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Cleared for take-off: Game-based learning to prepare airline pilots for critical situations

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PROEFSCHRIFT

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de graad van Doctor aan de Universiteit Leiden,
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volgens besluit van het College voor Promoties
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Esther Christine Kuindersma
geboren te Holten
in 1977

Samenstelling van de promotiecommissie:

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Prof. dr. A. Plaat

Copromotor:
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Prof. dr. E. O. Postma — Tilburg University
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Voor mijn jongens

Preface

The book that you are holding right now marks an era. An era of my life that I had not envisioned until September 2014. That was when I came across a vacancy, posted on Twitter. It read "serious gaming and didactics", and it was at the Netherlands Aerospace Centre (NLR). When I read it, a fire inside me ignited. Working on training methods for airline pilots. This was what I wanted to do!

It took a while before I realised the vacancy was for a PhD position. I had never considered doing a PhD or even doing research. I hesitated: I was not sure that I could do this, and it would involve a pretty steep cutback in my paycheck.

At that time, there was a song on the radio that I liked very much. It was "Geronimo" by the Australian band "Sheppard". The title of the song is a reference to the famous Apache military leader Geronimo, and the custom of yelling his name before doing a courageous act. I took it as an inspiration and decided to take the leap.

Time flies by, and now it is 2019. Finishing my thesis took a bit longer than I hoped for, but I have made it. You are holding my book in your hands. It has been fun. It has been tough. It has been an adventure.

I would like to take this opportunity to express my gratitude to everyone who contributed to the completion of this work. I received the support and help of many people. Too many to thank everyone by name.

I would like to start by expressing my gratitude to my supervisors Jaap van den Herik and Aske Plaat from the Leiden Centre of Data Science (LCDS) at Leiden University, and my co-supervisor Jelke van der Pal at the Netherlands Aerospace Centre (NLR). I am grateful to all three of them for their guidance and support, but I owe Jaap a special thank you for his unfailing drive and enthusiasm to critique my writings in order to make me a real scientist. Thank you for working through all my puzzles.

Next, I wish to thank the participants in all my experiments and every teacher and flight instructor that helped me find my participants. Without them, I would not have had anything to write about.

I thank NLR for giving me the opportunity to do this research, and I thank my colleagues at NLR for all they did for me. For helping me create the games for my research, contributing to my experiments and my data analysis, giving me feedback on my ideas and my writings, and for the great talks at the coffee machine and the fun during extra-curricular activities.

Thank you to my family and family-in-law for their continued interest in the progress of my research. Thank you to my friends for their encouragement and their patience when I needed to blow off some steam.

A special thank you to my paranymphs, Armon and Alistair.

Armon, it was good to have you as a companion during my time at NLR. I enjoyed our discussions during our carpool rides about your research and mine, and the many days that we spent sequestered in our "cave".

Alistair, I am happy to have met you as one of my new colleagues at the HvA. Our coffee conversations have saved me from quite a few panic attacks during the final stages of my PhD.

Finally, thank you and lots of love to Sjoerd, who supported my decision to quit a good job and dive into this scientific adventure, and to Jasper and Thomas, who accepted many times that I did not have much time for them, because I had to write my book. Thank you for all your love and patience. My book is done now. Let's play.

Esther Kuindersma
Almere, 2019

Contents

List of Abbreviations

4C/ID	Four Components for Instructional Design (model)
AFPM-A	Aircraft Flight Path Management - Automation (ICAO core competency)
AFPM-M	Aircraft Flight Path Management - Manual (ICAO core competency)
AP	Application of Procedures (ICAO core competency)
AR	Augmented Reality
ATPL	Airline Transport Pilot Licence
BI	Behavioural Indicator
CBE	Competency-Based Education
CBT	Computer-Based Training
CBTA	Competency-Based Training and Assessment
CEGE	Core Elements of Gaming Experience
CEGEQ	Core Elements of Gaming Experience Questionnaire
COM	Communication (ICAO core competency)
CPL	Commercial Pilot Licence
EASA	European Aviation Safety Agency
EBT	Evidence-Based Training
FAA	Federal Aviation Administration
GBL	Game-Based Learning
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFALPA	International Federation of Airline Pilots Associations
IMI	Intrinsic Motivation Inventory

KNVvL	Royal Netherlands Aeronautical Association
KSA	Knowledge, Skills and Attitudes
L&T	Leadership & Teamwork (ICAO core competency)
MG	Mandatory Gameplay (experiment condition)
MP	Mandatory Participation (experiment condition)
MPL	Multicrew Pilot Licence
MPMG	Mandatory Participation, Mandatory Gameplay (experiment group)
MPVG	Mandatory Participation, Voluntary Gameplay (experiment group)
NG	No Gameplay (experiment condition)
NLR	Netherlands Aerospace Centre
PPL	Private Pilot Licence
PS&DM	Problem Solving & Decision Making (ICAO core competency)
SA	Situation Awareness (ICAO core competency)
SG4CD	Serious Games for Competency Development (model)
SOP	Standard Operating Procedure
StM	Shuttle to Mars (game)
UEQ	User Experience Questionnaire
VG	Voluntary Gameplay (experiment condition)
VP	Voluntary Participation (experiment condition)
VPMG	Voluntary Participation, Mandatory Gameplay (experiment group)
VPVG	Voluntary Participation, Voluntary Gameplay (experiment group)
VR	Virtual Reality
WM	Workload Management (ICAO core competency)

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