balanced seat movement. These findings indicate that Skill Level 1 improves their seat performance simply by the exposure to deliberate simulated-based practice.

The results of Skill Level 1 having a significant performance at Session 1 compared to Session 3 across all other study groups is typical for a beginner's stage in motor learning. Magill and Anderson (2018) explain that motor-learning improvement is significant in the early stages and has a negative decline as progress is made toward expertise, a concept described in the *power law of practice* (Snoddy, 1926). Although this is not a theoretical or conceptual lens of the study, it is essential to consider that an individual's motor skill experience and the amount and quality of practice that is represented by that experience can be mathematically predicted, especially at the early stages of learning (Magill & Anderson, 2018). These findings are substantial because they support beginners using an equine simulator for deliberate practice to improve riding seat balance and stability is beneficial regardless of the feedback provided. By providing new riders with simulated practice, they can successfully work on these motor skills. Learning to have a balance and stable seat is one of the most critical rider qualities that lead to effective rider-horse communication, rider safety, and decreased equine physical ramifications.

Session Impact

Results demonstrated that feedback modality and skill level had significance on performance outcomes when the interaction of practice sessions was accounted for. For Study Group 4 and Skill Level 1, all three seat scores had significant differences between Session 1 to Session 3. These findings indicate that participation in three practice sessions effectively stabilized and balanced the riding seat. In addition, Study Group 4 longitudinal seat balance improvement scores had significant differences between Session 1 to Session 2. These findings indicate that Study Group 4 became more longitudinally balanced by the end of Session 2. Skill Level 1 had significant differences in longitudinal seat balance and seat stability from Session 1 to Session 2. These findings indicate that longitudinal seat balance and seat stability for Skill Level 1 is significantly improved by the end of Session 2.

The results are important to identify the quantity of sessions that will provide a positive impact to learner's performance. In order to significantly improve all three seat scores for beginners and riders in a multi-modality feedback environment, three sessions are required. The study results indicate that participating in just one session is not sufficient to significantly improve seat balance and stability for Study Group 4 or Skill Level 1.

Additionally, it is worth considering that improvement scores decreasing can represent a concept in motor skill learning called performance plateau, where quantitative improvement in performance may cease for some time. Researchers agree that this is a pause in the learner's performance but is not demonstrative of learning plateauing since learning, developing, and refining is occurring as to develop this new cognitive schema (Anderson et al., 2021; Magill & Anderson, 2018; Vygotsky, 1978). Anderson et al. explained that the "effects of these new solutions on outcome scores may not be apparent until much later in the learning process" (p. 9). As discussed in Research Question 3 below, despite various outcomes on quantitative seat scores, a majority of the participants identified that they were able to develop new understandings and strategies that will improve their riding seat. This data supports the concept that the decrease in improvement scores by Session 3 was an indication that participants were not only becoming more balanced and stable, but integrating new skills and strategies as they progressed through each session.

Research Question 2

Research Question 2 was, "*What is the rider's perception of their feedback experience while using a horseback riding simulator to improve seat balance and stability?"* There is extensive research and literature that supports the effectiveness of multi-modality feedback approaches in SBL on motor skill acquisition, which was supported in the findings of this study. However, several factors affect the learner's ability to uptake feedback, and they are accounted for in the conceptual model from Carless' (2019b) adapted 3P Model of the Learner Experience with Feedback. This model captures all the nuanced feedback literacy factors that interplay into the ability of a learner to use feedback in their learning process. A critical undertone of this conceptual model is that characteristics that influence feedback uptake are a culmination of interconnected learner and teaching factors. The perception of the participant's feedback experience was captured to help explain the complexity of the relationship between feedback modalities and feedback literacy.

No Feedback

When no feedback was presented, multiple participants expressed that *any* feedback during practice would have been beneficial. In the no feedback group (i.e., Group 1), numerous participants appreciated the feedback from the auto-training results and the explanation from the simulator operator. The acknowledgment of this feedback is considerably more present in Group 1 because it was the only source of feedback accessible to inform and guide their practice sessions. The auto-training results are a form of terminal KR feedback.

When no feedback was provided during practice sessions, the participants were more apt to focus on their weaknesses of Presage factors of lacking previous experience. A majority felt that their lack of prior experience in riding made it challenging to practice and, ultimately, make significant strides toward improvement. Since the practice session requires the participants to guide themselves for improvement, which requires a substantial amount of domain knowledge, experience riding, and sophisticated intrinsic feedback, it makes sense that this became a focus of these participants. From the social constructivist lens of feedback, not receiving feedback would make it difficult for participants to close the learning gap alone.

The absence of feedback also negatively influenced Process factors because most all participants would have liked feedback during the practice session. As stated above, there was an appreciation of the auto-training results, a form of KR feedback. Still, for many participants, that was not sufficient to help them engage or sense-make during practice, and for some even evoked an emotional response. For example, participant 103 explained, “I would greatly have benefitted from more discussion and especially real-time instruction during my practice sessions. When I was practicing on my own, it felt like a lot of guesswork.” Through the 3P Model and factors of feedback literacy, participants were more likely to struggle with Process factors when they did not receive any feedback. In return, they justified the inability to uptake the feedback because they had weaknesses within their Presage factors.

Simulator Feedback

When participants in Group 3 shared their experiences of receiving only simulator-mediated feedback, negative perceptions of combined Presage and Process factors were expressed. A frequent complaint was about the Process factor of sense-making since they did not understand how to take the simulator sensor feedback and make improvements. Sense-making was especially difficult for the participants who lacked in Presage of previous experiences, indicating that the more novice a participant, the more they expressed an inability to know how to improve. Multiple times, these participants preferred feedback from an instructor to help provide clarification and direction during practice. The participants conveyed that they were unsure how to adjust their position to improve the visual measures being provided by the simulator, and this could have been achieved with instructor-mediated feedback. These responses indicate that the feedback from a simulator-only modality elicits negative Process factors of engagement, sense-making, and dialogue. While practicing, participants struggle to engage and make sense of the simulator-mediated feedback and dialogue with the simulator’s visual language. The perception was that instructor-mediated feedback would have helped more engagement, sense-making, and dialogue. However, for participants in Group 1, there was no indication of a preference for a type of feedback modality.

For more skilled participants, the negative responses were attributed to the simulator fidelity. This resulted in low perceptions of all factors in the feedback process, especially in sense-making, because they did not believe the simulator feedback was correlated to the reality of riding a real horse. Based on the 3P conceptual model, the uptake of the simulator feedback will only occur if the individual appreciates the simulator's ability to provide feedback that aligns with their beliefs about riding. Specifically, a rider who believes that a simulator cannot replicate a real horse and accurately measure a rider's seat stability and balance will not appreciate the feedback. This may also be a function of the professional rider's high intrinsic feedback and experience of the "real thing." The simulator components that cannot fully replicate the horse could be detectable by the professional and, in return, diminish the efficacy for improvement.

In contrast, some participants appreciated the simulator's unbiased, unemotional, and objective feedback, indicating their appreciation for its ability to provide insight into seat balance and stability. This resulted in an improved feedback process because the participant considered the visual measurements as the simulator's feedback language, which allowed them to engage in an iterative dialogue about how to improve. Participants could improve during practice by using the simulator's feedback to determine what the adjustments did to their balance and stability and how effective they were in reaching their target goal. As a result, these participants indicated a high level of Presage factors that granted a high level of Process factors. The participants who appreciated the simulator's feedback were engaged and made sense of the feedback through visual dialogue.

Instructor Feedback

The participants who received feedback from an instructor-only were the most expressive in positive Presage and Process factors. Participants in the instructor-only group were less likely to express negative Presage factors but rather speak positively about their capacities, previous experiences, and the teaching contexts. Most participants expressed appreciation for the instructor and auto-training feedback and the opportunity to focus on their riding without the variability or risk of the horse. Participants with an instructor were also less likely to have relational concerns with the fidelity or practicality of the simulator.

Responses relating to Process factors of engagement, sense-making, and dialogue were the most frequently expressed with positive emotional undertones. This aligns with social constructivism's function of the social interaction of feedback through engaging and dialoguing with instructors as a learner works through what needs improving and how to achieve it (Boud & Molloy, 2013; Calress, 2019; Vygotsky, 1978).

Simulator and Instructor Feedback

The participants' perceptions in the multi-modality feedback group were more positive when compared to the participants' perceptions in the no feedback or simulator-only feedback group. However, the participants' perceptions in the multi-modality feedback group were slightly less positive when compared to the instructor-only feedback group. The Presage factors were similar to Study Group 2 regarding positive perceptions of the prior experiences, capacities, and teaching contexts. Only one participant referred to the simulator as having an abstract feel that made the experience unauthentic. For Process factors, most participants were positive toward engagement, sense-making, and dialogue. Several participants expressed the benefit of both modalities to complement the learning process. However, a few participants felt that having both feedback modalities was distracting, while others mentioned they have emotional responses to feedback.

Feedback Literacy Factors

This study examined whether relationships exist between the rider's perception of their feedback experience and factors that influence feedback literacy. Based on the 3P conceptual model, Presage factors influence the Process factors that influence the uptake of feedback. The findings from this study indicate that participants who received no feedback (i.e., Group 1) or feedback from only a simulator (i.e., Group 3) were more likely to express negative factors of feedback literacy. Whereas, when there was a presence of an instructor (i.e., Group 2 and Group 4), participants were more likely to express positive factors of feedback literacy.

In both Group 1 and Group 3, most of the negative perceptions of Process were attributed to the lack of capability to improve without guidance. Even if participants understood that there were imbalances or instability in their seats, they did not know how to improve them. Through the lens of social constructivism, particularly with Vygotsky's (1978) ZPD, a learner has a particular schema of ability that is accessible without any help, but to expand and sophisticate those skills requires assistance. So, these participants understood they were not balanced or stable but needed support to identify and apply the appropriate skills to improve. A noticeable difference between the two groups was the accountability within their capacity and engagement during the practice sessions. For Group 1, despite not having sufficient skills or domain knowledge to know what to do, collectively, as a group, they would still appreciate what feedback they did have and used the practice time to engage as best as they could to improve their seat balance and stability. In contrast, Group 3, in the same situation, was much more likely to be apathetic to the feedback, disengage in the practice session, and rationalize the potential improvement if an instructor was present.

An explanation for this discrepancy can be linked to concurrent visual feedback not being operationalized by the participant in a way that transforms their understanding and ability. Sigrist et al. (2013) found in their study that concurrent visual feedback degraded learning in a complex rowing skill because learners were more externally focused on the visible measures, reducing the development of the motor skill's intrinsic elements. When feedback is provided as it is with the simulator, it could be perceived by the learner as something to make correct but does not elicit a transformative change in their motor-function and muscle-coordination, nor a sustainable improvement in their performance. Participants may have focused more on fixing the kinematic visuals than on elements that improve their seat imbalances and instability. As a result, when the concurrent visual feedback was removed during the auto-training, there was a lack of intrinsic development to replicate the improvements occurring in the practice session. Whereas Study Group 1 did not have any feedback to focus on and, in return, used the practice time to do their best to improve based on intrinsic feedback, which could be replicated during the auto-training.

For both Group 2 and Group 4, the presence of an instructor positively influenced the perception of the feedback modality. In addition, participants had positive perceptions about the Presage teaching context factors and all the Process factors during their practice sessions. It would indicate that the presence of the instructor was able to help the participant use the verbal and visual external feedback to improve intrinsic responses.

Overall Perceptions

Through the quantitative and qualitative survey responses, participants communicated a generally positive attitude toward their experiences with the feedback processes. A common perception was that when only one feedback modality was provided, participants believed their improvement would be enhanced if the other feedback modality was incorporated. If participants expressed positive Presage factors, especially concerning appreciating feedback as a way to improve, they also expressed positive Process factors during their practice sessions. In contrast, if participants expressed negative Presage factors, they also expressed negative Process factors during their practice sessions.

Research Question 3

Research Question 3 was, "*What is the rider's perception of their improvement while using a horseback riding simulator to improve seat balance and stability?"* How learners perceive their improvement is essential in understanding how feedback impacts their learning and provides insight into their feedback literacy. This study examined the intersecting concepts of feedback modality and feedback literacy during practice on a simulator. The subsections below will answer Research Question 3 through the independent concepts in the study and the collective interpretation based on the triangulation of the two data sets.

Simulation-Based Learning

Though this study examined improvement scores to evidence the efficacy of different feedback modalities, this is only one way to evidence improvement in motor skill acquisition. As represented by Product in the 3P model, improved strategies, contributions to feedback spirals, and adding to ongoing puzzles are other indicators of learning and improvement. Examining these different areas of improvement, it was evident in the open-ended responses that, regardless of quantitative seat scores, most participants acknowledged various ways they improved their seat balance and stability.

The significance of these findings is that they support the literature and research on the efficacy of developing complex motor skills through simulated learning environments. Achieving expertise in a complex motor skill requires years of practice and experience and begins with mastering smaller components of the concept (Cecilio-Fernandes et al., 2020). Using a riding simulator allowed participants to concentrate on their proprioception and muscle coordination in tandem with the equine movement without the distraction and risk that a horse presents. In addition, all participants received terminal KR feedback on the kinematic measurements of their balance and stability from the auto-training tests. Providing this objective feedback allows the abstract nature of the diametric opposition between the rider's seat and the horse's movement to become more concrete and quantifiable, drawing less on feel and illusion (González & Šarabon, 2020, 2021, 2022a, 2022b; Hobbs et al., 2020; Lagarde et al., 2005). Ultimately, this learning environment provided a unique opportunity for participants to practice a complicated performance competency without interference and, most importantly, with targeted feedback that precisely addressed the riding skill, which is unavailable in a traditional training situation.

Feedback Modality

Of the 74 participants who responded to the exit survey, 54 mentioned completing the sessions with a positive perception of improvement (i.e., Product). Only three participants had a negative response to the experience regarding Product factors, and these participants were from the no-feedback and simulator-only Groups. As demonstrated in Research Question 2, the presence of an instructor strongly influenced participants' perceptions. There was a 100% positive response from the participants that responded about Product in Group 2 and Group 4. These results indicate that the presence of an instructor to provide feedback during practice mitigated the negative perception of no improvement.

Based on the social constructivist framework of this study, the instructor represents the "more knowledgeable person" who assists the learner in developing and closing the learning gap (Carless, 2020; Vygotsky, 1978). This understanding of the instructor supports the findings in the study because the instructor's feedback empowered and validated the participant's efforts to progress toward a more balanced and stable seat. In addition, the social nature of the instructor-learner dyad allows for the collaboration of new strategies and approaches, including reassurance from the instructor that the participant's adjustments will produce positive results (Jaszczur-Nowicki et al., 2021). It also supports why the negative Product responses came from participants without instructor-mediated feedback. Those participants lacked the guidance to close the learning gap without the instructor.

Triangulation

Tensions existed in the findings that represented contradictions between feedback, performance scores, and perceptions. For example, participants improved despite practicing with no feedback or less effective feedback modalities. Yet, other participants in the multi-modality feedback group did not improve despite this being the most effective feedback approach. Some participants would digress in performance but still identify improvement. Others improved their performance but felt the experience did not benefit their seat balance and stability development. Triangulation of the two data sets was converged and interpreted to understand further the complexity of this relationship between feedback modality, feedback literacy factors, performance, and perceptions.

The results indicate that a participant that exemplifies a high level of Presage and Process feedback literacy will diligently engage in learning experiences that result in positive Product factors. The higher feedback literacy learners possess, the more they will appreciate, engage, and dialogue with feedback during practice to improve their seat balance and stability. When participants are developing new techniques, adapting different approaches, and refining muscle memory coordination, it is not uncommon for performance to temporarily decline or plateau, which is why participants digressed in improvement scores but still perceived improvement (Anderson et al., 2021; Magill & Anderson, 2018). Participants who improved in all three improvement scores tended to dialogue with their feedback modality, including those with the simulator-only feedback—indicating that participants performed better when they took a social constructivist approach to feedback.

If participants had negative feedback literacy qualities, they focused on their lack of domain knowledge and intrinsic feedback, disengaged with feedback during practice, had a negative emotional response, and focused on the absence of the simulator's fidelity (e.g., an inability to give biofeedback as a real horse would). Even the participants who improved in two or three seat scores, their struggles with negative Presage and Process factors dampened their perceptions. The learner's Presage factors had the most influence on whether or not a participant would perceive improvement. Participants also had relational issues with the simulator's fidelity in representing the concept of the riding seat accurately, and, therefore, the simulator has no benefit to that individual's performance. SBL requires that learners participate with a "suspension of disbelief." When a learner is willing to suspend disbelief and engage with the simulator as if it was a real horse, the engagement and effectiveness of the learning are increased (Muckler, 2017). For these participants, the simulator led to negative Process factors and formed the perception that improving their seat balance and stability was not helpful. These findings indicate that the lower the level of feedback literacy a learner possesses, the more discord they have with the feedback and the more likely they are to disengage during practice resulting in low scores and negative perceptions.

Research Question 4

Research question 4 was, *"What is the rider's perception of using a horseback riding simulator as an instructional tool to improve seat balance and stability?"* As equestrian sports evolve and elements (i.e., safety, welfare) that highlight the benefit of

SBL become relevant, emerging simulation technologies are becoming a tool of interest. Every participant in the study rode the Eventing Racewood simulator to practice and evaluate their seat competencies. The dominant perception of the riding simulator as an instructional tool was positive and viewed as an enjoyable and helpful experience. Another significant perception was the consistent reference of being able to transfer knowledge and skills learned on the simulator to actual riding. This sentiment is observed in the literature on horseback riding simulators (Kim et al., 2018; W. Lee et al., 2018).

The complexity of the human muscular coordination attempting to synchronize with the horse's diametric movement makes learning proper riding position difficult. A solution in the literature has been to explicate the riding position through objective measures offered by technology (J.-N. Lee & Kwack, 2014; Williams & Tabor, 2017). Historically, high-speed optic captures and electromyography were used to capture and quantify the kinematics of a rider's seat, which required extensive setup and had limitations regarding real-time viewing options. Utilizing a riding simulator that required no setup and provided quantitative measures that visually and concurrently demonstrated balance and stability gave participants a helpful tool to understand their seats and consider the implications in a real-life scenario (Al-Elq, 2010; Clark et al., 2022; Landman et al., 2018; Rauter et al., 2013).

Limitations

As with all research, this study is subjected to limitations. The first set of limitations identified begin with the sample population. The sample participants were mostly from the four Northern regions of Utah, with only a handful of participants from the other regional areas. This is not completely reflective of the United States equestrians at large (American Horse Council Foundation, 2017). Acknowledging that Utah has a lower percentage of nationally competitive professionals, competitors, and facilities and a much higher recreational population of equestrians, this may lead to some discrepancies of participants familiarity of equestrian riding standards that elicit better performance (American Horse Council Foundation, 2017; American Quarter Horse Association, 2021; United States Equestrian Federation, n.d.).

Another limitation with sample population is the majority of participants were female. This means the study lacks generalizability to the population. Replication of this study would be improved from recruiting efforts to enroll participants of other genders to better represent the population. This could also be potentially accomplished through a larger sample size. Another limitation of the study was the unbalanced number of participants skill groups. Acknowledging that skill level had an effect on motor skill acquisition, it is important to ensure a balanced number of each skill level was represented in each group to produce more accurate results. Again, a larger sample size would be a potential solution if this study was to be replicated.

It is also important to identify the limitation regarding recruitment. This study’s recruitment efforts were focused on a convenience sample from USU’s College of Agriculture and Applied Sciences (CAAS) and the Utah equestrian community which may have contributed to the limited demographics, bias, and threat to internal validity. Additionally, the lead researcher was a well-known member of the Utah equestrian community and an instructor at USU; this may have led to a positivity bias since participants could have anticipated what results were desired. Some of these participants may have had exposure to the simulator prior to the study through participation in a USU equine course, community program, or through a publicly available one.

The second group of limitations are identified within the methodology. The first limitation is that the participants self-reported their skill levels. Although the survey is an IHSA standard tool for placing riders into the appropriate divisions based on experience, participants selected their responses with no required evidence of those experiences or skills means that biased responses (e.g., exaggeration, selective/telescoping memory, attribution) could misappropriate participant's actual skill level. Recruitment and retention are problematic for research studies, and requiring supplemental evidence to verify skill level might deter participants from enrolling. However, it would be valuable to reexamine other approaches and/or tools for improving accuracy in identifying skill level placement.

The second methodological limitation is that the time between practice sessions was not controlled. With over 100 participants initially enrolled, it would have been a huge undertaking to manage the schedules for that number of participants. Participants used an online scheduler to sign up, cancel, and/or reschedule all their sessions. The only requirement that participants had to follow was to not sign up for sessions back-to-back, a factor that was restricted in the online scheduler. Not allowing back-to-back sessions was an attempt to reduce participant physical and cognitive fatigue and to maximize the number of participant sessions that could sign up in a day. The location of the simulator added to the time between sessions problem as participants located outside of Cache

Valley, where the simulator was located, had to make a longer drive which may have led them to signing up for multiple sessions in one day. Location considerations should be evaluated in the future so that access to the simulator is more centrally located, improving the feasibility for more participants to participate.

Another limitation associated with the research processes was the length of the practice sessions. The limited time participants spent in the training sessions may have had an effect on the outcomes of the study. As with many motor skills, it takes a lot of practice for riders to develop a balanced seat (Blokhuis et al., 2008; Williams & Tabor, 2017). With the limits of time to complete this study and to reduce the chance of dropout because of an excessive time commitment, the study engaged participants in only ten minutes of practice. Training programs that offer training on a Racewood Simulator are approximately 45 minutes long, which might represent a standard for practice session length. For future studies, it would be valuable to consider the time spent practicing as a factor of influence on performance.

Limitations relating to the simulator and instructor must also be considered. The saddle used on the simulator posed conflicting confounding variability and validity. It was decided to use the same saddle that accommodates the range of heights, pelvic structures, and body types that would participate in this study to control for saddle factors. Riding is still possible with an ill-fitting saddle; however, it does have a negative impact on rider kinematics (Dyson et al., 2015; González & Šarabon, 2022a). This can be likened to other sports where an inappropriate type and size of equipment does not stop performance but, likely, negatively affects it (e.g., skis, tennis racket, biking). Allowing riders to bring their own saddles was considered but the variability of saddle panels can negatively affect the simulator's calibration as well as introduced other confounding variability for those who did not ride in their own saddles. Offering a variety of saddles so that a participant could be properly fitted was considered and was a sound solution, but it was decided to forgo that route because of the amount of time it would take to assess every participant. Additionally, there were not enough seat size options in a saddle of the same brand and model available to the researcher. A future consideration would be to find a saddle company that would lend, or if resources allowed to purchase, several saddles of the same type and model in all seat size options.

An instructor's knowledge and pedagogy could also be a limitation of the study and should be selected appropriately. Since the focus of the study was on the rider's seat balances, the instructor should possess a well-developed eye for evaluating and addressing this skill, something that is difficult to see and address for many riding instructors (Blokhuis et al., 2008). Also, keeping in line with the theory of this study, an instructor must approach their pedagogy from a social constructivist view. Instructor's lacking expertise in correct positional principles and using feedback in the practice sessions through a monolithic approach would potentially influence the impacts of the study.

The last, and most significant limitation identified in this study was the survey tool for exploring factors from the conceptual model. The closed-ended survey questions would have been vastly improved if they were piloted prior to the study so that a higher standard of refinement for reliability and validation could have been completed. There were noticeable gaps in questions addressing the specifics relating to the Presage and Product factors that would have provided a clearer representation of the conceptual framework. In addition, the two end of session surveys need reconsideration as to their value and justification for being used. Through the analysis, it seemed that questions that aligned better to the exit survey addressing the Process factors would have provided more robust interpretations of how the feedback modalities were influencing feedback processes. For open-ended questions, the results provided data that was satisfactory for finding the nuanced factors of feedback literacy. However, when interpreting the analysis, it became clear that the open-ended responses were often ambiguous, and participants would have contradictory explanations. Consideration should be given to conducting interviews for the qualitative methods so that clarification and further inquiry can be explored when need.

Delimitations

A delimitation of this study should be considered in context of feedback modality in SBL. Although this study explored how motor skill acquisition in SBL was affected by feedback modality, the simulator and motor skills are contained to the sport of equestrianism. It is unknown if the results of this study would apply to other subjects and fields using simulation in motor skill acquisition.

Implications for Practice

The findings of this study have implications for stakeholders involved in simulation based training and equine professionals involved in riding and training programs. Since the implications are somewhat different for the respective stakeholders, they are presented as different subsections below.

Simulation-Based Learning

Using simulators is an accepted and beneficial way to develop, experience, teach, and assess complex motor skills (Al-Saud et al., 2017; Baechle et al., 2022; Hadinejad-Roudi et al., 2021; Hatala et al., 2014; González & Šarabon, 2022b; Todorov et al., 1997; Zhou et al., 2011), especially for fields that are heavily reliant on performance competencies (e.g., medicine, flight, driving). With the addition of simulators, programs can offer a learning experience that is safer, improves welfare, increases the opportunity for repeated practice, and reduces the burden on resources. As confirmed in this study, beginners can positively impact their seat stability and balance by simply being provided with a simulated experience to practice. Learners and instructors can use simulators to focus on specific performance competencies otherwise challenging to isolate with the external variables of the real scenario (e.g., controlling a horse). Programs that require performance competencies should invest in simulators as instructional tools and adopt the concept of SBL as a mainstay of the curriculum, assessment practices, and instructional methods.

Another implication for stakeholders in SBL programs is the pedagogical approaches to providing feedback during practice. It is substantiated in the literature that multi-modalities of feedback are effective in performance and learning. Specifically, in SBL, visual feedback produced by a simulator and verbal feedback from an instructor has a positive impact. As a result, selecting a simulator that does not provide feedback can still be beneficial. Nevertheless, a priority should be placed on choosing a simulator that provides visual feedback on the kinematics of the complex motor skill. Verbal feedback is not as impactful when delivered as a one-way, passive transfer of information about the learner's performance. To produce positive impacts, instructors should provide verbal feedback as a collaborative dialogue with the learner. If an instructor or program does not employ this pedagogical approach, then it would be necessary for leadership to invest in professional development to help train strategies oriented to the socially constructed approach of feedback in instruction.

This study also demonstrated consideration of exposure time to maximize learning. Evident throughout the study was that the amount of improvement was greatest at Session 1 and became significantly lower by Session 3, which means that saturation of skill improvement was likely reached in three sessions or that a performance plateau was occurring. How many sessions are required to provide improvement is an important consideration when designing practice on simulators.

Equine Industry

The equine industry is notoriously known for encompassing stakeholders' belief systems that are grounded in traditional practices and cultures that have existed for centuries (Lord, 2019). A threat to this belief system is using innovative technologies to help with varying aspects of the ridden horse (e.g., health wearables, movement analysis monitors, exercise trackers). Research examining stakeholders' perceptions found that technology could be useful but there needs to be a significant cost-benefit and time-benefit ratio, strong evidence of the usefulness, and the high-level expert rider's endorsement of the technology (Egan et al., 2019). These perceptions are informative to why high-fidelity equine simulators are emerging in the industry but have yet to become a mainstay in training programs in the U.S.

An interest in conducting this study was to provide equine professional stakeholders involved with riding and training programs insight into the effectiveness of using a simulator to improve riding skills. Since riding is a fairly dangerous and complex sport, it is logical to elicit the use of a simulator to enhance riding education and performance. It is documented that the safety and expertise of a rider are affected by the ability to maintain balance and stability (Thompson et al., 2015; Wolframm, 2013). These are the skills that this study demonstrated the Racewood Eventing simulator was capable of improving, especially with beginners. For those programs who serve beginner and novice clientele, incorporating a simulator would allow new riders to develop a complex skill while reducing the risk associated with using lesson horses. Improving the safety of beginning riders while they are learning an imperative skill that increases safety of future riding endeavors would be a strong justification for adopting a simulator in a training and riding program.

In programs with more skilled riders, the incorporation of a simulator would also improve rider's seat competencies through the dialogical and discovery process to explore ambiguous factors that might be affecting their seat balance and stability (Blokhuis et al., 2008). Since the seat balance and stability is a result of complex motor functions, it can be hard to identify where the issue is without a way to isolate the rider from the horse. If the rider can eliminate the responsibility of controlling a horse, but still have the influence of motion, then various adjustments and diagnostics can be investigated that would be otherwise challenging (i.e., moving arms and hands around) (Blokhuis et al., 2008).

Stakeholders that use lesson horses should also consider a riding simulator for economical purposes. Simulators provide an opportunity to increase lessons because they can be used multiple times in a day, by multiple riders, and for whatever length of time it takes to reach the session goal. In contrast, a horse's ability to be used in multiple sessions and for prolonged periods of time is far more restrictive due to mental and physical abilities. As it stands at the time of this study, the Racewood Eventing simulator's largest cost is the initial purchase, but has a low overhead cost inclusive of the electricity to operate it and whatever expenses are required to maintain the room it is housed in. A lesson horse can have varying initial purchase costs, but the overhead expense is more substantial than that of the simulator. There is reason to explore financially the cost-benefit of implementing an equestrian simulator into a program.

The last implication from this study on the equine industry is for the competition sector and preservation of their "social license" to use horses for sport. The social license of the equine sport is considered the non-legal contract to operate so long as it meets the ethical dimension of the society (i.e., equine welfare; Campbell, 2021; Furtado et al., 2021). Although equine sports are not new to public scrutiny, increasing negative media attention (i.e., Tokyo Olympics pentathlon), exposing poor welfare through technology advances (i.e., camera phones, social media), and increasing scientific evidence of animal social and mental welfare (i.e., equine cognition) have resulted in increased threats to the social license (Douglas et al., 2022; Minero & Canali, 2009). In order to keep the social license and preserve the future of equine sports, the competition sector's allocation of resources and support of evidence-based endeavors should continue, if not increase, to improve all aspects of the equine welfare in sports. Since rider asymmetry and instability has adverse effects on rider safety and equine physicality (MacKechnie-Guire et al., 2020), the promotion and support of using riding simulator technology in riding programs and instructor certifications should be a consideration for protecting equine sport's social license.

Recommendations for Research

Research in motor skill acquisition using various types, timing, and applications of augmented feedback has been quite extensive. A recommendation of this study is a continued exploration of the factors that influence the learner's uptake of feedback in motor skill acquisition through the lens of social constructivism. Some emerging approaches, like ecological dynamic theory (Renshaw et al., 2022) and its orientation in feedback literacy (Chong, 2021), are being explored and offer some insights to factors that help fit a learner to the learning environment. Feedback literacy evaluation tools and methods (Tripodi et al., 2021; Zhan, 2022) have also been explored. However, being able to identify the learner's feedback literacy specifically in motor skill acquisition could help better understand the effectiveness of specific feedback modalities as well as identify ways to empower the learner to engage and act on feedback.

Feedback literacy oriented towards long-term impacts could also be explored. Some participants did well in performance scores despite having a low level of feedback literacy and, on the contrary, some did poorly on performance scores despite having a high level of feedback literacy. A future direction could be to examine if the performance scores are affected over time based on the level of feedback literacy of the individual. For example, would a learner who obtained good performance scores actually digress those scores over times if they possessed a low level of feedback literacy?

Another recommendation from this study is examining the influence of simulator feedback on the instructor. With high perceptions for both groups that received feedback from the instructor, but only the group that included simulator-mediated feedback had significant quantitative performance results, there could be an interesting factor in the role the simulator-mediated feedback informs the instructor. Martínez et al. (2016) found that visual feedback was complimentary in instructional verbal feedback in teaching alpine ski skills as well as training the instructor on effective feedback strategies. Research into the role simulated-mediated feedback used by the instructor could provide further evidence of the efficacy of the combination of instructor- and simulator-mediated feedback.

Motor skill acquisition takes a lot of practice, appropriate motor skill coordination, development of intrinsic feedback to reach expertise and while development and learning is occurring, performance can appear negatively affected. The recommendation from this study is to explore the impact of session quantity and various related factors. One factor to explore can be the number of sessions it takes to achieve another significant increase in improvement as demonstrated in the first session. Since expertise in complex motor skill acquisition takes a significant amount of practice and time, it would be important to examine the number of sessions it requires to master a higher level of skill and move out of the performance plateau. The second factor could be examining the factors that contribute to a plateau of performance and identifying what learning is taking place that adversely affects the performance scores. Understanding what learning is still occurring during performance plateaus would be helpful for instructors and learners to recognize, especially for individuals more apt to have a negative emotional response. The last factor could be exploring interventions (i.e., instruction on strategies,) that could be applied after the three sessions and before the next grouping of sessions to continue the improvement. It would be beneficial to explore interventions that help with the learning plateau by supporting the learning and positively influencing closing the learning gap (i.e., ZPD) to move individuals towards higher levels of expertise.

In regard to this specific study's methodology, improvement scores were used to determine the efficacy of feedback modalities. Another approach could be to exclusively use the deviation scores to inform performance and mastery. For example, if a participant begins with deviation scores in the high 20s, instead of focusing on how much improvement they make in each session, it would be interesting to study if the sessions over time improve the deviation score, including the retention of the improved score. Consideration would need to be made for confounding variables of participant's physical activity outside of the study that can influence their seat scores (i.e., running a marathon, additional riding time, strength training, etc.).

With respect to the learners in complex motor skill acquisition of equestrian sports, it should be considered to assess the participant's understanding and knowledge of the skill to be performed (i.e., domain knowledge). Research demonstrates that a novice learner's ability to improve is related to their domain knowledge, specifically in the ability to draw connections and recognize patterns (Persky & Robinson, 2017). In this study, several participants, regardless of feedback modality provided, revealed that they were not sure how to improve, how it should feel, or what muscles to activate. Investigating deficiencies in the knowledge base on balanced and stabled riding position could offer insight into how domain knowledge impacts motor skill acquisition.

The last recommendation for future research is to explore the transferability of skill sets to the reality of riding the horse. An important component of SBL is to possess enough fidelity in the learning environment that the targeted skills and knowledge successfully transfer to the real-life scenario. Future studies should consider comparing the rider stability and balance between the simulator and actual horse as well as examining the impact of simulator training sessions for improving performance while riding.

REFERENCES

Ackerman, P. L. (2007). New developments in understanding skilled performance. *Current Directions in Psychological Science*, *16*(5), 235-239.

Akpan, V. I., Igwe, U. A., Mpamah, I. C., & Okoro, C. O. (2020) Social constructivism: Implications on teaching and learning. *British Journal of Education, (8)*8, 49-56.

Al-Elq, A. H. (2010). Simulation-based medical teaching and learning. *Journal of Family & Community Medicine, (17)*1, 35-40. https://doi.org/10.4103/1319-1683.68787

Al-Saud, L. M., Mushtaq, F., Allsop, M. J., Culmer, P. C., Mirghani, I., Yates, E., Keeling, A., Mon-Williams, M. A., & Manogue, M. (2017). Feedback and motor skill acquisition using a haptic dental simulator. *European Journal of Dental Education*, *21*(4), 240-247.

American Horse Council Foundation. (2017). *Economic impact of the U.S. horse industry*. https://www.horsecouncil.org/product/2017-economic-impact-study-of-the-u-s-horseindustry/

American Quarter Horse Association. (2021). *2021 Annual report*. https://www.aqha.com/documents/82601/1589238/2021+AQHA+Annual+Report.pdf/94454881-c00d-f587-4482-be16c5acf3a5?t=1649771187977

Amineh, R. J., & Asl, H. D. (2015). Review of constructivism and social constructivism. *Journal of Social Sciences, Literature and Languages*, *1*(1), 9-16.

Anderson, D. I., Lohse, K. R., Lopes, T. C. V., & Williams, A. M. (2021). Individual differences in motor skill learning: Past, present and future. *Human Movement Science, 78*. https://doi.org/10.1016/j.humov.2021.102818

Anderson, D. I., Magill, R. A., Mayo, A. M., & Steel, K. A. (2019). Enhancing motor skill acquisition with augmented feedback. In N. J. Hodge & A. M. Williams (Eds.), *Skill acquisition in sport: Research, theory and practice* (pp. 3-19). Routledge.

Arsalan, M., Ashish, G., & Yashendra, S. (2021). The role of augmented feedback on motor learning: A systematic review. *Cureus*, *13*(11), Article e19695. https://doi.org/10.7759/cureus.19695

Baechle, M. A., Gottlieb, R., Carrico, C. K., & Brody, E. R. (2022). Practice makes perfect? Association between students' performance measures in an advanced dental simulation course. *Journal of Dental Education., 86,* 1535-1544. https://doi.org/10.1002/jdd.13017

Barsuk, J. H., Cohen, E. R., Vozenilek, J. A., Oconnor, L. M., Mcgaghie, W. C., & Wayne, D. B. (2012). Simulation-based education with mastery learning improves paracentesis skills. *Journal of Graduate Medical Education, 4*(1), 23-27. https://doi.org/10.4300/jgme-d-11-00161.1

Biggs, J. (1993). From theory to practice: A cognitive systems approach. *Higher Education Research and Development, 12,* 73-86. https://doi.org/10.1080/07294369301201O7

Biggs, J. (1999). *Teaching for quality learning at university: What the student does*. Buckingham: SRHE and Open University Press

Black, P., & William, D. (1996). Meanings and consequences: a basis for distinguishing formative and summative functions of assessment? *British Educational Research Journal*, *22*(5), 537-548.

Blokhuis, M. Z., Aronsson, A., Hartmann, E., Van Reenen, C. G., & Keeling, L. (2008). Assessing the rider's seat and horse's behavior: Difficulties and perspectives. *Journal of Applied Animal Welfare Science, (11*)3, 191-203. https://doi.org/10.1080/10888700802100876

Bloom, B. S. (1968). Learning for mastery. Instruction and curriculum. Regional Education Laboratory for the Carolinas and Virginia, Topical Papers and Reprints, Number 1. *Evaluation comment*, *1*(2), n2.

Bloom, B. S., Hastings, J. T., & Madaus, G. F. (1971). *Handbook on formative and summative evaluation of student learning*. McGraw-Hill.

Boud, D., & Molloy, E. (2013). Rethinking models of feedback for learning: The challenge of design. *Assessment & Evaluation in Higher Education*, *38*(6), 698-712.

Brabeck, M., Jeffrey, J., & Fry, S. (2010). *Practice for knowledge acquisition (not drill and kill).* American Psychological Association. http://www.apa.org/education/k12/practice-acquisition

Brandt, K. (2004). A language of their own: An interactionist approach to human-horse communication. *Society & Animals, 12(*4), 299-316. https://doi.org/10.1163/1568553004306801O

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101.

British Horseracing Authority. (2019). *Jockey training and development*. http://www.britishhorseracing.com/wp-content/uploads/2019/01/92084-BHA-Jockey-Training-and-Development-folder.pdf

British Racing School. (n.d.). *Courses and training.* https://brs.org.uk/coursecategories/jockey

Buchner, J., Buntins, K., & Kerres, M. (2021). The impact of augmented reality on cognitive load and performance: A systematic review. *Journal of Computer Assisted Learning, 38*(1), 285-303. https://doi.org/10.1111/jcal.12617

Byström, A., Rhodin, M., Von Peinen, K., Weishaupt, M. A., & Roepstorff, L. (2009). Basic kinematics of the saddle and rider in high-level dressage horses trotting on a treadmill. *Equine Veterinary Journal, 41*(3), 280-284. https://doi.org/10.2746/042516409x394454

Cant, R. P., & Cooper, S. J. (2016). Use of simulation-based learning in undergraduate nurse education: An umbrella systematic review. *Nurse Education Today, 49*, 63-71. https://doi.org/10.1016/j.nedt.2016.11.015

Campbell, M. L. (2021). An ethical framework for the use of horses in competitive sport: Theory and function. *Animals, 11*(6), Article e1725. https://doi.org/10.3390/ani11061725

Campitelli, G., & Gobet, F. (2011). Deliberate practice: Necessary but not sufficient. *Current Directions in Psychological Science*, *20*(5), 280-285.

Carless, D. (2006). Differing perceptions in the feedback process. *Studies in Higher Education*, *31*(2), 219-233.

Carless, D. (2019a). Feedback loops and the longer-term: towards feedback spirals. *Assessment & Evaluation in Higher Education, (44)*5, 705-714. https://doi.org/10.1080/02602938.2018.1531108

Carless, D. (2019b). Learners' feedback literacy and the longer term: Developing capacity for impact. In M. Henderson, R. Ajjawi, D. Boud, & E. Molloy (Eds.), *The impact of feedback in higher education: Improving assessment outcomes for learners* (pp. 51-65). Springer International Publishing AG. https://doi.org/10.1007/978-3-030-25112-3_4

Carless, D. (2020). Longitudinal perspectives on students' experiences of feedback: A need for teacher-student partnerships. *Higher Education Research & Development*, *39*(3), 425-438.

Carless, D., & Boud, D. (2018). The development of student feedback literacy: Enabling uptake of feedback. *Assessment & Evaluation in Higher Education, 43*, 1315-1325. https://doi.org/10.1080/02602938.2018.1463354

Casutt, G., Theill, N., Martin, M., Keller, M., & Jäncke, L. (2014). The drive-wise project: Driving simulator training increases real driving performance in healthy older drivers. *Frontiers in Aging Neuroscience*, *6*, Article e85. https://doi.org/10.3389/fnagi.2014.00085

Cecilio-Fernandes, D., Cnossen, F., Coster, J., Jaarsma, A. D. C., & Tio, R. A. (2020). The effects of expert and augmented feedback on learning a complex medical skill. *Perceptual and Motor Skills*, *127*(4), 766-784.

Champagne, M. V. (2014). *The survey playbook: The only survey guide you'll ever need*. CreateSpace.

Chang, J. Y., Chang, G. L., Chien, C. J. C., Chung, K. C., & Hsu, A. T. (2007). Effectiveness of two forms of feedback on training of a joint mobilization skill by using a joint translation simulator. *Physical Therapy, 87*(4), 418-430. https://doi.org/10.2522/ptj.20060154

Chong, S. W. (2021). Reconsidering student feedback literacy from an ecological perspective. *Assessment & Evaluation in Higher Education*, *46*(1), 92-104.

Clark, L., Bradley, E. J., Mackechnie-Guire, R., Taylor, A., & Ling, J. (2022). Trunk kinematics of experienced riders and novice riders during Rising trot on a riding simulator. *Journal of Equine Veterinary Science*, *119*. https://doi.org/10.1016/j.jevs.2022.104163

Clark, L., Bradley, E. J., Nankervis, K., & Ling, J. (2021). Repeatability vs complexity: Kinematic comparison between a dressage simulator and real horses. *Comparative Exercise Physiology*, *17*(5), 467-474. https://doi.org/10.3920/cep200063

Clayton, H. M., & Hobbs, S. J. (2017). The role of biomechanical analysis of horse and rider in equitation science. *Applied Animal Behaviour Science*, *190*, 123-132. https://doi.org/10.1016/j.applanim.2017.02.011

Concannon, B. J., Esmail, S., & Roberts, R. M. (2019). Head-mounted display virtual reality in post-secondary education and skill training. *Frontiers in Education, 4*, Article e80. https://doi.org/10.3389/feduc.2019.00080

Creswell, J. W. (2015). *A concise introduction to mixed methods research*. SAGE.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). SAGE Publications.

Curry, L. A., Nembhard, I. M., & Bradley, E. H. (2009). Qualitative and mixed methods provide unique contributions to outcomes research. *Circulation, 119*, 1442-1452.

DataUSA. (n.d.). *Equestrian studies*. dataUSA.io. https://datausa.io/profile/cip/equestrian-studies#demographics

Davis, D., & Maurstad, A. (2017). *The meaning of horses: Biosocial encounters* (1st ed.). Routledge.

DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field Methods, 23*(2), 136-155. https://doi.org/10.1177/1525822X10388468

Demarie, S., Minganti, C., Piacentini, M. F., Parisi, A., Cerulli, C., & Magini, V. (2013). Reducing anxiety in novel horse riders by a mechanical horse simulator. *Medicina Dello Sport, 66,* 179-188.

DeVellis, R. F., & Thrope, C. T. (2021). *Scale development: Theory and applications*. Sage Publications.

Dillman D. A., Smyth J. D., & Christian L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The Tailored Design Method.* Wiley.

Dominguez-Romero, J. G., Molina-Aroca, A., Moral-Munoz, J. A., Luque-Moreno, C., & Lucena-Anton, D. (2020). Effectiveness of mechanical horse-riding simulators on postural balance in neurological rehabilitation: Systematic review and meta-analysis. *International Journal of Environmental Research and Public Health, 17*(1), Article e165. https://doi.org/10.3390/ijerph17010165

Douglas, J., Owers, R., & Campbell, M. L. H. (2022). Social license to operate: What can equestrian sports learn from other industries? *Animals, 12*(15), Article e1987. https://doi.org/10.3390/ani12151987

Dyson, S. (2017). Equine performance and equitation science: Clinical issues. *Applied Animal Behaviour Science, 190*, 5-17.

Dyson, S., Carson, S., & Fisher, M. (2015). Saddle fitting, recognising an ill-fitting saddle and the consequences of an ill-fitting saddle to horse and rider. *Equine Veterinary Education, 27*(10), 533-543.

Egan, S., Brama, P., & McGrath, D. (2019). Irish equine industry stakeholder perspectives of objective technology for biomechanical analyses in the field. *Animals, 9*(8), Article e539. https://doi.org/10.3390/ani9080539

El Hussein, M. T., & Ha, C. (2023). Experiences of nursing students in observer roles during simulation-based learning and the impact on patient safety: A scoping review. *Clinical Simulation in Nursing*, *78*, 7-17.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*(3), 363-406. https://doi.org/10.1037/0033-295X.100.3.363

Equicizer. (n.d.). *Used by experts: The equicizer*. https://equicizer.com/pages/used-by-experts

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191.

Federal Aviation Administration (FAA). (2020). *National Simulator Program (NSP)*. https://www.faa.gov/about/initiatives/nsp/

Fortis. (n.d.). *History.* http://fortiseng.fortis.or.kr/page/history

Franklin, S. (2020). *Degrees of freedom.* Sword STEM. http://swordstem.com/2020/01/22/degrees-of-freedom/

Frikha, M., Chaâri, N., Elghoul, Y., Mohamed-Ali, H. H., & Zinkovsky, A. V. (2019). Effects of combined versus singular verbal or haptic feedback on acquisition, retention, difficulty, and competence perceptions in motor learning. *Perceptual and Motor Skills*, *126*(4), 713-732.

Furtado, T., Preshaw, L., Hockenhull, J., Wathan, J., Douglas, J., Horseman, S., Smith, R., Pollard, D., Pinchbeck, G., Rogers, J., & Hall, C. (2021). How happy are equine athletes? Stakeholder perceptions of equine welfare issues associated with equestrian sport. *Animals, 11*(11), Article e3228. https://doi.org/10.3390/ani11113228

Giannousi, M., Mountaki, F., & Kioumourtzoglou, E. (2017). The effects of verbal and visual feedback on performance and learning freestyle swimming in novice swimmers. *Kinesiology*, *49*(1), 65-73.

Giordano, G. (2005). *How testing came to dominate American schools: The history of educational assessment*. Peter Lang Publishing.

Gliem, J. A., & Gliem, R. R. (2003, October 8-10). *Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales* [Paper presentation]. Midwest research-to-Practice Conference in Adult, Continuing, and Community Education, Columbus, OH.

González, M. E., & Šarabon, N. (2020). Muscle modes of the equestrian rider at walk, rising trot and canter. *PloS one*, *15*(8), e0237727.

González, M. E., & Šarabon, N. (2021). Shock attenuation and electromyographic activity of advanced and novice equestrian riders' trunk. *Applied Sciences*, *11*(5), Article e2304. https://doi.org/10.3390/app11052304

González, M. E., & Šarabon, N. (2022a). Effects of saddle tilt and stirrup length on the kinetics of horseback riders. *PeerJ*, *10*, e14438. https://doi.org/10.7717/peerj.14438

González, M. E., & Šarabon, N. (2022b). The effects of a real-time visual kinetic feedback intervention on shock attenuation of the equestrian rider's trunk: A pilot study. *Frontiers in Sports and Active Living*, *4*, Article e899379. https://doi.org/10.3389/fspor.2022.899379

Guadagnoli, M. A., & Lee, T. D. (2004). Challenge point: A framework for conceptualizing the effects of various practice conditions in motor learning. *Journal of Motor Behavior, 36*(2), 212-224. https://doi.org/10.3200/JMBR.36.2.212-224.PMID:15130871

Guskey, T. R. (2005). Formative classroom assessment and Benjamin S. Bloom: Theory, research, and implications. https://files.eric.ed.gov/fulltext/ED490412.pdf

Hadinejad-Roudi, A. A., Fesharakifard, R., Rezaei, S. M., & Nahvi, A. (2021). Virtual manual arc welding by real-time process simulation for an effective training. *AUT Journal of Mechanical Engineering, 5*(1), 121-140 https://doi.org/10.22060/ajme.2020.17800.5875

Hancock, J., Vander Hoek, K. J., Bradshaw, S., Coffman, J. D., & Engelmann, J. (2007). *Equestrian design guidebook for trails, trailheads, and campgrounds*. USDA, Forest Service, Technology and Development Program. https://www.fs.fed.us/td/pubs/htmlpubs/htm07232816/page03.htm#star

Hatala, R., Cook, D. A., Zendejas, B., Hamstra, S. J., & Brydges, R. (2014). Feedback for simulation-based procedural skills training: A meta-analysis and critical narrative synthesis. *Advances in Health Sciences Education, 19*(2), 251-272. https://doi.org/10.1007/s10459-013-9462-8

Hattie, J., & Clarke, S. (2018). *Visible learning: Feedback*. Routledge.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81-112. https://doi.org/10.3102/003465430298487

Hilliere, C., Collado-Mateo, D., Villafaina, S., Duque-Fonseca, P., & Parraca, J. A. (2018). Benefits of hippotherapy and horse riding simulation exercise on healthy older adults: A systematic review. *PM&R*, *10*(10), 1062-1072. https://doi.org/10.1016/j.pmrj.2018.03.019

Hobbs, S. J., St George, L., Reed, J., Stockley, R., Thetford, C., Sinclair, J., Williams, J., Nankervis, K., & Clayton, H. M. (2020). A scoping review of determinants of performance in dressage. *PeerJ Life & Environment*, *8*, Article e9022 https://doi.org/10.7717/peerj.9022

Horseracing Integrity and Safety Authority. (n.d.). *Regulations.* https://hisaus.org/regulations

Intercollegiate Horse Show Association (IHSA). (2019). *2019-2020 rider placement form.* IHSAINC. https://www.ihsainc.com/docs/default-source/coach-information-forms/ihsa-2019-2020-rider-placement-form-worksheet-final.pdf?sfvrsn=e571a105_0

Jaszczur-Nowicki, J., Romero-Ramos, O., Rydzik, Ł., Ambroży, T., Biegajło, M., Nogal, M., Wiśniowski, W., Kruczkowski, D., Łuszczewska-Sierakowska, I., & Niźnikowski, T. (2021). Motor learning of complex tasks with augmented feedback: Modality-dependent effectiveness. *International Journal of Environmental Research and Public Health*, *18*(23), 12495. https://doi.org/10.3390/ijerph182312495

Jenn, N. C. (2006). Designing a questionnaire. *Malaysian Family Physician, 1*(1), 32-35.

Jones, J. (2015). The power of proprioception. *Equus*, (449). https://equusmagazine.com/riding/power-proprioception-27096

Kang O-D, Ryu Y-C, Ryew C-C, Oh W-Y, Lee C-E, Kang M-S. (2010). Comparative analyses of rider position according to skill levels during walk and trot in Jeju horse. *Human Movement Science 29*, 956-963

Kant, I., & Smith, N. K. (1979*). Immanuel Kant's critique of pure reason*. Macmillan.

Kieson, E., & Abramson, C. I. (2017). Equines as tools vs partners: A critical look at the uses and beliefs surrounding horses in equine therapies and argument for mechanical horses. *Journal of Veterinary Science& Animal Husbandry*, *5*(1), Article e105. https://doi.org/10.15744/2348-9790.5.107

Kim, M. J., Kim, T., Oh, S., & Yoon, B. (2018). Equine exercise in younger and older adults: Simulated versus real horseback riding. *Perceptual and Motor Skills, 125(*1), 93-108.

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, *6*(5), 26-41.

Kulhavy, R. W. (1977). Feedback in written instruction. *Review of Educational Research, 47*(2), 211-232. https://doi.org/10.3102/00346543047002211

Kulhavy, R. W., White, M. T., Topp, B. W., Chan, A. L., & Adams, J. (1985). Feedback complexity and corrective efficiency. *Contemporary Educational Psychology*, *10*(3), 285-291. https://doi.org/10.1016/0361-476x(85)90025-6

Lagarde, J., Peham, C., Licka, T., & Kelso, J. S. (2005). Coordination dynamics of the horse-rider system. *Journal of Motor Behavior*, *37*(6), 418-424.

Landman, A., van Oorschot, P., van Paassen, M. M. R., Groen, E. L., Bronkhorst, A. W., & Mulder, M. (2018). Training pilots for unexpected events: A simulator study on the advantage of unpredictable and variable scenarios. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 60*(6), 793-805. https://doi.org/10.1177/0018720818779928

Lateef, F. (2010). Simulation-based learning: Just like the real thing. *Journal of Emergencies, Trauma and Shock*, *3*(4), 348-352. https://doi.org/10.4103/0974-2700.70743

Lauber, B., & Keller, M. (2014). Improving motor performance: Selected aspects of augmented feedback in exercise and health. *European Journal of Sport Science, 14*(1), 36-43. https://doi.org/10.1080/17461391.2012.725104

Lazic, D. A., Grujic, V., & Tanaskovic, M. (2022). The role of flight simulation in flight training of pilots for crisis management. *South Florida Journal of Development, 3*(3), 3624-3636. https://doi.org/10.46932/sfjdv3n3-046

Lee, J.-N., & Kwak, K.-C. (2014). A three-dimensional motion analysis of horse rider in wireless sensor network environments. *International Journal of Advanced Computer Science and Applications, 5*(11). https://doi.org/10.14569/ijacsa.2014.051109

Lee, W., So, B. R., Lee, Y., & Moon, C. (2018). A new robotic horseback-riding simulator for riding lessons and equine-assisted therapy. *International Journal of Advanced Robotic Systems, 15*(4). https://doi.org/10.1177/1729881418784433

Lesimple, C., Fureix, C., Menguy, H., & Hausberger, M. (2010). Human direct actions may alter animal welfare, a study on horses (Equus caballus). *PLoS ONE*, *5*(5). https://doi.org/10.1371/annotation/530e1439-fee8-434c-97b1-7d2cd87e2e46

Lipnevich, A. A., & Panadero, E. (2021). A review of feedback models and theories: Descriptions, definitions, and conclusions. *Frontiers in Education*, *6*. https://doi.org/10.3389/feduc.2021.720195

Lord, R. (2019). The equine industry: Competing beliefs, change and conflict. *Muma Business Review, 3*, 99-120. https://doi.org/10.28945/4399

MacKechnie-Guire, R., MacKechnie-Guire, E., Fairfax, V., Fisher, M., Hargreaves, S., & Pfau, T. (2020). The effect that induced rider asymmetry has on equine locomotion and the range of motion of the thoracolumbar spine when ridden in rising trot. *Journal of equine veterinary science*, *88*. https://doi.org/10.1016/j.jevs.2020.102946

Magill, R. A. (1994). The influence of augmented feedback on skill learning depends on characteristics of the skill and the learner. *Quest*, *46*(3), 314-327. https://doi.org/10.1080/00336297.1994.10484129

Magill, R. A., & Anderson, D. I. (Eds.). (2018). *Motor learning and control: Concepts and applications* (11th ed.). McGraw Hill. https://accessphysiotherapy.mhmedical.com/Content.aspx?bookid=2311&sectionid=179410122

Magill, R. A., Chamberlin, C. J., & Hall, K. G. (1991). Verbal knowledge of results as redundant information for learning an anticipation timing skill. *Human Movement Science*, *10*(4), 485-507.

Malterud, K. (2001). Qualitative research: Standards, challenges, and guidelines. *The Lancet*, *358*(9280), 483-488. https://doi.org/10.1016/s0140-6736(01)05627-6

Martin, J. A., Regehr, G., Reznick, R., Macrae, H., Murnaghan, J., Hutchison, C., & Brown, M. (1997). Objective structured assessment of technical skill (OSATS) for surgical residents. *British Journal of Surgery, 84*(2), 273-278. https://doi:10.1046/j.1365-2168.1997.02502.x

Martínez, J. C., Gómez-López, P. J., Femia, P., Mayorga-Vega, D., & Viciana, J. (2016). Effect of augmented verbal and visual feedback on efficiency in skiing teaching. *Kinesiology*, *48*(1), 49-57. https://doi.org/10.26582/k.48.1.12

Maryland Horse Council. (2023). *Maryland horse industry overview.* https://mdhorsecouncil.org/about/industry-overview/

Maxfield, M. (2019). *Paint simulation training saves time, money, reduces waste*. Naval Sea Systems Command. https://www.navsea.navy.mil/Media/News/Article/1916411/paint-simulation-training-saves-time-money-reduces-waste/

McCullough, C. (2014). Simulated training saves money, prepares soldiers for combat. United States Army. https://www.army.mil/article/125385/simulated_training_saves_money_prepares_soldiers_for_combat

McDowell, L., Sambell, K., & Davison, G. (2009). Assessment for learning: A brief history and review of terminology. In C. Rust (Ed.), *Improving student learning: improving student learning through the curriculum: Proceedings of the 16th international symposium* (pp. 56-64). Oxford Centre for Staff and Learning Development.

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica, 22(*3), 276-282. https://doi.org/10.11613/bm.2012.031

McKay, B., Hussien, J., Vinh, M. A., Mir-Orefice, A., Brooks, H., & Ste-Marie, D. M. (2022). Meta-analysis of the reduced relative feedback frequency effect on motor learning and performance. *Psychology of Sport and Exercise, 61*. https://doi.org/10.1016/j.psychsport.2022.102165

McLeod, S. (2022). *Piaget's stages of cognitive development background and key concepts of Piaget's theory*. Simply psychology. https://www.simplypsychology.org/piaget.html

Merriam-Webster. (n.d.). Proprioception. In *Merriam-Webster.com dictionary*. https://www.merriam-webster.com/dictionary/proprioception

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Minero, M., & Canali, E. (2009). Welfare issues of horses: an overview and practical recommendations. *Italian Journal of Animal Science*, *8*(sup1), 219-230. https://doi.org/10.4081/ijas.2009.s1.219

Molloy, E., Boud, D., & Henderson, M. (2020). Developing a learning-centered framework for feedback literacy. *Assessment & Evaluation in Higher Education*, *45*(4), 527-540.

Morse, J. M. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research*, *40*(2), 120-123.

Muckler, V. C. (2017). Exploring suspension of disbelief during simulation-based learning. *Clinical Simulation in Nursing*, *13*(1), 3-9.

Münz, A., Eckardt, F., & Witte, K. (2014). Horse-rider interaction in dressage riding. *Human Movement Science*, *33*, 227-237.

Nicol, D. (2010). From monologue to dialogue: Improving written feedback processes in mass higher education. *Assessment & Evaluation in Higher Education, 35*(5), 501-517. https://www.tandfonline.com/doi/full/10.1080/02602931003786559

O'Cathain, A., & Thomas, K. J. (2004). "Any other comments?" Open questions on questionnaires-a bane or a bonus to research? *BMC Medical Research Methodology*, *4*(1), 1-7. https://doi.org10.1186/1471-2288-4-25

Olivier, A., Faugloire, E., Lejeune, L., Biau, S., & Isableu, B. (2017). Head stability and head-trunk coordination in horseback riders: The contribution of visual information according to expertise. *Frontiers in Human Neuroscience, 11*(11)*,* 1-16. https://doi.org.dist.lib.usu.edu/10.3389/fnhum.2017.00011

Olivier, A., Viseu, J-P., Vignais, N., & Vuillerme ,N. (2019). Balance control during stance: A comparison between horseback riding athletes and non-athletes. *PLoS ONE 14*(2), e0211834. https://doi.org/10.1371/journal.pone.0211834

Oppici, L., Dix, A., & Narciss, S. (2021). When is knowledge of performance (KP) superior to knowledge of results (KR) in promoting motor skill learning? A systematic review. *International Review of Sport and Exercise Psychology*, 1-25. https://doi.org/10.1080/1750984x.2021.1986849

Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology*, *49*(1), 345-375.

Persky, A. M., & Robinson, J. D. (2017). Moving from novice to expertise and its implications for instruction. *American Journal of Pharmaceutical Education*, *81*(9), 72-80. https://doi.org/10.5688/ajpe6065

Petancevski, E. L., Inns, J., Fransen, J., & Impellizzeri, F. M. (2022). The effect of augmented feedback on the performance and learning of gross motor and sport-specific skills: A systematic review. *Psychology of Sport and Exercise*, *63*. https://doi.org/10.1016/j.psychsport.2022.102277

Plano Clark, V. L. (2019). Meaningful integration within mixed methods studies: Identifying why, what, when, and how. *Contemporary Educational Psychology*, *57*, 106-111.

Racewood. (n.d.). *Racewood equestrian simulators.* https://www.racewood.com/our-customers.html

Rauter, G., Sigrist, R., Koch, C., Crivelli, F., van Raai, M., Riener, R., & Wolf, P. (2013). Transfer of complex skill learning from virtual to real rowing. *PloS one*, *8*(12), e82145. https://doi.org/10.1371/journal.pone.0082145

Renshaw, I., Davids, K., O'Sullivan, M., Maloney, M. A., Crowther, R., & McCosker, C. (2022). An ecological dynamics approach to motor learning in practice: Reframing the learning and performing relationship in high performance sport. *Asian Journal of Sport and Exercise Psychology*, *2*(1), 18-26.

Rouder, J., Saucier, O., Kinder, R., & Jans, M. (2021). What to do with all those open ended responses? Data visualization techniques for survey researchers. *Survey Practice*, *14*(1), 1-9. https://doi.org/10.29115/sp-2021-0008

Ruiz, S., Aguado, C., & Moreno, R. (2014). A teaching experience using a flight simulator: Educational simulation in practice. *Journal of Technology and Science Education*, *4*(3)*,* 181-200. https://doi:10.3926/jotse.129

Ryan, T., & Henderson, M. (2018). Feeling feedback: students' emotional responses to educator feedback. *Assessment & Evaluation in Higher Education*, *43*(6), 880-892.

Sadler, D. R. (1989). Formative assessment and the design of instructional systems. *Instructional Science*, *18*(2), 119-144. https://doi.org/10.1007/bf00117714

Sadler, D. R. (2010). Beyond feedback: Developing student capability in complex appraisal. *Assessment & Evaluation in Higher Education*, *35*(5), 535-550. https://doi.org/10.1080/02602930903541015

Santos, S., Parraca, J. A., Fernandes, O., Villafaina, S., Clemente-Suarez, V. J., & Melo, F. (2022). The effect of expertise during simulated flight emergencies on the autonomic response and operative performance in military pilots. *International Journal of Environmental Research and Public Health*, *19*(15), Article e9141. https://doi.org/10.3390/ijerph19159141

Sharma, D. A., Chevidikunnan, M. F., Khan, F. R., & Gaowgzeh, R. A. (2016). Effectiveness of knowledge of result and knowledge of performance in the learning of a skilled motor activity by healthy young adults. *Journal of Physical Therapy Science*, *28*(5), 1482-1486.

Sigrist, R., Rauter, G., Riener, R., & Wolf, P. (2013). Augmented visual, auditory, haptic, and multimodal feedback in motor learning: A review. *Psychonomic Bulletin & Review*, *20*, 21-53. https://doi.org/10.3758/s13423-012-0333-8

Singer, E., & Couper, M. P. (2017). Some methodological uses of responses to open questions and other verbatim comments in quantitative surveys. *Methods, Data, Analyses)*, *11*(2), 115-134. https://doi.org/10.12758/mda.2017.01

Snoddy, G. (1926). Learning and stability: A psychophysiological analysis of a case of motor learning with clinical applications*.* *Journal of Applied Psychology*, *10*(1), 1-36. https://doi.org/10.1037/h0075814

Spector, P. (1992). *Summated rating scale construction*. SAGE Publications.

Sutton, P. (2012). Conceptualizing feedback literacy: Knowing, being, and acting. *Innovations in Education and Teaching International, 49*(1), 31-40. https://doi.org/10.1080/14703297.2012.647781

Tarr, R. (2023). *Random group generator* [online tool]. https://www.classtools.net/random-group-generator

Terada, K. (2000). Comparison of head movement and EMG activity of muscles between advanced and novice horseback riders at different gaits. *Journal of Equine Science*, *11*(4), 83-90.

Thompson, K., McGreevy, P., & McManus, P. (2015). A critical review of horse-related risk: A research agenda for safer mounts, riders and equestrian cultures. *Animals, 5*(3), 561-575. https://doi.org/10.3390/ani5030372

Tissera, K., Orth, D., Huynh, M., & Benson, A. C. (2022). The impact of augmented feedback (and technology) on learning and teaching cricket skill: A systematic review with meta-analysis. *PLOS ONE*, *17*(12), e0279121. https://doi.org/10.1371/journal.pone.0279121

Todorov, E., Shadmehr, R., & Bizzi, E. (1997). Augmented feedback presented in a virtual environment accelerates learning of a difficult motor task. *Journal of motor behavior*, *29*(2), 147-158. https://doi.org/10.1080/00222899709600829

Tian, Y., Liu, H., Yin, J., Luo, M., & Wu, G. (2015). Evaluation of simulation-based training for aircraft carrier marshalling with learning cubic and Kirkpatrick's models. *Chinese Journal of Aeronautics, 28*(1), 152-163. https://doi:10.1016/j.cja.2014.12.002

Tripodi, N., Feehan, J., Wospil, R., & Vaughan, B. (2021). Twelve tips for developing feedback literacy in health professions learners. *Medical Teacher*, *43*(8), 960-965.

United States Equestrian Federation. (n.d.). *Competitive events*. https://www.usef.org/compete/competitions

Utah State University. (2023). *Animal, Dairy and Veterinary Sciences: Equine Science and Management Emphasis - BS*. https://catalog.usu.edu/preview_program.php?catoid=35&poid=34056

Vanderstraeten, R. (2002). Dewey's transactional constructivism. *Journal of Philosophy of Education*, *36*(2), 233-246. https://doi.org/10.1111/1467-9752.00272

von Glasersfeld, E. (1995). A constructivist approach to teaching. In L. P. Steffe & J. Gale (Eds.), *Constructivism in education* (pp. 3-16). Erlbaum.

Vygotsky, L. (1978). *Mind in society*. Harvard University Press.

Walker, A. M., Applegate, C., Pfau, T., Sparkes, E. L., Wilson, A. M., & Witte, T. H. (2016). The kinematics and kinetics of riding a racehorse: A quantitative comparison of a training simulator and real horses. *Journal of Biomechanics*, *49*(14), 3368-3374. https://doi.org/10.1016/j.jbiomech.2016.08.031

Walker, A. M., Martin, A., Pfau, T., Sparkes, E. L., Wilson, A. M., & Witte, T. H. (2016). How realistic is a racehorse simulator? *Journal of biomechanics*, *49*(14), 3570-3575. https://doi.org/10.1016/j.jbiomech.2016.08.026

Watson, D., & Clark, L. A. (1994). *The PANAS-X: Manual for the positive and negative affect schedule-expanded form.* University of Iowa. https://doi.org/10.17077/48vt-m4t2

Weeks, D. L., & Kordus, R. N. (1998). Relative frequency of knowledge of performance and motor skill learning. *Research Quarterly for Exercise and Sport*, *69*(3), 224-230.

Wickens, C. D. (2002). Multiple resources and performance prediction. *Theoretical Issues in Ergonomics Science, 3*(2), 159-177. https://doi.org/10.1080/14639220210123806

Wickens, C. D. (2008). Multiple resources and mental workload. *Human Factors*, *50*(3), 449-455. https://doi.org/10.1518/001872008x288394

Williams, J., & Tabor, G. (2017). Rider impacts on equitation. *Applied Animal Behaviour Science*, *190*, 28-42. https://doi.org/10.1016/j.applanim.2017.02.019

Winstein, C. J., & Pohl, P. S., & Lewthwaite, P. (1994). Effects of physical guidance and knowledge of results on motor learning: Support for the guidance hypothesis. *Research Quarterly for Exercise and Sport*, *65*(4), 316-323. https://doi.org/10.1080/02701367.1994.10607635

Winstone, N. E., & Carless, D. (2019). *Designing effective feedback processes in higher education: A learning-focused approach*. Routledge.

Winstone, N. E., Mathlin, G., & Nash, R. A. (2019). Building feedback literacy: Students' perceptions of the developing engagement with feedback toolkit. *Frontiers in Education*, *4*, Article e39. https://doi.org/10.3389/feduc2019.0039

Wolframm, I. (2013). *The science of equestrian sports: Theory, practice and performance of the equestrian rider*. Routledge.

Wulf, G., McNevin, N., & Shea, C. H. (2001). The automaticity of complex motor skill learning as a function of attentional focus. *The Quarterly Journal of Experimental Psychology Section A*, *54*(4), 1143-1154. https://doi.org/10.1080/713756012

Wulf, G., & Shea, C. H. (2002). Principles derived from the study of simple skills do not generalize to complex skill learning. *Psychonomic Bulletin & Review*, *9*(2), 185-211. https://doi.org/10.3758/bf03196276

Wulf, G., & Shea, C. H. (2004). Understanding the role of augmented feedback: Thegood, the bad and the ugly. In A. M. William & N. J. Hodges (Eds.), *Skill acquisition in sport* (pp. 145-168). Routledge.

Wulf, G., Shea, C. H., & Lewthwaite, R. (2010). Motor skill learning and performance: A review of influential factors. *Medical Education*, *44*(1), 75-84. https://doi.org/10.1111/j.1365-2923.2009.03421.x

Wulf, G., Shea, C. H., & Matschiner, S. (1998). Frequent feedback enhances complex motor skill learning. *Journal of Motor Behavior*, *30*(2), 180-192. https://doi.org/10.1080/00222899809601335

Yamamoto, R., Akizuki, K., Kanai, Y., Nakano, W., Kobayashi, Y., & Ohashi, Y. (2019). Differences in skill level influence the effects of visual feedback on motor learning. *Journal of Physical Therapy Science*, *31*(11), 939-945. https://doi.org/10.1589/jpts.31.939

Yang, M., & Carless, D. (2013). The feedback triangle and the enhancement of dialogic feedback processes. *Teaching in Higher Education*, *18*(3), 285-297. https://doi.org/10.1080/13562517.2012.719154

Zhan, Y. (2022). Developing and validating a student feedback literacy scale. *Assessment & Evaluation in Higher Education*, *47*(7), 1087-1100. https://doi.org/10.1080/02602938.2021.2001430

Zhou, M., Tse, S., Derevianko, A., Jones, D. B., Schwaitzberg, S. D., & Cao, C. G. L. (2011). Effect of haptic feedback in laparoscopic surgery skill acquisition. *Surgical Endoscopy*, *26*(4), 1128-1134. https://doi.org/10.1007/s00464-011-2011-8

Ziv, A., Wolpe, P. R., Small, S. D., & Glick, S. (2003). Simulation-based medical education: An ethical imperative. *Academic Medicine*, *78*(8), 783-788. https://doi.org/10.1097/00001888-200308000-00006

Zubiaur, M., Oña, A., & Delgado, J. (1999). Learning volleyball serves: A preliminary study of the effects of knowledge of performance and of results. *Perceptual and Motor Skills*, *89*(1), 223-232. https://doi.org/10.2466/pms.1999.89.1.223

APPENDICES

Appendix A

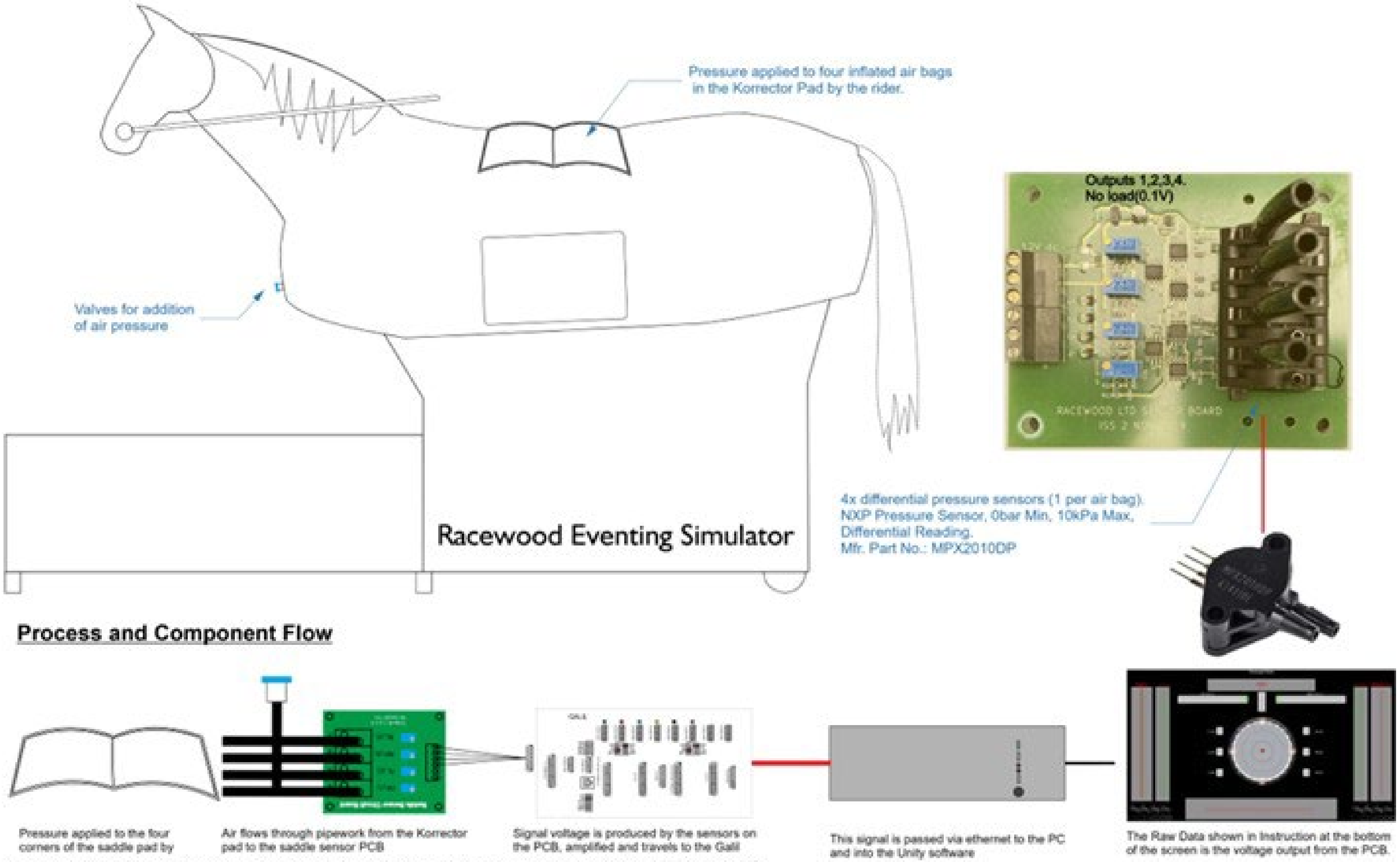
Participant Screener of Contraindications for Riding

For medical safety, persons in the following categories are NOT PERMITTED to participate.

1. Children under the age of three
2. Excessive weight: maximum weight is one hundred eighty pounds. Stability issues among the physically disabled will be considered in addition to weight. Student must be able to maintain sitting balance for riding.
3. Students with DOWN SYNDROME must have exam for Neurologic Symptoms of Atlantoaxial Instability..
4. Moderate agitation with severe confusion, aggression or self-abusive behavior.
5. Unstable spine.
6. Lack of neck control
7. Moderate to severe osteoporosis.
8. Uncontrolled seizures within the last 12 months.
9. Acute stages of arthritis.
10. Open pressure sores or open wounds.
11. Structural scoliosis greater than 30 degrees. Excessive hyphosis or lordosis, hemi-vertebrae.
12. Drug dosages causing a physical state inappropriate to safe riding.
13. Hemophilia
14. Hip subluxation and or dislocation.
15. Coxa Arthrosis (degeneration of the hip).
16. Spondylolisthesis.
17. Acute herniated disk.
18. Spinal fusion within on e year post surgery. Includes Harrington rods.
19. Juvenile Kyphosis (Scheurman) in the acute phase.
20. Patient on medication that affects the coagulation of blood.
21. CVA caused by aneurysm with spontaneous bleeding if not surgically removed; or presence of other aneurysms; CVA from angioma of brain if not totally surgically removed, or a known embolus or thrombus.
22. Heterotropic ossification in the hip resulting in inadequate range of motion.
23. Osteogenesis Imperfecta.
24. Hydrocephalus or cranial deficits if helmet cannot offer complete protection.
25. Tethered Cord, Hydromyelia or development of Chiari II malformation symptoms associated with Spina Bifida.
26. Spinal Cord Injury above T-6.
27. Poor endurance if fatigue persists well after riding session and impairs function.
28. Uncontrolled diabetes or medically unstable conditions associated with diabetes.
29. Peripheral Vascular Disease (PVD) if indication of skin damage due to riding.
30. Severe cases of Varicose Vein.
31. Uncontrolled hypertension.
32. Serious heart condition.
33. Disorders in exacerbation
34. Persons with indwelling catheter.
35. Post surgery riding only:
    0. Status - post tendon lengthening 8 to 10 weeks
    1. Status – post fracture/osteotomy 6 to 8 weeks
    2. Status – post rhizotomy 3 to 12 months

Appendix B

Eventing Simulator Saddle Sensor Overview



the rider (ressure differential sensor) motion controller analogue input Normally set pressure to an output Voltage of ~0.7

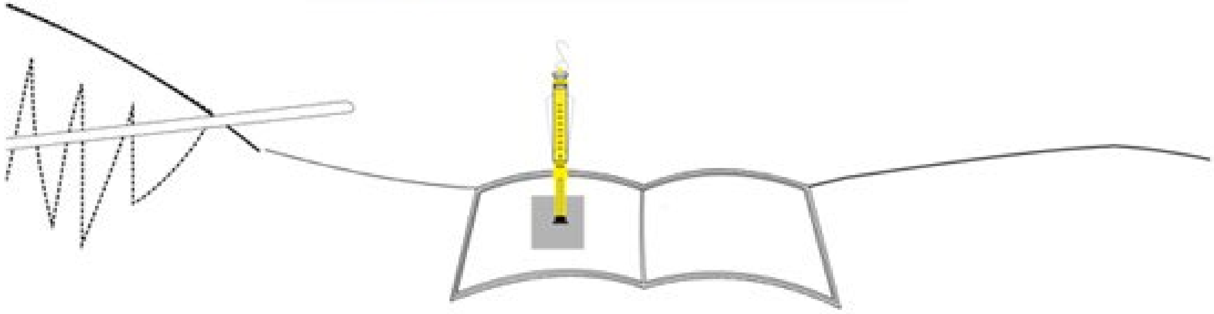
Eventing Simulator Saddle Sensor Overview - Test Data

A scale was used to apply a range of pressures to each air bag individually. The scale was applied to the center of a piece of 12mm plywood with dimensions of 100mmx100mm The results are recorded below.

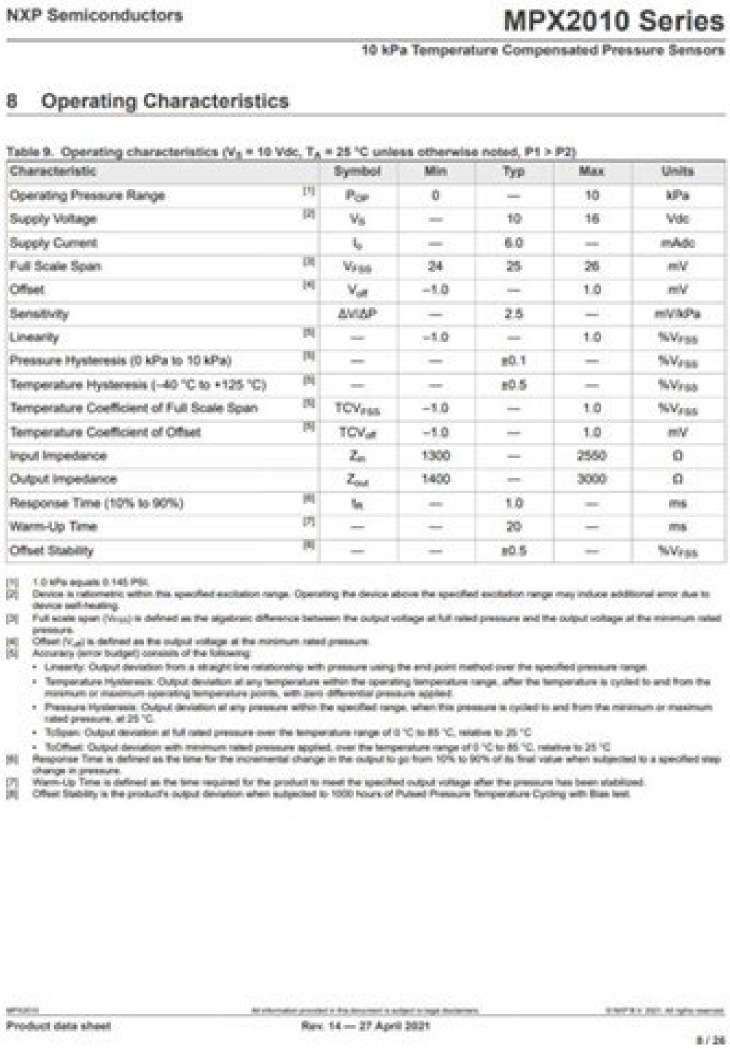
Data was obtained from Racewood's simulator. The air bags had been preset to a Raw Data value of 0.7 with no load.

Air bag measured	Load Applied (kg)	Resultant Raw Data Value (V)
Front Left	0	0.5
Front Left	1	0.8
Front Left	2	1
Front Left	3	1.2
Front Left	4	1.4
Front Left	5	1.7
Front Right	0	0.5
Front Right	1	0.8
Front Right	2	1
Front Right	3	1.2
Front Right	4	1.4
Front Right	5	1.7
Rear Left	0	0.5
Rear Left	1	0.8
Rear Left	2	1
Rear Left	3	1.2
Rear Left	4	1.4
Rear Left	5	1.7
Rear Right	0	0.5
Rear Right	1	0.8
Rear Right	2	1
Rear Right	3	1.2
Rear Right	4	1.4
Rear Right	5	1.7

Diagram of Test



Eventing Simulator Saddle Sensor Overview - Pressure Sensor Data ½



NXP Semiconductors

MPX2010 Series

10 kPa Temperature Compensated Pressure Sensors

8 Operating Characteristics

Table 9. Operating characteristics (V_S = 10 Vdc, T_A = 25 °C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Typ	Max	Units
Operating Pressure Range [1]	P_{OP}	0	—	10	kPa
Supply Voltage [2]	V_S	—	10	16	Vdc
Supply Current	I_o	—	6.0	—	mAdc
Full Scale Span [3]	V_{FSS}	24	25	26	mV
Offset [4]	V_{off}	−1.0	—	1.0	mV
Sensitivity	ΔV/ΔP	—	2.5	—	mV/kPa
Linearity [5]	—	−1.0	—	1.0	%V_{FSS}
Pressure Hysteresis (0 kPa to 10 kPa) [5]	—	—	±0.1	—	%V_{FSS}
Temperature Hysteresis (−40 °C to +125 °C) [5]	—	—	±0.5	—	%V_{FSS}
Temperature Coefficient of Full Scale Span [5]	TCV_{FSS}	−1.0	—	1.0	%V_{FSS}
Temperature Coefficient of Offset [5]	TCV_{off}	−1.0	—	1.0	mV
Input Impedance	Z_{in}	1300	—	2550	Ω
Output Impedance	Z_{out}	1400	—	3000	Ω
Response Time (10% to 90%) [6]	t_R	—	1.0	—	ms
Warm-Up Time [7]	—	—	20	—	ms
Offset Stability [8]	—	—	±0.5	—	%V_{FSS}

[1] 1.0 kPa equals 0.145 PSI.

[2] Device is ratiometric within this specified excitation range. Operating the device above the specified excitation range may induce additional error due to device self-heating.

[3] Full scale span (V_{FSS}) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum rated pressure.

[4] Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.

[5] Accuracy (error budget) consists of the following:

- Linearity: Output deviation from a straight line relationship with pressure using the end point method over the specified pressure range.
- Temperature Hysteresis: Output deviation at any temperature within the operating temperature range, after the temperature is cycled to and from the minimum or maximum operating temperature points, with zero differential pressure applied.
- Pressure Hysteresis: Output deviation at any pressure within the specified range, when this pressure is cycled to and from the minimum or maximum rated pressure, at 25 °C.
- TcSpan: Output deviation at full rated pressure over the temperature range of 0 °C to 85 °C, relative to 25 °C.
- TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 °C to 85 °C, relative to 25 °C.

[6] Response Time is defined as the time for the incremental change in the output to go from 10% to 90% of its final value when subjected to a specified step change in pressure.

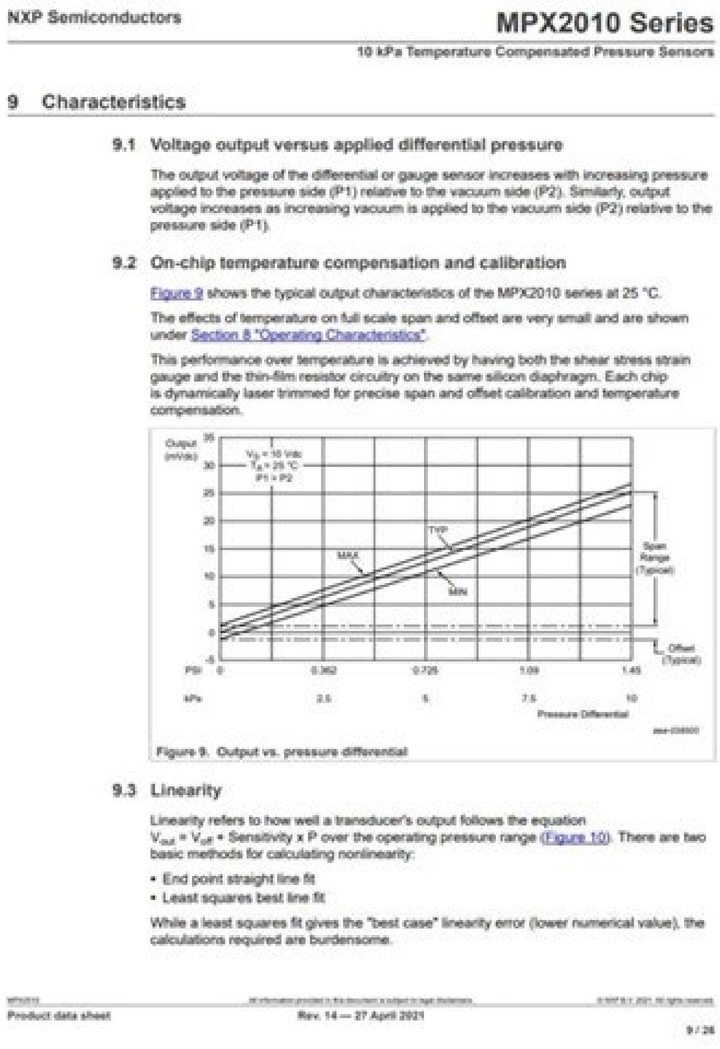
[7] Warm-Up Time is defined as the time required for the product to meet the specified output voltage after the pressure has been stabilized.

[8] Offset Stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure Temperature Cycling with Bias test.

Product data sheet

Rev. 14 — 27 April 2021

8 / 26



NXP Semiconductors

MPX2010 Series

10 kPa Temperature Compensated Pressure Sensors

9 Characteristics

9.1 Voltage output versus applied differential pressure

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure side (P1) relative to the vacuum side (P2). Similarly, output voltage increases as increasing vacuum is applied to the vacuum side (P2) relative to the pressure side (P1).

9.2 On-chip temperature compensation and calibration

Figure 9 shows the typical output characteristics of the MPX2010 series at 25 °C.

The effects of temperature on full scale span and offset are very small and are shown under Section 8 "Operating Characteristics".

This performance over temperature is achieved by having both the shear stress strain gauge and the thin-film resistor circuitry on the same silicon diaphragm. Each chip is dynamically laser trimmed for precise span and offset calibration and temperature compensation.

Figure 9. Output vs. pressure differential

9.3 Linearity

Linearity refers to how well a transducer's output follows the equation $V_{out} = V_{off} + \text{Sensitivity} \times P$ over the operating pressure range (Figure 10). There are two basic methods for calculating nonlinearity:

- End point straight line fit
- Least squares best line fit

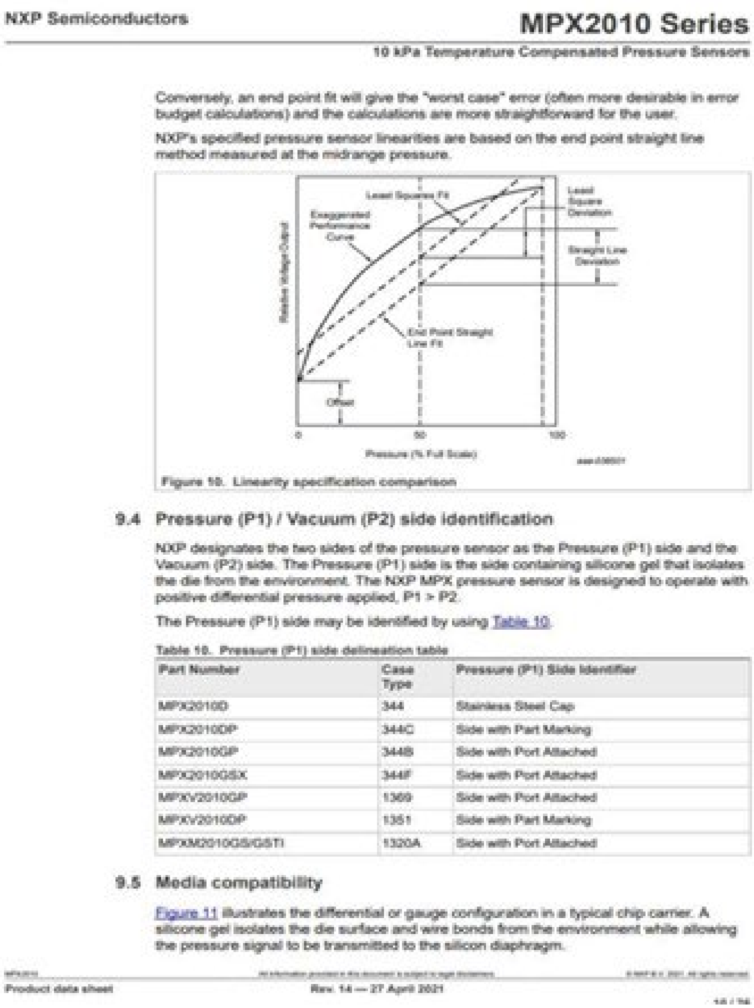
While a least squares fit gives the "best case" linearity error (lower numerical value), the calculations required are burdensome.

Product data sheet

Rev. 14 — 27 April 2021

9 / 26

Eventing Simulator Saddle Sensor Overview - Pressure Sensor Data 2/2



NXP Semiconductors

MPX2010 Series

10 kPa Temperature Compensated Pressure Sensors

Conversely, an end point fit will give the "worst case" error (often more desirable in error budget calculations) and the calculations are more straightforward for the user.

NXP's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

Figure 10. Linearity specification comparison

9.4 Pressure (P1) / Vacuum (P2) side identification

NXP designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing silicone gel that isolates the die from the environment. The NXP MPX pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

The Pressure (P1) side may be identified by using Table 10.

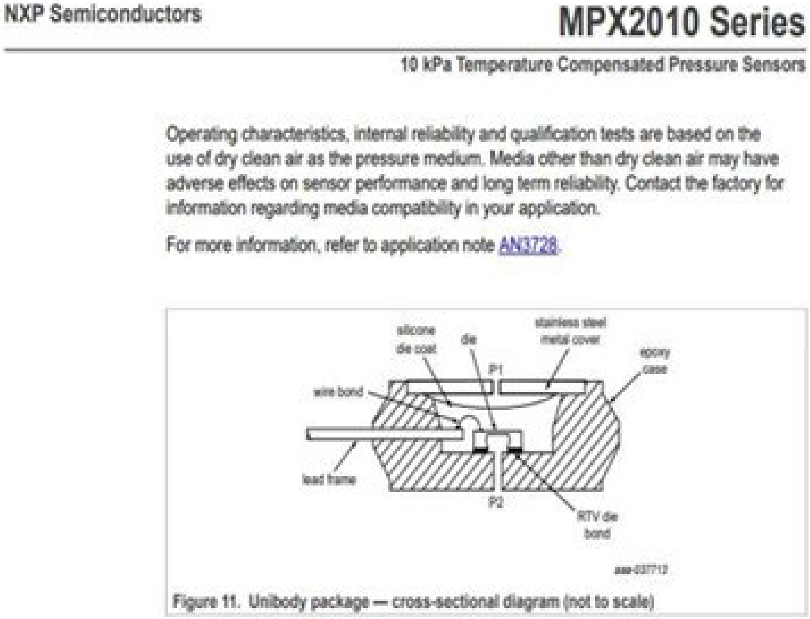
Table 10. Pressure (P1) side delineation table

Part Number	Case Type	Pressure (P1) Side Identifier
MPX2010D	344	Stainless Steel Cap
MPX2010DP	344C	Side with Part Marking
MPX2010GP	344B	Side with Port Attached
MPX2010GSX	344F	Side with Port Attached
MPXV2010GP	1369	Side with Port Attached
MPXV2010DP	1351	Side with Part Marking
MPXM2010GS/GSTI	1320A	Side with Port Attached

9.5 Media compatibility

Figure 11 illustrates the differential or gauge configuration in a typical chip carrier. A silicone gel isolates the die surface and wire bonds from the environment while allowing the pressure signal to be transmitted to the silicon diaphragm.

Product data sheet Rev. 14 — 27 April 2021



NXP Semiconductors

MPX2010 Series

10 kPa Temperature Compensated Pressure Sensors

Operating characteristics, internal reliability and qualification tests are based on the use of dry clean air as the pressure medium. Media other than dry clean air may have adverse effects on sensor performance and long term reliability. Contact the factory for information regarding media compatibility in your application.

For more information, refer to application note AN3728.

Figure 11. Unibody package — cross-sectional diagram (not to scale)

Appendix C

Exit Survey

Simulator Study

Exit Survey Questions

Presage

Learner Factors

1. My previous experience with receiving feedback on performance-based tasks helped me utilize the information from the auto training (pre and posttest scores)

1- strongly disagree – 5-strongly agree

Circle Your Number

1-----------2-----------3-----------4-----------5

2. My previous experience with receiving feedback on performance-based tasks helped me utilize the feedback from the instructor

1- strongly disagree – 5-strongly agree

Circle Your Number

1-----------2-----------3-----------4-----------5

or

Did not receive feedback

3. My previous experience with receiving feedback on performance-based tasks helped me utilize the feedback from the simulator

1- strongly disagree – 5-strongly agree

Circle Your Number

1-----------2-----------3-----------4-----------5

or

Did not receive feedback

[Learning Strategies]/Capacities]

4. When learning a skill, I prefer to (select all that apply)
   - A. Learn how to do the task while I am doing it (no prior explanation or observations)
   - B. Watch the task being done, then attempt it
   - C. Read about how to do it before I attempt it
   - D. Have the task explained by an instructor before I attempt it

[Motivation]

5. What was your level of motivation when it came to improving your horseback riding seat?

1-strongly unmotivated – 5-strongly motivated

Circle Your Number

1-----------2-----------3-----------4-----------5

Teaching Context

[Organized learning & assessments]

6. How would you rate the effectiveness of the training session format (pre-test, review, instructional time, post-test, review) in helping you work through improving your seat stability and balance? 1- extremely ineffective – 5-extremely effective

Circle Your Number

1-----------2-----------3-----------4-----------5

Process

[Engagement]

7. How would you rate your engagement with the **instructor feedback** being given during the instructional portion of the training?

1-not engaged – 5-highly engaged

Circle Your Number

1-----------2-----------3-----------4-----------5

or

Did not receive feedback

8. How would you rate your engagement with the **simulator feedback** being given during the instructional portion of the training?

1-not engaged – 5-highly engaged

Circle Your Number

1-----------2-----------3-----------4-----------5

or

Did not receive feedback

9. How would you rate your overall engagement with the general riding of the simulator to improve your seat stability and balance?

1-not engaged – 5-highly engaged

Circle Your Number

1-----------2-----------3-----------4-----------5

[Sense-making]

10. How would you rate your understanding of the auto-training results (pre and posttest) you received from the simulator?

1-completely did not understand
2-mostly did not understand
3-somewhat understood
4-mostly understood
5- completely understood

11. How would you rate your understanding of the feedback you **received from the simulator?**

1-completely did not understand
2-mostly did not understand
3-somewhat understood
4-mostly understood
5- completely understood
Didn’t receive simulator feedback

12. How would you rate your understanding of the feedback you **received from the instructor?**

1-completely did not understand
2-mostly did not understand
3-somewhat understood
4-mostly understood
5- completely understood
Didn’t receive simulator feedback

[Dialogue]

13. The results of the <u>auto-training pretest</u> **helped me improve** during the practice portion of the training

1- strongly disagree – 5-strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5

14. Reviewing the results of the <u>auto-training pretest</u> with Kelli **helped me improve** during the practice portion of the training

1- strongly disagree – 5-strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5

15. The results of the <u>auto-training pretest</u> **helped me utilize the feedback** I received during the practice portion of the training

1- strongly disagree – 5-strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5
or
Did not receive feedback

16. Reviewing the results of the <u>auto-training pretest</u> with Kelli **helped me utilize the feedback** I received during the practice portion of the training

1- strongly disagree – 5-strongly agree

Circle Your Number

1-----------2-----------3-----------4-----------5

or

Did not receive feedback

17. What emotion, if any, did you feel when you **received feedback from the simulator** during the practice portion of the training was (select all that apply):
    A. Anger
    B. Disgust
    C. Fear
    D. Happiness
    E. Sadness
    F. annoyance
    G. Didn't feel any emotions
    H. Other (please specify) ___________
    I. Did not receive simulator feedback

18. What emotion, if any, did you feel when you **received feedback from the instructor** during the practice portion of the training was (select all that apply):
    A. Anger
    B. Disgust
    C. Fear
    D. Happiness
    E. Sadness
    F. Annoyance
    G. Didn't feel any emotions
    H. Other (please specify) ___________
    I. Did not receive instructor feedback

19. What emotion, if any, did you feel when riding the simulator **without feedback** during the practice portion of the training was (select all that apply):
    A. Anger
    B. Disgust
    C. Fear
    D. Happiness
    E. Sadness
    F. Annoyance
    G. Didn't feel any emotions
    H. Other (please specify) ___________
    I. I had feedback so this doesn't apply to me

[Product]

20. How much do you agree with this statement: The **simulator feedback** is useful in improving my seat balance.

1-strongly disagree – 5- strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5
or
Did not receive feedback

21. How much do you agree with this statement: The **instructor feedback** is useful in improving my seat balance.

1-strongly disagree – 5- strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5
or
Did not receive feedback

22. How much do you agree with this statement: Even though **I did not receive any feedback** during my 10-minute practice time, the simulator is useful in improving my seat balance. [leave blank <u>if you received</u> any feedback during your 10-minute practice session]

1-strongly disagree – 5- strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5

23. How much do you agree with this statement: The **simulator feedback** improved my strategies for improving my seat balance.

1-strongly disagree – 5- strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5
or
Did not receive feedback

24. How much do you agree with this statement: The **instructor feedback** improved my strategies for improving my seat balance.

1-strongly disagree – 5- strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5
or
Did not receive feedback

25. How much do you agree with this statement: **Even though I did not receive any feedback** during my 10-minute practice time, the simulator improved my strategies for improving my seat balance. [leave blank <u>if you received</u> any feedback during your 10-minute practice session]

1-strongly disagree – 5- strongly agree
Circle Your Number
1-----------2-----------3-----------4-----------5

<u>Open Ended Questions</u>

26. Please explain your experience riding the simulator.

27. What was your overall experience with the feedback received?

28. Is there anything else you would like to express about your simulator training experience?

Appendix D

Data Sets from Survey Questions

Exit Survey Contextual Factor Descriptive Statistics for Study Groups

Question	Study Group 1		Study Group 2		Study Group 3		Study Group 4	
	M	SD	M	SD	M	SD	M	SD
				Presage				
1	4.00	1.19	4.67	0.49	4.63	0.50	4.56	0.70
2			4.89	0.32	4.88	0.34	4.72	0.46
3							4.67	0.59
5	4.56	0.86	4.89	0.32	4.88	0.34	4.94	0.24
6	3.44	1.10	4.56	0.51	4.30	0.73	4. 83	0.38
Sum	12	3.15	19.01	1.54	18.69	1.91	23.72	2.37
				Process				
7			4.67	0.49			4.94	0.24
8					4.67	0.69	4.83	0.51
9	3.89	1.32	4.72	0.46	4.75	0.55	4.83	0.38
10	4.56	0.51	4.44	0.78	4.40	0.60	4.72	0.46
11					4.35	0.59	4.83	0.38
12			4.67	0.49			4.67	0.49
13	4.17	1.04	4.39	0.85	4.13	1.10	4.72	0.46
14	4.11	1.08	4.50	0.71	4.68	0.61	4.83	0.38
15			4.61	0.61	4.58	0.65	4.72	0.57
16			4.44	0.86	4.68	0.64	4.89	0.32
Sum	16.73	3.95	36.44	5.25	36.24	5.43	47.98	4.19
				Product				
20					4.60	0.75	4.92	0.26
21			4.89	0.34			4.89	0.32
22	4.06	1.09						
23					4.29	0.99	4.69	0.46
24			4.82	0.53			4.83	0.38
25	3.78	1.17						
Sum	7.84	2.26	9.71	0.87	8.89	1.74	19.33	1.42

Exit Survey Contextual Factor Descriptive Statistics for Skill Levels

Question	Skill Level 1		Skill Level 2		Skill Level 3	
	M	SD	M	SD	M	SD
			Presage			
1	4.22	0.91	4.56	0.64	4.62	0.87
2	4.56	0.62	4.85	0.38	4.89	0.33
3	4.33	0.66	4.71	0.61	4.75	0.46
5	4.75	0.51	4.96	0.19	4.77	0.83
6	4.38	0.87	4.11	0.93	4.38	0.87
Sum	22.24	3.57	23.19	2.75	23.41	3.36
			Process			
7	4.79	0.43	4.75	0.45	5.00	0.00
8	4.81	0.54	4.77	0.60	4.57	0.79
9	4.66	0.60	4.65	0.56	4.46	0.97
10	4.47	0.67	4.52	0.51	4.69	0.63
11	4.53	0.51	4.57	0.65	4.75	0.46
12	4.57	0.51	4.75	0.45	4.75	0.46
13	4.23	0.96	4.44	0.93	4.38	0.87
14	4.39	0.92	4.59	0.64	4.69	0.63
15	4.54	0.87	4.65	0.67	4.56	0.73
16	4.52	0.92	4.63	0.83	4.78	0.44
Sum	45.51	6.93	46.32	6.29	46.63	5.98
			Product			
20	4.76	0.56	4.79	0.58	4.64	0.75
21	4.92	0.28	4.73	0.47	5.00	0.00
22	3.75	1.49	4.29	0.49	4.67	0.58
23	4.40	0.83	4.69	0.85	4.36	0.48
24	4.71	0.61	5.00	0.00	4.88	0.35
25	3.75	1.39	3.57	0.98	4.33	1.15
Sum	26.29	5.16	27.07	3.37	27.88	3.31

Appendix E

Thematic Analysis Code Book

Level	Code Theme	Code	Definition	Examples
PRESAGE *Prior Experiences*	**Previous Feedback Experiences**	**P1.1**	Any reference to past feedback that shaped how the participant used feedback	Exemplar: *I appreciate having feedback because I haven't had any help from an instructor for a long time.*
	Capacities	**P1.2**	Existing ability to engage with feedback- like self-monitoring, previous strategies that helped them practice. A general appreciation of the value of feedback to improve. Feedback from instructor or simulator aligned to their priorities or belief system.	Exemplar: *I have never had lessons before, so I didn't really know what all this stuff meant so I just did stuff to make the numbers look good.*
	Motivation	**P1.3**	Participant motivation to use feedback for ongoing improvement. See feedback as a tool for improvement- motivated to engage with it for that reason.	Exemplar: *I really want to be a better rider and I liked that this experience gave me a lot of ways I can do that.* *I don't think my type of riding needs this type of instruction.*
	Inputs & Activities	**P1.4.A**	The review of the auto-training results, before and/or after.	Exemplar: *I really like knowing how I am doing before I start practicing, so the baseline of the auto-training was helpful to know what to work on.*
		P1.4.B	Experiences, attitudes, perceptions about the practice session quality, time, feedback. Did the learner have agency to act?	Exemplar: *I think ten minutes is not long enough to really practice my seat.* *Knowing I was timed made the practice session a bit intense for me to try to make improvements*
	Assessment Design	**P1.5**	How a participant perceives the assessment (pre- & post-test) and the feedback involved- did the feedback from these allow	Exemplar: *I like that I could focus on my stability in the canter since that's the gait the auto-training showed that I messed up the*

Level	Code Theme	Code	Definition	Examples
			for action on feedback, inform KP or KR effectively? Did they not give enough feedback? **mentions actual assessment**	*most in.*
	Relational Issues	**P1.6.A**	Atmosphere of the practice session	Exemplar: *I think the simulator was cool, but I don't think the feedback was helpful since I couldn't hear footfalls.*
		P1.6.B	Relationship perceptions of the participant with the machine and/or instructor. Did they want praise or critical FB? Did the FB feel relevant from the instructor/simulator to the perception of the participant?	Exemplar: *I like feedback to be positive and the I felt the instructor was too critical.*
	Disciplinary Norms	**P1.7**	Disciplinary cultures that encompass how teaching and learning is implemented	Exemplar: *I know I didn't improve much by the end but I also know it just takes a long time to develop the feel in horseback riding.*
PROCESS *Engaging & Responding with Feedback*	**Engagement**	**P2.1**	Extent of the engagement with feedback ***participating and interacting with feedback	Exemplar: *I found that the feedback was extremely helpful. It helped me realize things that I never would have thought about helping my balance and stability.*
	Sense-making	**P2.2**	Making sense of the feedback's meaning and how it related to making improvements. Operative word: informative ***yes, they are interacting (aka engaging) but a bigger piece is sorting out what and how to make the FB useful for themselves	Exemplar: *Sarah [the instructor] helped me visualize the movement of the horse and how I move with it. She was able to fine-tune and make sense of what the simulator feedback was.*
	Dialogue	**P2.3**	Dialogues and co-construction resonating with principles of social constructivism.	Exemplar: (***simulator***) *I thought the feedback from the simulator was helpful because I could*

Level	Code Theme	Code	Definition	Examples
			Did the FB create a dialogue to engage with how to improve? Dialogue is reflective of the action and information exchange from simulator screens/sensor	*make a change and the simulator would show me how it made me worse or better, so all my adjustments had objective measures in real-time. (**instructor**) I thought the instructor was helpful in helping because we talked through what I was doing and feeling to figure out how to make me more balanced.*
	Managing Affect	**P2.3**	Emotional or attitudinal responses prompted by feedback- managing those responses so participant does not reject feedback. OR, FB might have elicited an emotional response, and the participant's emotions made them reject the feedback.	Exemplar: ***(+)*** *It was shocking to see that I wasn't as symmetrical as I thought, but the simulator feedback helped me realize that my feeling of straight was actually me leaning a little too much on right seat bone.* ***(-)*** *I was frustrated that the simulator was telling me I was too far back and when I leaned forward it got better but other things just got messed up and I just didn't know what to fix.*
PRODUCT *Outcomes & Impact of the Processes*	**Improved Strategies**	**P3.1**	Participants use experience to improve or develop a strategy that helps with riding seat skills	Exemplar: *I realized that when I think I am being really quiet, I am way too loose in my thighs making me move more backwards and forwards. So, I need to work on finding the right grip in my thigh which keeps me with the horse and if I have too much, I usually lose my stirrup.*
	Feedback Spirals	**P3.2**	Temporal and iterative perceptions that are insightful about how the feedback has a gradual, cumulative impact (Carless, 2019a) Participant builds on engagement with previous feedback experiences- can include concepts that are hard to solve, inquisitions,	Exemplar: *I have been hearing from my trainer for years that I am too tight in my back when I ride, and since working on the simulator, I think I am leaning on my reins for balance and maybe fighting against the motion of the horse instead of absorbing it.*

Level	Code Theme	Code	Definition	Examples
			and drawing on connections to other learning experiences. Perceptions on how improving seat skills is challenging and abstract. Is individually related.	
	Ongoing Puzzles	**P3.3**	Participants relate this feedback process/experience to help understand or questions or invest in other ideas, sentiments, skills, experiences, knowledge that are very complex in equestrianism/riding and is not easily resolved. Usually relates to a bigger concept and may or may not be individually related.	Exemplar: *This simulator lets me focus on my own seat without worrying also about the horse, which makes me wonder how can this help riders develop better skills without compensating for the horse?*
Emergent Theme	**Transferability**	**P4.1**	How would riding the simulator or knowledge obtained or improvements made transfer to the riding of an actual horse ***must mention the context of riding an actual horse or engaging in the actual riding experience	Exemplar: *This experience is going to help me sit more balanced on my own horse now that I learned how my seat should follow the motion of the gaits.*

Appendix F

Triangulated Data

Participant #	**Negative Coded Responses**			**Seat Improvement Scores**			**Exit Survey Means Scores**			**Researcher's Notes**
	Presage	Process	Product	Lateral	Longitudinal	Stability	Presage	Process	Product	
103	☒	☒	☒	↓	↓	↓	2	3.25	4	Had no intrinsic or domain knowledge to help themselves, but had no positive perception about what they could do with the time they had
105	☒	☒	☐	↓	↑	↑	2	3.25	3.6	Didn't find the FB applied to her
108	☒	☒	☐	↑	↑	0	1.67	2.4	1	No capacity or motivation to try lacked prior experience and growth mindset
113	☐	☒	☒	↓	↓	↓	4.67	5	5	Wanted a horse to give FB, felt like intrinsic FB was new to them, did feel like it gave them something to consider in future riding
121	☐	☐	☐	↑	↑	↑	4.67	4.75	5	Totally positive and used fb from test to inform practice and improvement
128	☒	☐	☐	↓	↓	↓	3.67	3.75	4	Dissonance with results "much stiffer" but is a novice and do they have enough of a frame of reference to know?
201	☒	☒	☐	↑	↑	↑	4.75	4.5	4.5	Wanted simulator visual feedback to help guide their practice session but they were grateful for Sarah's help
206	☐	☐	☐	↑	↓	↓	4.75	3.75	4.5	Really liked the auto-training results and was happy with Sarah's instruction and how the machine was useful for her actual riding. All +
216	☒	☒	☐	↓	↑	↑	5	4.88	5	Didn't like that there was not hoofbeats associated to the machine movement which impeded them being able to move but did help them watch for mistakes on seat
217	☐	☐	☐	↑	↓	↓	4.5	4.63	5	Appreciated the one-on-one feedback and the opportunity to focus on themselves without a horse factor, liked that they could make small changes and that made big improvements
223	☐	☐	☐	↓	↓	↓	5	4.75	5	Felt like they learned a lot and made improvements and adjustments to their seat
316	☒	☒	☐	↑	↑	↑	4.25	3.38	3.5	Didn't think the simulator was realistic enough and felt they had enough ability, that what the machine offered was not

Participant #	Negative Coded Responses			Seat Improvement Scores			Exit Survey Means Scores			Researcher's Notes
	Presage	Process	Product	Lateral	Longitudinal	Stability	Presage	Process	Product	
										benefitting their expertise. Would have liked to know more about what the machine does for a potential better use.
318	☒	☒	☐	↑	↓	↑	4.25	4.25	4	They knew the simulator was giving them feedback on what they were doing but they didn't know how to make any adjustments and wanted an instructor to help them. But they felt the information was insightful for what to improve.
324	☒	☒	☐	↓	↑	↑	4	3.88	3	Liked the auto training results, and they took all 3 sessions to improve their forward tendency (it seemed to frustrate them that it took that long). They did want an instructor's help.
328	☐	☐	☐	↓	↓	↓	4.5	5	5	The appreciated the simulator and the feedback during the sessions and had no problems understanding it, they felt like they improved
329	☒	☒	☒	↑	↓	↓	4	3.25	2.5	Really felt that a real horse's feedback is what they use to gauge their adjustments, and they weren't improving, and this was frustrating them.
401	☐	☒	☐	↓	↓	↑	3.8	4.7	5	Distracting to focus on all the feedback, otherwise positive on learning to "lock in" seat bones and develop that feel
409	☐	☐	☐	↓	↑	↓	4.8	4.6	5	Perceived improved strategies
412	☒	☒	☐	↓	↑	↑	5	4.7	4.8	Nervous which they felt like made their results poor, but loved seeing the simulator show the results of the instructor's feedback
418	☒	☒	☐	↑	↑	↑	4.2	4.3	4	Didn't know what muscles groups to engage & felt simulator wasn't as real, but liked that the simulator was consistent to practice and measure progress
424	☒	☒	☐	↑	↓	↓	4.2	4.2	4.5	Overthought their riding while in the assessments, but liked the real time feedback and that this experience will be a good way to converse about seat improvements with others
106	☐	☒	☐	↑	↑	↑	5	4	4	Took accountability for a FB spiral on their horse getting frustrated

Participant #	**Negative Coded Responses**			**Seat Improvement Scores**			**Exit Survey Means Scores**			**Researcher's Notes**
	Presage	Process	Product	Lateral	Longitudinal	Stability	Presage	Process	Product	
										since they had a hard time finding center, which during the process they kept going back and forth between, but they were trying and specifically mentioned wanting instructor FB
112	☐	☒	☐	↑	↑	↑	4	3.75	3	Took responsibility to give themselves a task because they only had FB from auto training, and they only were negative about process b/c they knew they could do so much more with help
116	☐	☐	☐	↑	↑	↑	4.67	5	5	They appreciated the auto training fb and used that to inform how to position and adjust seat during practice, and kept trying through all 3 sessions and is excited to try on their horse
210	☐	☐	☐	↑	↑	↑	5	5	5	Really appreciated all the FB and the fact there was no horse interference. Felt that they learned about the areas they could improve and are hopeful it will work on their horse and the horse responds positively.
215	☐	☐	☐	↑	↑	↑	4	4.25	5	Really interesting to how changes affected improvement- didn't say much else
302	☐	☐	☐	↑	↑	↑	4.5	4.75	5	The feedback was used to experiment and determine how the adjustments were influencing their performance. Really liked practicing before auto training final test
312	☐	☐	☐	↑	↑	↑	5	4.75	5	Really appreciated the feedback and practice without a horse factor, liked that the simulator FB was able to help them decide what adjustments were working or not working, really enjoyed every session
408	☐	☐	☐	↑	↑	↑	5	4.8	5	Really excited about the experience and felt it was informative-excited to implement adjustments in their riding
410	☐	☐	☐	↑	↑	↑	5	5	5	Useful and wants to go try it on their horse
413	☐	☐	☐	↑	↑	↑	5	5	5	Felt like it helped them learn a lot and find strategies to work on

Participant #	**<u>Negative</u> Coded Responses**			**Seat Improvement Scores**			**Exit Survey Means Scores**			**Researcher's Notes**
	Presage	Process	Product	Lateral	Longitudinal	Stability	Presage	Process	Product	
										improving, it was motivating for them to keep working

☒ Negative Coded Response Present

☐ No Negative Coded Response Present

↑ Seat Score Improved
↓ Seat Score Digressed
0 Seat Score Did Not Change

Appendix G

Copyright Permission for 3P Model of Learners Experience of Feedback

SPRINGER NATURE LICENSE TERMS AND CONDITIONS

May 29, 2023

This Agreement between kelli Munns ("You") and Springer Nature ("Springer Nature") consists of your license details and the terms and conditions provided by Springer Nature and Copyright Clearance Center.

License Number	5515340700625
License date	Mar 24, 2023
Licensed Content Publisher	Springer Nature
Licensed Content Publication	Springer eBook
Licensed Content Title	Learners' Feedback Literacy and the Longer Term: Developing Capacity for Impact
Licensed Content Author	David Carless
Licensed Content Date	Jan 1, 2019
Type of Use	Thesis/Dissertation
Requestor type	academic/university or research institute
Format	print and electronic
Portion	figures/tables/illustrations
Number of figures/tables/illustrations	1
Will you be translating?	no

Circulation/distribution	1 - 29
Author of this Springer Nature content	no
Title	The Effects of an Equine Riding Simulator as an Objective Feedback Modality on Learning Outcomes for Rider Competency on Performance Skills in Equestrian Riding
Institution name	Utah State University
Expected presentation date	Apr 2023
Portions	Figure 1: 3P Model of the Learners Experience of Feedback
Requestor Location	kelli Munns P.O. Box 717 SNOWVILLE, UT 84336 United States Attn: kelli Muns
Total	0.00 USD
Terms and Conditions	

Springer Nature Customer Service Centre GmbH Terms and Conditions

The following terms and conditions (“Terms and Conditions”) together with the terms specified in your [RightsLink] constitute the License (“License”) between you as Licensee and Springer Nature Customer Service Centre GmbH as Licensor. By clicking ‘accept’ and completing the transaction for your use of the material (“Licensed Material”), you confirm your acceptance of and obligation to be bound by these Terms and Conditions.

1. Grant and Scope of License

1. 1. The Licensor grants you a personal, non-exclusive, non-transferable, nonsublicensable, revocable, world-wide License to reproduce, distribute, communicate to the public, make available, broadcast, electronically transmit or create derivative works using the Licensed Material for the purpose(s) specified in your RightsLink Licence Details only. Licenses are granted for the specific use

requested in the order and for no other use, subject to these Terms and Conditions. You acknowledge and agree that the rights granted to you under this License do not include the right to modify, edit, translate, include in collective works, or create derivative works of the Licensed Material in whole or in part unless expressly stated in your RightsLink
Licence Details. You may use the Licensed Material only as permitted under this Agreement and will not reproduce, distribute, display, perform, or otherwise use or exploit any Licensed Material in any way, in whole or in part, except as expressly permitted by this License.

1. 2. You may only use the Licensed Content in the manner and to the extent permitted by these Terms and Conditions, by your RightsLink Licence Details and by any applicable laws.

1. 3. A separate license may be required for any additional use of the Licensed Material, e.g. where a license has been purchased for print use only, separate permission must be obtained for electronic re-use. Similarly, a License is only valid in the language selected and does not apply for editions in other languages unless additional translation rights have been granted separately in the License.

1. 4. Any content within the Licensed Material that is owned by third parties is expressly excluded from the License.

1. 5. Rights for additional reuses such as custom editions, computer/mobile applications, film or TV reuses and/or any other derivative rights requests require additional permission and may be subject to an additional fee. Please apply to journalpermissions@springernature.com or bookpermissions@springernature.com for these rights.

2. Reservation of Rights

Licensor reserves all rights not expressly granted to you under this License. You acknowledge and agree that nothing in this License limits or restricts Licensor’s rights in or use of the Licensed Material in any way. Neither this License, nor any act, omission, or statement by Licensor or you, conveys any ownership right to you in any Licensed Material, or to any element or portion thereof. As between Licensor and you, Licensor owns and retains all right, title, and interest in and to the Licensed Material subject to the license granted in Section 1.1. Your permission to use the Licensed Material is expressly conditioned on you not impairing Licensor’s or the applicable copyright owner’s rights in the Licensed Material in any way. **3. Restrictions on use**
3. 1. Minor editing privileges are allowed for adaptations for stylistic purposes or formatting purposes provided such alterations do not alter the original meaning or intention of the Licensed Material and the new figure(s) are still accurate and representative of the Licensed Material. Any other changes including but not limited to, cropping, adapting, and/or omitting material that affect the meaning, intention or moral rights of the author(s) are strictly prohibited.

3. 2. You must not use any Licensed Material as part of any design or trademark.

3. 3. Licensed Material may be used in Open Access Publications (OAP), but any such reuse must include a clear acknowledgment of this permission visible at the same time as the figures/tables/illustration or abstract and which must indicate that the Licensed Material is not part of the governing OA license but has been reproduced with permission. This may be indicated according to any standard referencing system but must include at a minimum 'Book/Journal title, Author, Journal Name (if applicable), Volume (if applicable), Publisher, Year, reproduced with permission from SNCSC'.

4. STM Permission Guidelines

4. 1. An alternative scope of license may apply to signatories of the STM Permissions Guidelines ("STM PG") as amended from time to time and made available at https://www.stm-assoc.org/intellectual-property/permissions/permissions-guidelines/.

4. 2. For content reuse requests that qualify for permission under the STM PG, and which may be updated from time to time, the STM PG supersede the terms and conditions contained in this License.

4. 3. If a License has been granted under the STM PG, but the STM PG no longer apply at the time of publication, further permission must be sought from the Rightsholder. Contact journalpermissions@springernature.com or bookpermissions@springernature.com for these rights.

5. Duration of License

5. 1. Unless otherwise indicated on your License, a License is valid from the date of purchase ("License Date") until the end of the relevant period in the below table:

Reuse in a medical communications project	Reuse up to distribution or time period indicated in License
Reuse in a dissertation/thesis	Lifetime of thesis
Reuse in a journal/magazine	Lifetime of journal/magazine
Reuse in a book/textbook	Lifetime of edition
Reuse on a website	1 year unless otherwise specified in the License
Reuse in a	Lifetime of presentation/slide kit/poster. Note: publication whether

presentation/slide kit/poster	electronic or in print of presentation/slide kit/poster may require further permission.
Reuse in conference proceedings	Lifetime of conference proceedings
Reuse in an annual report	Lifetime of annual report
Reuse in training/CME materials	Reuse up to distribution or time period indicated in License
Reuse in newsmedia	Lifetime of newsmedia
Reuse in coursepack/classroom materials	Reuse up to distribution and/or time period indicated in license

6. Acknowledgement

6. 1. The Licensor's permission must be acknowledged next to the Licensed Material in print. In electronic form, this acknowledgement must be visible at the same time as the figures/tables/illustrations or abstract and must be hyperlinked to the journal/book's homepage.

6. 2. Acknowledgement may be provided according to any standard referencing system and at a minimum should include "Author, Article/Book Title, Journal name/Book imprint, volume, page number, year, Springer Nature."

7. Reuse in a dissertation or thesis

7. 1. Where 'reuse in a dissertation/thesis' has been selected, the following terms apply: Print rights of the Version of Record are provided for; electronic rights for use only on institutional repository as defined by the Sherpa guideline (www.sherpa.ac.uk/romeo/) and only up to what is required by the awarding institution.

7. 2. For theses published under an ISBN or ISSN, separate permission is required. Please contact journalpermissions@springernature.com or bookpermissions@springernature.com for these rights.

7. 3. Authors must properly cite the published manuscript in their thesis according to current citation standards and include the following acknowledgement: '*Reproduced with permission from Springer Nature*'.

8. License Fee

You must pay the fee set forth in the License Agreement (the “License Fees”). All amounts payable by you under this License are exclusive of any sales, use, withholding, value added or similar taxes, government fees or levies or other assessments. Collection and/or remittance of such taxes to the relevant tax authority shall be the responsibility of the party who has the legal obligation to do so.

9. Warranty

9. 1. The Licensor warrants that it has, to the best of its knowledge, the rights to license reuse of the Licensed Material. **You are solely responsible for ensuring that the material you wish to license is original to the Licensor and does not carry the copyright of another entity or third party (as credited in the published version).** If the credit line on any part of the Licensed Material indicates that it was reprinted or adapted with permission from another source, then you should seek additional permission from that source to reuse the material.

9. 2. EXCEPT FOR THE EXPRESS WARRANTY STATED HEREIN AND TO THE EXTENT PERMITTED BY APPLICABLE LAW, LICENSOR PROVIDES THE LICENSED MATERIAL “AS IS” AND MAKES NO OTHER REPRESENTATION OR WARRANTY. LICENSOR EXPRESSLY DISCLAIMS ANY LIABILITY FOR ANY CLAIM ARISING FROM OR OUT OF THE CONTENT, INCLUDING BUT NOT LIMITED TO ANY ERRORS, INACCURACIES, OMISSIONS, OR DEFECTS CONTAINED THEREIN, AND ANY IMPLIED OR EXPRESS WARRANTY AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL LICENSOR BE LIABLE TO YOU OR ANY OTHER PARTY OR ANY OTHER PERSON OR FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL, INDIRECT, PUNITIVE, OR EXEMPLARY DAMAGES, HOWEVER CAUSED, ARISING OUT OF OR IN CONNECTION WITH THE DOWNLOADING, VIEWING OR USE OF THE LICENSED MATERIAL REGARDLESS OF THE FORM OF ACTION, WHETHER FOR BREACH OF CONTRACT, BREACH OF WARRANTY, TORT, NEGLIGENCE, INFRINGEMENT OR OTHERWISE (INCLUDING, WITHOUT LIMITATION, DAMAGES BASED ON LOSS OF PROFITS, DATA, FILES, USE, BUSINESS OPPORTUNITY OR CLAIMS OF THIRD PARTIES), AND WHETHER OR NOT THE PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THIS LIMITATION APPLIES NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY PROVIDED HEREIN.

10. Termination and Cancellation

10. 1. The License and all rights granted hereunder will continue until the end of the applicable period shown in Clause 5.1 above. Thereafter, this license will be terminated and all rights granted hereunder will cease.

10. 2. Licensor reserves the right to terminate the License in the event that payment is not received in full or if you breach the terms of this License.

11. General

11. 1. The License and the rights and obligations of the parties hereto shall be construed, interpreted and determined in accordance with the laws of the Federal Republic of Germany without reference to the stipulations of the CISG (United Nations Convention on Contracts for the International Sale of Goods) or to Germany´s choice-of-law principle.

11. 2. The parties acknowledge and agree that any controversies and disputes arising out of this License shall be decided exclusively by the courts of or having jurisdiction for Heidelberg, Germany, as far as legally permissible.

11. 3. This License is solely for Licensor's and Licensee's benefit. It is not for the benefit of any other person or entity.

Questions? For questions on Copyright Clearance Center accounts or website issues please contact springernaturesupport@copyright.com or +1-855-239-3415 (toll free in the US) or +1-978-646-2777. For questions on Springer Nature licensing please visit https://www.springernature.com/gp/partners/rights-permissions-third-party-distribution

Other Conditions:

Version 1.4 - Dec 2022

Questions? customercare@copyright.com.

CURRICULUM VITAE

KELLI C. MUNNS

Professional Practice Instructor | Utah State University | Logan, Utah 84322 |
801-822-4993 | kelli.munns@usu.edu

EDUCATION

Utah State University, Logan, UT
Ph.D. Career and Technical Education
2019 –2023

Southern Utah University, Cedar City, UT
M.Ed. Educational Leadership & Administration Development
2015 - 2018

Utah Valley University, Orem, UT
B.S. Biology Education
2008 - 2012

PROFESSIONAL EXPERIENCE

Utah State University, Logan, UT
Prof. Practice Instructor – Instructional Technology & Learning Sciences
2016 - Present

My priorities are to sustain and build upon an existing professional network to facilitate student and program success. I teach undergraduate and graduate courses both in-person and online, advise and mentor students in the MEd and SLMA programs, facilitate student creative projects and internships, facilitate students' pursuit of post-degree employment, recruit working professionals into the degree programs of the department at the graduate levels, and manage the ITLS MEd and SLMA degree programs.

Utah State University, Logan, UT
Lecturer – Animal, Dairy, Veterinary Sciences Department
2016 - 2022

Developed new ADVS courses to facilitate a scaffolded infrastructure for the Equine Science and Management Major, curriculum mapping/alignment for multiple ADVS course, implemented ADVS Faculty Learning Circle (PLC), Created department wide online equine safety and handling training, implement Mastery Grading outcomes for evaluating student learning and instructor effectiveness, worked on ADVS Assessment Plan for Accreditation, implemented first US riding simulation into academic program to increase innovation, safety, and student competency, created program teaching and management internship opportunities for students, and created program placement assessments for hands-on courses.

Box Elder Middle School, Brigham City, UT
Science Educator - Earth Systems Educator
2015 - 2016
Helped developed PLC that worked towards data-based decisions through CFAs, implemented appropriate interventions and student remediation for science team, and improved BEMS's science SAGE scores through effective science instruction

Fort Herriman Middle School, Herriman, UT
Science Educator- Biology, Earth Systems & Integrated Science
2012 - 2015
Taught Biology, Integrated Science and Earth Science, PLC Team leader, created an inquiry-based curriculum in compliance with district and state requirements, developed curriculum maps for mastery grading: rubrics, guidelines for "Above Mastery," student learning goals, "I can" statements, and assessments

PROFESSIONAL ACTIVITIES & COMMUNICATION

National Association of Equine Affiliated Academics, Logan, UT
Session Presenter
June 2022
Presented on the efficacy and cost-benefit of an Equine Riding simulator into academic programs.

Utah State University ETE VITAL Workshop, Logan, UT
Coach
May 2022
Coached faculty on developing and strengthen teaching dossiers and teaching statements; including how to document evidence on teaching practices.

Utah State University ETE, Logan, UT
ETE Program Evaluation
Academic Year 2021-22
Helped develop, organize, and execute an evaluation of the ETE program to identify areas of excellence, impact on students, performance gaps, and resource needs.

Utah State University, ADVS Department, Logan, UT
Assessment for Accreditation Project
March 2019 -January 2022
Developing a new system to demonstrate how the ADVS Department is meeting departmental learning objectives via data-informed decisions. The end result will provide accrediting organization with evidence, develop a new system for faculty to meet in emphasis/degree PLCs to analyze data and continued improvement for overall health of ADVS programs

Utah State University Teaching Excellence Series, Logan, UT
Session Presenter
February 2019
Taught a learning seminar on how to keep your students engaged with active learning strategies during face-to-face lectures

National Association of Equine Affiliated Academics, San Antonio, TX
Session Presenter
June 2018
Presented to NAEAA members on scaffolding courses to help "New Entrants" find success and develop into competent equine professionals

Empowering Teaching Excellence Conference, Logan, UT
Session Presenter
August 2018
Co-presented with Dr. Karl Hoopes on using Canvas to maximize assessment through the programs different assessment models and data analytics

Utah Science Teachers Association, Orem, UT
Session Presenter
February 2018
Presented to Utah science teachers on developing the Utah science core through alignment and student learning outcomes

United States Pony Club Intermountain Regional Meeting, Pocatello, ID
Presenter
October 2017
Taught at the Upper Level Pony Club students during the regional meeting about effective lesson planning and instructing

Empowering Teaching Excellence Conference, Logan, UT
Keynote Speaker
August 2017
Presented on *Targeted Outcomes for Mastery Learning* for USU Faculty

ETE Foundation of USU Teaching Workshop
Breakout Session
August 2017
Taught new USU Faculty about *Instructional Alignment: Planning objectives, content, activities and assessments*

SERVICE

ITLS, USU, Logan, Utah
ITSA Faculty Advisor

January 2022-Present
Advise and support ITSA's efforts through the ITLS Department, CEHS College, USU, and other national events.

Wasatch Pony Club, Eden, UT
Cross Country Steward
January 2018 - Present
Facilitate Golden Spike's cross country course design, check course's design with USEF technical delegate, updated jumps and worked with course designer to keep course up to specification

Golden Spike Event Center, Ogden, UT
Show Jump Coordinator- Mock Horse Trials
May 2017 - Present
Set up show jumping course, set distances and times, over-see schooling rounds, coordinated volunteers and set-up/take-down

Utah State University, Logan, UT
English Equestrian Team Coach
August 2016 -Jan 2022
Coached USU's English Equestrian Team, coordinated IHSA shows and hosted home schooling shows

Utah Science Teachers Association, UT
Board Member- Region 1 Representative
January 2018 –2019
Help coordinate information from K-12 science activities, information and news to Region 1, create Region 1 newsletter, help put on UtSTA's conference and participate in Utah Science programs

4H Utah State English Show, Mount Pleasant, UT
Technical Delegate
October 2016-2018
Participated as the technical delegate at the State Show to clarify any discrepancies in competition's judging/rulings and help ensure competitors were following the 4H's rules

MEMBERSHIPS

ITSE
UELMA
National Association of Equine Affiliated Academics
Utah Science Teachers Association
United States Equestrian Federation
United States Eventing Association