

Describing and Studying Domain-Specific Serious Games: Introduction

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Abstract The past decade witnessed increasing interest and extremely positive beliefs in the use of games, and especially so-called “serious” games, as educational tools. This AGBL-book on “Describing and studying domain-specific serious games” aims at complementing our current insights into the effectiveness of games as educational tools. In this introductory chapter, we discuss the general scope and outline of the book, with special attention for the content of and relation between the chapters included in Part 1 (game descriptions) and Part 2 (empirical studies on serious games).

Keywords Game descriptions • Empirical studies on serious games • Outline of the book

The past decade witnessed increasing interest and extremely positive beliefs in the use of games, and especially so-called serious games, as educational tools. However, up to now, empirical evidence on the effectiveness of games as potential learning tools is limited and inconclusive due to weaknesses in both the conceptual framework and the methodology in the available research literature (e.g., Girard, Ecalle, & Magnan, 2013; Papastergiou, 2009; Sitzman, 2011; Vogel et al., 2006).

A first weakness of empirical studies on (serious) games as educational tools relates to the definition of a (serious) game. Although researchers generally agree

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on broad definitions of serious games as “games primarily focused on education rather than entertainment” (Miller, Chang, Wang, Beier, & Klisch, 2011, p. 1425) or “digital games, simulations, virtual environments and mixed reality/media that provide opportunities to engage in activities through responsive narrative/story, gameplay or encounters to inform, influence, for well-being, and/or experience to convey meaning” (Marsh, 2011, p. 63), the concrete operationalization of these broad definitions into the core mechanisms of the serious games under study significantly varies across studies.

Second, on top of the unclear and diverse concrete definitions of serious games, the major characteristics of the games under study are only loosely described in the available research literature. One of the major arguments for using game-based learning environments is that games and gaming activities are more engaging and lead to more active learning processes than conventional pedagogical classroom practices. However, more detailed analysis is needed of the specific features of games which are supposed to be engaging and the nature of the activities students are engaged in during gameplay. Recent meta-analyses show that in school contexts serious games are not always as motivating as expected (e.g., Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013). From the point of view of goal-oriented learning, the mere engagement in an intensive activity is not sufficient; the activity should involve focusing on meaningful content in a way that is beneficial for learning (Engle & Conant, 2002).

A third major problem refers to the scope and methodologies of current studies on serious games, characterized by a rich variety in both major aims and materials used. It is difficult to get a convincing overview of the educational effectiveness of games because most published articles are descriptive or only loosely demonstrate learning outcomes without controlled empirical designs (Young et al., 2012).

This book aims at complementing our current insights into the effectiveness of games as educational tools. Different from previous work, the contributions to this book do not merely focus on “serious games” but discuss the characteristics and the potential effectiveness of “game-based learning environments” or GBLE, defined as learning environments that contain (serious) games as potential learning tools. By doing so, the essential interplay between game features and context is highlighted and brought to the front as an important research issue. Moreover, the different contributions all address the potentials of such game-based learning environments for students’ learning and motivation in the domain of Science, Technology, Engineering, and Mathematics (STEM). As outlined below, there is only one exception in terms of definition and scope, focusing on the potential of serious games as diagnostic tools in the domain of reading and as such nicely complementing the other contributions to the book.

Taking into account the importance of clear and complete descriptions of the games under study, the first part of this book focuses on the core mechanisms of six recently developed game-based learning environments in the domains of STEM and reading.

In the first chapter, Linsen, Maertens, and colleagues describe the GBLE “Dudeman & Sidegirl: Operation clean world,” specifically designed to stimulate Kindergartners’ and lower elementary school students’ numerical magnitude processing skills.

The second chapter, by Vandercruyssen, Maertens, and Elen, focuses on the core mechanisms of the commercially available GBLE “Monkey Tales,” aiming at improving elementary school students’ mathematical competencies.

The GBLE described in the third chapter by Lehtinen and colleagues, namely “Number Navigation Game,” is specifically designed to stimulate upper elementary school students’ number knowledge and problem-solving skills.

In the fourth chapter, Vandercruyssen and colleagues describe the GBLE “Zeldenrust,” a mathematical GBLE for prevocational secondary school students, aiming at promoting these students’ motivation for and understanding of proportional reasoning problems.

In the fifth chapter, Star, Chen, and Dede discuss the design process and the core characteristics of a GBLE that was designed on the basis of Eccles and Wigfield’s (2000) expectancy-value theory of motivation. The authors refer to this GBLE as an Immersive Virtual Environment (IVE), specifically aimed at promoting upper elementary and secondary school students’ interest in and motivation for STEM careers.

The sixth chapter, by Geurts and colleagues, focuses on the design principles and rationale behind DIESEL-X, a serious game for detecting a high risk for developing dyslexia in Kindergartners.

Following the concrete and extensive GBLE descriptions in the first part of the book, the second part of the book discusses recent empirical investigations on the learning and motivational effectiveness of (most of) these GBLEs. Table 1 provides an overview of the GBLEs described in the first part of the book and the empirical studies on these GBLEs in the second part of the book.

As demonstrated in Table 1, the seventh and eighth chapters focus on two recent studies with the GBLE Monkey Tales. In “Performance in Educational Math Games: Is it a Question of Math Knowledge?”, Maertens, Vandewaetere, Cornillie, and Desmet focus on the contribution of both mathematical knowledge and gaming skills to elementary school students’ learning processes within this GBLE. In “Integration in the Curriculum as a Factor in Math-game Effectiveness,” Vandercruyssen, Desmet, Vandewaetere, and Elen address the issue of game integration in the curriculum and its influence on students’ learning, perception, and motivation using Monkey Tales.

In “Developing Adaptive Number Knowledge with the Number Navigation Game-based Learning Environment” Chapter 9 and “Number Navigation Game Experience and Motivational Effects,” Chapter 10 Brezovszky and colleagues and Rodríguez Padilla and colleagues report on the learning and motivational effectiveness of the GBLE Number Navigation Game, respectively. “Developing Adaptive Number Knowledge with the Number Navigation Game-based Learning Environment” mainly focuses on the effectiveness of Number Navigation Game in terms of learning outcomes, whereas “Number Navigation Game Experience and Motivational Effects” also addresses the important assumptions regarding the motivational effectiveness of GBLEs in general and Number Navigation Game in particular.

Table 1 Overview of GBLE descriptions (Part 1) and empirical studies (Part 2)

GBLE	Domain	Age	Description (Part 1)	Empirical study (Part 2)
Dudeman & Sidegirl: Operation clean world	STEM	Kindergartners, lower grades elementary school	“Design of the Game ‘Dudeman & Sidegirl: Operation Clean World’, A Numerical Magnitude Processing Training”	–
Monkey Tales	STEM	Elementary school	“Description of the Educational Math Game ‘Monkey Tales: The Museum of Anything’”	“Performance in Educational Math Games: Is it a Question of Math Knowledge?”
Number Navigation Game	STEM	Upper grades elementary school	“Number Navigation Game (NNG): Design Principles and Game Description”	“Integration in the Curriculum as a Factor in Math-game Effectiveness” “Developing Adaptive Number Knowledge with the Number Navigation Game-based Learning Environment”
Zeldenrust	STEM	Prevocational secondary school students	“‘Zeldenrust’: a Mathematical Game-based Learning Environment for Prevocational Students”	“Number Navigation Game Experience and Motivational Effects” “The Role of Curiosity-Triggering Events in Game-based Learning for Mathematics”
Immersive Virtual Environment	STEM	Upper grades of elementary school; lower grades of secondary school	“Applying Motivation Theory to the Design of Game-based Learning Environments”	“Evaluating Game-based Learning Environments for Enhancing Motivation in Mathematics”
DIESEL-X	Reading	Kindergartners	“DIESEL-X: A Game-based Tool for Early Risk Detection of Dyslexia in Preschoolers”	–
Conventional board games	STEM	Kindergartners	–	“Formal and Informal Learning Environments: Using Games to Support Early Numeracy”

“The Role of Curiosity-triggering Events in Game-based Learning for Mathematics,” Chapter 11 by Wouters and colleagues, focuses on the effectiveness of including extra curiosity-triggering events to the GBLE Zeldenrust for increasing prevocational secondary students’ motivational and learning outcomes.

In “Evaluating Game-based Learning Environments for Enhancing Motivation in Mathematics,” Chapter 12 Star and colleagues critically discuss the motivational effectiveness of the GBLE designed on the basis of Eccles and Wigfield’s (2000) expectancy-value theory of motivation with a view to stimulate upper elementary and secondary school students’ interest in and motivation for STEM careers (see Part 1, “Applying Motivation Theory to the Design of Game-based Learning Environments”).

The book closes with the contribution of Gasteiger, Obersteiner, and Reiss (“Formal and Informal Learning Environments: Using Games to Support Early Numeracy”) Chapter 13 on the effectiveness of using conventional board games for enhancing Kindergartners’ early mathematical development. Prior to the report of their own intervention study, the authors critically review (the definition of) conventional board games and previous work on the use of these games in educational contexts.

Taken together, the contributions to the book at first sight display the rich diversity in the current research literature on (serious) games, given the clear focus on either the design process (contributions to Part 1) or the learning and/or motivational effectiveness of GBLEs (contributions to Part 2), as well as the various GBLEs that are described and studied in the different chapters. However, the common GBLE starting point and definition, the detailed descriptions of the core mechanisms of the GBLEs under study, and the concrete focus and sound design of the different empirical studies provide building blocks for empirically addressing the positive claims and expectations regarding the potential of serious games as educational tools in future studies. As such, this book does not only significantly add to our understanding of the core mechanisms of different GBLEs and their design and effectiveness in educational contexts, but also offers interesting and timely avenues for future studies on these topics.

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