UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Transforming Errors into Learning Opportunities in Simulation-Based Learning

By Evelyn Palominos Letelier

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Under the supervision of

Distinguished Professor Tracy Levett-Jones

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Certificate of original authorship

I, Evelyn Palominos, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy in the School of Nursing and Midwifery, Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution. This research was supported by the Australian Government Research Training Program.

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Dedication

I dedicate this thesis to:

Paola, whose love knows no limits. My parents, Ana Maria and Raul, for giving me the strength to chase my dreams. My sisters, Claudia and Ana Maria, for always being there for me. My nieces and nephews, Daniela, Benjamin, Valentina and Ricardo, for their unconditional love. My second family, Lizzie and Ricardo for their unyielding support since I commenced this journey. My friends, Ely, Norma, Jane, Mariana, Genaro, Cecilia, Jorge and Rodrigo, for the treasure of their friendship.

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Thesis by compilation

I certify that the format of this thesis is by compilation, which comprises papers that follow a sequential order. A written declaration from each co-author certifying my contribution to the authored manuscripts is included.

Publications included in this thesis

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Conference presentations and research forums

28–30 November 2018. *Healthcare students' perceptions and experiences of making errors in simulation: An integrative review* (oral presentation). Research Student Conference. Faculty of Health, UTS.

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Awards

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Other publication during candidature

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Glossary of Terms

> "When I have eliminated the ways that will not work, I will find the way that will work."
>
> — Thomas A. Edison

Declarative knowledge

refers to knowledge about facts (Ohlsson, 1996). Declarative questions often start with the word “what” (Jacobson et al., 2017). For example, “what are the sign and symptoms of …?”

Delayed instruction

“… includes minimal structured activities followed by pedagogical guidance” (Jacobson et al., 2015, p. 716). Westermann and Rummel (2012) refer to it as a delay in the content-related instruction until a subsequent phase. In other words, the educator does not provide content-related support before students participate in practical learning activities.

Desirable difficulties

refers to providing challenging activities to learners (Bjork, 1994). Unguided problem-solving tasks and delayed feedback or instruction are examples of desirable difficulties (Kapur, 2016).

Direct instruction

is an approach that provides pedagogical information and support needed (e.g., explanation of concepts and procedures) for students to achieve learning outcomes (Kirschner et al., 2006). In terms of timing of instruction, direct

instruction combines instruction followed by problem-solving activities (Cao et al., 2020).

Direct instruction simulation

is a form of simulation that starts with instruction about the simulation topic, followed by the simulation activity (Zendejas et al., 2010).

Errors

"encompass all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcomes and when these failures cannot be attributed to the intervention of some chance agency" (Reason, 1990, p. 9).

Error management training

(EMT) aims to minimise the potential negative outcomes of making errors (Frese & Keith, 2015) and develop coping strategies for responding to errors effectively (Keith, 2011). EMT engages trainees in active exploration of the learning tasks and explicitly encourages error making (Keith, 2011).

Explanatory knowledge

measures students' understanding of a particular event (Coleman, 1998; Jacobson et al., 2017). "Why" or "how" words are often used as a preface to these types of questions (Jacobson et al., 2017).

Failure

refers to students' inability to generate correct solutions by themselves (Kapur, 2016).

Mistakes

occur when the plan to achieve a desirable goal is inadequate (Reason, 1990). “In a mistake, the action proceeds as planned but fails to achieve its intended outcome because the planned action was wrong” (Institute of Medicine, 2000, p. 54).

Normalisation of errors

refers to accepting errors as a natural occurrence of the learning process.

Positive error framing

involves making errors evident and prompting individuals to visualise them as learning opportunities (Steele-Johnson & Kalinoski, 2014). Positive error framing is employed in statements such as “The more errors you make, the more you learn!” or “You have made an error? Great! Because now you can learn something new!” (Keith & Frese, 2008, p. 60).

Productive failure

is described as “a learning design that affords students opportunities to generate representations and solutions to a novel problem that targets a concept that they have not learned yet, followed by consolidation and knowledge assembly where they learn the targeted concept” (Kapur, 2015, p. 52).

Productive failure simulations

are experiences that allow students to participate in a simulation activity before receiving instruction about the content or concepts of the session.

Simulation

"… is a technique—not a technology—to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner" (Gaba, 2004, p. i2). Simulation-based learning enables students to practice nursing care in simulated settings that mimic the situations encountered in real clinical contexts (Cant & Cooper, 2017).

Psychologically safe environment

refers to: 1) the opportunity of making mistakes without consequences for the leaner, the patient or both; 2) the qualities of the facilitator, such as being approachable, being honest and flexible and admitting mistakes; and 3) the use of foundational activities embedded within the simulation such as orientation, objectives and expectations (Turner & Harder, 2018).

Timing of instruction

refers to when the instruction is provided, namely, before or after problem-solving activities (Jacobson et al., 2015).

Transfer of learning

is "the ability to appropriately apply information and skills learned in one setting to a similar or different setting" (Thomas, 2007, p. 5).

Abbreviations

CVC	Central venous catheter
CO	Correct only
CE	Correct plus error
DI	Direct instruction
DI-GBL	Direct instruction game-based learning
EAT	Error avoidance training
EMT	Error management training
LE	Learning from Errors [conceptual model]
PF	Productive failure
PF-GBL	Productive failure game-based learning
SSE	Satisfaction with Simulation Experience
SBL	Simulation-based learning
TI	Traditional instruction
UTS	University of Technology Sydney
VE	Vicarious error

Abstract

This thesis explores how productive failure simulations influence nursing students' learning, perceptions and satisfaction compared with traditional simulations. Simulation-based learning enables learners to make mistakes and learn from them without compromising real patients' safety. Productive failure is a pedagogical approach that allows students to make mistakes as they solve novel learning tasks before receiving instruction. Productive failure simulations comprise a simulation followed by instruction, which contrasts with direct instruction simulations that begin with instruction followed by the simulation. Productive failure has facilitated meaningful learning outcomes in diverse educational settings, but no previous studies have examined the impact of productive failure in nursing simulation. To fill this research gap, an exploratory, sequential mixed-methods design with a three-stage approach was used.

The first stage of the study, an integrative literature review, explored healthcare students' perceptions of making errors in simulation. It identified that supporting students to take responsibility for their mistakes is critical to moderating the negative impact of making errors and transforming them into learning opportunities.

The second stage of this study resulted in the Learning from Errors conceptual model. Building on productive failure and error management training approaches, the model was designed to inform healthcare simulations that explicitly embrace learning from errors. This model includes the following elements: normalisation of errors, challenging simulation scenarios, self-directed learning, collaborative teamwork, and comparison with best practice.

The third stage of this study evaluated nursing students' learning from and satisfaction with productive failure simulations compared to direct instruction simulations and explored students' perceptions of productive failure simulations. Participants were randomly allocated to either a productive failure group (n = 181) or a direct instruction group (n = 163). Quantitative data included knowledge tests measuring declarative knowledge, explanatory knowledge and transfer of learning, and the Satisfaction with Simulation Experience scale. Qualitative data involved interviews with students in the productive failure group.

For explanatory knowledge and transfer of learning, the productive failure group outperformed the direct instruction group. This group also scored significantly higher on the satisfaction items related to reflection on practice and clinical learning. The qualitative results identified the following themes: the benefits of simulation prior to instruction; the value of performing a second simulation; and the importance of normalising errors.

This doctoral study demonstrated that productive failure simulations improve nursing students' learning, perceptions and satisfaction levels. The thesis concludes with implications for nursing education, directions for further research, and recommendations for future practice.