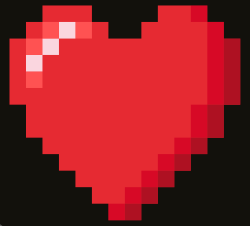

Design for Transfer

Figural Transfer through Metaphorical Recontextualization in Games for Health

Derek A. Kuipers

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Design for Transfer

Research Institute
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Life is Strange (2015)

Follow the story of Max Caulfield, a photography senior who discovers she can rewind time while saving her best friend Chloe Price. The pair soon find themselves investigating the mysterious disappearance of fellow student Rachel Amber, uncovering a dark side to life in Arcadia Bay. Meanwhile, Max must quickly learn that changing the past can sometimes lead to a devastating future.

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Design for Transfer

Figural transfer through metaphorical recontextualization in Games for Health

Proefschrift

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ISBN: 978-94-034-1854-4

Voor Janneke.

Jij kunt alles.

Chapters

Beyond Eyes (2015)

Beyond Eyes is a modern fairy tale about finding courage and friendship. Step by step, uncover an incredible world, carefully guiding Rae, a young blind girl, on a life-changing journey.

Image: Tiger & Squid / Team17 Digital, All Rights Reserved.

H1: Introduction and Rationale

BLOAD"CAS:",R,

We must have been around 6 years old, my brother and I, when everything was a game to us. Tree houses were sky castles, rafts were pirate ships and everything we built from Lego came to life. We were not alone in this, as to the best of my knowledge all our contemporaries engaged in play back then. Playing was an autotelic experience [1], done without instructions or supervision. We discovered and gave meaning to the world through play. It is said that children learn by playing, and that could well be the case. But at the time, we didn't play to learn something, we just played for fun.

Not long after our tree house construction period, we were the first in our little village with a home computer: an MSX-1 with its sometimes precarious tape recorder. The video games we played on this magical device fitted seamlessly into our fantasy world and virtually extended our playground. It's remarkable how many details I still remember of those video games: the end bosses, the quests and even the music. Even though it was over 30 years ago, the in-game experiences felt real and meaningful. But: was playing those games meaningful? Did I learn anything from playing them? Did it somehow influence my behavior in the now? Somehow I know it did.

For quite some time now serious games are held in high esteem for having great potential for education and learning [2]. Studies on serious gaming offer insights on how these should be designed to facilitate learning, and why they are unique to use in learning situations, e.g., [3,4,5].
These studies share an analytical perspective on such games through trying to understand them, explicating their mechanics, or finding out how they perform juxtaposed to existing approaches. Reality shows that in many cases the serious game lacks the feel of a leisure game and cannot provide the same levels of flow and immersiveness.

Some scholars point out that in general, game research lacks quality [6,7] and that serious games are not more effective in terms of learning than other instruction methods [8]. An often-observed phenomenon is that despite rules and guidelines [9,10], efforts in making a serious game do not result in a good game [11], mostly because the unique motivational features of games are lost in the design process, whilst the foremost reason to use serious games is their alleged motivational appeal [12]. A recent meta-analysis of the cognitive and motivational effects of serious games [13] showed that serious games are not more

motivating than the instructional methods used in the comparison group. This is a remarkable result, keeping in mind that the scientific interest in games as a learning tool stems primarily from the strong motivational properties of a game [14]. This provokes the idea that this inevitably has to do with the design of these serious games themselves.

If game-based learning is regarded as an emergent paradigm of digitally mediated learning [15,16] in formal and professional contexts, what conceptual work can the design of these games be based upon? Why do so many serious games in Health hardly resemble the games I grew up with? If good video games are regarded as learning machines [11], it seems justified to go into more detail on how to keep them good, also as a serious game. Broadening the field of education with technologies such as video games not only raises questions on their appearance and mechanics, but surely needs rigorous research on how serious content can be integrated in a game without harming the unique features games offer for learning, since the connection between game design with a focus on entertainment and instructional design with a focus on learning is not a natural one [13].

Simulations and Games

It is important to be clear about the distinction between simulations and games. Key features of simulations are that they represent real-world systems [17], whereas games do not have to. The term game-like interventions used throughout this thesis refers to the space between simulations and games: game-like simulations or simulation games. The past two decades have seen rapidly growing interest in using simulation for purposes of improving patient safety and patient care through a variety of applications [18], but games for Health hardly seem to gain a foothold in Health education.

Design for Transfer

This thesis argues that the results achieved with games and game-like interventions are not so much due to the capacities of the medium itself, but are diminished due to persisting difficulties in, from an instructional perspective, making existing learning content suitable for use in games. I am giving here a somewhat exculpatory version of reality, with the aim of highlighting the issue at hand. Transfer theory distinguishes between mere learning and transfer [19]. Mere learning is about remembering knowledge, with the aim of passing a test.

Often this knowledge is, in fact, de-contextualized knowledge and can be seen as the findings of someone else. The learner only has to take note of it and try to remember and reproduce it as correctly as possible. A test environment can be seen as a target context, but that is not what transfer theory is about. The recontextualization of mere knowledge in a simulation is based on -with simulations being seen as representations of real-world systems- imitating the source context as accurate as possible. When simulating an operating room or following medical protocols, it is of the utmost importance that the learning within the simulation context matches the required competencies needed in the target context. In an almost self-evident way, this thinking about learning leads to the simulations we know from Health, the army or aviation: learning occurs via the road of literal transfer.

The difficulty of applying learning content in games depends on the way in which this explicit, mere knowledge is given a place in the game itself. When we think of mere knowledge as a derivative from an existing context, and we consider the game as a new context, this mere knowledge must be recontextualized. Placing mere knowledge as is in serious games leads to flow-breaking pop-ups, textual interventions during game-play and quiz-like games. With the preservation of the unique motivational and immersive properties of games in mind, the focus of this thesis is on design for figural transfer by metaphorical recontextualization of mere knowledge, for the purpose of learning via the road of figural transfer. The reason for further exploring this subject is the assumption that metaphorical recontextualization of mere knowledge fits in a more natural way with how learning takes place in games. If in-game learning occurs by figural transfer [20] using metaphorical recontextualization can be seen as a key element for success in learning and game-play. This defines the premise of this thesis and in case of proven effect and feasibility, a focus on figural transfer contributes to the field of serious gaming research by adding a new possibility in approaching designing serious games.

The results and explorations of this dissertation may be of interest to Health education innovators, curriculum developers and Health experts who are involved in the development of serious games and game-like interventions. In addition, this research hopes to contribute to the discourse regarding the design of serious games in general and thus also to be relevant for game designers outside Health contexts.

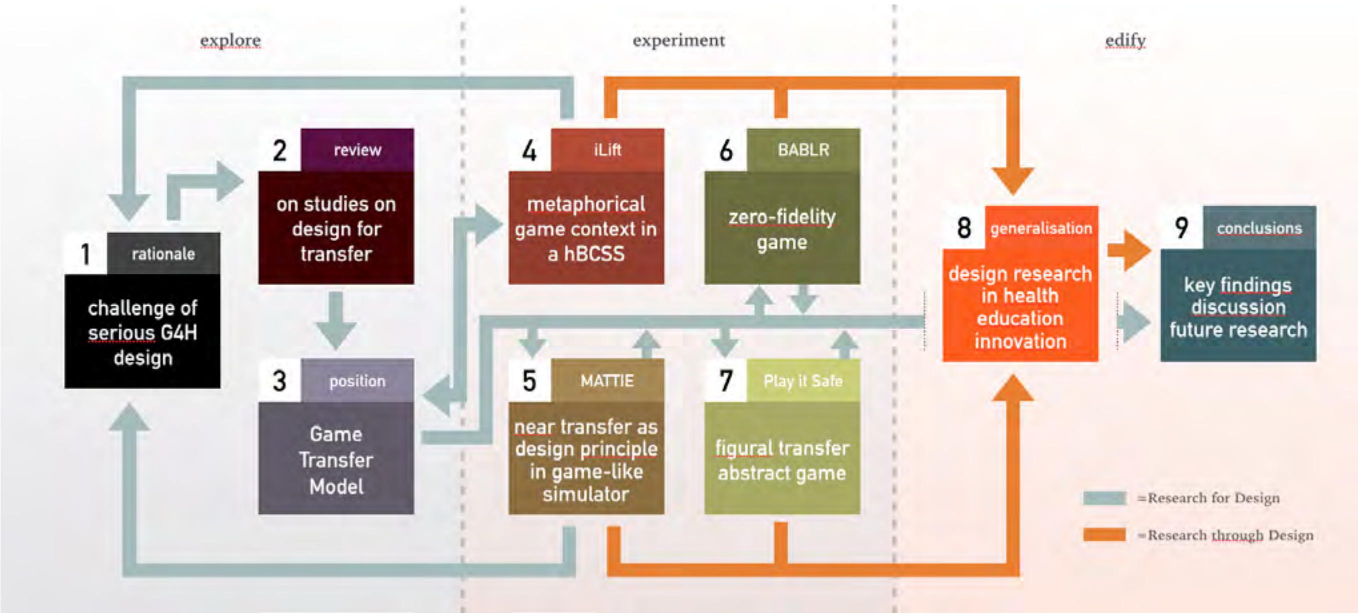
Outline of the thesis

Figure 1 provides a schematic overview of the following chapters and their interrelationships. The chapters can be divided into three themes (explore, experiment and edify), which are explained in more detail below. The image shows two tracks, where the blue route involves the exploration, conceptualization, and application of transfer theory in games for Health, the orange route describes the by-catch of the design research and the unforeseen effects of the gaming artifacts as boundary objects in the social system for which the game-like interventions are designed.

EXPLORE

In a systematic review, **Chapter 2** describes the literature found specifically on the second class of transfer types in the design of serious games and simulations. Focusing on game-like interventions for Health and Health care, this study aimed to (1) determine whether the second class of transfer is recognized as a road for transfer in game-like interventions, (2) review the application of the second class of transfer type in designing game-like interventions, and (3) assess studies that include second-class transfer types reporting transfer outcomes.

Figure 1: a schematic overview of the chapters in this thesis in their mutual relationship.



Building on the findings of the previous chapter, **Chapter 3** provides an in-depth exploration of the use of Design for Transfer in simulations and serious games, aligning associated concepts in the Game Transfer Model (GTM). It describes the importance of conceptual continuity in serious game design, defined by the congruence of fidelity-elements and elaborates on the differences between realisticness and realism. Furthermore, this article coins the term fidelity dissonance as a possible influential factor in the problem of making serious games good games.

Because almost no games for Health were found that were deliberately designed on the basis of a desired or expected transfer type, within this thesis the possibilities of Design for Transfer are explored through a number of cases. By means of design research, game-like interventions are designed for a number of Health-related contexts, all with a conscious transfer-focused approach.

EXPERIMENT

Chapter 4 describes the substantiation, development, and evaluation of a serious game as an essential part of a Health Behavioral Change Support System (hBCSS). The prototypical game BackSpace is designed to facilitate figural transfer of a specific form of behavioral change in order to prevent low back pain in nurses. Data gathered in the final field test showed an in-game training effect, causing players to exhibit correct techniques for static lifting and transferring techniques but also revealed the necessity for future social system development, especially regarding intervention acceptance. Social system factors showed a strong impact on the game's persuasive capacities and its autogenous intent.

Chapter 5 delineates the conceptualization and development of an assistive application that focuses on learning social problem-solving skills for adolescents with a mild intellectual disability. This article describes and substantiates a number of meticulously made design choices to bring together target groups, learning objectives and environmental variables in a game-like intervention for psycho-education. A guiding principle is a design-for-transfer requirement, bridging the transfer problem by instigating a near transfer approach in alignment with the possibilities of the target group.

In the systematic review, we found that in games for Health a distinction is made between high fidelity and low fidelity. In fact, this distinction is a major design decision, because it directly translates into the design of the game itself. Second class transfer could possibly become manifest in a low fidelity design because abstractions or metaphorical recontextualization do not necessarily have to be created with high fidelity. The reasons for choosing low fidelity in games for Health turned out to be different: reducing cognitive load by omitting detail, lowering production costs or a focus on training skills. In addition to the distinction in figural and literal transfer, design choices with regard to fidelity are rarely explained, argued or consciously utilized.

Chapter 3 describes the importance of congruence of these three fidelity types: physical fidelity, functional fidelity and psychological fidelity, in which the basic idea is that the level (low, middle, high) of these fidelity types can differ from each other independently, as long as there is conceptual continuity in the game design. This is the starting point for Chapter 6.

In **Chapter 6** a prototype of a so-called zero-fidelity simulator is developed with the aim of discovering whether a learning experience can be elicited with psychological fidelity as the sole carrier. With physical and functional fidelity limited to an absolute minimum (hence the indication zero-fidelity), the transfer can only take place in a figurative way: the learning context exists only in the head of the player. Building on the experience gained in underpinning and investigating the gaming artifacts for Health in the previous studies, this chapter also introduces a framework for conducting design research into serious games.

Chapter 7 describes the design choices and theoretical constructs that have led to the development of an occupational safety game, going by the name Play it Safe. Play it Safe is a tower defense game that uses situational data collected by employees during their daily work, to impact the parameters of the video game. The game, as a behavioral change support system (BCSS), utilizes metaphorical re-contextualization to create parameters for similar decision making encountered in the work environment and implicitly reinforce the training of the STAR protocol and conservative decision making. Play it Safe aims to improve employees' situational awareness, creating a shared mental model and bottom-up accountability, meant to improve and align (shared) safety behaviors.

EDIFY

Chapter 8 aggregates lessons learned from earlier chapters and addresses the problem of the classical conception of implementation in design projects. It describes a novel framework for future design research projects for digital innovation in Health. Moreover, designers of Health curricula as well as educators in Health innovation are called upon to address the transformation of the social system as an integral part of a design process for successful integration of the developed artifacts.

The essence and conclusions of all chapters will be summarized in **Chapter 9** including a modest draft on future perspectives in Design for Transfer for games for Health.

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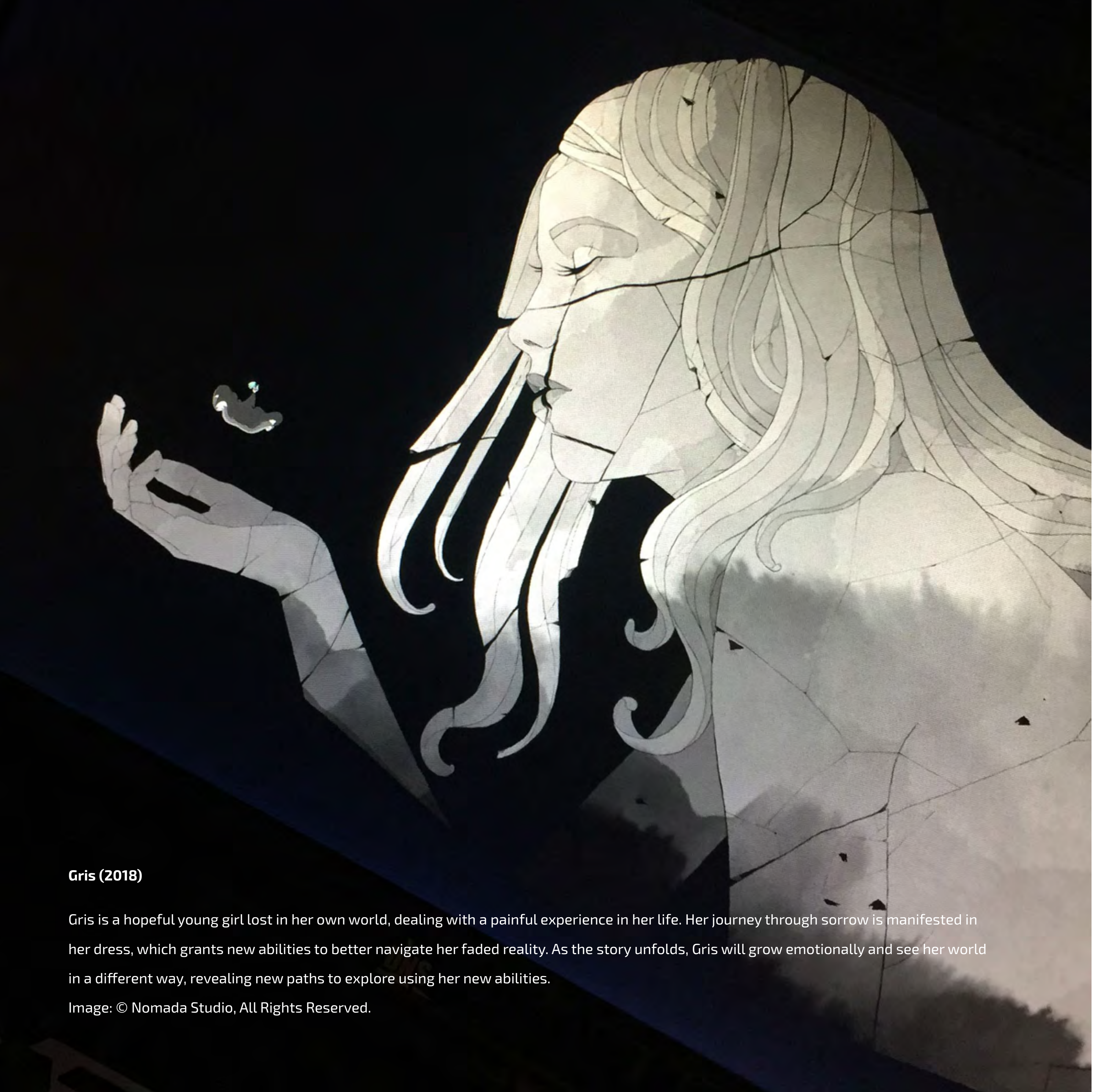


Gris (2018)

Gris is a hopeful young girl lost in her own world, dealing with a painful experience in her life. Her journey through sorrow is manifested in her dress, which grants new abilities to better navigate her faded reality. As the story unfolds, Gris will grow emotionally and see her world in a different way, revealing new paths to explore using her new abilities.

Image: © Nomada Studio, All Rights Reserved.

H2: The Role of Transfer in Designing Games and Simulations for Health: Systematic Review

Published: Kuipers DA, Terlouw G, Wartena BO, van't Veer JT, Prins JT, Pierie JP. The Role of Transfer in Designing Games and Simulations for Health: Systematic Review. JMIR serious games. 2017 Oct;5(4).

Abstract

Background: The usefulness and importance of serious games and simulations in learning and behavior change for health and health-related issues are widely recognized. Studies have addressed games and simulations as interventions, mostly in comparison with their analog counterparts. Numerous complex design choices have to be made with serious games and simulations for health, including choices that directly contribute to the effects of the intervention. One of these decisions is the way an intervention is expected to lead to desirable transfer effects. Most designs adopt a first-class transfer rationale, whereas the second class of transfer types seems a rarity in serious games and simulations for health.

Objective:

This study sought to review the literature specifically on the second class of transfer types in the design of serious games and simulations. Focusing on game-like interventions for health and health care, this study aimed to (1) determine whether the second class of transfer is recognized as a road for transfer in game-like interventions, (2) review the application of the second class of transfer type in designing game-like interventions, and (3) assess studies that include second-class transfer types reporting transfer outcomes.

Methods:

A total of 6 Web-based databases were systematically searched by titles, abstracts, and keywords using the search strategy (video games OR game OR games OR gaming OR computer simulation*) AND (software design OR design) AND (fidelity OR fidelities OR transfer* OR behaviour OR behavior). The databases searched were identified as relevant to health, education, and social science.

Results:

A total of 15 relevant studies were included, covering a range of game-like interventions, all more or less mentioning design parameters aimed at transfer. We found 9 studies where first-class transfer was part of the design of the intervention. In total, 8 studies dealt with transfer concepts and fidelity types in game-like intervention design in general; 3 studies dealt with the concept of second-class transfer types and reported effects, and 2 of those recognized transfer as a design parameter.

Conclusions:

In studies on game-like interventions for health and health care, transfer is regarded as a desirable effect but not as a basic principle for design. None of the studies determined the second class of transfer or instances thereof, although in 3 cases a nonliteral transfer type was present. We also found that studies on game-like interventions for health do not elucidate design choices made and rarely provide design principles for future work. Games and simulations for health abundantly build upon the principles of first-class transfer, but the adoption of second-class transfer types proves scarce. It is likely to be worthwhile to explore the possibilities of second-class transfer types, as they may considerably influence educational objectives in terms of future serious game design for health.

Keywords:

transfer; computer simulation; video games; serious games; games for health; fidelity; abstract learning; immersion; metaphor

Introduction

Games and simulations hold the promise of being learning machines [1] because of the ability to build in learning principles. They can harvest unique features to motivate, trigger, and facilitate learning processes, opening up new possibilities for designing learning for health care professionals and patients. With the positive effects on learner motivation and learning outcomes in mind [1–4], educators must think of new ways to make serious subject matter suitable for game play. A transformation of current forms and beliefs on learning may be needed to make a more natural connection between the serious and the game.

Transfer

A possible way to make such a connection can be found in thinking in terms of transfer. Although there are a wide variety of viewpoints and theoretical frameworks regarding transfer in the literature, transfer is seldom a starting point in developing serious games. Studies on serious games [5,6] have identified design principles for flow and immersion as major contributors to the gaming experience and presumably beneficial for learning. However, the way games facilitate learning is often regarded as a black box. From an educational and technological perspective, transfer is a key concept in learning theory and education [7]. The purpose of (medical) education is transfer: the application of skills, knowledge, or attitudes that were or learned in one situation to another context. The concept of transfer is widely recognized, but ample evidence shows that transfer from learning experiences often does not occur. The prospects and conditions of transfer are crucial educational issues.

If we regard games and simulations as learning contexts that can be designed and specifically tailored for (at least a type of) transfer, it seems legitimate to focus attention on how transfer has been taken into account in designing game-like health interventions.

Two Classes of Transfer

Transfer theory determines two classes of transfer, both encompassing a variety of transfer types [8]. The first class takes the position that the more the learning context resembles the target context, the more likely transfer is to occur. The conditions for transfer are met when the learning experience shares common stimulus properties with the target context. This means that when game or simulation environments try to represent the real world as literal as possible, they aim for first-class transfer. The first class of transfer encompasses instances of literal, specific, nonspecific, vertical, lateral and low-road transfer.

The second class of transfer theories may be harder to grasp. According to Royer [7], figural transfer (belonging to the second transfer class) involves situations where a known complex of ideas, concepts, and knowledge is juxtaposed against some new problem or situation. Figural transfer uses existing world knowledge to think or learn about a particular issue. Clear examples of the usage of figural transfer can be found in figural language such as metaphor or simile. Transfer occurs because of a successful memory search triggered by a figural learning context, assisting in understanding the transfer context. In some situations, the second class of transfer requires a debrief to explicate experiences and connections made. This class encompasses high-road transfer [8].

Optimizing Transfer Conditions

Games and simulations for health abundantly build on the principles of first-class literal transfer, but the adoption of second-class transfer types has proven to be scarce. In contrast to commercial off-the-

shelf games, in serious game design, the usage of mindful abstractions and metaphorical representations is not common practice, despite the fact that it forms a natural fit with the second class of transfer theories. Earlier research has shown [9] that transfer is hard to establish and that the design of education should be key to optimize the conditions under which transfer can occur. Although transfer of learning is a well-established concept in the educational domain, the extent to which transfer may guide the development of game-like interventions in health has rarely been explored. This may be especially true for second-class transfer types: optimizing a game-like intervention design to accommodate the principles of figural transfer.

Fidelity Types

The most visible examples of the designers' uptake of transfer in game-like interventions are apparent in the application of fidelity types: the way fidelity is used in a game-like intervention or simulation demonstrates the expected road to transfer. A dominant perspective on fidelity in serious game design is that high fidelity is conditional for learning and transfer, corresponding with the first class of transfer. According to Alexander [10], fidelity has dimensions beyond the visual design—physical, functional, and psychological fidelity. A game or simulation therefore can be low in physical and functional fidelity but can be high in psychological fidelity. It is also possible that a simulation by design is high in functional and physical fidelity but lacks psychological fidelity. In the literature, the degree of fidelity often refers to physical fidelity alone. Therefore, in this study, cases of cognizant design decisions toward lower fidelity types may prove interesting, as they might include second class of transfer types.

Aim

Focusing on the design of game-like interventions for health and health care, this study aimed to (1) find out whether the second class of transfer is recognized or present as a road for transfer in game-like interventions, (2) review the application of the second class of transfer type in designing game-like interventions, and (3) assess studies that include second-class transfer types reporting transfer outcomes.

Methods

Databases and Search Strategy

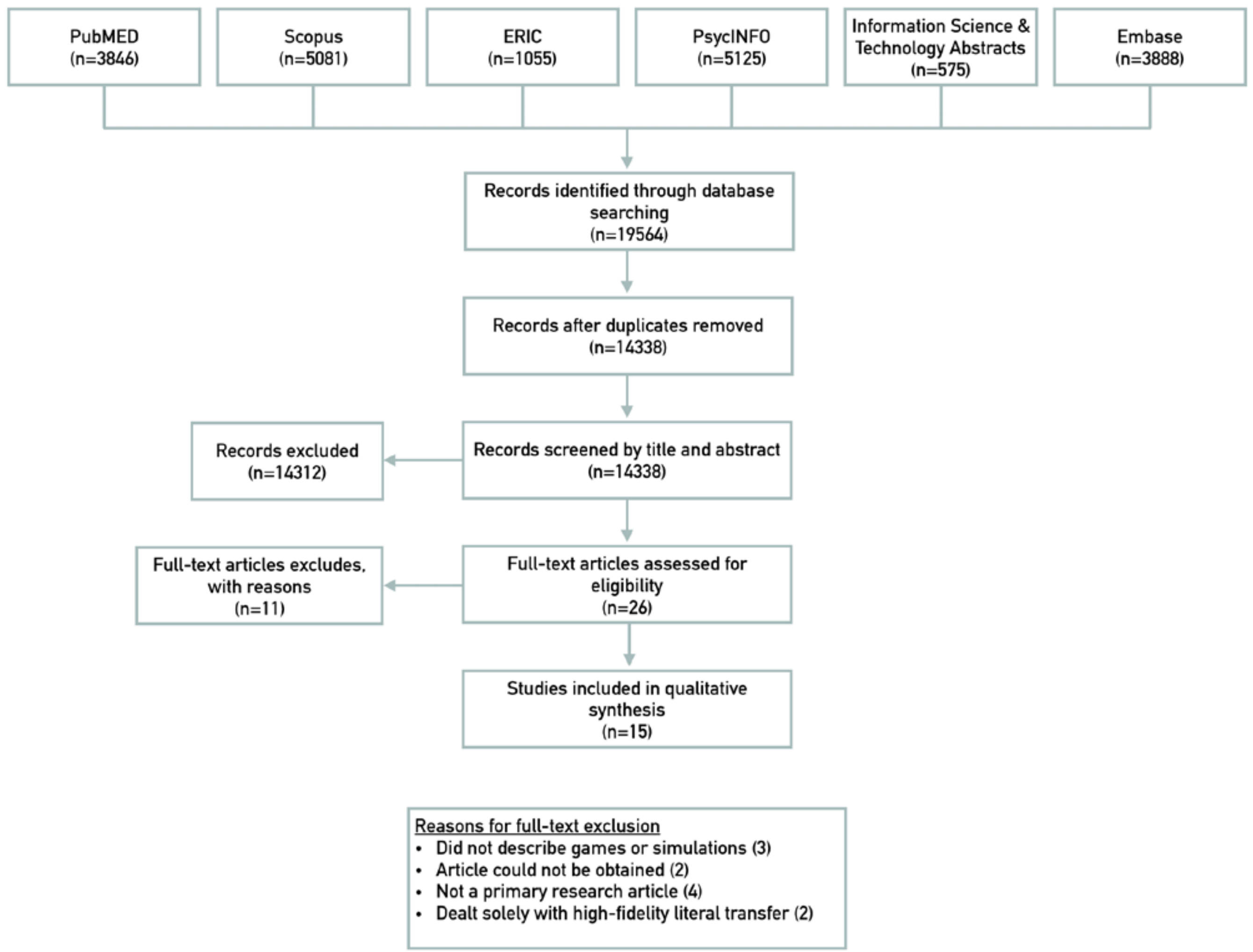
In total, 6 databases were searched for potentially relevant abstracts: PubMed, Scopus, ERIC, PsycINFO, Information Science & Technology Abstracts, and EMBASE. These databases covered a wide range of published research from the field of health and social care. A combination of search terms were used to identify relevant papers under the following categories: (video games OR game OR games OR gaming OR computer simulation*) AND (software design OR design) AND (fidelity OR fidelities OR transfer* OR behaviour OR behavior), where * represents a wildcard to allow for alternative suffixes. Search strategies were customized for each database. Searches included papers published between database inception and October 2016. The search was conducted between October 3, 2016 and October 21, 2016.

Study Selection and Inclusion and Exclusion Criteria

We included studies that discussed either digital simulations osr games designed for health providers or on health topics. We included only original reports or papers that (1) addressed the design of a serious game or digital simulation; (2) involved an empirical study, either piloting a game-like intervention or validating the aspired effects; or (3) otherwise focused on a newly developed game or simulation, created specifically for the study in question. Papers were included when title and abstract were considered to be at least indicative of the presence of second class of transfer. Papers meeting any of the above criteria were selected for full-text screening.

The following exclusion criteria were used for full-text screening: (1) non–peer-reviewed papers such as abstracts, conference posters, or trade journals; (2) full text not available; (3) language other than English and Dutch; (4) papers that referred to transfer as transfer of data or disease; (5) not sufficient information; (6) repurposed commercial off-the-shelf games; (7) low fidelity as a means to reduce production costs; (8) nondigital games and simulations; and (9) papers using high fidelity solely as a description of the artifact rather than as a founded design decision. Also, in our screening, we considered the transfer class in relation to the fidelity type: high fidelity as a means for achieving literal transfer led to exclusion.

Figure 1. Flowchart of the results of the initial searches, screening, and selection processes.



Screening Process

After removing the duplicates, the papers were screened based on title and abstract using Rayyan [11]. In total, 2 reviewers (DK and GT) independently reviewed the title and abstract for relevance against the formulated inclusion/exclusion criteria. Papers were only included on the agreement of both DK and GT; a third reviewer (BW) resolved any disagreements. The degree of agreement was calculated by a kappa statistic. Full-text papers were retrieved after this step. Both reviewers (DK and GT) reviewed each included full-text article. Disagreements in this stage about inclusion were discussed until an agreement was reached. Finally, to check whether any eligible paper had been overlooked during the review process, our check included studies' references for additional papers.

Results

Search Results

Our initial search yielded 19,564 records. After removing all duplicates (5226), 14,338 records remained for title and abstract screening, leaving 26 potential suitable papers for full-text assessment. We used Cohen kappa to assess the interrater reliability of paper inclusion. We found good agreement between the 2 reviewers (κ=.78, 95% CI 0.655-0.883). A total of 11 papers were excluded at full-text screening for various reasons. The total number of included papers is therefore 15. See Figure 1 for a flowchart of the results of the initial searches, screening, and selection processes. Table 1 shows an overview of included studies.

Second-Class Transfer in Game-like Interventions for Health and Health Care

We studied the full-text papers on how transfer was regarded and described in serious games or simulations. All 15 studies mentioned transfer in the initial concept of the design and described forthcoming consequences, mostly expressed in terms of fidelity. Although we assumed that the second class of transfer would be identified in varying ways, we found several other reasons to use abstract concepts and low fidelity. In the following section, we have categorized the papers, based on similarities in conjoining characteristics.

Table 1. Details of included papers.

Author	Title	Transfer class [a]	Fidelity and transfer rationale	Year
Dankbaar, Alsma, Jansen, Van Merrienboer, Van Saase, and Schuit [12]	An experimental study on the effects of a simulation game on students' clinical cognitive skills and motivation	First	Low fidelity, reducing cognitive load	2016
Kuipers, Wartena, Dijkstra, Terlouw, van T Veer, Van Dijk, Prins, and Pierie [16]	iLift: A health behavior change support system for lifting and transfer techniques to prevent lower-back injuries in healthcare	First	Low-road transfer, skill automatization, metaphorical	2016
Jalink, Gores, Heineman, Pierie, and Ten Cate Hoedemaker [17]	Face validity of a Wii U video game for training basic laparoscopic skills	First	Low-road transfer, skill automatization, metaphorical	2016
Connors, Chrastil, Sanchez, and Merabet [18]	Action video game play and transfer of navigation and spatial cognition skills in adolescents who are blind	First	Low-road transfer, spatial recognition	2014
Rosenberg, Baughman, and Bailenson [21]	Virtual superheroes: using superpowers in virtual reality to encourage prosocial behavior	Second	Figural, metaphorical	2013
Schrader and Bastiaens [13]	The influence of virtual presence: effects on experienced cognitive load and learning outcomes in educational computer games	First	Low fidelity, reducing cognitive load	2012
De Freitas and Dunwell [22]	Understanding the representational dimension of learning: the implications of interactivity, immersion and fidelity on the development of serious games	Second	Figural, metaphorical	2012
Knoll and Moar [19]	The space of digital health games	Blended	Locative, situational	2012
Rooney [23]	A theoretical framework for serious game design: exploring pedagogy, play, and fidelity and their implications for the design process	Blended, Both	Abstraction, situational	2012
Toups, Kerne, and Hamilton [24]	The team coordination game: zero-fidelity simulation abstracted from fire emergency response practice	Second	Cognitive fidelity, skill acquisition	2011
Hochmitz and Yuviler-Gavish [25]	Physical fidelity versus cognitive fidelity training in procedural skills acquisition	First	Cost reduction	2011
Stone [26]	The (human) science of medical virtual learning environments	First	Low fidelity, execution skills, reducing cognitive load	2011
Wood, Beckmann, and Birney [14]	Simulations, learning, and real world capabilities	First	Situational	2009
Markovic, Petrovic, Kittl, and Edegger [20]	Pervasive learning games: a comparative study	First	Varying fidelity under conditions	2007
Alessi [27]	Fidelity in the design of instructional simulations	Both	Varying fidelity under conditions	1988

a) Refers to the aspired transfer type described or sought after with the game-like intervention.

Reducing Cognitive Load

Out of the selected studies, 3 [12–14] questioned the necessity of high fidelity to achieve transfer. The basic theory is that high-immersive gaming environments decrease learning outcomes. The studies argue that reducing complexity prevents extraneous cognitive load. In these situations, low fidelity and deliberate abstractions are aiming—by design—for managing the trainees' working memory capacity. This is grounded in the cognitive load theory [15].

Motor and Spatial Skills Training in Metaphorical Contexts

In our initial selection process, papers that presented literal transfer axiomatically were excluded. Out of the included studies, 3 [16–18] were regarded more closely because they use metaphorical game environments, possibly indicating the presence of second-class transfer types. These game-like interventions were designed for skills training (ie, laparoscopic surgery, spatial cognition skills, lifting and transfer techniques). In these scenarios, emphasis is placed on a high degree of validated functional fidelity, aimed at faithfully mimicking the desired skills. These games facilitate first-class low-road transfer by automating motor and spatial skills, hosted by low physical fidelity metaphors.

For example, the game Underground carefully mimics basic laparoscopic skills, including custom-made laparoscopic tool shells. The movements in the game are carefully calibrated to faithfully represent actual laparoscopic skills. These skills are acquired in a literal way. It is noteworthy that the tools and movements share high functional fidelity properties, whereas the physical fidelity is low or even nonexistent. The same goes for iLift, where the lifting and transfer techniques maintain a mimetic correspondence to real-world tasks, although the game metaphor encompasses physical and psychological fidelity: catching sheep or helping little robots escape from a mine shows no medical content. These games use metaphorical contexts to host meaningful play for training skills.

Situational Games

Pervasive game design provides a different approach toward transfer. Of the papers, 2 [19] advocate pervasive games, where fusing the virtual world with the real-world positions them in between the first and second class of transfer. One could argue that situational games seek to provide what we like to call blended transfer by emphasizing

context awareness in a true-to-life experience on the one hand and on the other hand adding virtual game elements. Both studies conclude by accentuating the promise of pervasive game play for transfer of knowledge [20] and transfer of behavior ([19,20] but provide no implications for the design of virtual elements for future pervasive games.

The Application of the Second Class of Transfer

Of the studies, 3 describe game designs applying the second class of transfer, and one study [21] describes a video game to stimulate prosocial behavior. It examines how playing an avatar with superhero abilities increases prosocial behavior in the real world. The study indicates that the in-game superhero metaphor leads to greater helping behavior outside the game. The game therefore builds on the second class of transfer, although the study does not explicate design considerations regarding transfer.

De Freitas et al [22] describe Re-Mission, a video game designed for young people with cancer to encourage them to take their medication. The game metaphor, where the player has to combat cancer cells, seeks to reinforce behavioral change toward medication use. Re-Mission fits the figural transfer class as the in-game representation of the illness and the power to conquer this illness are metaphorical rather than literal [22]. The game play shows little physical or functional fidelity to real-world processes, and measured effects can only be explained in terms of changed mental conceptions, referring to an instance of second-class (figural) transfer. However, the design considerations were not elucidated either in this study.

The third study [24] describes the Team Coordination Game, a simulation to practice team coordination during fire emergency response situations. The Team Coordination Game is a simulation that offers a game environment that requires the use of effective team communication skills, without concrete elements of the mimicked environment. This nonmimetic game offers a two-dimensional environment that shows low-fidelity to real-life fire emergency environments. In the game, 3 avatars in the role of seeker are searching for specific goals, while avoiding threats. A player in the role of coordinator directs the seekers based on observing the environment from a different angle. Limited game time creates a certain amount of stress and pushes the players to work effectively. The study suggests that players were able to restore learned behaviors in communication and stress management in an alternative environment, remixing and repurposing them, suggesting a transfer effect.

Although the game offers a so-called zero-fidelity physical environment, it uses communication instruments that have the same characteristics as real-world radios. This implies at least a modicum of functional fidelity. Furthermore, the game is based on communication strategies and stress levels from real-world fire emergency situations, which suggests some level of psychological fidelity. The Team Coordination Game simulation study offers clear design implications, labeling and elaborating on abstraction from reality as a guiding principle, which differs from the other studies included.

Psychological Fidelity

In total, 7 studies [12,22–27] mention psychological fidelity as, if not the most, an important design parameter in serious games and simulations. In addition, these studies claim that representing the real world as literal as possible is less important for learning. The definition of psychological fidelity in these studies varies slightly [25], but all studies mention the abstraction of certain real-world concepts and a process of recontextualization. Of the studies considered, one [24] added suspension of disbelief as an important characteristic of psychological fidelity: one's temporary allowance to believe something that is not true. Despite the fact that the second class of transfer is not explicitly stated in those studies, they implicitly confirm the second class of transfer as a promising concept in serious game design for learning.

Effects of Design for Figural Transfer

The virtual superhero study [21] only reported a transfer effect just after playing the game. The study did not cover long-term effects but showed in an experimental 2⁄2 design that participants (n=60) in the flying superhero condition displayed significantly increased prosocial behavior compared with participants who were in the helicopter condition. The study mentions several possibilities for the differences found between the testing conditions: different experiences of immersiveness, involvement versus observation discrepancy, and primed concepts and stereotypes related to superheroes in general.

The study reporting on Re-Mission [22] did not elaborate on the efficacy of the intervention. Another study [28] focused in greater detail on the transfer effects of Re-Mission and found that playing the game increased young cancer patients' feelings of self-efficacy or beliefs in their own ability to control and cope with the disease.

A randomized trial with 197 intervention group participants showed a significant increase in cancer-related knowledge and self-efficacy scores and offers empirical support for the efficacy of a game-like intervention in improving behavioral outcomes in adolescents and young adults with cancer.

Using a mixed-method approach, the Team Coordination Game [24] also reported some transfer effect, in addition to an in-game effect (n=64). The study suggested that players were not only able to restore learned behaviors in communication and stress management in an alternative environment but also capable of remixing and repurposing them. The article—in several substudies—describes a variety of positive effects on communication and organizational skills, carried over from the game environment to live training.

Discussion

To our knowledge, this is the first review to explore the aspired transfer in designing game-like interventions in health. We tried to find and describe examples of the application of second-class transfer types by answering 3 research questions, discussed below.

Design for Transfer in Health

We tried to determine whether the second class of transfer types is recognized or present as a road for transfer in game-like interventions for health. In our initial search, we expected to find studies in which thinking about a desired transfer outcome would form a guiding principle in the design of game-like interventions. Moreover, clearer distinctions in suitable transfer types and established examples of figural transfer (or forms thereof) were anticipated. Both assumptions were proven wrong, and we had to broaden our inclusion criteria to capture studies regarding design considerations, including transfer.

Our results show that transfer is mainly mentioned as a desired outcome, not as a guide in the design process. The appear–ance of most included game-like artifacts can be explained by the designer's fidelity approach. As obvious as this seems, this fidelity approach also expresses assumptions about the way the transfer is expected to take place. As described before, we found several reasons for choosing low fidelity over high fidelity and vice versa. As none of the studies were designed for achieving transfer via a specific type or class of transfer, the question arises why the design for transfer perspective has received no attention.

By nature, design-centered research focuses more on the design itself and puts less emphasis on the eventual aspired outcome. Although it is too strong to state that the design itself of game-like interventions in health is not taken into account in thinking about desirable transfer outcomes, our search results show that describing the game-like interventions in terms of transfer variables is uncommon. One might argue that the design of a drug is essential to its workings and that the same principle applies for game-like interventions. The design of the artifacts as exercised in the virtual superhero game [21], Re-Mission [22], and the Team Coordination Game simulation [24] is intentional and differs strongly from game-like interventions as Underground [17] or Digital Economy [20]. These differences arise from a broad and ill-defined range of variables but inevitably reveal the design–er's intent with regard to how the intervention should carry over the effect. Herein lies the rationale for design for transfer.

The Presence of the Second Class of Transfer

As described, we searched for particular examples of aspired transfer in the second class of transfer types, and found none. In 3 studies, the reported effects can only be explained via the road of a second-class transfer type but are described in other terminology. Most studies report about psychological fidelity [12,22–27], virtual presence [13], and immersion [21,22] as important conditions for desired outcome.

An interesting observation is that the included papers show that functional and physical fidelity can be high or low for varying, well-founded reasons and that psychological fidelity is regarded as a variable that preferably should be high. The Team Coordination Game simulation [24] adopts a different position in stating that the gaming artifact has zero psychological fidelity. However, the way deliberate abstractions are described and how these resulted in the design of the game itself strongly suggests second-class transfer.

The 3 studies we identified exemplifying an instance of figural transfer introduced a metaphorical approach with recontextualized fidelity types. These game metaphors seem to address and replace both high

functional and physical needs as well as promote immersion. At this point, we hypothesize that figural transfer builds upon immersion or virtual presence and subsequent suspension of disbelief [24]. In more abstract game-like interventions, metaphors provide a storyline, a context, and a reason for engaging in play. In this way, psychological fidelity is reappointed by the concept of suspension of disbelief, instigated by the metaphor itself.

Second-Class Transfer Outcomes

As the literature on transfer has consistently confirmed, long-term transfer effects are hard to measure. This might be particularly the case for the second class of transfer. All 3 examples report transfer effects, albeit short term and only vaguely proven. As second-class transfer is the result of the effects interventions trigger in one's head, the transfer outcomes are individual, often nonlinear, and even unpredictable if the second class is not implemented with due care. Precisely because of this, we anticipated more conscious and elucidated design examples.

Limitations

Although this review is based on an extensive search of a large number of health and computer science databases, we hardly found any studies of second-class transfer types in game-like interventions for health. Studies tend to focus on the effectiveness of game-like interventions and the research methods used, not on design factors that lead or contribute to measured effects. Due to the very few direct hits, we focused on the subconscious application of the second class of transfer types by thoroughly screening titles and abstracts. The papers that were included were subject to interpretation, discussion, and consensus of the reviewers (DK, GT, and BW). To counteract subjectivity, papers were independently reviewed by 2 reviewers (DK and GT) and were only included on consensus from both reviewers. Remaining conflicts between the reviewers were resolved by the third reviewer (BW).

Conclusions

Studies about serious games and game-like interventions for health do not provide a conscious rationale for designing the artifacts for optimizing transfer conditions. We did not find any example of a game-like intervention that was the result of a cognizant design process focusing on transfer outcomes. In general, we found that definitions of low and high fidelity form the strongest influencers on the design of artifacts, mostly exemplified in visual quality or a true-to-life approach. High fidelity was aspired to for its first class, literal transfer aspects without exception. None of the studies explained second class of transfer or instances thereof, although in 3 instances, implicit design choices suggested other–wise. It is notable that studies on game-like interventions for health do not elucidate the design choices made, as they bridge the designer's intent and the aspired transfer outcome.

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Conflicts of Interest

None declared.

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Dys4ia (2012)

Dys4ia is a retro arcade-y piece of interactive art by transsexual author Anna Anthropy about her six-month experience with hormonal therapy. Raw and emotional, but surprisingly humorous, for good or for bad, this is the kind of game that will get people thinking and talking.

H3: Design for Transfer

Meaningful Play through Metaphorical Recontextualisation

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Abstract

This paper explores the use of design for transfer in simulations and serious games. Key in this study is the hypothesis that meaningful play can be achieved by designing for figural transfer by the use of metaphorical recontextualization. The Game Transfer Model (GTM) is introduced as a tool for designing and thinking about serious game design, stretching the possibilities from high-fidelity simulations to metaphorical fantasy worlds. Key for an in-game learning experience is the presence of conceptual continuity defined by the congruence of fidelity-elements. The GTM differentiates between realisticness and realism. Where simulations use the road of literal transfer and therefore relies on realisticness and high-fidelity, figural transfer can be a guiding principle for serious game design, using metaphorical recontextualization to maintain conceptual continuity. Conceptual continuity aligns fidelity and enables the game to connect its serious content to the realities of life.

Keywords:

Serious video games; figural transfer; game transfer model; metaphorical recontextualization; fidelity dissonance; conceptual continuity; meaningful play.

Introduction

Broadening the field of education with relatively new technologies as video games not only raises questions on their appearance and mechanics but surely needs rigorous research on how serious content can be integrated into a game, without harming the unique features games offer for learning.

'Other than pure entertainment' is part of the common definition of a serious game. The 'serious' adjective is needed to ensure the game will train, educate or inform. It also leads to an oxymoron, since games are inherently fun and not serious e.g., [1]. Serious seems at odds with play, and play is central to games [2]. Most serious games have been deliberately designed for learning or are so-called commercial off-the-shelf video games (COTS). The latter case opens opportunities for existing games to add to the educational field, causing the inevitable comparison between an educator's point of view on games and the world of the leisure games. In many cases, the serious part of serious games seems to justify the sacrifice of fun, entertainment, and aesthetics in order to achieve a desired goal by the player. An often-observed phenomenon is that despite rules and guidelines, efforts in making serious games don't result in a good game, mostly because the unique motivational features of games are lost in the process. This paper argues that (1) with the choice of a video game as a medium for learning a choice for essential design principles comes along, and (2) in order to maintain these principles, educators must explore and adopt new views and insights on learning.

Education needs good games

Well-designed games have the ability to tempt and challenge people to engage in complex and difficult tasks, without forcing them to do so. Gee [3] believes it is the way that games are designed that makes them deeply motivating. Not just motivating to play a game, but to learn, to get better. He states that good games are good games because they touch a core element of human beings: a biologically need for learning. Studies on serious games frequently mention the importance of flow experience [4] as a central prerequisite for enjoyment, being the optimal balance between challenge and skill. By nature, games provide this balance, being adaptive and adaptable at the same time. Flow state induces a state of mind, causing players to have a heightened sense of presence through individual identity [5] engagement in the content, and intrinsically motivating to succeed in the challenge of the game's goal. Annetta [6] mentions flow as an underlying goal of all good game design. Amongst others, important features of games are the game's ability to adapt to the skill level of the player, facilitate interactivity and enable discovery learning under the user's control. In fact, many studies on serious games show guidelines and design principles for good serious game design, so, what is keeping us from doing so? It is the medium itself and here aforementioned characteristics that make games suitable for learning.

Design for transfer

With the positive effects on learner motivation and learning outcomes in mind [7,8]; [9], educators must think of new ways to make serious matter suitable for gameplay. A transformation of current forms and beliefs on learning may be needed to make a more natural connection between the serious and the game. A possible way to make such connection can be found in thinking in terms of transfer. Although there's a wide variety of viewpoints and theoretical frameworks regarding transfer in the literature, seldom transfer is a starting point for educationalists in developing serious games. As in many cases of innovation, people tend to use known repertoire in a new environment: an interesting case of transfer in itself. There is a clear distinction between mere learning and learning for transfer [10]. One could argue that modern education is mostly occupied with mere learning: passing tests and preparing for exams. How transfer takes place or even if transfer occurs, is mostly not an issue. This paper argues that a focus on transfer gives new perspectives on serious game design. Royer [11] mentions two classes of theories on the subject of transfer. The first is based on the idea that an original learning event and a transfer event have to share common stimulus properties. The second class of theories explains the occurrence of transfer in terms of mental effort and cognitive process. He also differentiates between literal transfer and figural transfer, a ranging with reminds in some ways to the low-road and high-road transfer, as described by Salomon & Perkins [10]. Royer [11] states that 'most of the material in the past literature on learning transfer could be included under the concept of literal transfer', implying a modest role for figural transfer in the educational field. Figural transfer may share similarities with high-road transfer, but it seems to have a place in its own right. It involves the use of existing world knowledge or schemata as a tool for thinking about or learning about, a particular problem or issue. This idea resonates with constructivist ideas about learning and cognitive theory and certainly becomes interesting when held next to game instances.

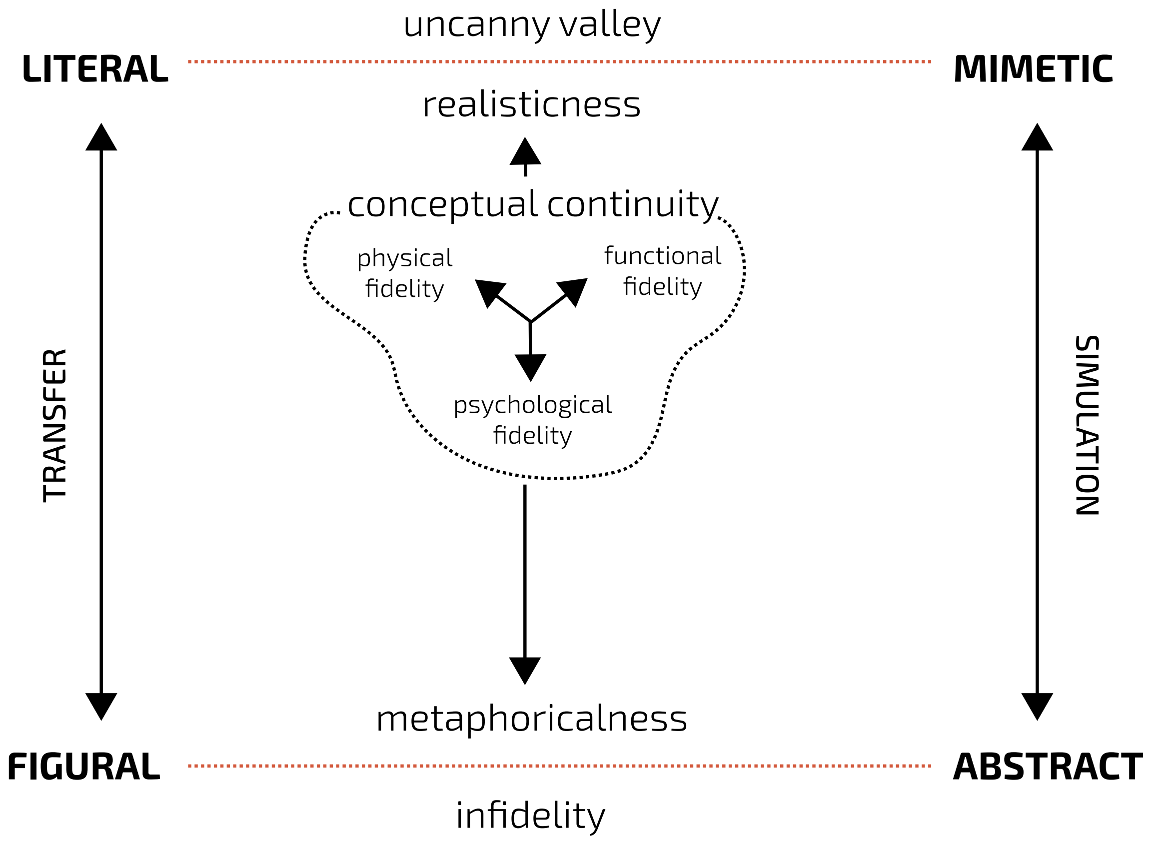
Conceptual continuity and Fidelity Dissonance

Flow state [4], as well as suspension of disbelief [12], are psychological states of mind, often mentioned to be essential to gameplay, or in the other words, can be induced by gameplay. It is these unique attributes that rely heavily on well-made design choices. Musician and composer Frank Zappa (1940-1993) introduced the term conceptual continuity, by which he probably did not have serious game design in mind, but referred to the importance of congruence in art. In game design, each element of the game is carefully chosen in order to put the player in the correct mindset to experience the game. In that way, games need conceptual continuity in order to facilitate suspension of disbelief.

In research, to some extent, the degree of realism is held to be conditional for transfer to occur. Fidelity is believed to be of importance in terms of relevance for learning and transfer [13], denoting the degree of similarity between the training situation and the operational situation, which is simulated [14]. According to Alexander [15,16] fidelity has dimensions beyond the visual design of a game. Notions of simulation fidelity include physical, functional and psychological fidelity [15].

Traditionally, the assumption has been that higher-fidelity is better than lower- fidelity, which in the case of simulations might be true. High-fidelity environments can provide an authentic context in which learners can learn-by-doing. This makes knowledge more meaningful and therefore has a higher impact on the transferred skill or knowledge [17]. This paper, however, makes a clear distinction between realisticness and realism. Where realisticness deals with the degree of real-world similarity, realism can be found in conceptual continuity, in the game's ability to correspond its serious con-

Figure 1. Shows a simulation game seeking common stimulus properties, using literal transfer for learning.

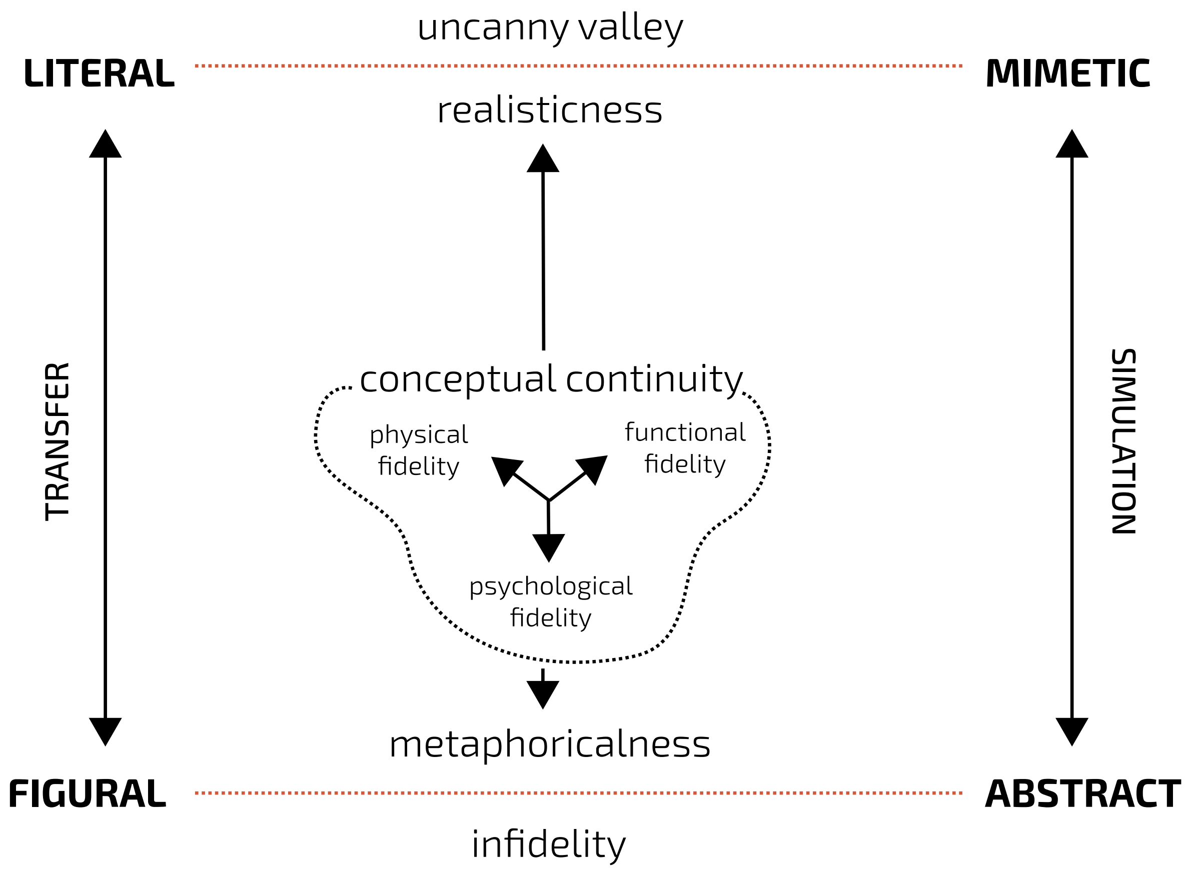


tent with the realities of life [18]. One could argue that realism correlates with artifact acceptance and credibility, underpinned by the congruence of the three types of fidelity.

Game Transfer Model

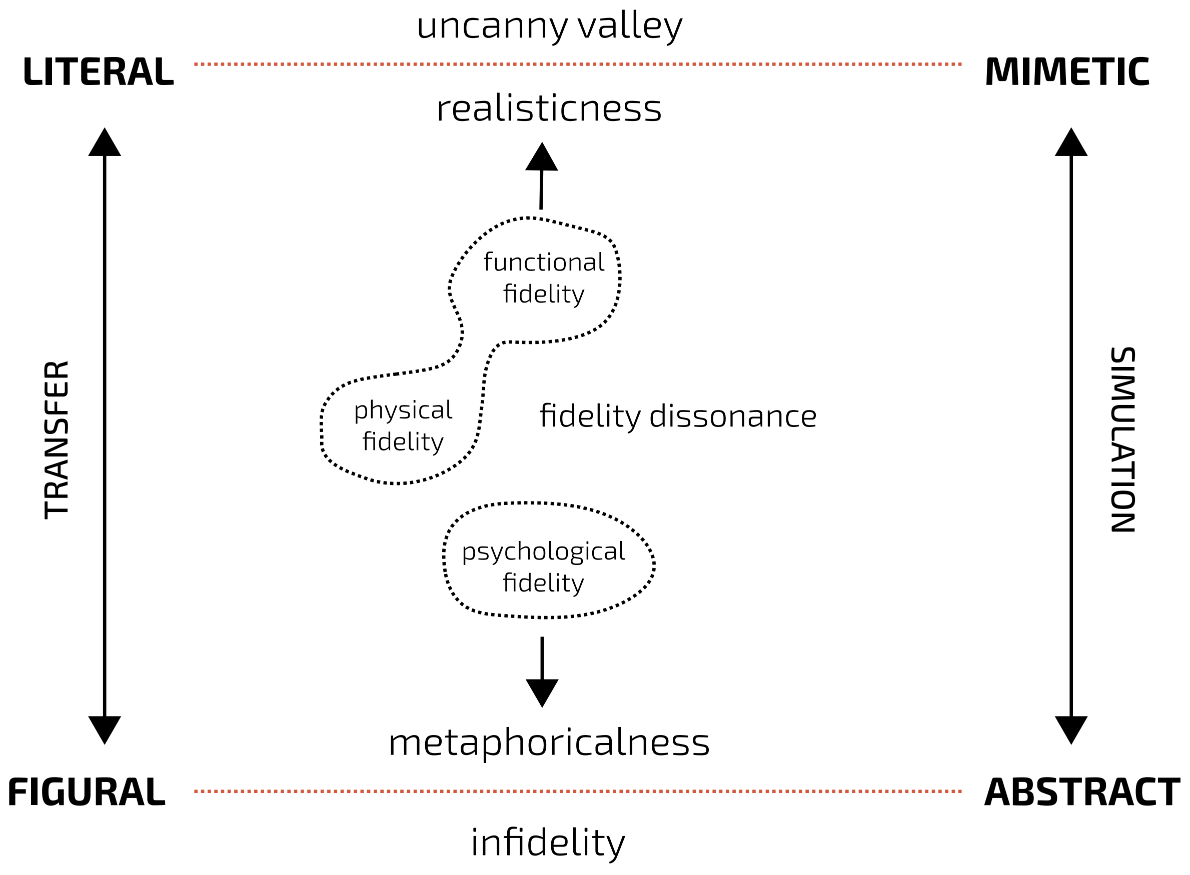
The game transfer model (GTM) combines transfer and video game instances, suggesting a space where it is possible to position educational content on a scale between literal and figural transfer. On the top of the model, the literal transfer corresponds with simulation, at the bottom figural transfer is connected to play. Depending on the desired educational outcome and profile of the learner, a sound judgment has to be made on "the what and the how" of transfer. Almost by default, and possibly influenced by the serious

Figure 2. Shows a game artifact, facilitating figural transfer for learning by using metaphorical recontextualization.



part of serious games, serious games mostly can be positioned in the upper regions of the model. Introducing figural transfer in the design of serious games hands the educationalist tools to explore new (or forgotten) ways to get serious content across and enables game designers to integrate serious content in more playful ways in games as depicted in figure 2. The conceptual continuity circle lowers in the model towards figural transfer, causing the serious content to take on different appearances. The shift from simulation to play initiates the need for a metaphorical approach recontextualization within the GTM the process of recontextualizing abstractions into meaningful game-play is called metaphorical recontextualization. In order to facilitate figural transfer authentic elements of the learning objectives are presented in a metaphorical context. Players are presented

Figure 3. Shows the occurrence of fidelity dissonance, caused by incongruence in fidelity-types.



serious matter in new and rich contexts, triggering a need for understanding, generating meaning and encouraging participation. This process where players are making sense of contexts within they function by constructing mental representations or concepts of them shows resemblance with Argyris' theory on double-loop learning [19].

Recognizing and evaluating abstracted essentials in a metaphorical recontextualized environment is key to figural transfer. The use of metaphors is a known didactic principle, probably as old as humanity itself. The Greek word μεταφορά (metaphorá) actually means 'to carry over' or 'to transfer'. Figural transfer uses simile or metaphors as a carrier to create and raise mental images, allowing new insights and knowledge to land in prior schemata. In-game learning can occur by figural transfer using metaphorical recontextualization as a key element for success in learning and gameplay. When creating a game the use of metaphors is common practice to distance yourself from reality. A metaphorical recontextualization constitutes using a metaphor to place a real-life/simulated skill or knowledge partitions and re-arrange the construct by the use of a metaphor. This re-arrangement process through the use of a metaphor influences the constructs' qualities, the games' validity, and fidelity as well as the overall player experience. Therefore when distancing oneself from a simulation towards a serious game designing the befitting metaphor is essential. When designing a game with transfer purposes, whether it is a simulation or serious game, conceptual continuity is key. The dimensions of fidelity can differ in their respective levels as well as their position on the grid of the game transfer model, however, the continuity of those levels through the gameplay influences the conceptual continuity. During gameplay, movement in the levels of fidelity or their position related to each other can vary to some extinct, but more rigid movements on the grid of the game transfer model cause the conceptual continuity to fall apart. Figure 3 shows the occurrence of what in the GTM is called fi–delity dissonance: an incongruence in fideity concepts, causing a disturbance in the game experience. It's this pitfall in serious game design that contributes to the absence of suspension of disbelief and makes it hard to stay in the flow channel [20]. Finally, the endpoints of the scale are labeled uncanny valley [21] and infidelity. The uncanny valley describes the phenomenon of experienced uncanniness evoked by a high degree of fidelity. On the other hand, the term infidelity is used to describe a situation where fidelity is thus low, the game loses its potential for learning.

Conclusions & Implications for Game Design

Manifestations of mere learning can contribute to a fidelity dissonance, when implemented unaltered from existing work forms into gameplay. When designing a game for learning purposes, whether it being a simulation or serious game, conceptual continuity is key. Conceptual continuity can be reached by aligning the dimensions of fidelty in order to establish a sense of realism and believability. Serious game designers should reach their serious goals by focusing on transfer types and correspond- ing game entities. The combination of learning abilities of the target audience desired learning outcomes and content specifications result in a position on the grid of the game transfer model. This position marks the center of the conceptual continuity circle and positions the fidelity types. The dimensions of fidelity can differ in their respective levels as well as their position on the grid of the game transfer model, how–ever the congruence of those levels through the gameplay influences the conceptual continuity. Whenever these points show incongruence, a fidelity dissonance may occur, resulting in a game that's unable to get hold of the player in terms of flow and motivation. In simulation games this conceptual continuity is reached by creating a high fidelity and realistic environment, whilst in serious games, the metaphorical recontextualization is used to keep conceptual continuity and realism within a less realistic game environment.

This also implies that by default games that are using a reinforcement or motivational paradigm [22] within serious games lack conceptual continuity. When the game-goals and educational goals fail to intertwine, fidelity dissonance is a direct result. Therefore a blended paradigm is the more befitting paradigm for meaningful play. By exploring and embracing figural transfer as a mechanism for learning, serious games can be more than simulations or drill & practice games. Metaphorical recontextualization can be key to change the future of serious games, giving the education professional as well as the game designers new tools to develop seriously good games.

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Papo & Yo (2013)

Quico's best friend, Monster, is a huge beast with razor-sharp teeth, but that doesn't scare Quico away from playing with him. That said, Monster does have a very dangerous problem: an addiction to poisonous frogs.

H4: iLift: A health behavior change support system for lifting and transfer techniques to prevent lower-back injuries in healthcare

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Abstract

Objective

Lower back problems are a common cause of sick leave of employees in Dutch care homes and hospitals. In the Netherlands over 40% of reported sick leave is due to back problems, mainly caused by carrying out heavy work. The goal of the iLift project was to develop a game for nursing personnel to train them in lifting and transfer techniques. The main focus was not on testing for the effectiveness of the game itself, but rather on the design of the game as an autogenous trigger and its place in a behavioral change support system. In this article, the design and development of such a health behavior change support system is addressed, describing cycles of design and evaluation.

Methods

(a) To define the problem space, use context and user context, focus group interviews were conducted with Occupational Therapists (n = 4), Nurses (n = 10) and Caregivers (n = 12) and a thematic analysis was performed. We interviewed experts (n = 5) on the subject of lifting and transferring techniques. (b) A design science research approach resulted in a playable prototype. An expert panel conducted analysis of video-recorded playing activities. (c) Field experiment: We performed a dynamic analysis in order to investigate the feasibility of the prototype through biometric data from player sessions (n = 620) by healthcare professionals (n = 37).

Results

(a) Occupational Therapists, Nurses, and Caregivers did not recognize a lack of knowledge with training in lifting and transferring techniques. All groups considered their workload, time pressure, and a culturally determined habit to place the patient's well being above their own as the main reason not to apply appropriate lifting and transferring techniques. This led to a shift in focus from a serious game teaching lifting and transferring techniques to a health behavior change support system containing a game with the intention to influence behavior. (b) Building and testing (subcomponents of) the prototype resulted in design choices regarding players perspective, auditory and visual feedback, overall playability and perceived immersiveness. This design process also addressed the behavior-shaping capacities of the game and its place within the health behavior change support system. An expert panel on lifting and transferring techniques validated the provoked in-game activities as being authentic. (c) Regression analysis showed an increase of the game score and dashboard score when more sessions were played, indicating an in-game training effect. A post-hoc test revealed that from an average of 10 playing sessions or more, the dashboard score and the game score align, which indicates behavioral change towards executing appropriate static lifting and transferring techniques.

Conclusions

Data gathered in the final field test shows an in-game training effect, causing players to exhibit correct techniques for static lifting and transferring techniques but also revealed the necessity for future social system development and especially regarding intervention acceptance. Social system factors showed a strong impact on the games persuasive capacities and its autogenous intent.

1 Introduction

1.1 Background

The Dutch National Compass for Public Health shows data from several studies [1–3]. This points toward lower back problems having a significant impact on insurance funds, and with all likelihood, will continue to do so in the near future. An estimated rate of 40% of reported sick leave is due to lower back problems, and about 2.4 million adults [4] in the Netherlands suffer from chronic lower back pain. This is defined by an employee's absence from work extending for more than 3 months. Between 2000 and 2020, with population growth and ageing this will increase the percentage of people suffering from neck and back problems by 14% [4]. The causes of lower back problems however, are nonspecific, both physical demands as personal and psychosocial variables are associated with an increased likelihood of low back pain [5]. This makes it difficult to prevent or cure lower back problems with a single intervention. In health care, nurses spend an important part of their time lifting and transferring, often beside the beds of their patients. Because of this, lower back problems are very common among these professionals. Within (Dutch) health care institutes and care homes, healthcare professionals are trained in applying lifting and transfer techniques (from now on referred to as LTTs). Most of these training modules exist of an (e)module containing theoretical aspects on the theme and a practicum led by a physiologist. However, observations [3] show that displayed work routines regarding LTTs do not meet the regulations, suggesting a possible ineffective approach in current training programs.

1.2 Objectives

The main objective of iLift is the exploration of the design of a hBCSS, supporting LTTs education, tailored around a video game. Oinas-Kukkonen [6,7] defines a BCSS as: a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception. All BCSSs are designed with persuasive intent, the socio-technical platforms differ in their architecture and inherent qualities [8]. Considering BCSSs background in web science, it comes as no surprise that game systems such as a BCSS diverge in their architecture [9,10,11] through, amongst others; procedural rhetorics [12], motivational affordances [13,14] and their mechanics, dynamics and aesthetics [15].

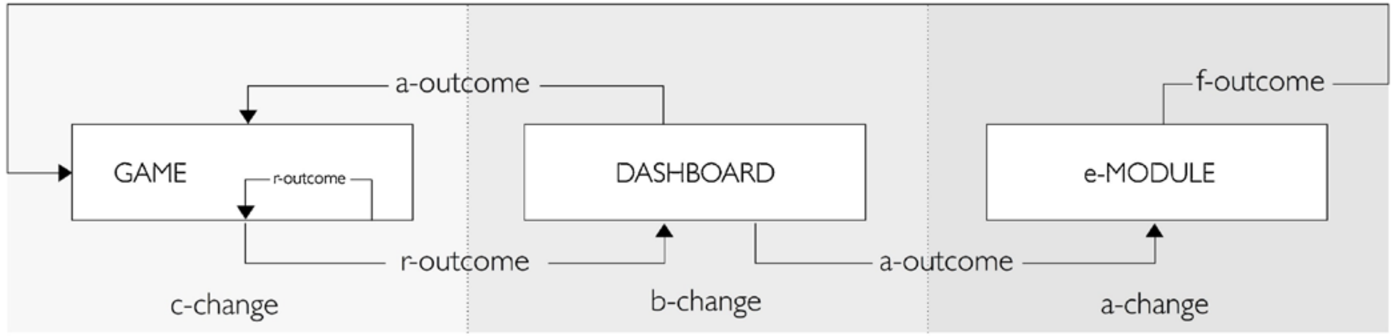
Serious gaming holds the promise of being a powerful tool for facilitating learning and encouraging behavior change [16]. The term serious game [17] used in this study, follows the presumption of Jenkins [18] which states that games are designed to be integrated into the socio-technical and social system they are intended to be used in. This view on serious games, being more than a standalone application, brings the social environment in the design space. This is a notion that Oinas-Kukkonen [7] also emphasizes as an important factor in BCSS-design. Most studies on serious gaming focus on the effects of the intervention, rather than on its design and specific mechanics leading up to a desired effect. As is the case with BCSS design, serious games are often regarded as a black box, leaving the systemic affordances and weaknesses unspoken.

The iLift study focuses on the design of the game and its context, as a response to an often uttered critique that the serious intentions of a game undermines its entertaining nature. Wouters et al. [19] conclude that more research is required on factors that connect the worlds of game design and instructional design. The blending paradigm [20] suggests the merging of entertainment and education, where learning becomes incidental and implicit. Kuipers et al. [21]

argue that it is the blend of educational and entertaining elements itself that define the overall quality of a serious game and is therefore an imperative design principle. Systemic affordances of a video game lead to specific and tailored design choices regarding the presence and form of educational content within the game, in order to achieve natural education-entertainment blends. A dominant intervention to educate healthcare practitioners about the dangers of exceeding the limits of static lifting is the Dutch national standard called the Lifting Thermometer. For the design of the game befitting elements regarding static and dynamic lifting techniques of this lifting thermometer were put into metaphors. As an added feature the game uses the psychological mechanism of behavioral inoculation [22].

The game offers an experimental environment wherein players are triggered and enabled to perform incorrect movements associated with static lifting and transfer techniques. The static lifting movements, in particular the bend angle and the duration, are assessed through the Kinect. Through experiential learning the player gets confronted with the prescribed limits of the lifting thermometer set against own movement through the score system (further described in 3.1.3). The intent of the game is to trigger behavioral inoculation, letting the player experiment with new behaviors, providing challenging tasks and goals. During playing time, the player is scaffolded towards compliance and safe in-game behavior by precise and tailored feedback. Huizinga [23] coined the term magic circle, adopted and ameliorated by Salen and Zimmerman [24], where immersion [25], engagement [25], and a state of flow [26] are recognised as key elements in the game experience. Klabbers [27] mentions that gameplay triggers a variety of cognitive processes. This experience-in-action asks for a need for understanding

Fig. 1. Ilift BCSS architecture



(game rules and focal point) and generates meaning (on in-game occurrences). To do so, players use explicit, tacit, enculturated and local knowing [27]. Amory [28] states that players can assimilate tacit knowledge through the process that is reconstructed after emerging from the state of flow. Other serious games studies emphasize the importance of appropriate debriefing [29]. All aforementioned constructs and concepts shaped the ideas for an iLift hBCSS, including an in-game experience, a dashboard with game data explicitation with visualisation and an underlying theoretical framework on lifting and transfer techniques.

1.3 iLIFT as a hBCSS

Aforementioned discrepancy between the observed situation [3] and an active implementation of LTTs by caregivers places the focus on behavioral aspects. Teaching healthcare professionals theories on LTTs, along with safety measures and protocols, seldom translate into an adequate practical execution of this knowledge. A BCSS is designed for behavioral change, using persuasive technologies in conjunction with specific end-user characteristics in a social system context. Oinas-Kukkonen [7] poses formation, alteration and reinforcement as three potential behavioral outcomes for a BCSS. The system can affect attitudes, behaviors or compliance. Fig. 1 shows the iLift BCSS architecture, wherein the different artifacts (game, dashboard and e-module) and their desired behavioral outcomes are presented in relation to the behavior change support system as a whole.

Fig. 1 is best understood in terms of the O/C Design Matrix [6], elucidating a C-Change as being a change in compliance, a B-Change as a change in behavior and an A-Change as a change in attitude. These change types can be laid out in three expected outcomes, being reinforcement (R-Outcome), alteration (A-Outcome) and formation (F-Outcome). The design of the iLift hBCSS exists of 3 artifacts as depicted in Fig. 1. Each of the artifacts has a dedicated task regarding behavioral influence. First, the user enters the system with a game designed to reinforce compliance. Second, a connected dashboard interprets in-game achievements and translates biometrical data into explicit and tailored information, designed to change behavior. Third, an eModule provides the user theoretical and normative background information, instigated by poor dashboard scores. The eModule is meant to establish the formation of new attitudes towards off-limit LTT behavior.

Table 1. Analysis of the persuasion context

Intent	Persuader	The persuader in the hBCSS is the game Back Space, designed to offer a compelling and enjoyable experience. The games motivational affordances underlines its autogenous intent.
	Change type(s)	iLift consists of three artifacts, each with a different intent. The games intent is to reinforce compliance: indulging in the game leads to an in-game training effect and an automated application of static LTTs. The dashboard is designed for altering behavior: the dashboard prompts and explicates in-game scores and provides tailored feedback on performed behavior and offers suggestions to alter in-game behavior. The hBCSS refers to an eModule only then when in-game performance is under set boundaries and dashboard consultation does not lead to altered in-game behavior. The eModule delivers specific information on the consequences of long-term inadequate usage of LTTs and is designed to form attitudes towards LTTs.
	Designer bias	The designer bias becomes clear after consulting the dashboard.
Event	Use context	The target group considered workload, pressure of time and the habit to place patients well being above their own as the main reason not to apply LTTs. The importance of applying LTTs however was recognized at a personal level, but knowingly neglected in the social context.
	User context	The game mechanics enables the user to set personal in-game goals and the dashboard offers peer comparison. Competition can be an effective way to influence both the user as the use context.
	Technology context	To promote transfer (of learning) the game is played on the workplace. The artifacts are designed to match users operational skills and knowledge. An example of this is the choice for the Kinect. This gesture sensing input device enables the player to control the game with body postures and gestures, without having any knowledge of how games work. Moreover, we regard the choice for a game as persuader and its design an important part of the technology context.
Strategy	Message	The persuadee voluntarily complies with the games rules and gradually learns about the set boundaries and limits of LLTs. These rules are the effectuation of the message: playing the game shapes and automates LLTs through behavioral inoculation.
	Route	The route at first is indirect. The system does not clarify its intent to teach LTTs, but presents itself as a game. If the route was more direct at this point, the game could be regarded as a training instrument and lose its persuasive character corollary. Mixed messages occur after involving in the game: the dashboard explains how in-game results correspond with LTTs and how progression is possible by adjusting in-game behavior. Direct messages are found in the eModule, containing tailored information and warnings of consequences of long-term inadequate usage of LTTs.

1.3.1 The persuasion context

The following section discusses the persuasion context of the iLift hBCSS. To understand the information processing event, Oinas-Kukkonen et al. [8] emphasize the importance of understanding the persuasion context. To understand and accommodate the complicated psychological events in a person's mind during persuasive communication, insight in the intent, the event and the strategy of the BCSS is needed. The intent deals with the persuader and the change type, the event addresses the contexts of use, user and technology. Finally, the strategy describes the message and the message route. Table 1 elaborates on the persuasion context addressed in this study.

The next step in persuasive system development or evaluation is, according to Oinas-Kukkonen et al. [8], to describe the persuasive systems design principles. Drawn from the work of Fogg [30], the set of design principles can be categorized in 4 support types, namely: primary task support, dialogue support, system credibility support and social support. The individual workings of the artifacts with their intended behavioral change types, outcomes and support types are further discussed in the sections below.

1.3.2 C-change: serious game

To reinforce compliance and offer a focus on the experience, a serious game is played. The nature of a game relates to the desired persuasive requirements of a BCSS. Design choices for the iLift game were designed with an eye for: (1) a specific transfer type (here transfer of learning is meant, not LTTs), and (2) players needs, abilities and socio-cultural aspects and (3) serious goals and topic characteristics [11]. Bogost [12] argues that video games hold unique persuasive power that prompts so-called procedural rhetorics, which he defined as being the art of persuasion through rule-based representation. Players are challenged to enact on rules and logics offered by gameplay by trying to structure and understand a playing experience. Kuipers et al. [21] link the desired persuasive nature of a game befitted for BCSSs to the players perceived conceptual continuity of the game, defined as congruence (of levels of) physical, functional and psychological fidelity [31]. iLift uses gameplay to trigger, shape and rehearse static LTTs in a metaphorical environment. The core principles, rules and logics of the benchmark [32] of static LTTs were translated into game elements. The iLift game experience is designed to trigger figural transfer [33] of LTTs by offering a series of carefully chosen and calibrated metaphors

(see Section 3.1.2.). The perpetuated persuasiveness of the game seeks for an enjoyable experience, designed to shape and refine the desired LTTs.

Persuasive system principles enabling primary task support within the game, are found in reduction, tunneling, simulation and rehearsal. The game simulates the postures and reaching movements that are common in static LTTs and reduces reality to a simplified environment. Within the iLift hBCSS the process of tunneling starts with a voluntarily entree, positioning the game as an autogenous technology [30]. Gradually the system provides the means to reflect on one's behavior and supports experiment towards target behavior. The game play continuously provokes physical action, enabling the user to rehearse and refine in-game behavior. Design principles in the game that enable dialogue support are praise, rewards and liking. The game offers rewards in points, immediate visual and auditory feedback on action. Design principles referring to elements of social support are competition (going for the high score) and recognition, because playing the game is often done in a social setting with colleagues. Table 2 shows the iLift game in terms of persuasive system principles and support types [8].

1.3.3 B-change: dashboard

An external dashboard is developed to explicate in-game events and biometrical data, and is designed to alter behavior towards the actual usage of lifting and transferring. This dashboard provides feedback on how in-game efforts translate to real life situations, including longitudinal inherent consequences like the increased chance of lower back problems. It supports social comparison by setting players achievements against efforts by peers. The game processes playing data to graphical and textual feedback. This feedback informs the player to what extent behavioral change (i.e. exercising) is needed. Furthermore, the dashboard can offer player specific tailored theoretical information (Section 3.2) triggered by in-game data, redirecting the player to an e-learning module. Achieved dashboard scores determine the tone of voice in texts, displayed references to sections of the e-learning module and the shown condition of your playing character. The combination of a different data presenting mode offers a thorough insight into own in-game behavior.

From a persuasive system design perspective [8], the dashboard employs elements of primary task support, like tailoring, personalization and self-monitoring.

The user is called by name, texts are tailored in conjunction with players performance and graphs show progress over the course of time. Performed dialogue support tasks are reminders, suggestions and (para)social role. A passport photograph of the player depicted as a robot is shown, attempting para-social relationship [34]. Reminders and suggestions come in short hinting and activating texts. For instance; "51 points is not a very good score. Try to comply to the feedback the game offers, somehow you're losing points during your play. Take a look at your graphs and find out in which ways you can alter your playing behavior. Try to consciously behave differently in the next gameplay session. Good luck!".

Social learning, social comparison, normative influence and competition are instigated by the visual information of the graphs. Not only the representing the player's score over time, but also by showing results of the other players achievements, instigating peer comparison. The picture of the avatar robot portrays a gradation of happiness calibrated with the dashboard as a normative influence, even displaying a short circuited robot with a broken back. Table 3 shows the iLift dashboard in terms of persuasive system principles and support types.

1.3.4 A-change: eModule

The e-module is the third artifact in the hBCSS, designated to form attitudes based on tailored and personal theoretical insights. Rooted in constructivist ideas on just-in-time learning, theoretical information only then is presented when a weighted and corrected dashboard score (see 3.2.1) requires so. Within their organizations nurses and caregivers are familiar in working within an e-learning environment. On-the-job training is facilitated by an extensive platform, hosting a variety of medical and safety related modules. The iLift hBCSS incorporates an e-learning platform known to players. The basic idea of using familiar technology as an e-learning environment at the end of the message route is based on inherent system qualities, respectively; trustworthiness, expertise, authority and verifiability. These system qualities contribute to the acceptance and perceived value of provided substantiating theoretical behavior underlayment. All of the above contributes to system credibility: the players are used to learning and being tested using the same platform as the eModule. The module Static Loads iLift is made by the same authors that wrote most modules on the platform and validated by domain experts. Primary task support is provided by personalizing and

Table 2. The iLift Game persuasive support types

	Primary task support	**Dialoque support**	**System credibility support**	**Social support**
Game	Reduction	Praise		Competition
	Tunneling	Rewards		Recognition
	Simulation	Liking		
	Rehearsal			

Table 3. The iLift Dashboard persuasive support types

	Primary task support	**Dialoque support**	**System credibility support**	**Social support**
Dashboard	Tailoring	Reminders		Social learning
	Personalization	Suggestion		Social comparison
	Self monitoring	(para)social role		Competition
	Rehearsal			

Table 4. The iLift eModule persuasive support types

	Primary task support	**Dialoque support**	**System credibility support**	**Social support**
eModule	Tailoring		Trustworthiness	Normative
	Personalization		Expertise	Influence
			Authority	
			Verifiability	

tailoring the information at an individual level: users are directed to designated parts within the module, befitting theoretical explicitation of dashboard concerns. The e-Module holds strong normative influence capacities due to an ofttimes admonishing character, placing an emphasis on the importance of the formation of attitudes towards longitudinal use of incorrect lifting and transfer behaviors. Table 4 shows the eModule in terms of persuasive system principles and support types.

2 Methods

The iLift hBCSS as described in this article, consists of three artifacts, all attempting to work in regard to different forms of change. The design science research approach (DSR) is described in Section 2.1. In 2.2 the preliminary studies evaluating and determining the use, user and technology context are described. Fig. 2 depicts an adapted version of the rapid prototyping ISD model [35]. Mapping our research methods on the corresponding phases of the model, gives an overview of the methodological approach. As illustrated in Fig. 2, we started with analysing the user context with focus groups. The data from the focus groups was analyzed and used as input for Scrum [36] sessions with occupational therapists, educational technologists and serious game designers. The focus of these iterations, shifted during the process accordingly to the non-linear steps as described by Simon [37], including ideation, prototype development and prototype selection. The prototype was evaluated in play test sessions with end-users, including an immersion study, again providing input for the design and development of the prototype. After each session, observational data and players feedback was analysed and led to a partial redesign or reconfiguration of the game. The final version of the prototype of the game, including the dashboard and eModule then were used in a field study.

2.1 Design research

The emphasis in the field of medical informatics lies in; improving the health of people through its contributions to high-quality efficient health care and to innovative research in biomedicine and related health and computer sciences [38]. Design Practice [39,40],[41] and Research through Design [42,43] contribute greatly to this aforementioned quality. Evaluation is a central component in conducting rigorous Design Science Research [44]. The DSR-approach

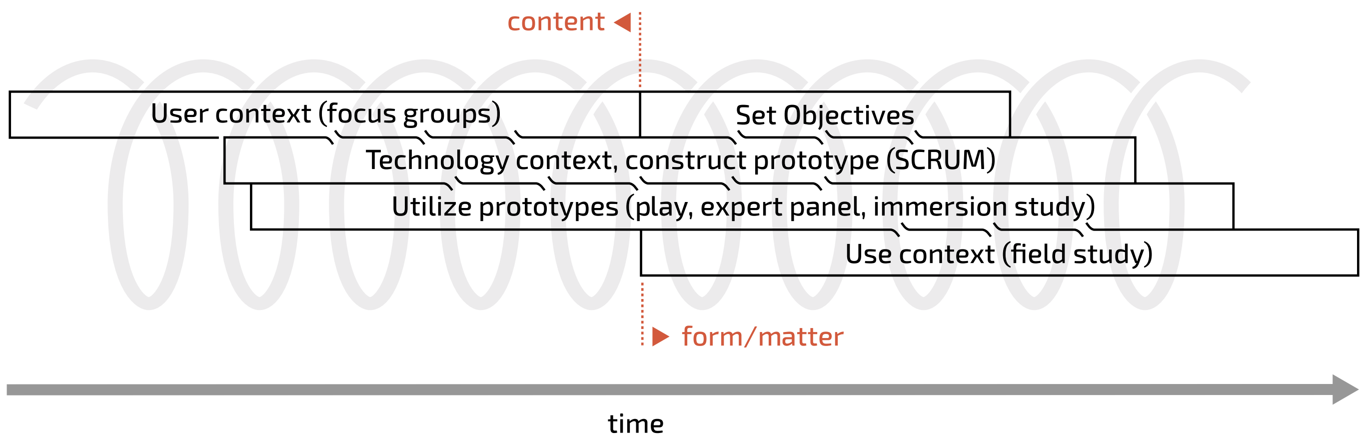
and guidelines offered by Hevner [45] was followed to attain rigor and relevance in the design cycle, as illustrated by Hevner [46] in Fig. 3. The centre of this figure depicts a design cycle, informed by building and analyzing design artifacts. DSR also addresses the need for real-life contextual understanding (cf. transfer in training [47]), distillate design patterns (Design patterns cf. [48] and testing (parts of) the prototype in situ (cf. Play as research [49]). Here Oinas-Kukkonen's notion of Use context corresponds with the environment as depicted in Fig. 3.

2.2 Preliminary studies

2.2.1 Use context: focus groups

Three homogeneous focus groups were conducted in order to inventorize peoples shared experiences. The main purpose during these sessions was to gather information on the cause and position of LTTs within their organisations. The three groups used were Occupational Therapists, Nurses and Caregivers. Two groups mentioned that the topic of LTTs had not been given sufficient attention or that it was found problematic that training and practical sessions had to be achieved outside working hours. The Occupational Therapists commented on

Fig. 2. Overview of our methodological approach. Adapted from Tripp & Bichelmeyer (1996).

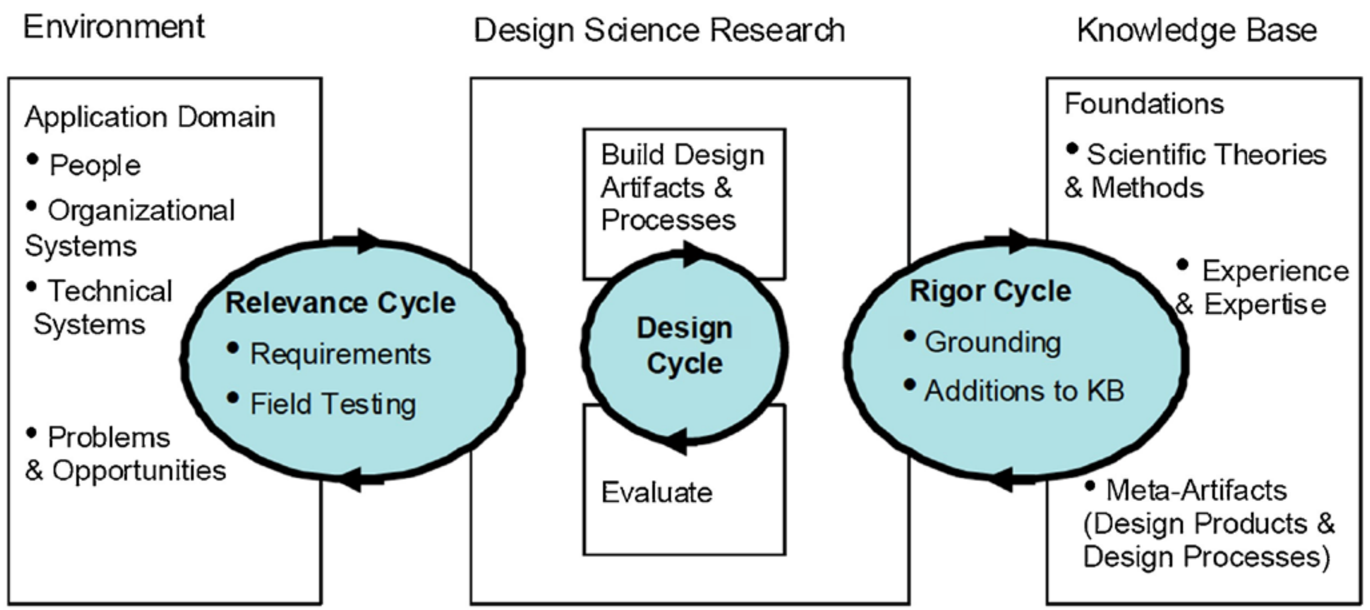


the fact that the lack of time and importance attached to the matter are part of the problem. Nurses and Caregivers however, do not descry a deficit of training of physical examination skills, nor a deficiency in knowledge of training in lifting and transfer techniques. All groups considered workload, pressure of time and a cultural determined need to place patients well being above their own as the main reason not to apply appropriate techniques when and where necessary.

2.2.2 User context: play research

A total of 10 nurses and caregivers were involved during the development of the first dome game. They were asked to play early versions of the game. Their feedback on the design of the game, game play, players perspective, auditory and visual feedback was gathered and led to adjustments of the game. At the end of the iterative development of the game, an immersion questionnaire was administered to 6 representatives of the target audience, followed by an inter-

Fig. 3. Hevner's [46] design science research cycles.



view. Since the persuasive character of the game has an important instigating function in the hBCSS as a whole, ascertained on the immersive and engaging qualities of the game had to be established.

2.2.3 User and technology context: expert panel

A preliminary prototype of Back Space was reviewed by an expert panel in lifting and transfer techniques. From the first iteration towards a playable prototype, one of the experts on LTTs was on the design team to make sure static LTTs were implemented correctly. Twelve healthcare practitioners were video-recorded whilst playing the game, without a brief about the proposed goal of the game. The recorded movements of players were analysed and compared to benchmark movements of healthcare practitioners. The authenticity and similarity to real-life lifting behavior was confirmed by the creators of the lifting thermometer. Their findings led to minor adjustments of the game to deal with players reaching activities that were a little too high and visual orientation on the screen instead on a bed causing the head position to be too upright. Movements were checked on authenticity of the LTTs conform to bed adjacent activities.

The iterative prototyping phase included several informal evaluations with occupational therapists, educational technologists and serious game designers. All the collected suggestions and comments contributed to greatly improve the prototype, leading to the serious game described in Section 3.1 in this paper.

2.3 Field study

The in this study developed hBCSS prototype, was evaluated at three different locations: hospital Medical Centre Leeuwarden, elderly care centre Noorderbreedte and care institute ZuidOostZorg. A total of 60 players were invited to play the game, all nursing professionals, caregivers and healthcare workers. Focus group results pointed out that lack of time was prompted a factor influencing the ill-performed LTTs in daily routine. Therefore we had to make sure the game was played on the workplace within working hours. Players themselves chose suitable time slots over a working day to play. Participants were informed about their dashboard results by email. Caregivers and nurse practitioners enrolled in the study, 36 female and 1 male. The hBCSS was deployed at three different organisations, of the 37 players 14 were employed by Medical Centre Leeuwarden, 17 by Noorderbreedte and

3 by ZuidOostZorg. Six iLift play sets were distributed over six locations of three participating care institutes and hospitals. After an introduction on the usage and purpose of the game, participants were instructed to play multiple sessions of the first dome game of iLift. Within a six week period an individual logged-in player ideally played 2 or 3 times a week, 3 rounds per sessions. For procedural guidance and substantive technical support members of the research team and development team were available.

3 Design of prototype

3.1 Serious game design

The serious game is designed for reinforcing compliance, as a catalyst in a BCSS developed for behavioral change towards the execution of transfer and lifting techniques in the workplace. The focus in this part of the study is on the design of the game itself, with a special interest in maintaining the inherent entertaining capacities of the medium in order to meet BCSSs persuasive demands. Here the main features of the game are summarized, additional video material can be found in the supplementary section.

3.1.1 Gameplay

The game introduces a female character called Emily. Emily travels on a hoverboard, floating inches above the ground (Fig. 4). Her journey starts in a pleasant mystery world, inviting her to discover how to operate her board by trying to follow rural paths through cosmic meadows. She will find herself in a dome-like world floating in space, with bridges over creeks, gardens and a little store (Fig. 5). Throughout the level she finds artifacts, worth some virtual money. In the store Emily can exchange her findings for upgrades and adjustments to her world, varying from waterfalls, alien trees, mushrooms and other ornaments. She also finds two long, winding roads leading out of the dome. Each of these roads lead to a smaller dome, hosting a sub level of the game, in which Emily can earn extra credits for sustaining her world. The first dome holds a game wherein Emily steps into a robot suit, specialised in capturing space sheep. In this smaller domes Emily's perspective changes to a first person view, showing both of her hands (Fig. 6). In order to catch sheep Emily has to reach out and apply dedicated moves to do so. The game provides visual and auditory feedback to guide the player into successful in-game behavior. The space sheep appear randomly on a grid, divided in three zones. Catching a sheep in the green

area results in three points, the yellow zone grants two points and a sheep from the red zone leads to one point. Stepping sideways to get to sheep on the outer corners of the grid is rewarded over spinal shear and torsional loads. Abrupt gestures will scare sheep and make them move backwards on the grid, into the red zone, making them harder to catch. With bending over, a gauge, placed on the top left corner of the screen, mimics the actual bend angle of the player whilst reaching out for sheep. An auditory signal, which bears strong resemblance to a car parking assist system, provides the player with feedback on the depth and length of the bow, made from the waist. The game carefully registers the duration and angle of the inclination of the upper body, responding with corresponding feedback. Crossing safety boundaries will result in a life loss event. Each session grants the player three lives, but the game actively scaffolds the players behavior to avoid precarious situations. Several real life issues regarding static LTTs at the actual working by the bedside are metaphorical re-contextualised in this part of game, providing a playful reason to perform the desired techniques in a controlled and pleasurable fashion. In the second dome Emily has to lift a big water barrel to fuel a water cannon. Here dynamic LTTs are necessary to play the game (Fig. 7). The game interface provides visual clues on how to apply the correct technique to lift the barrel. The more accurate this technique is executed, the more water is preserved for Emily's next task: watering and growing extraterrestrial fruits. Again from a first person perspective, the water cannon is operated. Aiming at a garden below, Emily shoots water beams to make seeds germinate. Concise shots make the plants grow and eventually bear fruit. When ready, Emily can go to the garden below and harvest her space fruit. Because the fruits grows on various heights on the plants, again Emily is challenged to apply befitting LTTs or use an assisting device when needed. Operating the water cannon, lifting the water barrel and harvesting fruit all mimic meticulously actual dynamic LTTs. The game mechanics scaffold the players ingame behavior: dynamic LTTs are re-contextualised and repurposed in a game context.

3.1.2 Used metaphors

Here the design of the game within the first dome is discussed, since this part was the main object of the field test. The serious part in serious games was implemented by metaphorical re-contextualisation, supported by theory on figural transfer (of learning).

The shape of the grid in first dome game reminds of a bed, demarcated by fences as foot and headboard.

The three-colour area of play corresponds with the theoretical benchmark of static LTTs, all characteristics that are conditional for mimicking the actual working along the bedside, showing high physical fidelity. Here the hBCSS is designed to reinforce compliance, so the actuated and repeatedly triggered physical in-game behavior needs to be meticulously accurate in comparison to desired real life performance. User group preferences are addressed in the actual task itself: taking care of animals has kinship with players daily routine in terms of care. Making abrupt gestures or reaching too hastily for sheep scares them away, hinting at perceived patient's discomfort when being lifted and or transferred rashly. A life-loss event is triggered when in-game limit-overstepping behavior takes place, set off by a combination of a performed forward bending angle and bending time. The spine of the robot represents the player's back and will show damage, debris and smoke after a life-loss. After three encroachments the spine of the robot will be broken and the session ends.

3.1.3 In-game score

The game score is comprised of the following formula: $x0 = g3 + y2 + r$. Catching a sheep in the green (g) area results in three points, sheep from the yellow (y) zone grants two points and a sheep from the red (r) area one point. Crossing the boundaries for spinal shear and torsional load results in life loss and ends the game session after the third loss.

3.2 Dashboard

A dedicated online dashboard presents and calculates an individual dashboard score by the use of the player's game score, using input from an online database connected to the back-end of the game (Fig. 8). Specific data on player in-game behavior is extracted from the game and stored in a local database as part of the back-end of the iLift game configuration. The iLift dashboard shows the player a corrected game score, entailing individual achievements and specific occurrences during game play. These key components are derived from existing LTTs, and integrated in the iLift game. The dashboard score can take on values from 0 to 100, where 100 equals exemplary in-game behavior, analogous to adequate LTTs and 0 refers to a destructive playing style. Pushing the limits may result in higher game

Fig. 4. Emily on her hoverboard visits the store.

Fig. 5. Overview of back spaces customizable dome world.

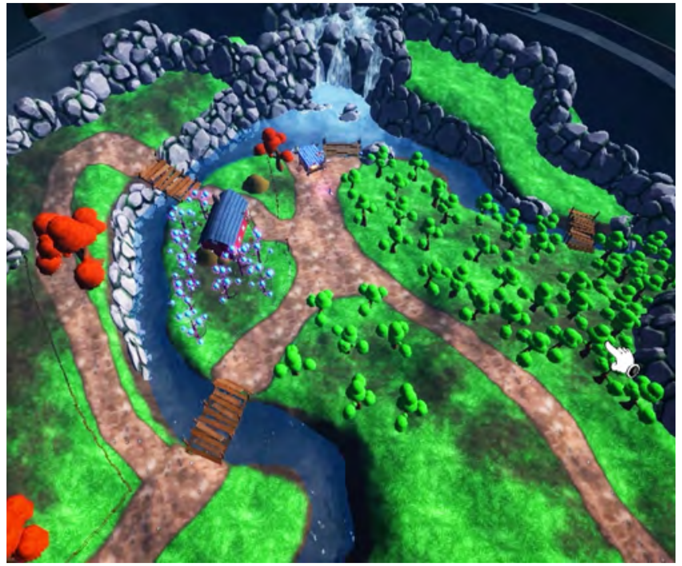


Fig. 6. Emily trying to catch space sheep.

Fig. 7. Applying dynamic LTTs in the second dome world.

scores, but the dashboard formula corrects for adverse strategies by deducting points. In order to calculate dashboard score; (x1) player's game score (x0) gets corrected on four variables: bend time (b), number of life loss events (l), the colors of the caught sheep (g,y,r) and the number of scared sheep (s). The bend time is the number of seconds that the player has exceeded the safety boundaries. Exceeding the safety boundaries for 12 s or more during a game session results in a maximum deduction of 30% of the player's game score, based on Knibbe [32] a score between 0 and 12 s results in a deduction of 0 to 30% of the player's game score. Each life lost event results in a deduction of 15% of the player's game score, with a maximum of 30%, a third life lost event ends the game session and results in a termination of the player's score. The number of picked up yellow and red sheep also leads to a correction of the player's game score, which can rise up to 30% deduction, if only red sheep are caught

Fig. 8. The Dashboard, as presented to players.

$$\left(1 - 0.3\,\frac{b}{12} - 0.3\,\frac{\ell}{12} - 0.3\,\frac{3s_y}{s_g + 3s_y + 5s_r} - 0.6\,\frac{5s_r}{s_g + 3s_y + 5s_r} - 0.1\,\frac{s_x}{8}\right) x \qquad (1)$$

in one session. For yellow sheep applies a ratio of 3:5 on red sheep, only yellow sheep caught in a game session would lead to a deduction of 18% of the player's game score. In the formula the proportionally number of yellow and red sheep caught in relation to the number green sheep caught are calculated to get the appropriate correction. Finally, a correction is made on the number of scared sheep. This correction is a deduction of up to 10% on the players total score at 8 scared sheep or more. A score between 0 and 8 leads to a correction of 0 to 10% deduction on the player's game score.

3.2.1 Dashboard score

The dashboard score as is a corrected, non-standardized game score;

The deducting variables that determine the dashboard score are:

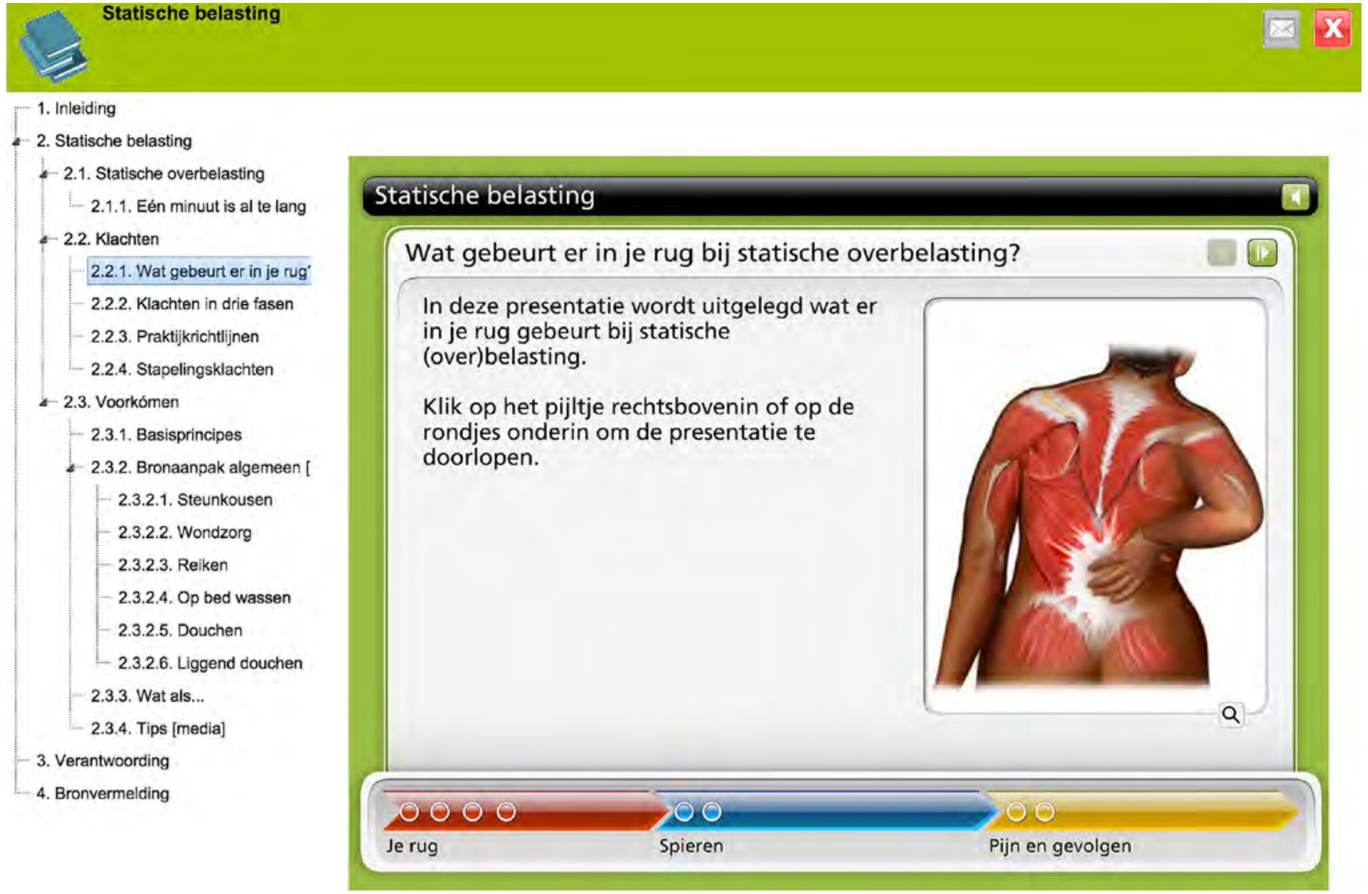
b = bend time in seconds, $0 \le b \le 12$,
l = life loss in occurrences, $0 \le l \le 2$,
g = (green sheep caught),
y = (yellow sheep caught),
r = (red sheep caught),
s = (scared sheep in occurrences $0 \le s \le 8$)

3.3 eModule

At the end of the message route the eModule is positioned for added system credibility support and placing emphasis on the importance of the need for new attitudes towards LTTs (Fig. 9). This resonates with certain key issues behind persuasive systems, as postulated by Oinas-Kukkonen [6]. The eModule offers a direct route of persuasion, next to the indirect route the game facilitates. This part of the hBCSS also aims at unobtrusiveness: the eModule leaves no doubt on the intentions of the system as a whole. Only when the C-change (game) and B-change (dashboard) does not result in observable improved in-game behavior the user will encounter the eModule.

The module holds information on several key topics regarding static LTTs. It covers topics like: what is static lifting, when static loads are overburdened, effects of spinal torsion and reaching on intervertebral discs, recognise symptoms of static load lifting problems in an early stage, guidelines on static LTTs, active knowledge on preventing lower back problems and understanding

Fig. 9. The iLift hBCSS eModule.



that spinal torsion in combination with bend angles form significant risks. The module exists of cases, presentations, questionnaires, illustrations, animations and tests.

4 Evaluation of prototype

4.1 Experimental design

In three different healthcare organisations, participants were asked to partake in the experiment by their local primus inter pares to play the game multiple times during the period of 3 weeks. As described in Sections 3.1.3 In-game score, 3.2.1 Dashboard score the game score and the dashboard score differ in their respective composition and behavior change goals. The experimental design of the study is to compare and contrast the interaction between these two types of game-scores. How is the game score, which can be high without inducing the desired lifting techniques, with the dashboard-score which gets higher based on the correct lifting behaviors of the players.

4.1.1 Procedures

Participants were asked to fill in their name on a consent form and sketch to take place in front of the play set. After a once-only instruction on the workings of the game, the participants logged in with upfront provided account credentials, using a mouse and keyboard. The participants used hand gestures to start the game. The game then was played for 3 min, 3 times in a row, for 2 or 3 times a week. After each play session the in-game score was shown and the player logs out. Mostly the participants played in groups. The game gathered all biometric data per player per session and stored it in a database. Each week the system sends the data of all players to the dashboard server. The dashboard server interprets the data per player and presents it to the player in an online environment, which can be assessed online by the player using the same account credentials used for logging in the game.

4.1.2 Apparatus

Back Space uses a Microsoft Kinect [50] gesture sensing input device to enable the player to control the game with body postures and gestures. The Kinect is connected to a personal computer, running Windows 7. Every tenth of a second a plurality of gestures and movements are stored after every session in a relational database hosted on the computer, providing immediate feedback on game play. Once a week all player sessions are sent via an online connection to the dashboard server. A 40 inch 1080p Samsung LE40 widescreen monitor is mounted on a movable carriage together with the personal computer, the Kinect sensor and a audio set. Back Space was developed using the Unity game engine, Microsoft Visual c++. Modeling was done using Autodesk 3ds Max. Participants viewed the display from a distance of approximately 2.5 m, dependable on the mounting angle of the Kinect.

4.1.3 Measurements

In-game-score (cf. 3.1.3) and dashboard-score (cf. 3.2.1) were used as main measures.

4.1.4 Data analysis

SPSS 22.0 was used to perform a linear regression analysis to analyze the growth and predictive factors through the amount of sessions for both the game score and dashboard scores. A one-way ANOVA were performed on both the dashboard score and game score to compare the categorized amount of sessions (1–10, 10–20, 21+).

4.2 Results

4.2.1 Game and dashboard scores

The 37 participants played the game in a range between 3 and 54 sessions, scoring between 0 and 229 points (M = 75.9, SD = 35.16) on the game score, between 0–144 (M = 52.22, SD = 11.34) on the dashboard score. A total of 620 play sessions were performed by 37 players.

4.2.2 Session-based analysis

A linear regression was performed to analyse the predictive values of the amount of session on game score and dashboard score. Amount of sessions played significantly predicted the game score, b = .108t(618) = 23.87, $p < .001$. Amount of sessions played also explained a significant proportion of variance of the game score, $R2 = .178$, $F(1, 618) = 134.01$, $p < .001$. Amount of sessions played also significantly predicted the dashboard score, b = .108t(618) = 11.053, $p < .001$. Amount of sessions played also explained a significant proportion of variance of the dashboard score, $R2 = .165$, $F(1, 618) = 121.68$, $p < .001$.

4.2.3 Group-based comparison

The participants were divided into 3 session-based clustered groups based on the amount of game sessions (1-10 session(n = 16), 11-20(n = 10) session and 20+ (n = 11)). There was a significant main effect found between these groups on the in-game score ($F(2, 34) = 4.77$, $p = .015$)) and Dashboard Score ($F(2, 34) = 4.26$, $p = .022$). A LSD post-hoc test revealed that the 1-10 group scored statistically significantly lower on the game score than the 11-20 (M = 27.59 ; SD = 12.49, p = 0.04) and 20+ group (M =

36.20 ; SD = 12.52, p = 0.007). A LSD post-hoc test revealed that the 1-10 group scored statistically significantly lower on the dashboard-score than the 11-20 (M = 24.05 ; SD11.50, p = 0.044) and 20+ group (M = 30.15; SD = 11.17, p = 0.011).

5 Discussion

The main focus of this study was to build and discover how and if a serious games persuasive capacities can be used in a hBCSS for LTTs. In this section we first discuss the results that indicate the persuasive effects of the game. Second, we relate these effects to the specific design choices made in the manufactured artifacts. Third, we discuss how implementation issues affected the uptake of the hBCSS in the organisation. Games for health are often placed in skills-labs, away from the influence of daily work routines. This project offers an opportunity to the field of nurse practitioners in the way that feedback and clear goals are presented to them in real time, giving rich feedback that otherwise is presented in a less engaging and immersive form.

5.1 Using a game to reinforce compliance

Regression analysis, reported in Section 4.2.2, shows that the number of sessions a person plays the game is a significant predictor of higher game scores and dashboard scores. For the design of the game this means that the game succeeded in allowing players to engage and persist in playing the game for at least 54 sessions (maximum sessions played). Important to the game artifact is that the repeatedly encouraged in-game movements adequately mimic the actual LTTs performed in the workplace. The expert panel validation described in Section 2.2.3 affirmed that the first dome game accurately captures the static LTTs. This makes in-game activities genuine static LTTs. Therefore, the increase of game scores results in the desired increase in training outcome: progression in the game can only be achieved with complying to desired behavior. Although we involved the end-users throughout the design process holding roles as testers, users and informants, the autogenous intent of the game alone might not be enough to become a part of day-to-day routine. This may imply that current practices of LTTs can not be changed by persuasion that focuses on LTTs themselves, but that persuasion should target the culture of neglecting one's own well being.

5.2 Changing behavior with a dashboard

The scores on the weighted dashboard scale are indicators of conscience in-game static LTTs related behavior. A positive effect in dashboard scores points out decreasing score deduction by key indicators of unwanted in-game behavior, meaning in-game behavior evolves towards benchmark performance. In Section 4.2.2 we compared the game score and the dashboard score set against the number of play sessions. Players with less than 10 sessions, scored significantly lower on the dashboard compared to the game score. This indicates that early play sessions triggered more incorrect LTTs behavior, causing score deduction. From 10 session and up, the dashboard score aligned with the game scores as they got higher, meaning that the game scores are achieved within set boundaries. The scaffolding mechanisms of the game and the behavioral influence of the dashboard feedback led to the alignment of both score types, making the dashboard score an embedded assessment of game behavior. The LSD post-hoc test revealed changed behavior to achieve better in-game performance. Although presented research data seems promising, this study can not claim that the registered behavioral changes can solely be addressed to users consulting the dashboard, since empirical basis is limited and a more rigorous research design is needed to make such claims.

5.3 Forming attitudes with an eModule

Aforementioned statistical data affirms the games capacity to act out as a tool for training with behavior shaping qualities. The dashboard score proves a valid indicator of behavioral change and monitors the soundness of the way growth in game scores is achieved. We found during this study that an A-change might be the intent needed to have impact on the daily working routines. Existing methods for learning and training LTTs did not lead to such an effect and it is it unlikely that the eModule alone, as positioned within the iLift architecture, will be able to do so. Due to project limitations the influence of the eModule on the formation of new attitudes were not covered in this study.

6 Limitations

As focus groups made clear in preliminary studies, other factors than a lack of knowledge were causes of leniency in performing desired LTTs in daily work routines. Circumstantial aspects like workload, time-pressure and cultural habits are also primary causes. Those outcomes befitted the iLifts project goals and led to forthcoming design choices, including the inclination towards a serious game as a possible solution. One could argue that the persuasive design elements were developed in full concertation with end users and LTTs professionals. On the other hand, the question whether care professionals in general were willing to engage in game-based-learning, was not addressed: the project dictated a game should fill the design gap. This may have caused an underrepresentation of care professionals with a more sceptical attitude towards the project, although there are studies that report opposite findings [17]. A weakness in the research approach was that the employees enrolled in the field test were not properly instructed concerning the aim of the game. Here the 5th postulate [8] that states that persuasive systems should always be open might be of influence: unintentionally we did not reveal the designer bias behind the game of the hBCSS. The use of a game within the hBCSS as a tool for learning was foreign to the target audience, and therefore not easily accepted. The fact that the game ostensibly dealt with LTTs was not recognized by some players and undermined the will to participate in the field test. A final assignable cause of subject dropout was due to an outbreak of the highly contagious Norovirus, causing severe delay in available playing time during the six week field test period in one of the participating nursing homes. Although requested upfront, in two cases the appointed locations for playing the game were not equipped with an internet connection, causing the game not to work. After developing the prototype the briefing and introduction of the game was given by the development team. The implementation and deployment of the hBCSS was executed by the involved care homes and hospitals. In retrospect, we noticed that the recruitment of participants and the deployment during the test period of the hBCSS in the use context did not meet the BCSSs demand that persuasion cannot be coercive. Where participation should be an action of one's own volition, users were assigned by the organisations, limiting user autonomy [14,51,52]. Rather divergent from daily routines, employees were instructed to play the game during working hours. Earlier mentioned cultural aspects made

it for some participants hard to accept that time spent playing a game might disadvantage clients and patients. For a full understanding of the capacity of the iLift hBCSS, the design should be evaluated and incrementally developed towards social system acceptance and a shared mental understanding of the chosen approach.
It is an open question to what extend the findings of our study can be generalized to similar contexts, mainly because the field test results were never translated into new design parameters because of limited project resources. A final remark has to be made about the reach of this study. The evaluative elements as described, deal with measuring the effects of the iterations. The field test has to be seen as a first iteration with the hBCSS in the social context. In Section 7 we draw several conclusions from this field test, but we also learned that the design of the hBCSS itself as well as the social system are in need of further development. In this stage of the process it is too soon to make statements concerning the effectiveness of the system as a whole or the long-term effects of this intervention.

7 Conclusion

In this study we developed a serious game for LTTs. We sought after designing the game in conjunction with the design principles of persuasive system design and deploying its inherent autogenous character. We succeeded in developing a game that persuades end-users in complying to the game's rules and were able to influence behaviors towards better LTTs. By using metaphorical re-contextualisation we developed a serious game that was persuasive and enjoyable to play whilst preserving serious intent. This design principle seems domain-independent and can be applied in other contexts outside healthcare. We found that in healthcare using a game as persuader in a hBCSS can be effective, but only then when the designer bias is made clear upfront. Furthermore, we conclude that when designing a persuasive system for healthcare, cultural aspects (the use context) form a rigorous influence that has to be reckoned with, especially in regard to technology acceptance.

8 Recommendations and future work

One of the observations of this study is that care professionals foster the culture of prioritizing patients' health and comfort and in the process tending to neglect one's own well-being. This implies that current practices of transfer and lifting cannot be changed by persuasion that merely fo cuses on the practices themselves. The iLift hBCSS showed promising results in utilizing C-change and B-change, but the field test revealed a necessity for A-change. To make claims about effects of the iLift hBCSS, our next step in the research will be evaluating the system in full with nurse practitioner students, leaving out the social system barriers as described. We found an in-game learning effect, but there are still some significant issues to overcome for this hBCSS intervention to have a bigger impact. Future work will include a new experiment amongst nursing practitioner students with the game and dashboard, with the sole purpose of measuring adapted behaviors outside the hBCSS environment.

Author contributions

DK and BD conceived and obtained funding for the research project that includes the described study. BD designed the preliminary trails, handled recruitment of participants and contributed to the organisation of the study. DK contributed to the design of the game artifact. BD and GT build the dashboard formula. BW and GT analysed the data. DK and BW drafted the manuscript, JV, HD, JP and JPP contributed to its revision.

Conflict of interest

No author has conflicts of interest.

Summary points

What is already known

1. Existing lifting and transfer techniques (LTTs) training programs appear to be ineffective since 70% of caregivers and nursing professionals report lower back problems.
2. Video games harvest systemic and motivational affordances that encompass persuasive elements closely related to design principles for BCSS design.
3. In health studies, the actual workings of BCSSs as well as serious games are often regarded as black boxes.

What this study added to our knowledge

1. Serious games can be effectively used as part of a hBCSS to reinforce compliance and alter behavior through behavioral inoculation, leading to significant increase of correct LTTs in ingame behavior.
2. Metaphorical recontextualisation can be used to design a serious game that preserves its persuasive capacities and performs as an embedded assessment of correct static LTTs, facilitating C-change and B-change.
3. In the design for A-change, user autonomy to partake in the hBCSS and its contextual design pertaining to the social system in place, seems essential. The autogenous intent of a serious game within a hBCSS needs to be balanced with additional components that reveal the designer bias, enabling other types of change.

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Appendix A

Supplementary Data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ijmedinf.2015.12.006

(The QR-code below can be scanned to obtain direct access to the URL)

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Valiant Hearts: The Great War (2014)

Valiant Hearts: The Great War is the story of 4 crossed destinies and a broken love in a world torn apart. Dive into a 2D animated comic book adventure, mixing exploration, action and puzzles. Lost in the middle of the trenches, play as each of the 4 strangers, relive the War and help a young German.

H5: Mobile Adaptive Therapeutic Tool In psycho-Education (M.A.T.T.I.E.).

Design principles for a persuasive application tailor-made for adolescents with a mild intellectual disability

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Abstract

This paper introduces the conceptualization and development of an assistive technology focussing on social problem-solving skills, as an addition to the field of psycho-education. This assistive technology in the form of an application goes by the name of MATTIE, Dutch slang for 'friend' and an abbreviation for Mobile Adaptive Therapeutic Tool In psycho-Education. MATTIE was tailor-made and befitting for adolescents with a mild intellectual disability and their therapists. The application introduces a simulated facetime call by an actor that is in a social predicament wherein social decision-making is warranted. The patient is asked to advise in the presented dilemma, making a decision and is afterward confronted with the outcome. Important design choices in the workings of the application are the choice of actors alike the target audience enhancing the parasocial interaction, the presentation of cases outside of the therapeutic setting, empowerment, and self-efficacy of the patient through role reversal and an answering system befitting the information processing of the target audience. Furthermore, it gives therapists the opportunity to have valuable input for their sessions and an adaptive system that gives them the control over the cases that are presented to the patient, thus picking the content befitting the specific needs of the patient.

Keywords

Mobile-assisted Learning; Mild Intellectual Disability; Psycho-Education; Parasocial interaction, Persuasive Technology; Social adjustment; Self-efficacy; Social Innovation; Transfer

Background

In the Netherlands, a Mild Intellectual Disability (MID) is defined as an IQ between 50 and 85 and limitations in social adaptability [1]. One of the main differences between these adolescents with the general population is the way in which they encode and process social situations; i.e. social information processing [2]. The limitations within the social information-processing manifest in low inhibition and sensitivity as well as vulnerability towards portraying anti-social behavior [3]. Several studies [4,5,6,7,8] suggest that behavioral problems of adolescents with average intelligence are related to their social problem-solving skills. Furthermore, adolescents with learning problems display a shortage in alternative solutions to social problems [9]. This is confirmed through the attitudes towards social limits [10,11] of adolescents with a Mild Intellectual Disability. The social limits are defined as four response patterns

to social dilemmas; Adjustment, Limit-overstepping, Bargaining, and Withdrawal. In a social conflict, adolescents with MID show a bias towards using the full range of response patterns resulting in the prevalence of the choice for either limit-overstepping or withdrawal. Problems in social adjustment are further exasperated by difficulty in generalizing learned skills and concepts [12] problems with theory of mind or perspective taking [13,14,15,16], i.e. the ability to see the world through the eyes of someone else. These limited social cognitive skills combined with a multitude of social contexts, lead to a contextual problem, i.e., using the social decision making that fits the specific social context or situation.

The current form of therapy that amongst other subjects encompasses this is psycho-education. Bäuml and Pitschel-Walz defined psycho-education as 'systematic, structured, didactic information on the illness and its treatment, including integrating emotional aspects in order to enable patients – as well as family members – to cope with the illness', in this case, MID [17]. The effect of psycho-education on the population with MID is relatively unknown [12] mixed effects were found [18,19].

In studying existing psycho-educational material the appearance of the materials do not differ from conventional methods in regular education and therefore the effect can presumably largely be attributed to the skills of the person conveying that message, rather than the material itself. The form in which psychoeducation currently takes place also seem to deviate from the six key principles found by De Wit et al. [12] leading to a successful intervention for the target audience;

1. Extensive assessment
2. Adapt to their level of communication
3. Make the practice or exercise material concrete
4. Structure and simplify
5. Social network and generalization of skills
6. Create a safe and positive learning environment

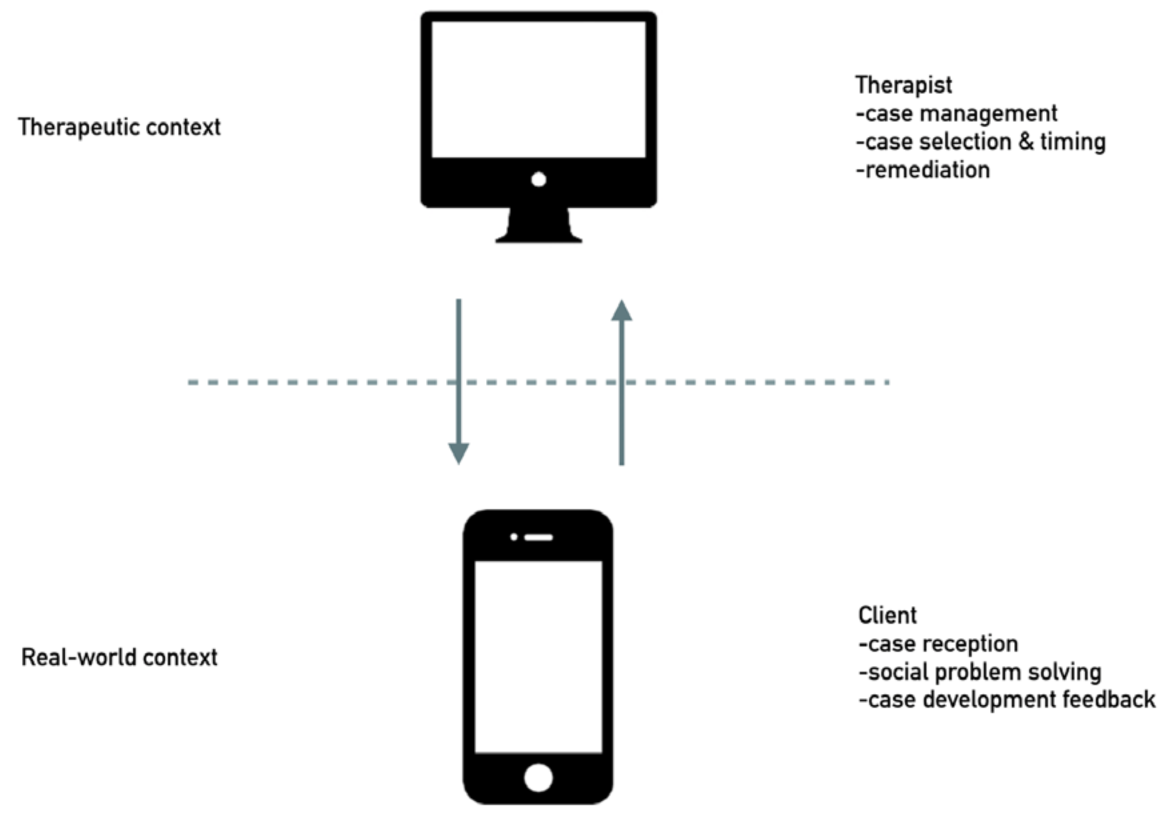
The specific needs of adolescents with MID legislates reaching out for alternate approaches, especially on the terrain of appearance and transfer. The role of the therapists and the way and form psycho-educational content is brought across largely determines the way in which it will be perceived.

To fully utilize the strengths of the patient as well as the therapist, serious media can play an instrumental role and transform the healthcare setting through social innovation. This paper presents the design process of an application, designed to aid the resolve to conflicts in social situations experienced by adolescents with a Mild Intellectual Disability, from this point on referred to as the patient, and the remediation of their social adaptability by their therapists.

The Mobile Adaptive Therapeutic Tool In psycho-Education (MATTIE) is a mobile application hosting videos with short, realistic cases with topics familiar to adolescents, dealing with social situations which require social problem-solving skills. These social situations are recontextualized in separate cases, presented as facetime calls. Each video is played out by an actor with strong similarity to the patients. After presenting a social dilemma, two possible solutions are suggested by the avatar. These options are two out of four optional response patterns to social dilemmas [10,11]. To strengthen and reinforce the social adaptability of the patient; a) the application gives feedback on the outcome of the decision made for the virtual character and; b) the therapist reiterates the decision making process and the motivations behind it at a later time. A back-end database system, operated from the therapeutic setting by the therapist, gives control over the timing and the content of the video cases presented to the patient, giving the therapist access to the patients decision making outside the therapeutic setting. The therapist is able to prompt a case with specific content on a desired moment in time to the mobile device via MATTIE to the patient. Cases can be selected by theme or optional social response patterns. Carefully selected and well-timed cases form a psycho-educational stimulus, triggers self-awareness, places relevant topics top-of-mind and create a precedent for transfer to take place. This makes MATTIE a powerful instrument to intervene in place and time in the real-world context of the patient.

As a starting point, the functional triad [20] was used in thinking about the use and application of persuasive technology. Persuasive technology is defined as technology that is designed to change attitudes or behaviors of the users through persuasion and social influence. Fogg [21] mentioned three layers of persuasive principles that can be embedded in interactive technologies: tools, medium and social actors. They form a functional triad in media technology, each or all-together triggering basic ways that people respond to computing technologies. As a tool, media can make it easier to realize

Figure 1: Schematic overview of the procedural application flow of MATTIE.



certain behavior, e.g., by offering structure or guidance in decision-making. Functioning as media, interactive technologies can use both interactivity and narrative to create persuasive experiences that support rehearsing a behavior, empathizing or exploring causal relationships. Finally, interactive technologies can function as a social actor, cueing social responses through their use of language, assumption of established social roles or even physical presence.

Because MATTIE is an application that was tailor-made for the target audience and their therapists, design choices based on several theoretical constructs were made.

Design Choice 1: Design for Transfer

Traditionally, transfer of learning [22,23] is often defined as applying what one has learned in one situation to another situation. Unusual and unwanted disruptive behavior in terms of choices, aptitudes or interests, often occurs away from the therapeutic environment. Thinking about transfer issues, the ideas on influencing the patient in a real-world setting seems promising. Using modern mobile technology makes it possible to position the psycho-educational content from the therapeutic setting into the real world, placing it right there where you want it to come into effect. Regarding the mental capabilities of the patient a low-road transfer [24] variance is in place. One of the key issues in learning is the difficulty the patient encounters when being in complex social situations involving decision-making and applies lessons learned from an earlier context into a new one. We try to bridge this transfer problem by instigating a near transfer approach by design, whereby it's crucial to be spot on regarding tone of voice, design, and content since the intervention takes place in their world. Authenticity and realism seem key in this interaction, so a strong focus on design seems just. Design choices have to be made carefully and be serving to transfer.

Design Choice 2: Creating Parasocial Interaction

The form and way in which a message is presented largely determine the way in which it will be perceived. In case of a particular target audience, the form should also amend to the specific social information processing of people with MID. An important issue in the design of MATTIE was to ensure and optimize parasocial interaction [25]; the social interaction and potential for bonding between media user (patient) and media figure (virtual character). By introducing video cases, showing non-abstract, real characters in a way an actual facetime call would appear on a mobile device, abstractions that would forego the mental capabilities of the adolescents with MID are averted. Thereby MATTIE is able to avoid any hint of a psycho-educational instrument, instigating parasocial interaction (PSI). Providing an indubitable relation between the MID and MATTIE maximizes authentic and uninhibited responding. Finally, trustingly providing the adolescents with a modern mobile device generates an easy commitment.

Design Choice 3: Empowerment & Self-efficacy through Role Reversal

Since MATTIE enters the realm of the patient; some precaution has to be taken into account. One of the most important factors is the establishment of the aforementioned PSI. As a token of respect and being deliberately modest about the influence MATTIE claims to have in the non-therapeutic setting, a non-directive and casual delivery system is needed. To make the mobile intervention valuable and authentic at the same time, the patient is hailed for help, instead of telling the patient what to do or not to do in specific situations. This is a role reversal from the established order in the therapeutic environment where the patient is the advisee instead of the adviser. This naturally empowers the patient, placing emphasis on the value of the patients' capabilities and trust in one's competence to give just advice. This empowerment will hypothetically influence the belief of the patient in his or her own ability to succeed in specific situations, enhancing the patients' self-efficacy [26]. Furthermore, the role reversal naturally forces perspective taking and leaves room for experimentation in self-representation, without any "real" consequences. The video call shows a boy or a girl of similar age, background and social status, with whom the patient identifies and who is likely to influence the person's beliefs and behavior. Every presented case sketches a realistic dilemma, always ending with this one, same question: what would you do?

Design Choice 4: Feedback and Remediation

When the patient makes a choice in assistance to the media figure on film, it is deemed important that the potential consequences of that advice are revealed. Case development feedback is presented in a short video fragment, simulating the outcome of the case-bound advice followed by the avatar. Depending on the case, feedback appears realistically timed within minutes or even hours after the advice given. Confronting the patient with consequences of the advice provides a natural and value-free stimulus for rethinking the case and the patients' role herein. In the real-world context the patient experiences control over situations, freedom in social decision-making, wherein the therapeutic context offers a safe environment for evaluating outcomes with therapists. By remediating the processed social decisions, retrieving details on the context they were made in and seeking after social cues to increase self-efficacy of the patient, the therapist can use MATTIE as an effective therapeutic tool, offering new leads for psycho-education.

Design Choice 5: Use of MATTIE outside of the Therapeutic setting

Though a person's cognitive limitations have a large part in decision making, the environment wherein a person is when making a decision also influences the decision making, i.e. bounded rationality [27,28]. The therapeutic setting is a structured, relatively safe, environment wherein the patient is free from the temptations of the outside world. The outside world is often; a) unstructured, because relatives often have the same mild intellectual disability and; b) unsafe, because peers can easily coerce the patient to display antisocial behavior. This disconnect between the therapeutic environment and the outside world leads to social desirable answers in the therapeutic setting that are not necessarily a reflection of the behavior in the real-world context. Therefore MATTIE prompts and presents its cases in the real world context inoculating response patterns that deviate from the social desirable answers given in the safe and structured therapeutic environment. This gives therapists the opportunity to go beyond the given response patterns and use the situation the patient was in whilst he or she was responding in the therapeutic session. Prompting cases in the real-world context thereby provides therapist useful insights in the social response patterns outside of the therapeutic setting.

Preliminary Results

A small trial was conducted with the prototype of the application. The patients (n=8) were given a mobile device (iPod) with the MATTIE application readily installed. Each of them signed a waiver, promising to take care of the mobile device, solely use it for MATTIE and returning it after a week. Upfront the therapists (n=5) supported by the development team, programmed the cases using the back-end database system, adjusted to the patient's agenda for a week. After a week non-directive interviews were conducted with the patients and the therapists. From both parties, the first findings were promising at least. The patients were sorry to hand in the device in the first place. More important was the collective notion of experienced bonding to the avatar. In different ways, the patients mentioned an active engagement with the presented dilemmas and a curiosity about the well-being and outcome of the cases. One patient spoke about amity towards the avatar. The test group seemed without exception positive about carrying the mobile device, knowingly a simulated call could emerge. Three mentions were made about a sensation of restlessness when waiting for a new case to be prompted.

The therapists were clear in their findings: MATTIE bridges a gap between the patients' world and the therapeutic environment. In particular, the willingness of their patients to talk about the presented cases and the effects of given advice stood out. The real value was found in the acquired leverage to make personal topics discussable through the video cases.

Discussion

With the heretofore-mentioned characteristics of the target audience in mind, a series of desirable specifications for the multimedia application was put together, based on the current state of the literature on mild intellectual disability and educational technology. Persuasive design was used to attempt to create an intervention that is tailor-made assistive technology for the target audience as well as an adaptive therapeutic tool for the therapist. The application was designed to foster transfer, PSI as well as enhance self-efficacy and empowerment through role reversal and experimentation in self-representation. The result was a product that is a serious therapeutic; i.e. an application that operates on a trade-off between control of parameters by the therapist whilst acting as an assistive aid for the patient. Preliminary results are promising but further research is needed.

Future Work

Novelty provides the initial motivation for the target group to engage with MATTIE. Since they use the mobile tool in their own time and space, it's important to think about therapy adherence and establishing a sustainable parasocial relationship. Gamification uses the engaging elements of gameplay, renown for its strong motivational characteristics.

To bridge the novelty effect and create acceptance into by the healthcare sector, rigorous testing will have to take place. In order to establish the application as an evidence-based intervention, within the psycho-educational curriculum, further research on the applications influence on self-efficacy, PSI and attitudes towards social limits will have to take place.

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NieR:Automata (2017)

NieR: Automata tells the story of androids 2B, 9S and A2 and their battle to reclaim the machine-driven dystopia overrun by powerful machines.

H6: Maximizing Authentic Learning and Real-world Problem Solving in Health Curricula through Psychological Fidelity in a Game-like intervention: Development, Feasibility and Pilot Studies

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Abstract

High fidelity is regarded as a hallmark of educational games and simulations for health education. Primarily physical and functional fidelity are associated with authenticity, resulting in the pursuit of a real-to-life simulation and suggesting the imposition of a generally accepted and often unconscious design rationale that assumes that the greater fidelity of a game or simulation to the real world, the more authentic the intervention is perceived.

Psychological fidelity receives significantly less attention, although it is correlated strongly to credibility, suspension of disbelief, and engagement. The BABLR simulator reduces physical and functional fidelity to a minimum and explores the use of psychological fidelity as the main carrier of an authentic learning experience. BABLR was assessed using 26 participants with varying backgrounds in health innovation and social work. In several pilot studies, we collected data on perceived realisticness and real-world relevance. Results show that experts, as well as participants, acknowledge BABLR for its engagement, immersiveness, and motivational qualities. Practical implications of these findings for future research into developing low-fidelity simulations with high psychological fidelity will be discussed.

Keywords

Serious games; health education; fidelity; simulation; learning innovation

1 Introduction

Growing interest in game-like interventions to educate and train health professionals is apparent from the number of serious games and simulations that are used in medical education [1]. In the literature, many studies have evaluated game-like interventions developed and used explicitly for health education and training. However, the use of games in medical education is relatively new, and the full potential of serious game applications in medical education should be explored further [2]. Similar to the development of pharmaceutical therapies, serious games are held to the same rigorous scientific standards as those in randomized trials [3], but the design rationale of serious games or game-like interventions are rarely explored [4]. In regards to the development of therapeutic drugs or medical procedures, the quest for efficacy is necessary and justified. Without diminishing the importance of effect studies, in the case of designing game-like interventions for health education, it is too early to state whether specific approaches do or do not work. Thus, it is necessary to create space for experimenting with different forms of games and simulations. In particular, when it comes to fidelity, there seems to be limited scope as to the appearance of game-like interventions. Studies on game-like interventions for medical education do not investigate the specific design choices made and rarely provide design principles used to create the intervention. The consensus is that games for health education should aim to achieve a true-to-life, high fidelity representation [5].

In the following chapters, we will describe: 1) the reasons for the exploration of a low-fidelity simulator, 2) the way in which the design research process was carried out, and 3) the first results obtained with the simulator. Terminology originating from disciplines other than medicine will be briefly explained. BABLR, the name of the simulator, is not an abbreviation, but a corrupted Dutch word that shares common ground with English terms such as chatterbox or babbler. This name seems appropriate because the simulator provides text-based scenarios, focused on communication. The term artifact, as used in this article, refers to the simulator in the prototypical phase.

We describe supporting theories in the problem space, in the design space, we examine the formulation of design choices and how these choices shaped the artifact. Here, the simulator itself is also briefly described. Finally, in the solution space, we discuss the preliminary results obtained from the first assessments.

1.1 Problem Space

The field of health innovation education encompasses socio-technological issues, including technology acceptance [6], user-centeredness [7] and a learners' mindset towards design science research [8]. Attitudes and mindsets are important components of this competencies, especially within health innovation curricula and in so-called 21st-century skills [9,10] on a broader scale. In traditional health curricula, these tacit elements of competencies are hard to teach, train and measure in concrete, literal form [11].

It might be useful to elaborate briefly on the reason why design research is needed in health. Current health curricula teach natural or analytical sciences that are appropriate for the study of inductive and deductive phenomena, with a focus on reconstruction the past [12], in other words: studying what already exists. On the other hand, design research focuses on shaping the future by addressing so-called wicked problems, that require creative and innovative solutions [13]. To deal with these wicked design issues, health curricula should, therefore, teach forms of abductive reasoning [14]. The literature describes the application of abductive research methods imperative to deal with unstable requirements and constraints, to be flexible in case of unforeseen interactions among problem and suggested solution, and a dependency on creativity and teamwork [15], all properties that do not have an explicit place in health education. Therefore, health curricula should emphasize a designer's mindset amongst students and equip them with skills such as prototyping, concept visualization and new strategies to engage problems as design opportunities for innovation [16].

A possible starting point to make the above possible can be found in the problem-based learning paradigm, well known and adopted in the current health education system [17–20]. Problem-based-learning in health curricula produces the "desired habits of mind, behavior, and action to become competent, caring, and ethical health care professionals" [21]. Defined as "learning that results from the process of working toward the understanding or resolution of a problem" [20,22], it forms a match with what we are expecting to achieve with the BABLR simulator. Exposing health students to authentic and ill-defined activities with real-world relevance [23] connects problem-based-learning principles to design research. The goal of the BABLR simulator is to offer (as low-fidelity as possible) authentic scenarios, in which students solve wicked design problems. In this sense, BABLR is a training tool for using, training and explicating the tacit elements of a designer's mindset.

1.2 Design Principles

The reason for labeling the BABLR simulator as a low-fidelity game-like intervention stems from the ideas on design for transfer [24] and zero-fidelity [25]. The elaboration of these principles goes beyond the scope of this article, but the main idea is that where realisticness is concerned with the degree of similarity with the real world, realism can be seen as perceived realisticness. Relevant in this respect is that realism can be perceived as long as the player experiences coherence in the design of the simulator, and forgets that a simulator is being played on [26]. The latter is called suspension of disbelief [27] and is the desired working ingredient for the performance of the simulator itself. In research, to some extent, the degree of realism is held to be conditional for transfer to occur.

Fidelity is believed to be of importance in terms of relevance for learning and transfer [28], denoting the degree of similarity between the training situation and the operational situation, which is simulated [29]. According to Alexander [30], fidelity has dimensions beyond the visual design of a game. Notions of simulation fidelity include physical, functional and psychological fidelity [31]. Physical fidelity is the fidelity of the simulated physical elements in a simulated representation, e.g., virtual intestines that resemble those in a real body in a laparoscopic surgery simulator.

The same goes for functional fidelity: how are the functions from the source environment translated into a virtual environment? A simulation of a rat should react identically as a laboratory animal to interventions from outside. Both types of fidelity are about the realisticness of simulated reality. Psychological fidelity, however, can be seen as the degree of similarity between the mental experience in a simulator and the simulated reality. Does a simulation evoke the desired degree of stress or urgency, are the experienced feelings of pain, inability or joy true to reality?

This theoretical starting point forms the basis for the exploration of the BABLR simulator, reducing physical and functional fidelity to a minimum and using psychological fidelity as the main carrier of an authentic learning experience.

1.3 Supporting Theories

A first supporting theory (ST) that informs the design of the artifact is that of double-loop learning [32]. In short, the concept of double-loop learning demands for tacit knowledge to become explicit. Initial actions of players arise from their mental models with regard to how to act in presented situations. Double-loop learning occurs when an error is detected and corrected in ways that involve the modification of one's underlying norms, beliefs, and objectives, rather than just adapting to the situation.

Further substantiation is found in the narrative transportation theory [33]. Narrative transportation occurs whenever the player experiences a feeling of entering a world evoked by the narrative because of empathy for the story characters and imagination of the story plot [34]. This theory actually shows that suspension of disbelief can be achieved by means of a strong narrative, or scenario. This offers possibilities for the intended low-fidelity character of the BABLR simulator. Narrative transportation is held to be more unintentionally affective than intentionally cognitive in nature. To enable double-loop learning (tapping into and explicate tacit knowledge), the design of the BABLR artifact must, therefore, implement dedicated feedback loops that facilitate reflection-in-action [35]. These built-in feedback loops must be an integral part of the experience, to avoid disturbing the experienced realisticness of the simulation.

In early simulations, psychological fidelity was considered as a byproduct of high fidelity [36]. This way of thinking implies that low fidelity does not have any psychological value, although there are also studies that argue for low fidelity simulations, provided that they maintain a direct connection with real-world tasks [37]. In research, to some extent, the degree of realism is held to be conditional for transfer to occur.

The literature describes the difference between first class transfer types and second class transfer types. The first class consists of transfer types that advocate a literal method of transfer. The second class contains figural, sometimes more difficult to explain, forms of transfer. Our previous research [38] on second class of transfer [39] types showed that low fidelity is rarely consciously applied as a design rationale for the development of game-like interventions for health education and is usually associated with physical or functional fidelity alone. Cost saving is by far the most common reason to choose low fidelity over high fidelity. Where we found low fidelity as a conscious basis for the design, the objective always was the reduction of cognitive load [40] or the assumption that reduced fidelity is most suitable for learning motor and spatial skills. One study coined the concept of zero fidelity in a game without concrete elements of the simulated environment [25] and is consequently almost the only study of a game-like artifact where a substantive reason is put forward in favor of the use of low fidelity.

There are certainly examples of research into game-like artifacts that deliberately bring physical and functional fidelity back to the minimum, especially in the field of employee selection [41]. As mentioned earlier, Psychological fidelity is an important design parameter in serious games and simulations [25]; [42–45]. In addition, these studies all claim that representing the real world as literal as possible is less important for learning. The definition of psychological fidelity in this studies varies slightly, e.g. cognitive fidelity [46], but all studies mention the abstraction of certain real-world concepts and a process of recontextualization. Suspension of disbelief as an important characteristic of psychological fidelity: oneself's temporarily allowance to believe in something that is not true-to-life. Despite

the second class of transfer is not explicitly stated in those studies, they do utilize second class transfer in serious game design. The above provides sufficient support to assume that when it comes to acquiring attitude and mindset aspects of health curricula competences, this can be achieved by a simulator specifically designed to achieve its goals by means of second class of transfer.

1.4 Working Theory

The working theory is the above theories captured in one design hypothesis, bridging the problem space with the design space (see the left side of Figure 1), laying out the contours of the first version of the artifact. The design hypothesis here states that the artifact to be designed should contribute to the acquisition and explicitation of attitudes and mindsets belonging to a new generation of innovative health professionals. The artifact can achieve this with a low fidelity simulation game, which with minimal means evokes a lifelike world, in where the players are enticed to perform meaningful actions.

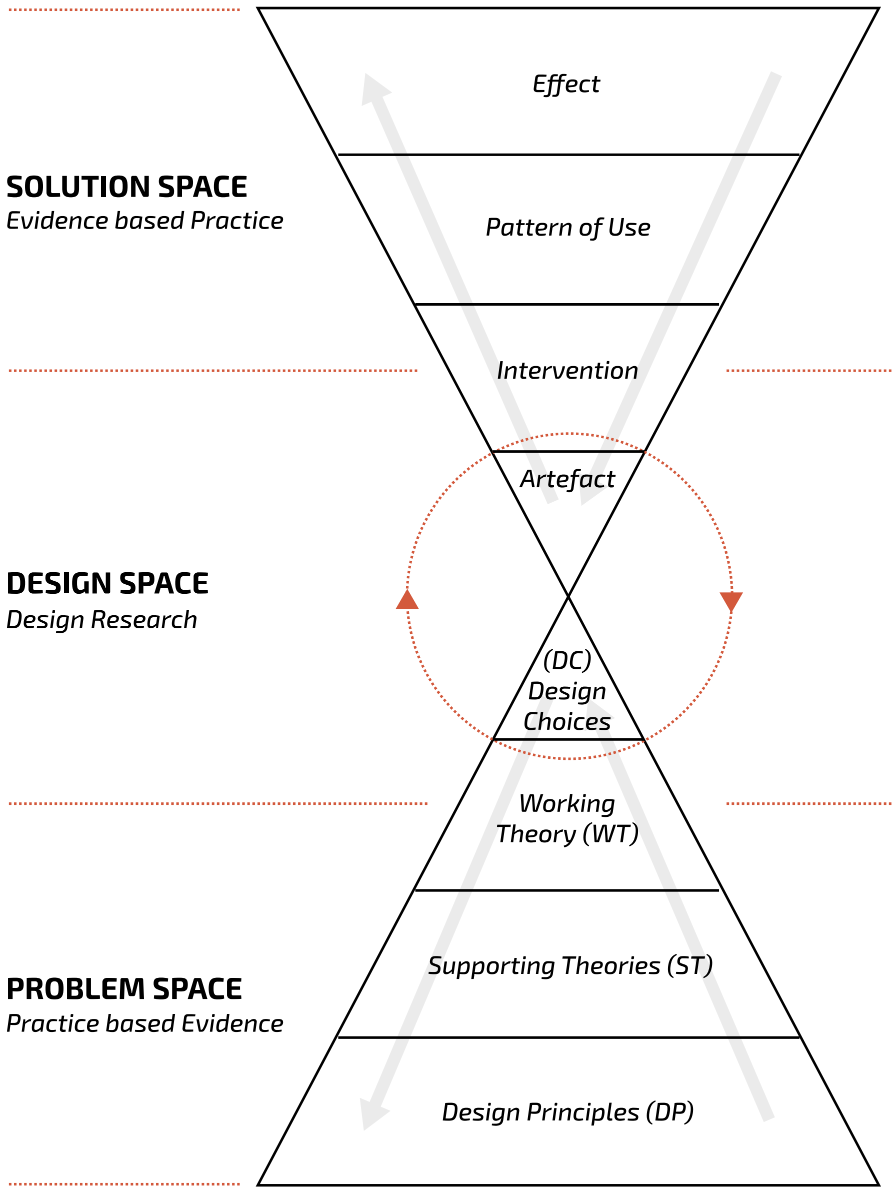
2 Methods

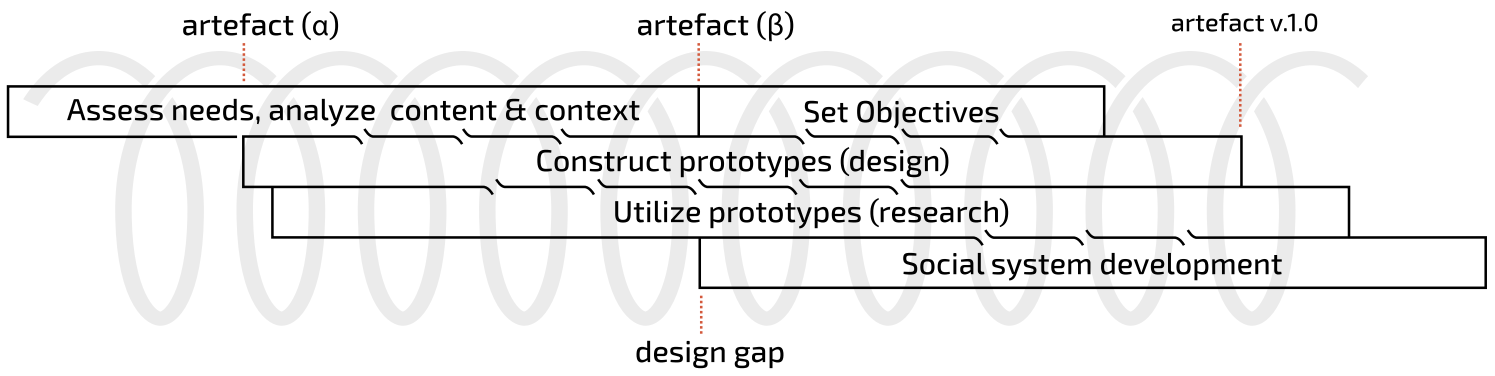
This chapter describes the way in which design research is applied, with the main focus on the substantiation and justification of design choices. The research and development of the BABLR artifact are structured around spaces laid out in the layers in serious media design model (LiSMD), depicted in the left side of Figure 1. The term artifact refers to the prototype of the simulator in this specific phase. Common to design research practice, the prototypical instance of the artifact itself is regarded as an emergent boundary object [47], endeavoring towards a befitting answer to the problem-solution binary. The artifact is placed, as it were, between the problem situation and the desired situation to see if and in which form it can be a solution. This process of appropriation is facilitated by a design research framework as shown on the right half of Figure 1.

2.1 Design Space

Within the design space, we adopted a design science research approach [13] for articulating the design choices for building the BABLR artifact. This framework [48] is adapted from the rapid prototyping ISD model [49] and facilitates the development of the BABLR artifact through an iterative-incremental process. The focus of the iterations shifted during the process along to non-linear design steps [50], including ideation, prototype development, and prototype testing. The first step involved the

Figure 1: Layers in serious media design (LiSMD) & Design Research Framework.





development of the LiSMD-model (left side of Figure 1). The initial version of the model was constructed through a synthesis of various concepts and best practices, aligned with the main findings from DPs and STs as mentioned in Sections 1.2 and 1.3.

2.2 Procedure and Participants

Expert Panel

Five field experts were selected on the basis of a variety of expertise, such as specific knowledge about the practice of health and social work, knowledge about serious games and simulations or knowledge about education in the field of healthcare. BABLR uses text-based scenarios, tailored to the target group, each with its own internal trajectory and objectives. A potential scenario that would be playable with BABLR was presented during panel sessions, in which the entire scenario in full detail was presented in a walkthrough of the storyline. The experts were then invited to share their initial reactions and findings on the scenario in question. In a final, semi-structured questionnaire the field experts we asked about their reactions to, respectively, the perceived realisticness of the scenarios, the expected learning effect, and engagement.

Pilot 1

A first 8 day-pilot in which 6 students participated from the bachelor of social work, all attending an eSocialwork specialization course. Afterward, all participants were invited to partake in an evaluation session. A questionnaire was used to ask the players about the perceived realisticness of the scenarios, the expected learning effect, and engagement. Conditional for participating in the evaluation was a minimum of 2 interactions every 24 hours. All participants were rewarded with a cinema voucher. In addition to the participants' gaming experience, the aim of this pilot was also to verify the overall system performance, to test playability and the lead time of the given scenario.

Pilot 2

Ten bachelor students from different study programmes at the NHL Stenden University of Applied Sciences, The Netherlands, participated in the second pilot. A shortened scenario concerning communication styles had been developed for this pilot in order to introduce students to BABLR. For one week the students played the role of a junior communications officer, who just started a new job. During the game, however, the various contacts with the virtual opponents showed

that there was a lot going on within the communication agency. The aim of this scenario was to find and interpret the communication problems, and then successfully use a communication model to guide the situation in the right direction. During a joint debrief, the experiences were discussed and shared.

Pilot 3

During the third pilot project, 9 social work professionals played a dedicated BABLR scenario for 4 weeks. These professionals were employees of the Tinten Welfare Group, a large social work organization (550 employees), located in the North-East of the Netherlands. The participants were part of a district team in the city of Emmen, and had different specializations within the social domain, such as youth worker, social worker or community worker. The district team participated as a whole in this pilot and was appointed by the Tinten Welfare Group's head of education. All participants were informed beforehand that the pilot was part of a study. A formative evaluation was conducted after two weeks and an extensive debrief took place at the end of the session. Again, the purpose of the third pilot was to gather information about the perceived realisticness of the scenarios, expected learning effects, and engagement.

In addition to acquiring early indicators of success of the overall functioning of the scenarios (perceived realisticness, expected learning effects, and engagement), each session gave the designers of BABLR insight into how to improve the artifact itself. The low-fidelity character of the simulator is characterized by the fact that BABLR's front end is actually nothing more than the respondent's mail client. Most of the changes are done to the back-end of the prototype, not visible to the players. In particular, the manageability of the various storylines in which individual players can find themselves in a scenario proved to be a real challenge. Following the experiences with the pilot studies, far-reaching changes have been made to the initial versions of BABLR. The design choices, the final prototype, and the early indicators of success are presented in the following chapter as a result of the design research process.

3 Results

3.1 Design Choices

As described in the introduction, BABLR is designed as a low-fidelity simulation game (DC). In order to optimize accessibility, the starting point was to be able to play the simulation without third-party software

(DC). The player plays the simulation from his or her own mail account. The text-based nature of communicating via email makes it possible to establish narrative transportation through scenarios (DC) which pre-selects on psychological fidelity alone. The scenarios are carefully crafted and based on authentic practical situations engaging players in real-to-life affairs (DC). All scenarios are set in the context of health and social work and place the player in a key position of a change agent (DC). In this capacity, the player must solve complex problems in the areas of project management, communication skills, and innovative design-based research projects.

3.2 The BABLR prototype

BABLR is designed to provide an authentic experience in a role-playing environment for students. A total of 26 players from different disciplinary backgrounds have used this learning tool with tailored scenarios to collaborate with others on authentic problems in the field of health innovation. All scenarios contain elements from project management, personal leadership, uncertainties and resistance in change processes and change agency through design research techniques.

The implemented BABLR scenarios provide complex socio-technological quests that give utterance to authentic decision-making, promoting collaboration, technology acceptance and leadership skills, all needed to be successful practitioners in the field of health innovation.

The prototype was evaluated in playtest sessions with end-users, including an immersion study, again providing input for the design and development of the prototype. After each session, observational data and players feedback were analyzed and led to a partial redesign or reconfiguration of the scenarios and back-end of the artifact.

BABLR front-end

Each scenario starts with a short introduction email, wherein the player is welcomed as a new team member. The mail email explains the task to be tackled and presents the virtual team members and their job profiles. The scenario starts to unfold when the player contacts the virtual team members, again by email. Each character holds specific information, which the player has to retrieve, combine and interpret, leading to the next move. Ideally, a golden path should be followed that leads to solving the wicked problem, but the scenario is that complex that it is imminent that this ideal line will

be difficult to find. In this search, players' actions become more tangible. The players' vigorousness towards virtual opponents, the quickness of establishing connections, seeing through motives, keeping key figures on-board and ultimately completing the scenario, are regarded as indicators of proven competent behavior.

BABLR back-end

The emails with responses from virtual team members are sent from the BABLR mail client. The game moderators can log in to the back-end via a web browser. Players can be added to BABLR, players can be divided into groups and players can be admitted in a specific scenario. In addition, the moderators can monitor and influence the course of a scenario from this back-end. The content of the reactions of the virtual team members is partly automatically provided by BABLR, but also augmented and refined by a moderator. This is primarily to ensure that the players experience the highest possible degree of authenticity in the conversations, but also to sometimes lead players back to the golden path in the scenario. The system knows where in the timeline of the scenario the player is situated and, based on that information, predicts the most appropriate response of a virtual character to an email from the player.

Moderators will modify and agree to these proposed responses as appropriate. Each player develops a certain understanding with his or her virtual opponents. For example, opponents can be happy or irritated and react from this state of mind. It is up to the player to recognize these emotions and respond accordingly.

Scenarios

The scenarios are separate entities that can be embedded in the BABLR environment. This way BABLR can host multiple scenarios, which can also be played simultaneously with multiple teams. It is beyond the scope of this article to discuss the design and origin of the scenarios in detail, but it suffices to rapport that each is divided into five parts, or acts [51], which some refer to as a dramatic arc: exposition, rising action, climax, falling action, and dénouement.
The scenario developed for pilot 1, called FOCUS, is about a health care institution, for which a digital innovation (serious game) has to be developed. Whereas the health care institution itself seemingly has strong ideas about the artifact to be, during the scenario the player has to find out that end-users of this serious game have totally different needs. The solution to this scenario lies in reframing the problem, resulting

Figure 2: The sphere display, depicting in-game interactions between the player and virtual team members.

in a totally different solution. The scenario in pilot 2 is named BABEL, and deals with misunderstandings within a communication agency. The key to playing this scenario can be found in addressing mutual disputes and applying a communication model provided by a specific virtual character.

The TINTEN scenario used in pilot 3 can be completed by informing each other about an ongoing case as social workers. The aim of this scenario is to illustrate that operating from a too one-sided perspective on a case can be counterproductive and even dangerous and that the complete picture is necessary to provide the right care in complex social situations. After obtaining this overall picture, it is possible to work towards the end by choosing a collective, coordinated method.

Sphere Display

A final part of the system is the sphere display (Figure 2). On an additional monitor, the BABLR back-end projects the individual timelines of a group of players in horizontally distributed vertical lines. A single line represents one player. Colored spheres are shown on this line, corresponding with the email traffic flow. Each virtual team member has its own sphere color. With several successive interactions in short order, a sphere increases in size. The last send email is shown as a pulsating sphere, which indicates a required action by the moderator. The spherical display ensures that moderators have an overview at a glance of the progression of a group of players, where obstacles arise, and to whom they should send a message on behalf of a virtual team member. The sphere display is the only graphical component of BABLR, but it is not visible to players. The only thing players see of BABLR is the email traffic. After the completion of a scenario, or on a set end date, players and moderators will evaluate and reflect on the course of the simulation, critical incidents and personal experiences in a debriefing session.

3.3 Intervention

This paragraph describes the early indicators of success, which preface final statements on the effect of the BABLR simulator. The LiSMD-model intervention layer (see the left side of Figure 1) bridges the design space and the solution space. At this point, only statements can be made about demonstrated appropriateness and effect, based on the pilots as described in Chapter 2. The artifact transcends its prototypical status and can, therefore, be seen as an intervention from this phase on.

Perceived usefulness

In response to the scenario, the experts indicated that it appeared to be very recognizable and lifelike, that the issue to be solved was relevant, and that a number of characters from the storyline could be linked to people they actually knew. In addition, they underlined the importance of the possibility of training extra-curricular skills in a safe environment. The ability to evoke real-life learning situations that are difficult to recreate in existing health curricula was identified as a strength of the BABLR concept. After the concept has been submitted to the experts, they were asked to give an initial response to the design. During the questioning, the strengths and weaknesses of the artifact were examined until a clear argumentation was given. Expert 1 was the first to mention that the prototype mainly deals with the relational aspect of such projects. In addition, expert 4 mentions the replayability as a major plus point, as well as “the ability to travel several routes, make different choices, the feedback mechanisms that ensure that there are consequences for the choices and the ability to gain experience with such projects.” As a possible weakness, expert 1 mentions that the system or the scenarios can steer too much: “If there is too much steering, it is tricky (...) that really has to be taken into account.” Also, expert 3 mentions the lack of actual visual designs to respond to: “I am of course also a designer, I think it would be very nice if students could also respond to visual designs in terms of content (...) you could, of course, put that into a scenario.”

Expert 2 comments: “This is really very recognizable from my practice”. The similarities with practice and the degree of realism are regarded as strengths. “I also think that gaining experience is a very strong point, very well done.” In addition, expert 2 recognizes the phases of design thinking principles as well as their application within the prototype. Expert 2 sees a possible risk in the construction of the scenario “because it may be quickly over the top.” “Of course you try to let the important moments and escalations happen, but that can easily become too much (...) or maybe it becomes too difficult.”

Motivation / engagement

Within the expert group the main reaction focuses on the player’s experience: “In this simulation you really engage the student in a unique experience within a vivid scenario”, and “We [expert 5’s association] have realistic-looking simulations and they work well, but as soon as they [students] get out again, it [the experience] is over. That’s just for a brief moment, but in this simulation, you can really keep them [the players] involved for a longer period of time...” The flexibility of the scenarios and storylines were also mentioned as a strong point. The time-consuming role of the facilitator as part of the simulation was identified as a weakness: “In order to keep it [the simulation experience] realistic, you [the facilitator] have to respond to the content and respond to what the player says. That is good, but it will also take time.”

Table 1. Average scores for artifact scoring conditions, both from experts and students

Pilot	N	Characteristics	Mean
Design - viewed a prototype			
Expert Panel	5	field experts	
Preview - tested a scenario			
1 group questionnaire and interview	7	bachelor students social work	
- perceived realisticness			4.34 / 5
- motivation / engagement			3.75 / 5
- perceived usefulness			4.01 / 5
- expected learning effect			3.42 / 5
Users - participated in a trial			
1 group group-interview	10	bachelor students	
1 group questionnaire and group-interview	9	social work professionals	
- perceived realisticness			3.87 / 5
- motivation / engagement			3.05 / 5
- perceived usefulness			3.25 / 5
- expected learning effect			3.39 / 5

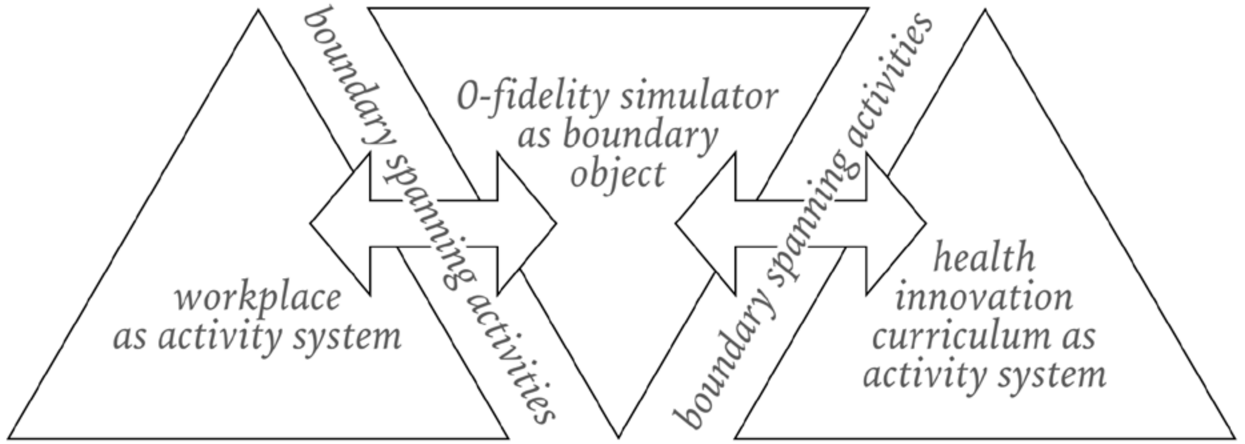
Perceived realisticness

When asked: "Do you expect the students will experience the simulation as realistic and authentic?", all the experts responded affirmatively. Expert 1 said: "Yes, very realistic. On several levels, both social and in terms of routes, there are many possibilities." Expert 3 added: "Yes, this is very realistic. Also in the scenario, the persons [virtual team members] are very recognizable and also their behavior is very true to life (...) a behavioral therapist [virtual character] who is critical, yes, I experienced that so often myself." In addition, the expert 4 suggested that the relationship between players and the virtual team members could differ per session, while these relationships might be one of the most important parts of the simulation: "Yes, you have to approach such a policy advisor [virtual character] with conviction, otherwise you will lose him. At least, that would be the case in real life. It would be nice if different approaches could have a different effect", and: "I think that insight into the status of relations would be of added value."

Expected learning effects

When asked about expected learning effects, the experts confirmed the principle of learning through an immersive experience "because you can really keep them involved for a longer period of time, they can gain a lot of experience." Expert 5 also mentions the aspect of gaining experience as an important point for learning. Expert 2 adds that

Figure 3: Boundary spanning as the core of learning.



"they are really forced into the role of project manager, they have to be proactive (...) that is very valuable." Expert 1 notes: "You have to discuss and reflect on the choices you have made in order to create a good learning experience". A consensus was found on the importance of a real-life debrief, because "physical contact moments and reflection are also important for learning."

The three pilots generated both practical and substantive results. The scenarios proved to be generic enough to engage the players from different studies and vocational backgrounds. During the debrief, individual progress was shown and the players shared their strategies. In a few occasions, the participants found the scenarios hard to play but were curious about the outcome when they were not able to finish the scenario. Furthermore, the participants indicated that sometimes they would prefer to be able to meet or call the virtual team members from the scenario in person in order to be able to talk to them directly. At the time of the debrief, it only became clear to some players that they were dealing with virtual opponents. Table 1 shows the gathered feedback in debrief sessions after finishing the playing periods.

4 Discussion

From the start of this design research project, the pre-set goal was to examine if it was possible to design a game-like intervention with psychological fidelity as the main carrier of an authentic learning experience. In the artifact, any tangible form, either in functions or physical elements, was avoided. The LiSMD-model was used to support the design choices, the theoretical basis is described in sections 1.1, 1.2 and 1.3. For a series of three pilot studies with different target groups, tailored scenarios have been developed, all around hard-to-train tacit elements of so-called 21st-century skills. Five content experts and 26 players responded to four test items after playtests and scenario-walkthroughs. The BABLR prototype is currently in the intervention phase of the LiSMD, showing promising results in terms of perceived realisticness, motivation & engagement, perceived usefulness and expected learning effects.

A point of discussion may be whether the proven early indicators of success will actually feed through into final measurements. Here we can state on the basis of the first results, that the artifact in this line of growth will meet the set objectives. This design study shows that it is possible to achieve authentic learning in real-world issues by using purely high psychological fidelity as the main carrier. What cannot be demonstrated at this stage of development is whether the use of BABLR will lead to transfer or lasting learning effects, mainly because the artifact is not yet ready to generate data in the upper 2 layers of the LiSMD-model.

Drawing from the work on transportation [52], it can be argued that players' experience within the BABLR artifact in the case of high-transportation influences existing beliefs, even though the player knows that the story is fictional. Transportation defined as immersion into a text or drawing into a different place corresponds to the immersion and perceived realisticness properties shown in BABLR. In this uptake, we found BABLR to act as a boundary object, providing ongoing, two-sided actions and interactions between activity systems, even when the inserted narrative (scenario) is a meaningful, but recontextualized rhetoric. We learned that the BABLR simulator acts as a boundary object, as depicted in Figure 3, where the act of boundary spanning facilitates the actual learning. The literature describes this type of learning activities as dialogical learning mechanisms, triggering identification, coordination, reflection, and transformation [53]. It is this process of dialogical learning that to a large extent ties in with attitudes and mindsets sought after in 21st-century skills, as described in section 1.1.

One final comment concerns the role of the facilitator in BABLR. During the pilots, the facilitators were the same people who developed and investigated the artifact. Despite the fact that the field experts indicated that the scenarios approached reality adequately, it seems advisable to assign the role of the facilitator from the perspective of both health innovation education and the professional field. In this way, BABLR will be able to function even more clearly as a boundary object.

For the generalization of these findings, it will be necessary to further explore the concept of psychological fidelity as the main carrier of learning of tacit concepts of cognition in game-like interventions in other contexts and guises. When doing so, the LiSMD-model can provide a cross-domain perspective, combining medical contexts to educational and design theories. The model can be used to create space for experimenting with different manifestations of game-like interventions and other serious media and offers a generic design research approach for future work. The LiSMD-model might even be a boundary object in itself, bridging the strict separation between medical science and design [54].

Acknowledgments

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Compliance with Ethical Standards

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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Gone Home (2013)

June 7th, 1995. 1:15 AM. You arrive home after a year abroad. You expect your family to greet you, but the house is empty. Something's not right. Where is everyone? And what's happened here? Unravel the mystery for yourself in Gone Home, a story exploration game.

H7: Play It Safe: A Situational Game for Occupational Safety

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Abstract

This chapter describes the design choices and theoretical constructs that have led to the development of an occupational safety game, going by the name Play it Safe. Play it Safe is a tower defense game that uses situational data collected by employees, during their daily work, to impact the parameters of the video game. These data are gathered through a safety campaign named, Count Yourself Lucky (CYL) to quantify the amount of times employees used the supplied safety technique (Stop, Think, Act, Review (STAR)). Play it Safe, as a form of situational gaming and as a behavioral change support system (BCSS), through metaphorical re-contextualization attempts to create parameters for similar decision making encountered in the work environment and implicitly reinforce the training of the STAR protocol and conservative decision making. Play it Safe aims to improve employees' situational awareness, creating a shared mental model and bottom-up accountability, meant to improve and align (shared) safety behaviors.

Keywords

Occupational safety; Serious games; Situational gaming; Conceptual continuity; Behavior change support system; Situation awareness; STAR

1 Introduction

Accidents happen, however, responsible employers are constantly attempting to create safer environments by improving measures to diminish the number of mishaps and accidents. The Incident Frequency Rate (IFR), the main measure of safety in industry, varies among sectors, as do the risk factors inherent in certain jobs. Measures to maximize safety (knowledge, skills, protocols, conditional safety structures, and safety interventions) contribute to lowering IFR. Not all companies are proactive when it comes to safety or equipped with ample precautions in the work environment and culture. However, even companies at the top of the HSE culture-ladder who have taken ample precautions, have a finite effect on safety [1].

Even when equipped with all the right tools in the correct environment the human factor can be the cause of failure [2]; as routine kicks in, vigilance checks out. To bring safety awareness to the next level, serious gaming might prove to be a valuable tool in employees' toolboxes. Serious gaming offers a new and engaging way to demonstrate an adaptive interaction with the immediate relevance of situations and contexts from the work-floor. In this way, serious gaming can mix reality with an open practice environment in an emergent feedback-loop that triggers the players to have safety, which is forefront in the mind at the moments that warrant vigilance while improving the safety awareness as well as the safety environment. This all through noticing and registering lapses or slips and their probable causes.

This chapter describes the trials and tribulations of the design and development process of a serious game, named Play it Safe, with the goal of behavioral change towards occupational safety aspects inherent to dynamic high-risk jobs and environments. Part two describes a short outline of occupational safety trends and related work in the field of serious gaming, as well as a short outline of the focus of Play it Safe. Part two focuses on the design process of and implications of situational gaming, part three focuses on Behavior Change Support Systems (BCSS), Stop Think Act Review (STAR) and the surrounding safety campaign; Count Yourself Lucky. Part four describes the video game Play it Safe the involved game-play and game-mechanics as the goals of the game. The final part discusses the possibilities of situational games and the initial experiences with Play it Safe and the Count Yourself Lucky campaign.

2 Safety Matters

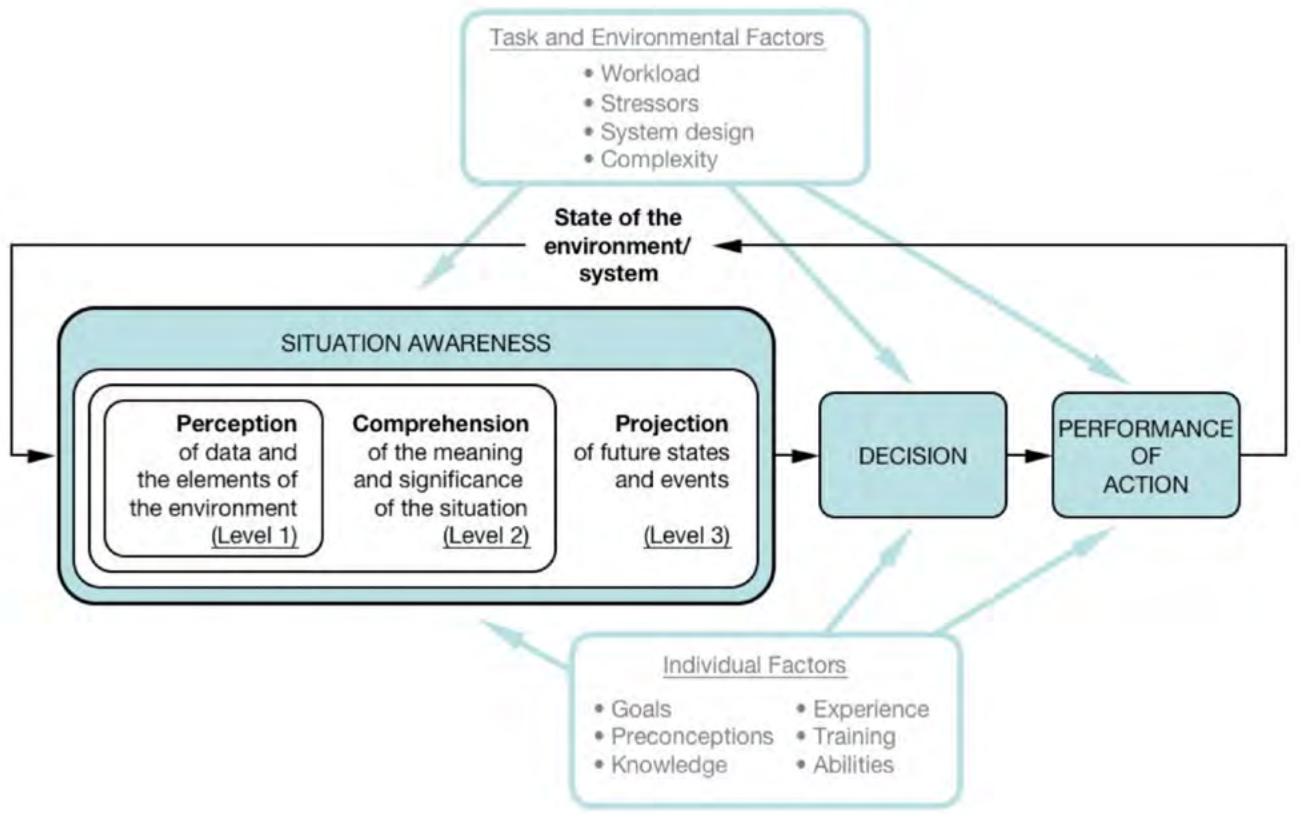
After physiological needs, the second step in the hierarchy of needs [3] on Maslow's pyramid is safety. Occupational safety has been a priority in the workplace since the beginning of the 19th century. Over the last decade, safety structures placed great emphasis on rule-based and behavior-based safety. This approach is described as Model 1 [4], a predominantly top-down approach. In Model 1 workers attain knowledge, skills and act as rule-based operators who follow golden rules that are strictly enforced top-down. In Model 2 these same rules apply, however they are seen as guidelines for the competent professional [4]. They are dynamic and rein-forced bottom-up, resulting in safety solutions coming from employees instead of management. Independent of the position of safety in an organization, the safety climate and culture of the company implementing the safety interventions have been found to be a key indicator for the attempted intervention [5]. In addition to the safety climate and culture, a large part of safety science focuses on conditional safety.

Conditional safety entails making the environment as well as the equipment used as safe as possible. This is realized by providing instructions, use of warning signs and protective clothing, making the equipment and the work environment as safe as possible. The primary cause of error and (near) accidents is the human operator. Therefore in safety science, Human Error [6] modeling, based on the underlying strengths and limitations of the human operator, is used to design protocols, rules, machinery and overall resilient systems to minimize accidents. Unsafe acts can be divided into execution errors (correct plan, wrong execution) and planning errors (incorrect plan). Execution errors can be divided into slips (attention failure) and lapses (memory failure), planning errors can be either rule-based or knowledge-based mistakes (unintentional decision to act against rules or standards) and violations (deliberate decisions to act against rules or standards). To gain further understanding of human error Rasmussen [7] developed the human performance model, consisting of the following levels:

1. Skill-based behavior: an automatized sensory-motor performance that one can perform without conscious control.
2. Rule-based behavior: based on stored procedures, gained through experience and learning. It works through recognition, association of state/task and then using the stored rule for the task.
3. Knowledge-based behavior: when confronted with unfamiliar situations, where explicit thought is necessary to develop a plan, exercise it and see if it works. It works through identification, decision of task and planning.

The different levels of reasoning can be accessed simultaneously, but are triggered by different aspects of contexts and situations. The mental model that workers have of the situation around them, i.e. Situation Awareness (SA, Figure 1) [8], and the decisions made depending on that situation, are highly influenced by the performance levels used by the operators. SA origins from military aviation [9] but since then has been used and researched in a wide range of contexts and fields. Endsley defines SA as 'the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future". This process is automatic. However, perception, comprehension, and projection of how a situation will evolve, depending on the action

Fig. 1. Adapted from Endsley's Situation Awareness Model [8], Model used from www.situationawareness.nl



a worker is planning to undertake, is vital in planning and undertaking an action. When making the decision to perform a task, it is vital to base that decision on a correct state of the necessary elements in the environment around you. Therefore a review of the activities undertaken and possible deviations of the projected state of the environment around you, are relevant for vigilance and safe behaviors. Besides an individuals SA, there is also Team or Shared SA (TSA/SSA) [10,11], the understanding between team members of each other's mental model of the situation. A high level of shared SA between team members provides a work environment in which the needs and way of approaching tasks and situations of others are understood and taken into account

[10,11]. Therefore a high SA is a vital part of safety on the work floor, both individually as well as in a team [12] and will make it a safer place/increase workplace safety [13].

2.1 Simulations and Games for occupational safety

Games and simulations for occupational safety have been used in a variety of fields with a wide range of goals, including;

1. Virtual Training in Construction Plants [14],
2. Virtual Training to increase SA during Cardiopulmonary Resuscitation [15],
3. Evacuation Drills [16–18],
4. Hazard Recognition [19],
5. Intervention to reduce work-stress and raise work-engagement [20],
6. Training and education of operations on ships and off-shore platforms [21],
7. Design in Construction [22],
8. Training for working at heights for mine-sites [23].

These are predominantly simulation games for safety training, depending heavily on a match between content and context, a high level of fidelity and a low level of play (or no play at all). Problems with these simulations are that they;

1. Almost automatically create a mismatch between the desired blend of entertainment and learning [24] within the game, missing out on the positive effects of entertainment on learning [25].
2. Require extensive training needs analysis (TNA) methodologies [25,26].
3. Can only be used for specific goals and situations. A created scenario within a simulation will only be useful for a specific target group and will only encompass limited tasks and environments. In an occupational safety game it would be impossible to simulate and program every possible accident or near accident inherent to the particular task in the particular work sector.

Therefore, instead of focusing on the outcomes of specific risks of specific task-related accidents, the more practical and feasible goal might be to intervene in the mental model an employee applies to approach general tasks, environments, and situations.

2.2 Play it safe

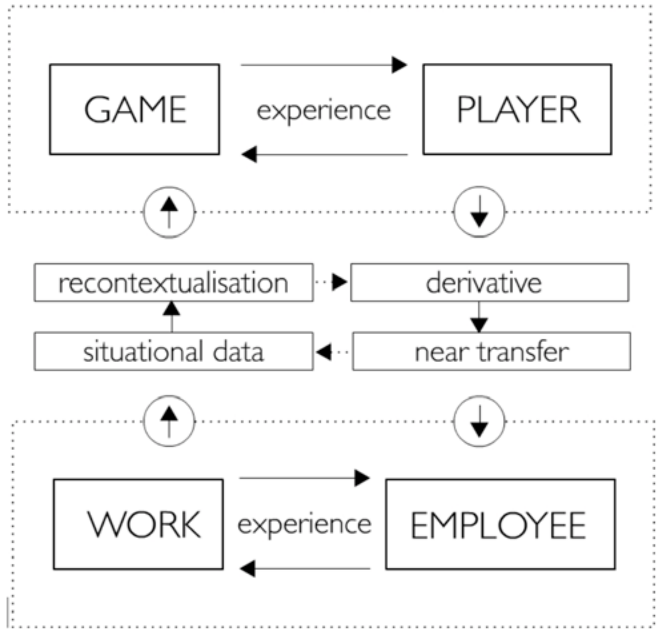
The Play it Safe project was established to address the needs of several small and medium-sized enterprises working in high-risk and highly dynamic task-environments. Each company faces a similar dilemma; despite specific rule-based behavior and the specific task-related knowledge being available and reinforced, accidents still occurred.

Play it Safe aims at creating top of mind safety awareness for workers in the construction and maintenance industry. The workers operate in small teams with variable constitution and at varying locations. Obviously, these workers know the safety rules, but in the heat of the moment slips, lapses and errors occur. Play it Safe focuses on preventing accidents using a cognitive intervention called STAR (Stop, Think, Act, Review), for procedural tasks, focusing on the context outside the game rather than the content within the game by the use of situational data retrieved through the count yourself lucky campaign.

3 Situational Gaming

Situational games [27] are games in which real-life data is used to affect the parameters of the game, often by the use of cross- and transmedial applications. The idea is to gather situational data and play the game in close proximity or on the location and in the context where the initial problems arose. The basic assumption of the effectiveness of a situational game for serious purposes is that situation provides an authentic setting that engages a player, helps to realize the logic, and triggers the player into action. The authenticity provides the necessary meaning and appreciation. The situation plays a role in multiple dimensions of persuasion, i.e., striving to persuade players

Fig. 2. This model describes the desired transfer model of the game and the reality outside the game as experienced by the player.



to change their behavior. The framework helps to make the role and possibly the impact of situation explicit during the design of serious games. Situation contributes in a positive way in reaching the underlying objective of the game. For Play it Safe situational gaming was used to attempt to increase safety awareness amongst workers. Eventing, thus taking real-life events into the gameplay, is suggested to be a good starting point for any situational game [27]. Situation and context determine the effect of a trigger. Triggers, when carefully timed and chosen, provide the spark to activate a change in behavior [28]. By adhering to a person's situation, triggers become authentic and actions become meaningful [29]. The player can identify itself with the matter. The use of situational data in Play it Safe reflects the belief that transfer should be considered as a design parameter. Kuipers et al. [30] argue that core principles (in this case the STAR protocol) in a game should be carefully designed in conjunction with a specific transfer type in mind, aligning the players' needs and abilities, including sociocultural aspects, serious goals, and topic characteristics. The process of translating situational data into game elements is called recontextualization, defining the pinnacle of serious game design: the subjective soundness and recognizability of the recontextualization is essential for transfer of safety awareness.

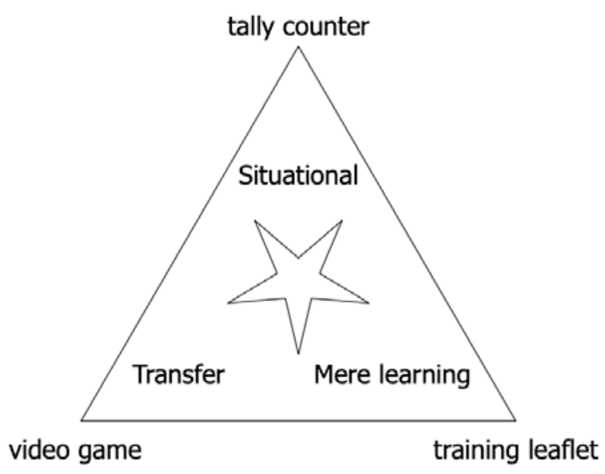
By introducing real-life data in the game they link the target context to the learning context (the game), enabling transfer between similar, but not identical contexts.

Near transfer can be categorized under literal transfer: transfer by the means of similarity, as opposed by figural transfer: transfer as a result of using some part of existing world knowledge for thinking about a particular problem. The game transfer model projects a game as a conceptual continuity in a continuum, stretching from mimetic simulation to abstract gameplay (see Figure 2). Within boundaries, the position of the game on the Game Transfer Model [30] has to correspond with design choices dedicated to facilitate transfer in a situational game aiming at raising safety awareness among employees through re-contextualization of the STAR-protocol and situational input.

4 Behavior Change Support System; Count yourself lucky with STAR and Play it Safe.

A Behavior Change Support System (BCSS) was defined by Oinas-Kukkonen [30–32] as: "a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes,

Fig. 3. Shows the ubiquitous workings of the STAR-protocol as a) situational safety detection tool b) a game-mechanic and c) the textual intervention.



behaviors or an act of complying without using coercion or deception". The computer game Play it Safe is not a stand-alone intervention, to be a BCSS, it needed a transmedial function [33] as a trigger to create the situational input and a complementary tool for assessment and participation to gather this input. Through the project, state of the art sensors and other elaborative options were proposed, however, they proved to be infeasible in a highly dynamic high-risk work environment. Many companies, for instance, did not allow smartphones because the digital disruptions could prove dangerous during working hours. Therefore an analog solution was found.

4.1 STAR: Stop, Think, Act, Review

Play it Safe uses the safety intervention STAR combined with situational aspects, i.e. events from the work floor are integrated to have effect in the game. STAR (Stop, Think, Act, Review) is a mental protocol to facilitate safety awareness. This mental protocol attributes the creation of awareness of a situation to three entangled processes: perception, comprehension, and projection. These processes attribute the enclosing environment, the physical context. The mental model is completed with a decision making process and effectuation of an intended action. The action obviously affects the state of the immediate environment. STAR is being and has been used in several fields [34–36] and is closely modeled on SA (see Figure 5). STAR has different modes of use (see Figure 3);

1. As a standard protocol to be used with every task (Skill-based behavior)
2. As a critical task protocol to be used only with tasks that are deemed to be a risk and require full attention (Rule-based behavior)
3. As an emergency protocol to be used when something goes wrong and one finds him/herself in an unfamiliar situation (Knowledge-based behavior)

4.2 Count yourself lucky with STAR

In the implementation of Play it Safe, STAR was utilized and integrated into all of the aforementioned modes. STAR was also used to detect deviations from the projected outcome of situations and record these with a tally counter (CYL), that amount was then used as an in-game reward. During the play it safe campaign STAR was used as a safety protocol and detection tool in the workplace; (see Figure 3);

1. A safety protocol to use while performing critical tasks and after some practice become part of skill-based, rule-based and knowledge-based behavior. This was attempted through mere learning on a leaflet and demonstrations.
2. A detection tool for situations that deviated from the projected outcome of action (through the Review in STAR), of oneself or others. These deviations were used as the input of the CYL score, keeping score daily on a tally counter.

The motivation to use one's tally counter in the CYL campaign (besides bottom-up accountability and communication culture) is to gain an in-game advantage. Through the use of an EMP in the game that makes it possible to progress with more ease in the game.

The EMP, however, is a re-contextualized STAR protocol that lets the players do two essential things, in the game;

1. Assess when the in-game situation becomes too dynamic to project a clear outcome, i.e. being unable to project the situation state after the action is undertaken.
2. While using the EMP players are forced to Review the situation and reorder the elements in the situation and the appropriate actions that can resolve it.

The ubiquitous implementation of STAR (see Figure 3) trains players outside of the game to use a mental protocol to integrate into their daily working behavior, while at the same time acting as a detection tool for situations that deviate from their projected outcome. This facilitates the players to take a closer look at their daily working environment and the boundaries to work safely within them, as well as noticing the limitations or shortcomings of conditional safety structures. The CYL campaign is motivated by the in-game reward system while in the game the STAR reinforces the already learned protocol in unrealistic situations that train the players SA.

Fig. 4. Shows a screenshot of Play it Safe being played.

Because the video game is played during lunch-breaks in the workplace, the situations become more tangible and the implementation of the CYL score can become a trigger to discuss workplace safety amongst colleagues. Furthermore, because all colleagues are using the same protocol the Shared/Team SA is trained and barriers in individual SA can be discussed as requirements for a high Team SA, creating an open communication culture where bottom-up initiatives are harnessed.

5 Play it safe; The Computer Game

Play it Safe (see figure 4) is a touch-screen tablet-based video game of the Tower Defense genre, the objective of a tower defender is to protect one's base against an enemy that wants to steal the supplies stored in that base. To succeed in this objective the player builds towers, tactically placed around the area to kill the stream of enemies. Play it Safe differs from traditional tower defense games, with the addition of workers that build and fix the towers and the possibility to use an Electro Magnetic Pulse (EMP) as a strategic advantage. The story behind the game is that a spaceship has crashed upon a distant planet that is inhabited by bug-like aliens who are attracted to energy cores that you need to power and repair the ship. To defend the crew and ship against the bug-like aliens, guard towers are built that automatically shoot the bug-like mechanized aliens.

5.1 Gameplay

When the player starts the game he/she can build as many towers as time allows, before a first wave of enemies arrives. The arrival of enemies is usually preceded by an alarm but as with any action in the game, there are exceptions that keep players on their toes. Towers are built by workers, when chosen workers have a primary objective to build, towers will be finished quicker. When towers are built, workers can be placed in the towers so that alien robots will not hurt them. After or during these attacks they can be directed to fix broken towers, however, there is a risk they will get hurt. Enemies approach in waves, so usually, there is time after a first wave to regroup and fix or build extra towers. During waves pressure builds and it gets harder and harder to keep control over workers while keeping track of the states of the environment as well as enemies. It is possible to use the EMP mechanic to regain control over the game environment and regain situational leadership over the workforce. If the player keeps the energy cores in the game, he/she wins, if the player loses all of them he/she loses. Extra points and badges can be won for using workers for their primary objectives, using the EMP and not letting your workforce get hurt.

5.2 Game Objects

Energy Cores
The energy cores are the main assets in the game. Workers try to defend them and the enemies attempt to steal them. They are kept in the base spaceship.

Base
The home base of the game avatars is a spaceship wherein the energy cores are stashed. Members from the workforce enter the game through the base when the player starts to build towers.

Enemies
There are two kinds of mechanized bug-like aliens. Both types can steal energy cores, however, the Eaters will attack towers and workers on their way to steal the cores, whereas the collectors will go straight for the energy cores.

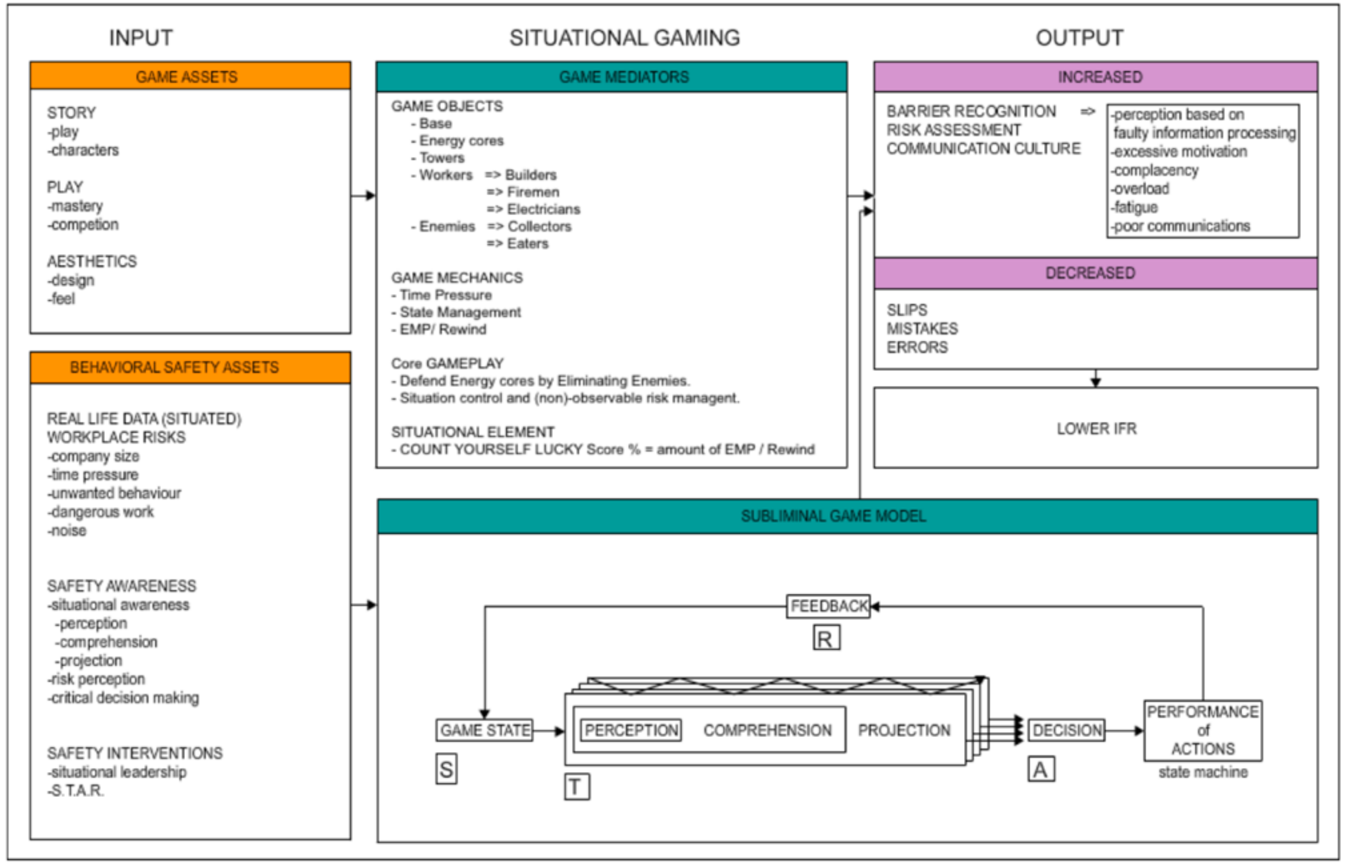
1. Eaters, their main objective is to destroy towers, by gnawing on them.
2. Collectors, their main objective is to walk into the base pick up an energy core and walk away with it, towards their own base.

Workers
To create towers it is necessary to have workers to built and restore the before mentioned towers. There are three types of workers.

1. Builders build and repair towers.
2. Firemen extinguish towers when they are on fire.
3. Mechanics fix mechanical damage in the towers.

The player can distinguish between the three types by the visual appearance of the workers. Their entire workforce has a single primary objective as well as a fitting suit to perform this primary task. It is possible to assign tasks to avatars that are not their primary objectives; the avatars will, however, be slower and less successful in performing these non-primary tasks and thus in more danger. When either fire, radiation from a tower or an enemy hurts a worker, their health state declines and they eventually die. To heal workers they can be directed into an undamaged tower, where they will be healed.

Fig. 5. Shows the proposed schematic behavior and attitude-changing model.



Towers

Before building a tower the integrity of the ground to be built on must be checked. The higher the integrity of the ground, the more resilient the tower will be against enemy attacks. Towers can be placed anywhere on the map and shoot intruding enemies on sight. Whenever enemies damage towers, their states deteriorate and markers (electricity sparks or fire) are visible before they eventually collapse or are repaired. The workers can hide in the tower from enemies closing in on them.

5.3 Game Mechanics

Count yourself lucky score

The player is asked to fill in the day score of the previous working day on the start screen of the game. This score is used to determine the amount of EMPs available to the player in the game.

Ground inspection

To build towers the integrity of the ground can be checked with a special option to use a looking glass that gives the percentage of the ground-integrity. This influences the towers deterioration process.

Electro Magnetic Pulse (EMP)

The EMP can be used either to freeze all enemies as well as workers or to just freeze their enemies, depending on successfully using the touch screen hold mode on the intended icon. In either situation, it gives the player time to use STAR and gain a new oversight in the game, which can be lost due to the pace in the game.

5.4 Transformational Learning

Through the use of metaphorical recontextualization [30] Play it Safe uses near transfer to create a metaphorical low-fidelity game-world in which less explicit and extensive parameters apply in comparison to the workplace. In the Game-world there are observable (enemies) and non-observable (ground-integrity) threats as well as simulated time-pressure, which forces the players to keep reassessing their plans and actions with regard to the ever changing the environment. Not to recognize specific or realistic threats, but to gain insight and perspective on the need for oversight into the aspects of a situation, i.e. situation awareness and the necessity of conservative decision making within a dynamic environment.

Mitgustsch [37] distinguishes three stages of learning through serious games aligning with Bateson [38] stages of learning; 1) in, 2) through and 3) beyond the game. In the case of Play it Safe the transformational learning process is;

1. In the game learning: the player carries out random tasks at hand and leads a workforce that can change into various states. Through trial and error, the player reacts to the game environment and learns to play the game.
2. Through the game learning: the player will learn what the limits and barriers of their situational awareness are and when they reach these parameters.

3. Beyond the game learning: at this stage, is expanded to real-life contexts outside of the game. The player recognizes the barriers for high situation awareness in their daily working environment. And is continuously training the use of STAR in skill- rule- and knowledge-based behaviors to reduce errors, slips and lapses, and ultimately the companies IFR.

SA and STAR are used to overcome the in-game challenges without being explicitly taught, creating an implicit training tool. Play it safe the computer game combined with CYL and the explicit STAR-training, together function as a transmedial BCSS that attempts to abide by the dynamic demands of the socio-technical environment.

6 Discussion

Because of the ubiquitous nature and transmedial character of the BCSS, a schematic breakdown of the active elements is given. Play it Safe implements four modes of use [39] of one BCSS through situational gaming:

As an intervention; STAR is implemented to attempt to improve individual SA and Team SA. Through the use in and outside of the game the recognition of a loss of overview or cognitive overload in working situations is trained and reinforced.

As a trigger; through the use of the CYL campaign. Wherein the employee through the use of a tally counter, keeps track of the situations in which he/she lost the overview of the situation.

As an assessment; for employees and safety leaders through the scores of the game, as well as the individual or shared CYL scores. Which both act as a self-assessment and give feedback about the number of unsafe events on the work floor.

As a tool for participation; through the CYL campaign empowering users to inform safety managers about unsafe practices, equipment, behaviors or specific situations or context.

This transmedial BCSS aims to impact compliance towards safety rules, lasting behavior change through creating a Team SA by using the mental protocol STAR and ultimately an attitude change in creating a bottom-up safety culture, making safety a tangible concept that all members of a team are involved in and feel accountable for.

Play it Safe harnesses the motivating and rewarding aspects of in-game appraisal for out-game actions (CYL), as well as implicitly reinforcing the actions outside of the game, in the game itself. Thereby Play it Safe can be considered a recursive BCSS, not to create high vigilance at all time, but to recognize the barriers inherent to an incomplete view of a situation. Performing knowledge-based behavior while wrapped up in other tasks can be dangerous at any time [40]; therefore an insight in the precursors of cognitive overload can be a powerful tool for safety awareness.

In the preliminary trials, safety-leaders, on site of the respective companies, noticed an increase in interactions and respective tally counters scores when group activities took place than when solitary tasks were performed. The CYL campaign seemed to increase the communication culture concerning safety matters during these group activities. The simple task of making a conscious note can be a tangible trigger to enhance situated cognition through situated play [41]. As a situational game Play It Safe makes the environment the trigger in and outside of the game, utilizing safety on the work floor through the game.

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The Stanley Parable (2013)

The Stanley Parable is a first-person exploration game. You will play as Stanley, and you will not play as Stanley. You will follow a story, you will not follow a story. You will have a choice, you will have no choice. The game will end, the game will never end.

H8: Design Research in Health Education: Don’t Jump to Conclusions

Lessons Learned From Digital Innovation in Health in The Netherlands

Kuipers DA; Wartena BO, Terlouw G; Van Dongelen R; Prins JT; Pierie JPEN. Design Research in Heatlh Education: Don’t Jump to Conclusions. Health Culture Society (2019). Manuscript submitted for publication.

Abstract

In recent years, a number of design research projects relating to digital innovation in health and welfare have been carried out within the NHL Stenden University of Applied Sciences. These design research projects included a fall prevention game for the elderly (HaSeGa), a game to prevent lower-back injuries for caretakers (iLift), an app for psycho-education in social limits for young people with a mild intellectual disorder (MATTIE) and a vitality game for the elderly (Fox hunting). Even though the project teams, target groups, and project objectives were different in all projects, the analysis showed that there were strong similarities in the lack or even absence of attention for the importance of social system development. Although all projects resulted in a prototype or artifact that had been enthusiastically responded to during the design research processes, the artifacts themselves never became integrated into the socio-technical contexts for which they were designed.

This article aggregates lessons learned from those projects, addresses the problem of the classical conception of implementation in design projects and offers a framework for future design research projects for digital innovation in health. Moreover, designers of health curricula as well as educators in health innovation are called upon to address the transformation of the social system as an integral part of a design process for a successful integration of the developed artifact.

Keywords
design research; health education innovation; socio-technical system development; game-like interventions; digital innovation

1 Prelude

The aging of society and the decline of the birth rate will be the primary reasons for the rise in care and support requests in the coming years. Greater medical knowledge has led to an ever-increasing life expectancy in the Netherlands [1]. Far-reaching changes in the organization of care and welfare support have been adopted in answer to these developments. Take, for instance, the decentralization of care, the transition of youth care to the municipal authorities, the step-by-step design and arrangement of the Social Support Act and a growth in the number of activities focused on prevention [2]. There seems to be little discussion about the opportunities and need for information technology to meet these challenges. Home automation, telemedicine, and online support are becoming increasingly common. Yet there are countless examples of digital innovations that do not make it into daily practice and run aground in development or implementation [3].

The emergence of information technology has been one of the most important advancements of the last century. It was widely accepted, with hints of skepticism, that the role of technology, and of computers, in particular, would be inescapable in our daily lives, revealing unlimited possibilities. More so than with the launch of earlier technological innovations, such as the printing press, electricity or television, information technology has had an impact on the social system. The social system may have reacted out of fear or resistance to the unknown in the past, but the so-called disruptive nature of the continued advancement of information technology has definitely led to a wide range of challenges. Now, in the 21st century and especially in the world of care and welfare, we would, therefore, expect greater interest in these socio-technological challenges, not least in the light of the developments around eHealth.

In contrast to printed books or the first motorized coach, information technology is not just one single concept: the development of information technology (abbreviated to IT, often referred to in the Netherlands and Belgium as ICT) has also expanded its definition. While Van Dale, the Netherlands' foremost dictionary, still describes IT as 'everything to do with the automated acquisition and processing of information', there is a noticeable shift towards psychometric characteristics [3,4] often expressed in terms of adoption [5] and acceptance [6]. This article explores observations made in a number of so-called 'games for health' IT projects of the iHuman research group [7–11] in which the social component of technological innovation has proved to be the biggest challenge, both among end-users on an individual level, but also on managerial and cultural levels as well.

1.1 Affinity

In the 1990s, implementation was often the final stage in a development process, particularly in terms of technical expansion. The final user only became acquainted with the artifact through an on-screen tutorial or a user manual. For the rest, the implementation focused on the installation of the artifact and efficient operation. When problems arose, they truly were of a technical nature and could only be solved by the software vendors themselves. This is where the current uncertainty with regard to technology in the areas of Health Care and Welfare springs from. Problems with technology are interpreted as a personal shortcoming: technology is difficult and intended for boffins, end users may find it puzzling or have no affinity with it.

In this day and age, this reflex can no longer be said to be entirely justified: new iterative development methods have made it possible to remove teething problems from software at an early stage and if something does not work correctly, the supplier has simply not done his job properly. Technology is here to stay. The issue now is whether the technology does the right things correctly, or rather, whether it's well-designed. The latter is crucial: as long as the healthcare or welfare professional continues to approach IT as something out of their control, opinion or input, implementation will remain the highest achievable feat. Lack of affinity with technology as an excuse not to interfere in the development of new applications could be interpreted as unprofessional behavior.

1.2 Implementation

A frequent term, which seems to have replaced implementation, is 'the rolling out of an innovation, strategy or software package'. This metaphor may at least address the insight that implementing is a process, but also raises questions. Freshly laid tarmac is rolled out with a roller, a roll of carpet just gives the floor a new look. You could argue that when there is an update of an alarm system or when it comes to the commissioning of new coffee machines in the office canteen, one could well speak of rolling out. But when an innovation comes with a different way of working or has a substantial influence on an existing way of thinking, the term 'rolling out' is almost disrespectful and at the very least naive.

Expectations and insights regarding the possibilities of technology rarely correspond with reality, and the projected promises often fail to materialize. In that sense, the experiences with eLearning in the world of education spring to mind. The most important similarity in our view is the perspective from which the potential innovation comes 'flying our way'. Logically, the existing reality is taken as a given and the artifact itself takes precedence. The use of the inescapable word – precondition – is typical. The organization standing on the edge of the

forthcoming challenge is seen as a condition. The preconditions are presumed and the innovation must take place within these frameworks. In this article, we want to make a distinction between the development of the artifact (a serious game, app, e-health application) and the development of the social system (services, culture, department) for which the artifact is intended [12].

2 The DIS/DIL Perspective

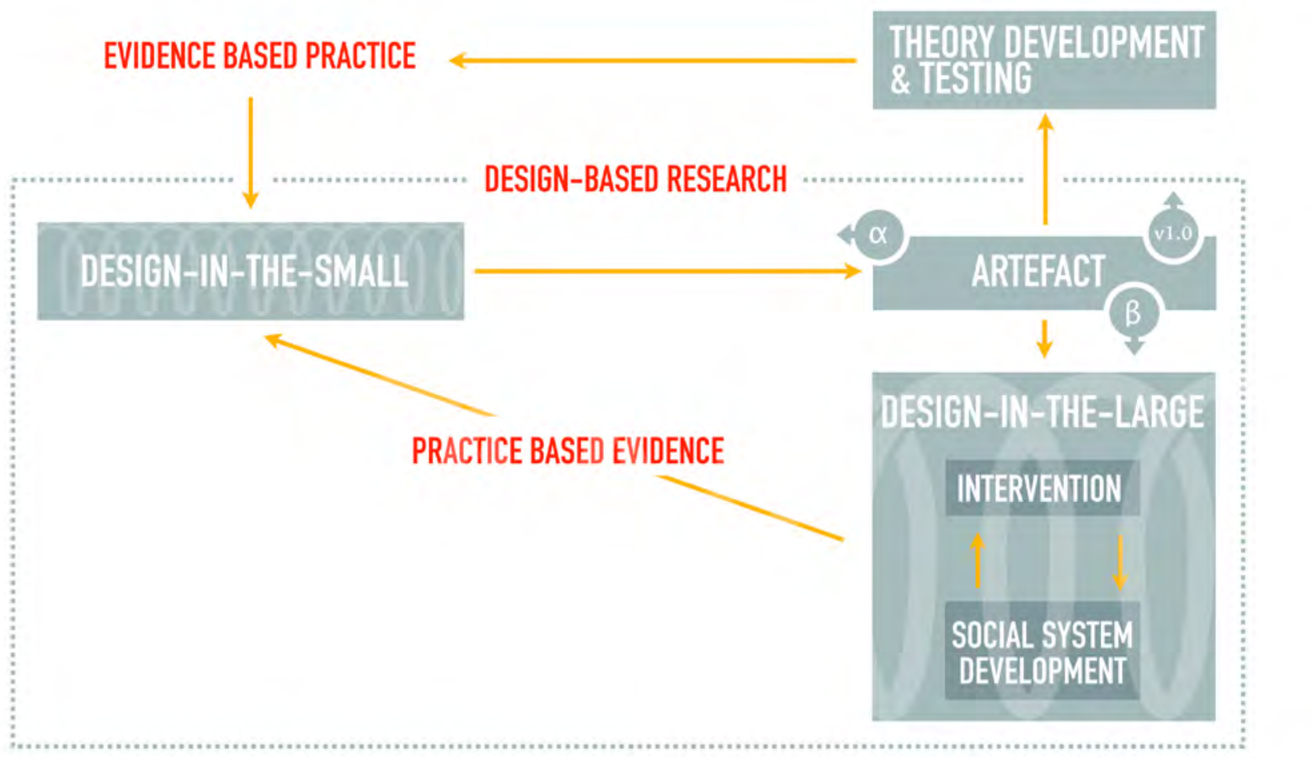
2.1 Design-in-the-Small

The design-in-the-small (DIS) [13] is a phase in the design process, with the instrumental perspective as its core, and the aim of iteratively arriving at a design of an artifact. It is iterative in the sense that the artifact grows into a fixed form by means of prototypes (predecessors). An artifact is a product consciously created by human action in the broadest sense of the word: it can be a traffic square, a mobile application, a service, a building or a law, for example. In this phase, an artifact is developed to improve, or better understand, a situation. The DIS, as shown in Figure 1, ultimately leads to a prototype of a certain justified 'completion' (artifact β), mature enough to be tested autonomously as an intervention in the social system for which it was developed.
It is emphatically not the intention that the artifact is implemented or judged by means of an impact study: the design process is still ongoing. The DIS takes artifact α, and through prototypical research arrives at artifact β.

2.2 Design in-the-Large

Like design-in-the-small, the design-in-the-large (DIL) is a phase. The DIL [13] deals with the further development of the prototype towards finalization, but in conjunction with, and fed by the social system. As said: at the start of the DIL, the prototype is still under development, but refined enough to be tested live. What is special is that at the moment it occupies its position in the social system, the artifact becomes, and evokes, more than can be expected from the prototype. In this situation, it can be said that the medium is the message [14]. The experienced artifact grows into an intervention (Figure 1), and with all its systemic affordances [10] the message is received more broadly and possibly explained differently than intended from its DIS.
Meanwhile, the various actors within the social system experience the prototype as a joint, negotiable zone: they attribute meaning to the artifact from their own cultures. The artifacts arising from the design activ-

Figure 1: Design-based Research, Design-in-the-Small and Design-in-the-Large, adapted from Klabbers (2003b)



ities become boundary objects [15], which lead to a shared understanding, trust, commitment and ultimately a common language that connects the worlds of the designer and the target context. The social system relates to the prototype and provides new and often unforeseen information that can be used to improve the artifact itself. The artifact is domesticated by the user. The artifact influences the user, and the user determines which elements of the artifact they will employ [16,17]. However, assumptions made in the DIS may turn out differently, and specific conditions in the DIL may impede on the operation of the artifact. The DIL provides rich insights into the operation of the artifact in situ and will lead to a further honing of the prototype, thus going further than implementation alone [18].

However, the influence described above is twofold: the disruptive nature of innovation means that it is not limited to the artifact alone, but the social system itself is also an object of development. It is designed with

and attuned to, the prototype. Herein lies the basis of social system development: the target context, the large, also changes. It is precisely because of this process, the development of the social system in conjunction with the artifact, that the DIL differs significantly from an implementation phase or roll-out. Through further development of the prototype, through the DIL, the artifact β expands to artifact v1.0.

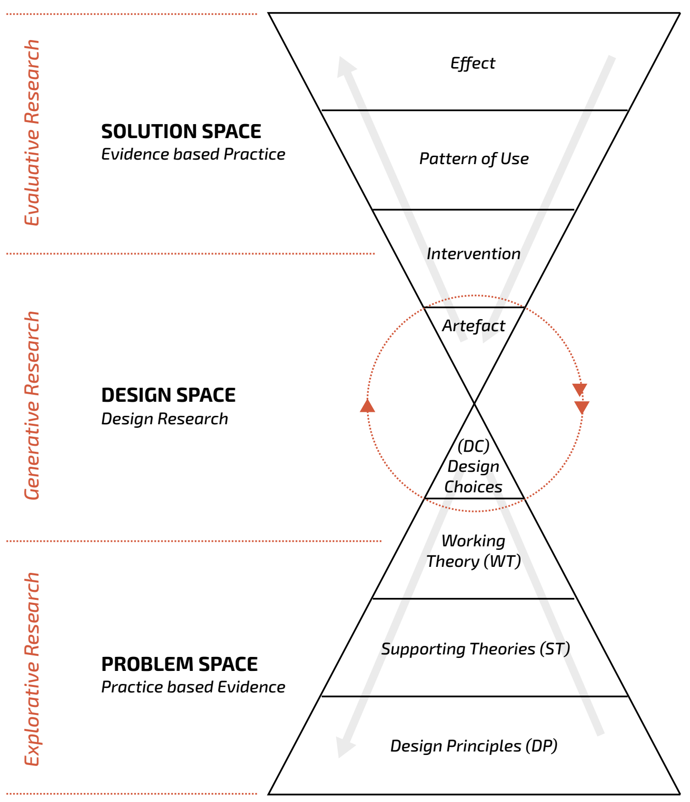
3 Theory Development & Testing

Within the domains of care and welfare, the terms practice-based evidence (PBE) and evidence-based practice (EBP) provide footholds for the typification of research activities. Figure 1 shows how PBE and EBP relate to the outlined DIS/DIL perspective. The position of EBP is important to clarify. A common discussion during the projects concerns the effectiveness of the digital innovation: how and when do we know if ‘it works’? This question on effectiveness often literally results in a jump to conclusions, whereby the design space (see Figure 2) is skipped. This important issue needs emphasizing when it comes to design research. It is only after its DIS and DIL that an artifact v1.0 is ready to be assessed from an empirical perspective.

3.1 Layers in Serious Media Design

The position of the design study is further explained in Figure 2. The so-called wickedness of issues [19,20] can be approached systematically by creating clarity as to where in the process the study takes place. Studies in the problem space are about the systematic exploration of the problem, target group and theoretical justification departing from existing interventions and leads to a so-called design hypothesis.

Figure 2: Layers in Serious Media Design

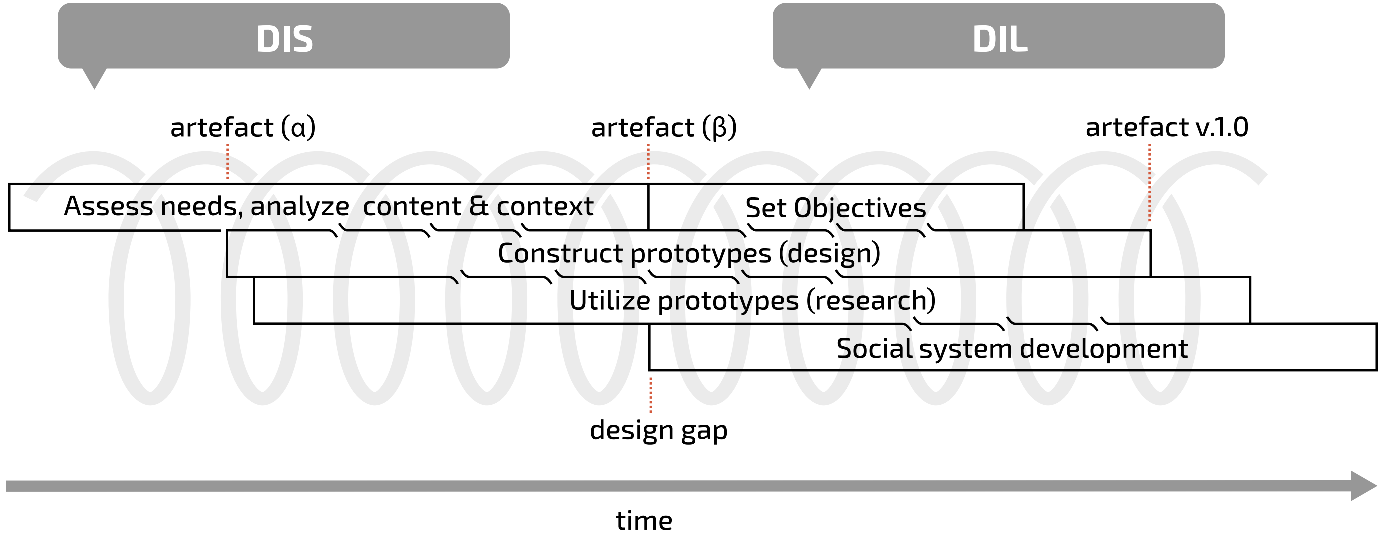


In the design space, the Design Research Framework (Figure 3) becomes the leading framework. In the DIS phase, the design hypothesis is concretized into design principles that are converted into prototypes-of-disposable-quality. In the DIL phase, the artifact grows to a certain maturity at the same time, while its effectiveness and suitability have already been demonstrated to a very large extent. In the solution space, one can use the implemented artifact to research the usage patterns and empirical effectiveness of the intervention.

3.2 Design Research Framework (DRF)

Specific to the design study, within the design space is the Design Research Framework (DRF, Figure 3). This model is based on the Instructional Design Model for rapid prototyping [21], which originates from the field of education. The reflex to think in terms of end solutions (often guiding a design process) is deliberately curbed by the DRF through methodically exploring the existing situation (assessment of needs, analysis of content and context). This almost always leads to a diversion and an in-depth investigation of the initial issue. A common mistake is to interpret the design gap as a single activity preceding the design

Figure 3: Design Research Framework (DRF), adapted from Tripp & Bichelmeyer (1990)



process. The closure of the design gap is the result of framing (Schön, 1983). It is not about pre-determining the current situation versus a desired situation, but about a deep understanding of needs, (existing) content and context. In this phase (DIS), reasoning should be resource-free (without a concrete solution in mind), with the current situation and the desired situation preferably defined from the perspective of the end user.

In the DRF, articulating the design gap coincides with artifact β, a key moment in the design study. This moment seems to be halfway through the project, but this can vary from project to project and depends on the wickedness of the issue at hand. Until then, prototypes are preferable of a disposable quality and do not contain the DNA of the end product. They are used to quickly validate ideas and concepts and serve as in-between objects: after all, the designer's paradox can only be solved through abduction [22]. The DIS works towards an eventually consistent closure of the design gap with a corresponding prototype (artifact β).

Figure 3 shows a spiral that interacts with the running phases of the DRF. The spiral represents the iterative and incremental character of the design study. The focus of these iterations is in line with the non-linear focal areas of design thinking, such as define, iterate, and ideate [23–25]. The framing stage (as part of the DIS) with its analyses has already been described above, as has the importance of social system development (as part of the DIL). The interaction between the construct and utilize prototype stages is the driving force of the design study. Depending on the position in the DRF (DIS/DIL), the prototype is continuously informed by research results from the iterations. It is important that a continuous balance is struck between rigor and relevance here [26] by correctly applying the right methods at the right time.

eHealth projects (like many other design driven projects) are by definition highly complex and bound to predetermined limits by grant providers. Detailed formulations of final objectives and products are almost always demanded in advance, which effectively means that the most drastic decisions are taken when the knowledge available within the project is at its minimum. In practice, these prerequisite learning outcomes are an obstacle to fully exploring an issue, with the result that valuable insights are not investigated or taken into account. A related consequence is the steering towards the end result or intended effects too quickly.

The DRF offers tools (including timing and dynamic role) to bring end-users, designers, producers, and other stakeholders closer together around the innovation of a shared digital future. It clarifies the research and design process and gives something to hold on to in the project organization.

3.3 Design Research in Education

The application of design research in Health Education requires students and teachers to have specific knowledge and skills. Mere knowledge of the DRF or design research, in general, does not suffice. It is the own social system, the educational practice, that needs to be co-developed in order to be able to employ design research in Health Education successfully. A growth mindset [27] also seems to be a necessary condition for teachers to give the design space a place in health curriculums: here, too, design-in-the-large seems necessary.

Acknowledgments

This article draws on the experience gained from a number of innovative design research projects in health and healthcare. Each project had its own structure and associated funding, for which acknowledgments were made in an appropriate manner at the time. The number of students, end-users, content experts and project staff involved is too large to mention here. The authors want to express their thanks to everyone involved, especially to Dr. Job van 't Veer for additional funding.

Declaration of Interest

The authors report no declarations of interest

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Brothers - A Tale of Two Sons (2013)

A man, clinging to life. His two sons, desperate to cure their ailing father, are left with but one option. They must set out upon a journey to find and bring back the "Water of Life" as they come to rely on one another to survive. One must be strong where the other is weak, brave where the other is fearful, they must be... Brothers.

Image: © Starbreeze Studio / 505 Games, All Rights Reserved.

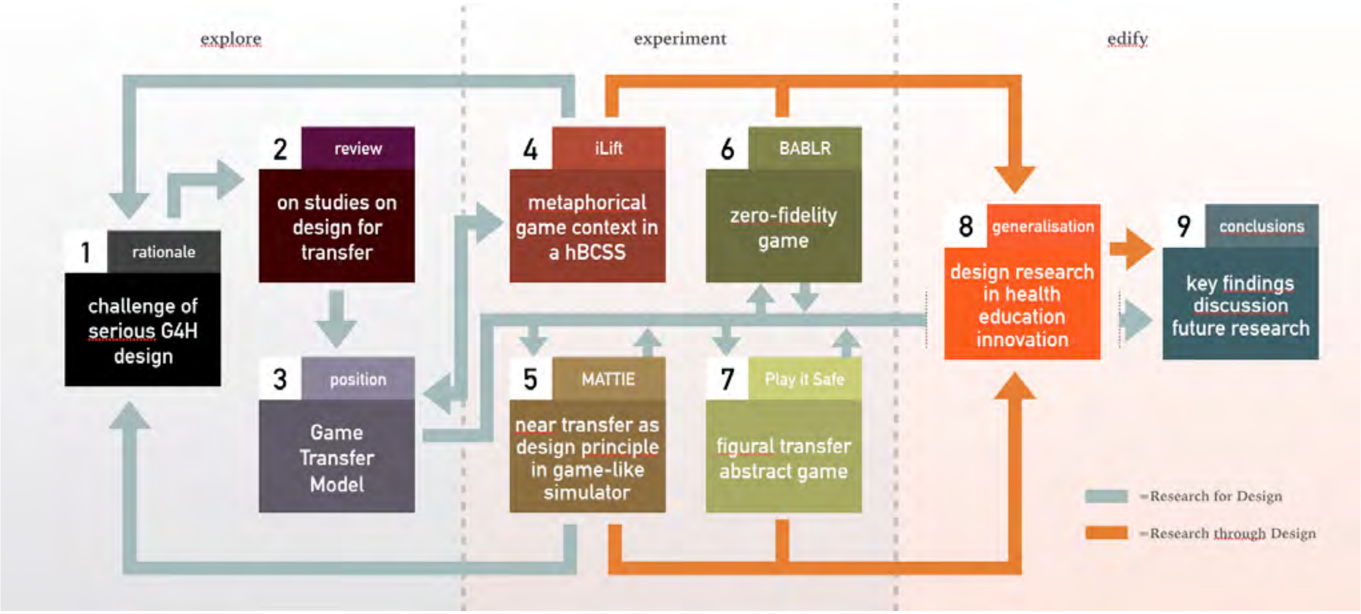
Chapter 9: Summary, Key Findings, and Future Perspectives

Epitome

In the literature surrounding serious games, one often finds reference to the so-called serious game oxymoron. Finding its origins in ancient Greek language, an oxymoron is a rhetorical device wherein two semantically opposite words are combined into one self-contradictory paradox (oxus meaning sharp and moros meaning blunt).

Abt (1970) was the first to identify the concept of serious gaming as oxymoronic, due to the contradictory nature of striving towards serious goals through making use of an inherently non-serious medium. After almost fifty years of further research, Games for Health (GfH), due to their inherent characteristics and opportunities, are still seen as promising regarding the possibility of their application in educational settings. However this application is as of yet far from commonplace. More precisely: the digital games and game-like interventions that have been applied within Health contexts are for the most part simulations wherein verisimilitude seems to be an almost necessary condition.

Figure 1: a schematic overview of the chapters in this thesis in their mutual relationship.



This thesis asserts that this design rationale focusing on realism, while perhaps being a perfectly reasonable choice in approach, upholds the current way of regarding serious games as oxymoronic, and therefore attention should be shifted toward different forms of serious gaming. Apart from the aforementioned simulations that are defined by their truthlikeness and a literal reflection of our reality, we must not forget the existence of games that follow a different design rationale, focussing more on figurative, metaphorical contexts as carriers of the gaming experience. It is predominantly this last type of game that seems most promising for effectuating lasting behavioural change and other educational goals.

Having systematically reviewed medical databases, it has become clear that games of the latter category –those relying on figurative rather than literal contexts- are almost completely unrepresented within Health applications. Tackling this matter through the conceptual lens of educational transfer offers the theoretical foundations for designing and applying this as of yet vastly unexplored type of serious Games for Health. Fundamental to the Game Transfer Model, as introduced in this thesis, is the assumption that the external appearance of a serious game foreshadows the type of transfer that said game will ultimately incite. This approach, encapsulated within the moniker design for transfer, has been the driving premise behind four studies focussed on designing non-literal serious gaming prototypes for Health.

Two tracks

As shown in Figure 1 from the introduction chapter, there are two tracks that run through this thesis. The blue route deals with the exploration, conceptualization, and application of transfer theory in the design of games and game-like interventions regarding various serious goals. It is the key findings and conclusions from the blue track (Research for Design) that form the heart of this dissertation.

In order to carry out the experiments, a design research approach was followed to investigate multiple variants of the game-like interventions for suitability and effect by means of prototypes. It was precisely this applied way of research in various Health contexts that yielded interesting by-catches, which are visualized in orange in Figure 1. However, these by-catches are not merely accidental and are thus to be understood as Research through Design [1].

The Layers in Serious Media Design framework (LisMD) was developed in order to elucidate the design research process of the gaming prototypes described in this thesis. While an educational-scientific perspective is already represented by the GTM, which identifies a new route for design rationale, the LisMD-framework works as a blueprint, a constructional plan of arrangements so to say, for creating a design research process for serious game-like interventions. All the while, mutual values from both Health Science and Design Practice are taken into account.

The findings of this thesis are of the utmost importance for both designers of games for Health as well as innovators in education because: a) these findings have deep implications for enhancing the way in which instances of serious gaming can be more directly matched with specific educational or behaviour-changing goals, and b) these findings prove that there are many possibilities for enlarging the arsenal of serious games and game-like interventions within the field of Health. Moreover, this thesis explicates the need for more attention to design research and abductive research methods in Health curricula, in order to prepare for future challenges.

Pt I: Blue (Research for Design)

Games and game-like interventions are widely regarded as an important carrier of learning and are even mentioned as a new paradigm for e-learning. Although the usefulness and possibilities of this technology are beyond dispute and there is sufficient support from scientific research, there is no widespread use of games in Health. Of course, the acceptance of such media as a serious educational instrument plays a role, but, certainly, in Health and Health care, truly meritable examples of serious games are rare, apart from simulations for training purposes. There (as of yet) is no wide adoption of games and game-like interventions within Health curricula.

It appears to be a wicked problem to design serious games that retain the unique and motivational characteristics that make games as a learning tool interesting in the first place. From an analytical perspective, game research studies the successes of major game titles and then concludes that our own serious games have adopted a number of characteristics, but lack the real look and feel of 'a good game'. Development budget is mentioned as an important factor for this, but that alone is not a tenable argument:

even in indie game development, very attractive and effective games are developed at a fraction of the budget available for educational instrumentation in general.

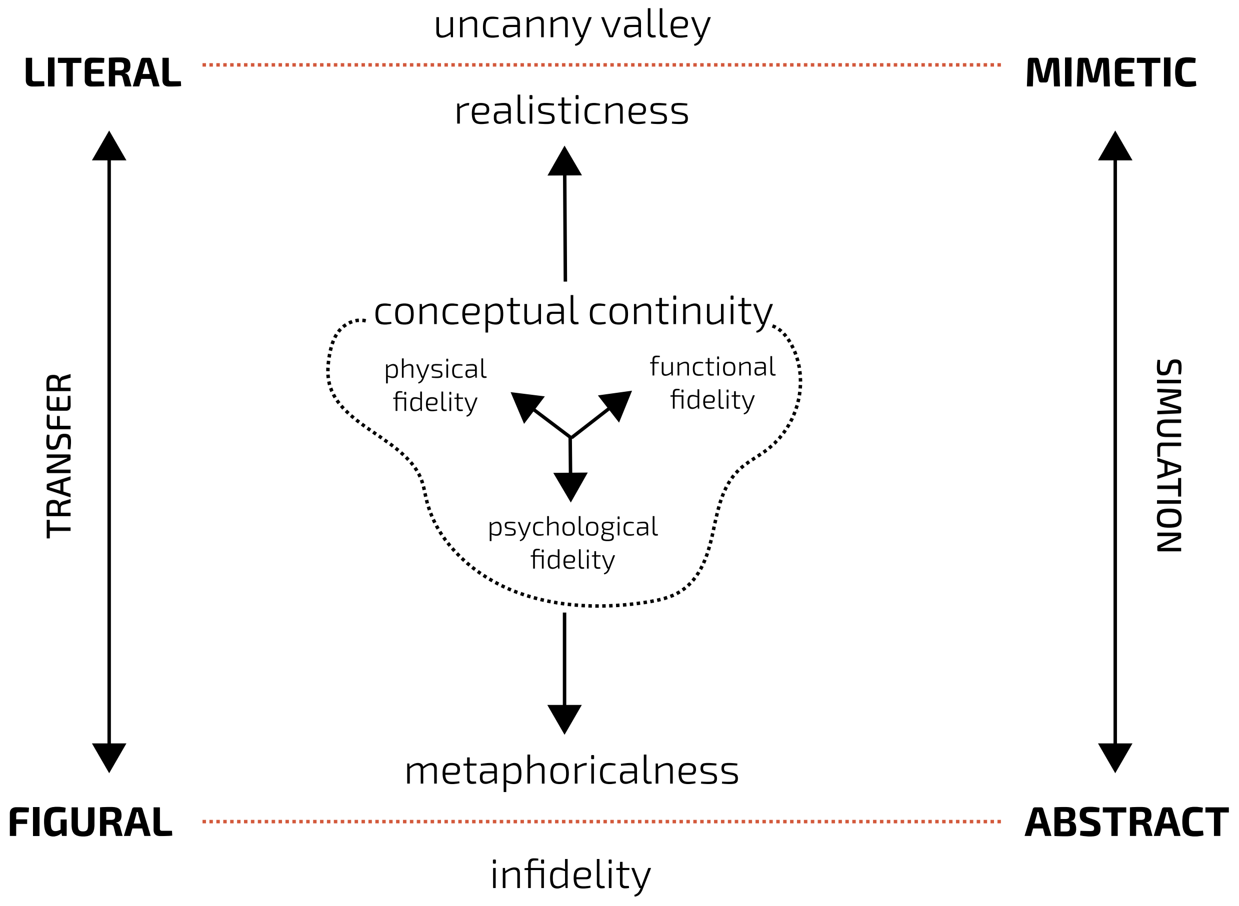
This research explored a possibly novel educational angle on how learning and behavioral change can be embedded in a game. Transfer theory offers an interesting starting point for this, in particular, the idea that one can design specifically and intentionally for learning to take place via a certain transfer road. Serious games, in general, tend to be literal, preferably high fidelity simulations of known reality. This literal approach of games for Health relies, whether intentionally or not, on (a form of) literal transfer. Key for literal transfer to occur is the degree of similarity of the simulation and the targeted context. Verisimilitude is conditional for its expected effectiveness.

At the same time, this rationale excludes other forms of transfer, the so-called second-class transfer types, which could make other, non-literal, manifestations of serious games possible. Game types that do not literally represent reality or lack an instantly recognizable link with reality, are rarely considered as serious games for learning or behavioral change.

In **Chapter 2**, a systematic review was executed through a literature search in medical databases for game research specifically aimed at more abstract, non-literal games. From almost 20,000 articles on serious games for Health, we found 3 studies in which the designed games utilized non-literal game elements. We found that in studies on game-like interventions for Health and Health care, transfer is regarded merely as a desirable effect, not as a guiding principle for design. None of the studies determined the second class of transfer or instances thereof. Games and simulations for Health abundantly build upon the principles of first-class transfer, but the adoption of second-class transfer types proves scarce. One of these 3 studies explained the design rationale, the other studies did not describe why or on what grounds this particular type of game was chosen.

The question remains whether this preference for literal instantiations of serious games is a conscious one or that it is simply because of not considering or knowing alternative transfer types. In addition, the proven one-sided transfer approach in the design of serious games for Health can be regarded as an obstacle in the endeavor to embed serious content into a game: the notorious) serious gaming oxymoron [2].

Figure 2: The Game Transfer Model links transfer types to instantiations of simulation, ranging between realisticness and metaphoricalness.



Loss of sense of time, loss of self-awareness and environment, heightened ability, control and agency, providing an autotelic experience and suspension of disbelief are coveted game features known from the literature. These properties are linked to motivational qualities, often found in imaginative worlds, providing intriguing adventures and curious quests. These games can be considered serious when in-game actions or experiences are meaningful for the target context. Making these meaningful actions explicit often happens before or after playing the game, which in literature is referred to as the motivational or reinforcement paradigm [3]. Pre- or debrief sessions are an essential part of the design of this type of

serious games and require a specific educational perspective. It is important to point out that the notion of learning and especially the transfer of learning to the target context seems to be a steering mechanism in the design of games or game-like interventions, and may be the cause of a one-sided approach in game design. This dissertation is about the exploration and application of precisely the counterpart of the known literal simulation of reality. Tailored to what needs to be learned, it can be an intentional choice to opt for non-literal game design. Educational science provides the theoretical underpinnings for such an approach in the form of transfer theory, where the various forms of transfer of learning are divided into a clear, literal way and a more difficult to capture abstract way.

Chapter 3 combines insights from various scientific disciplines (media and cognitive psychology, educational technology and game design) to construct the Game Transfer Model (GTM, Figure 2). This model forms the theoretical framework and design hypothesis for a number of prototypical game-like interventions, in which experiments are conducted with design for figural transfer.

Passage

An example of a metaphorical, abstract game is Passage. Passage is a very minimally designed side-scroller game, which can be played in a few minutes. You are an avatar, who has to maneuver through a two-dimensional maze as your life unfolds. You become aware of the passage of time through decreasing vividness of colors, the

Figure 3: The protagonist a few moments before the death of his spouse.

Image: © Jason Rohrer, All Rights Reserved.

finding/marriage-and death- of a partner, and your own external characteristics that indicate the dissipation of your life. All of this happens relatively quickly and you become aware of it while playing. Due to the fixed duration of the game and the player's steady aging, regardless of the in-game choices, the game ends with the death of the avatar. In the game, the player spends five minutes experiencing a character's entire lifetime, but that is more than enough to evoke a powerful emotional experience. Passage is an example of a game without high fidelity graphics, deliberately set up very minimal, which nonetheless still maintains an immersive character. Although the game has not been designed as a serious game, it does provide a number of lessons. The reminder of life being volatile and thus the importance of being considerate to one another within its relatively short span, perhaps even leading to a revaluation of one's own existence are possible benefits after playing.

A game is a context is a metaphor

In **Chapters 4, 6** and **7**, the Game Transfer Model (GTM) was used as a starting point for designing game-like interventions in various contexts. In these design-oriented projects, GTM was applied to design games, wherein the serious goals are achieved by a second class of transfer type. As proposed in the theoretical exploration in **Chapter 3**, a process of metaphorical recontextualization has been initiated for this purpose. In each project, the essence of the issue at hand was investigated and, together with content experts, possibilities for a non-literal approach were explored. In all cases, a design research approach was used to find the best suitable metaphor for the target group in question and the intended results. The preservation of the described conceptual continuity to prevent fidelity dissonance was fortuitous. The iLift game experience (**Chapter 4**) is designed to trigger figural transfer of lifting and transfer techniques (LTTs) by offering a series of carefully chosen and calibrated metaphors. The game mechanics scaffold the players' in-game behavior: static LTTs are recontextualized and repurposed in a game context. Within this research, we have been able to demonstrate that, in terms of Health behavioral change supporting systems (hBCSS), compliance and behavioral change have been realized. In retrospect, also driven by the course of the project, the gaming artifact has worked in a blended transfer manner. The LTTs were automated by repeatedly playing and mimicking the actual necessary techniques in a true-to-life manner. Learning and behavioral change are achieved by low road [4], first-

class transfer. The awareness of the importance of and insight into one's own lifting and moving behavior was triggered by figural elements. In **Chapter 5**, the Design for Transfer rationale led to a design for a game-like simulator for training social problem-solving skills in adolescents with a mild intellectual disability, as an addition to the field of psycho-education. A specific characteristic of mild intellectual disability (MID) is that transfer of learning hardly occurs with this target group. Cause and effect relationships are barely established and lessons learned do not transfer to new contexts. Existing psycho-education is given in a therapeutic setting, whereby transfer (in whatever form) to the real-world context is taken for granted. The literature on MID describes that abstractions (and therefore possibly metaphors) are too complex for this target group and that learning should take place in line with the world of perception as much as possible. In the design, we maximized authenticity and realism, not just in the appearance of the presented video cases, but also in timing and in the presentation in the personal, non-therapeutic setting, contributed to the optimization of transfer conditions. Maintaining conceptual continuity was key in the successful design for near transfer: a first class, literal transfer type.

As stated in **Chapter 3**, a key driver of success for a good serious game is conceptual continuity. Congruence in fidelity types is therefore made conditional. To further explore the possibilities of designing for figural transfer, an experiment with a prototypical game-like simulator was conducted, as described in **Chapter 6**. Magnifying the notion of low fidelity to a somewhat overstated extent, this study deals with a zero-fidelity stimulator, building on existing theories about reducing fidelity. Usually, fidelity is about abstracting all physical and functional elements. But there is a third type of fidelity, which forms the soul of the game experience: psychological fidelity. In the literature, psychological fidelity receives significantly less attention, although it correlates strongly to credibility, suspension of disbelief, and engagement. The BABLR simulator reduces physical and functional fidelity to a minimum (hence the label zero-fidelity) and explores the use of psychological fidelity as the main carrier of an authentic learning experience. Future learning and meaningful experiences gained within the zero-fidelity simulator can, due to the lack of both physical and functional fidelity, only be attributed to transfer via a figural, second class transfer type (high road, backward reaching). **Chapter 7** describes the design choices and theoretical constructs that have led to the development of an occupational safety game, going by the name Play it Safe. I was initially hesitant to include this chapter in this dissertation because the intended results were not achieved. In no way have any predictors of success been found, that could indicate the occurrence of transfer towards increased situational awareness. Nevertheless, the article is included, because the experiment with designing for a second class transfer type has been of value in exploring the Game Transfer Model. Play it Safe is a tower-defense game that uses situational data collected by employees during their daily work, to impact the parameters of the game. This data is gathered through a safety campaign called Count Yourself Lucky (CYL) to quantify the amount of times employees used the supplied STAR-safety protocol (Stop Think Act Review). Play it Safe aimed to improve employees situational awareness, creating a shared mental model and bottom-up accountability, meant to improve and align shared safety behaviors. In the game, the real-life data for decision-making encountered in the work environment is recontextualized and was expected to subconsciously reinforce the training of the STAR-protocol and conservative decision-making in real-life.

The main problem with the game was that use context was not sufficiently taken into account in the design -and thus recontextualization- of the gaming artifact. The main reason for the use of a metaphor was not prompted by the desire to consciously design for a specific transfer type, but by the idea that a generic metaphor could be appropriate for all kinds of security issues. This resulted in a game metaphor that was far from recognizable to the intended end user, making it unrelatable to any context and thus untransferable. This conclusion is an important lesson in intentionally designing for non-literal transfer: the metaphor must bring together use context, user context, and technology context [5] in a consistent whole while addressing the right problem.

In summary, it can be concluded that metaphorical recontextualization is effective as a design principle for designing serious games and game-like interventions for Health. An important notion is that learning or behavioral change in such Health contexts occurs through second class or transfer types, and more specifically figural transfer. The main reason for considering design for figural transfer in thinking about serious game design is that it offers opportunities for designing close to the nature of what a game can be. In a number of con-

texts, experiments were conducted with designing for figural transfer. Because of the difficult to capture nature of transfer, it is usually measured on mere learning, something that is often seen in serious games: the decontextualized offering of explicit knowledge in a gamified form. These are the games in which serious goals do not or hardly coincide with the systemic affordances of (good) games: the baby is thrown away with the bathwater, while we are left with only mediocre games, that are marginally enjoyable to play.

If a serious game is seen as a context of its own, designed to optimize transfer conditions, the serious goals must be meaningfully recontextualized, whether or not in a metaphorical way. Monitoring conceptual continuity, carefully weighing up fidelity types in accordance with the goals to be achieved and a deliberate, predetermined choice for the entertainment-educational blending paradigm , will lead to better games. Introducing figural transfer in the design of serious games hands the educationalist tools to explore new (or under-exposed) ways to get serious content across and enables game designers to integrate serious content in more playful ways.
It is a known fact that transfer is difficult to measure, mainly because it is never exactly clear when and in what form it will manifest itself. Measuring the effects of education is therefore often limited to measuring mere learning, or 'memory tests' versus 'different learning experiences' [6].

The use of metaphor is a well-known didactic principle, probably as old as humanity itself. The Greek word μεταφορά (metaphorá) actually means 'to carry over' or 'to transfer'. A metaphor is a designed context within which everything is connected, has meaning or within which truths are packed, waiting to be discovered. A game can very well be such a designed context.

Key findings

1. In designing serious games or game-like interventions for Health, transfer of learning or skills is seen merely as a desirable outcome, not as a guiding principle to aim for.
2. The intentional application of second class transfer does not occur in the design of serious games or game-like artifacts in Health, which excludes the most immersive and successful game types.

3. The occurrence of transfer of learning is problematic to measure, which is why tests are often limited to determining the presence of mere learning. The result is that mere learning in serious games almost always results in literal or de-contextualized instantiations of serious games.
4. The application of metaphorical recontextualization is a complex and creative step in translating design choices into a manifestation of the game-like artifact. Based on educational principles regarding second class of transfer, the GTM expands and advances the possibilities of serious game design for Health in accordance with the innate properties of video games.
5. Moderators for triggering learning experiences e.g. wishful identification, parasocial interaction, narrative transportation, immersion and presence, flow experience, mastery of challenges, and suspension of disbelief are particularly suited to be enhanced through abstract, second class transfer game types.

Pt II: Orange (Research through Design)

The Game Transfer Model is a demonstrated practicable addition to the discourse surrounding the design of serious games for Health. In numerous conversations and presentations, the model has invariably been supported and approved, and the experiments from this thesis yield enough early predictors of success to justify further research. However, in a hypothetical state, it remains a theoretical construct, and thus without tangible implications. The aim of this thesis is to assess the merits of the design hypothesis labeled Design for Transfer in different Health contexts. **Pt I** of this chapter described these contexts and their conclusions, **pt II** reports on a number of noteworthy by-catches, especially regarding the models developed to bridge the gap between Health and Design.

Research and development of interactive digital Health interventions, like games for Health, require expertise in identifying user needs, utilize abductive design techniques and call for the ability to appropriate prototypes towards proven effective interventions. Two of the central areas of expertise required are Health (broadly defined) and Design Practice. In carrying out the experiments, it turned out that these two worlds still seem far apart. I will endeavor to illustrate this with an example.

Figure 4: The Re-Mission video game was created by HopeLab specifically for young cancer patients.

Image: © Realtime Associates / Hopelab, All Rights Reserved.

Chapter 2 describes a systematic review in which examples were sought of the presence of figural transfer in serious games for Health. In advance of the review, we had knowledge of the existence of the video game Re-Mission [7]. Re-Mission is a well-known example of a successful game for Health, designed for children with leukemia. Video-game play includes destroying cancer cells and dealing with common treatment-related adverse effects. The player controls the microscopical nanobot Roxxi to battle cancer in the body of a fictional cancer patient. She does this by shooting

bad cells with a chemo-blaster, using rockets loaded with medicines, floating through the lymphatic system. Re-Mission makes obvious use of non-literal metaphors, and, from the perspective of this research, clearly uses second class transfer in achieving its results. In a number of studies, the effect of the game is convincingly demonstrated, especially in terms of increased therapy adherence and self-efficacy among the target group. However, the studies on Re-Mission did not surface in our systematic review, even after broadening the scope of the search strategies. A closer look at the main studies on Re-Mission showed a focus on the effects of the game. These were measured by comparing them to a knowledge test in a control group: testing mere knowledge. A mentioned working ingredient for the expected effectiveness of the game was found in the self-modeling theory [8], without further exploration of how this theory leads to the chosen design of the game. Studies on Re-Mission do not describe why the game looks as it does, nor do they give generalizable clues or design principles for future serious games for Health.

Not explicating the design of Re-Mission, makes the chosen appearance of the intervention, which has proven to be successful, almost seem to be based on coincidence. This is obviously not the case since in Re-mission 2, in the successor of the first game, the purely knowledge-based educational elements are reduced and the focus is mainly on where the first version proved successful: boosting positive emotion, increasing self-efficacy, and shifting attitudes toward chemotherapy.

Although Health and Design share some research methods and values, interdisciplinary research invariably poses challenges: values, assumptions, terminology, methodology, and culture make interdisciplinary collaborations challenging, often resulting in sub-optimal project outcomes [9]. Testing and validating, on and with the shop floor, the Design for Transfer hypothesis, as conceptualized in the GTM in actual Health practice settings, required a common language necessary to get design research approach understood and accepted in the contexts of Health Innovation.

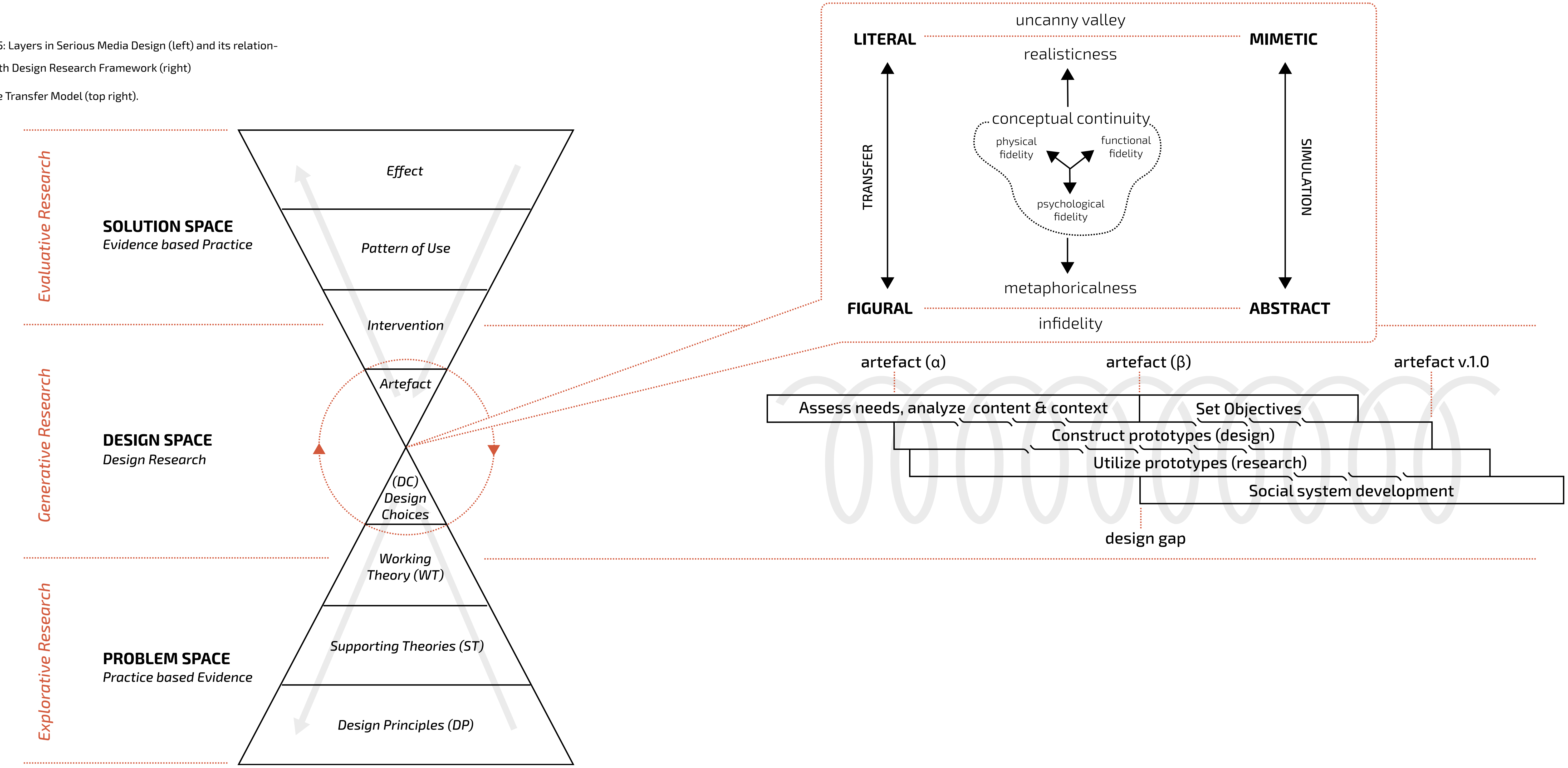
In an effort to address these aforementioned differences, design through research (orange track) resulted in the development and application of an overarching model. Whereas the Game Transfer Model (GTM) forges a specific, unexplored connection between educational transfer theory and serious game design and is, therefore, a specific addition explicitating design rationales within the design space, the Layers in Serious Media Design is a framework for the well-founded design, appropriation, integration, and testing of (digital) artifacts with serious intent. The Design Research

Framework is placed in the design space of the LiSMD which monitors both the iterative and incremental character as well as the required rigor-relevance balance within the design research process.

In **Chapter 6**, LiSMD is presented in its entirety and used within the BABLR context. In the previous contexts, initial ideas and precursors of the framework have been used. Chapter 8 is devoted to the difference in Health and Design culture and provides further substantiation for the LiSMD as an in-between object and an explanation thereof. The LiSMD framework fulfills a number of functions. First, it can be used as a means of communication, particularly to unite the world of Health and Design. Besides the professional, cultural, and vocational differences, there is an important distinction in research philosophy. The LiSMD places explorative, generative and evaluative research in its own spaces, each with its specific methods and position in a design research process. Secondly, the LiSMD can be used as a guideline in design research by interpreting the layers in the spaces as (not necessarily consecutive) steps to be taken in the process. Documenting the methods used and the subsequent findings per layer ensures the explicitation and substantiation of the design process. The iterative and incremental character of the research as it takes place in the Design Space is illustrated by the Design Research Framework. This gives further substance to the way in which design research informs the gradual build-up of an artifact. Thirdly, LiSMD ensures that known evidence-based knowledge is given a clear place in the design process. In line with the serious intentions of the artifact to be designed, the active ingredients from an appropriate, existing Health intervention or theory form the starting point. However, the goal is not to provide a digital, game-like translation of an already existing, analog approach, but to create a new artifact with an innovative approach to the issue at hand, combining the critical appraisal from Health and the abductive character of Design.

In summary, the LiSMD model provides a cross-domain perspective and overview of key areas for achieving an innovative and effective artifact with serious intent. Besides the theoretical foundation and use of practice-based evidence from the problem space, the model places focus on the design space, in which iterative and incremental design research works towards early predictors of success. This leads to a blueprint of an artifact which, besides being the carrier of the working ingredients in a new form, is also a concept trialed on appropriateness and social acceptance before entering the solution space. In this way, the artifact will be fitted to

Figure 5: Layers in Serious Media Design (left) and its relationship with Design Research Framework (right) & Game Transfer Model (top right).



meet the serious objectives and the chance of an effective intervention will be optimized. All this offers a new understanding of what is now called implementation.

Key findings

1. LiSMD offers a framework within which shared language, perspectives on research and design practices are combined and can, therefore, play a supporting role in (the discourse on) design-oriented research processes aimed at designing artifacts with a serious approach, such as games for Health or digital innovations in general.
2. Especially design-in-the-large is lacking in Health innovation projects, where implementation often replaces the crucial phase of social system development. Social system development within Health innovation aiming for artifact development should be an integral part of a design process for successful adoption.
3. Designers of Health curricula and professionals in the field of Health innovation are called upon to pay attention to a cross-domain perspective. In particular, the introduction and use of design research for achieving innovation and finding solutions for wicked problems require attention. Creative confidence, abductive reasoning, and a designer's mindset are competencies that belong to the Health professional of the future.
4. Studies on proven effective games or game-like interventions for Health should explicate their design rationale, so generalizable design knowledge becomes usable for future G4H. Successful game-like interventions are the result of a well-executed design research process, from which lessons must be learned to advance the field of Health Innovation.

Future work

'Designerly ways of knowing' may sound insubstantial, but is exactly what Health culture should be looking at in its search for innovation through serious digital interventions. Health research has a rich history in the sciences: studying the natural world with profound cultural values such as objectivity, rationality, neutrality, and a concern with truth. Values of Design can be found in practicality, ingenuity, empathy, and concern for appropriateness [10]. In order to master these values and appropriate research methods, the manner in which people are educated is just as important as the matter which is transferred. The above is in itself a wicked problem for future Health education, however insufficient

attention is devoted to the matter in current curricula. en lijkt niet een punt van aandacht in huidige curricula. The values of Design are more easily understood when taking into account the contexts of, for example, the development of serious games for Health or e-Learning purposes. Especially considering the ageing nature of our world's population and an ever increasing reliance on (health) technology, values of design are ever more indispensable in the process theorizing about future proof Healthcare.

As addressed in **Chapter 6**, problem-based learning, defined as learning that results from the process of working toward the understanding or resolution of a problem [11], offers leads. Exposing Health students in multidisciplinary teams to authentic and ill-defined activities concerning design issues with real-world relevance [12] may connect problem-based learning principles to design research.

Furthermore, it must be concluded that Health, when regarded as a subculture in and of itself, has now reached a crossroads where it must either choose the path of complacency toward its long-established habits, protocols and lines of thinking, or, instead of opting for a remissive attitude toward positive change, choose the path of innovative thinking. Of course, it can not be denied that Health's rich history and its ingrained values are of unmistakable importance stature, however when it comes to designing and innovating within Health contexts, these values are decidedly constraining in their effect, rather than conducive. The fact of the matter is that almost no attention at all is devoted to explicating the design rationale behind serious games for Health.

So long as scientific publications constrain their area of research to solely the question of effect, rather than the preliminary design of serious games, knowledge regarding effectively designing serious games will remain marginal and insufficient. However, this dissertation's message reaches further than just the specific practicalities regarding serious games within the field of Health. What has been described here about the matter of serious gaming is a symptom of a far larger problem of negligence toward those skill sets and insights that derive from outside Health research itself. Therefore this thesis also serves as a call to action for all those working on development and innovation (of educational and technological (products/mediums/media)), to be receptive to insights from other fields of study, that might at first seem strange and startling, but in the end may very well have a great chance of sparking much needed innovation. Through the experiences of the experiments conducted in this dissertation, it has become clear that one one must be wary of too easily conforming to currently prevailing lines of thinking with regards to education and research, as they are rigid obstacles on the way toward progress.

Another suggestion that may be helpful in thinking about, designing, and embedding game-like artifacts and serious games for Health is to see innovative attempts to this end as boundary objects. Even though there are different theories about what boundary objects are and how they work [13],[14], the idea that a shared object gets signified from different activity systems, promotes dialogue and mutual understanding. Future research should focus on whether the LiSMD framework in its current state fulfills its role as a boundary object or whether it should be refined by further trials in a novel context. Yet, I would like to conclude this point with the title of **Chapter 8:** don't jump to conclusions, and to approach this subject as a design issue itself, a wicked problem. The fact that the design research framework, as used and discussed in this dissertation, is based on a specific educational design model [15], could serve this purpose.

Then, for future research into design for transfer, there are a number of distinct research directions to formulate. This dissertation explains and substantiates how design for transfer can be seen in literal and figural game instantiations. The Game Transfer Model (GTM) is introduced as a means for designing and thinking about serious game design, stretching the possibilities from high-fidelity simulations to metaphorical fantasy worlds. The latter is important because it can substantially expand the possibilities of serious game design and is more compatible with the innate properties of a video game. By means of game-like prototypes, the design hypothesis that meaningful play can be achieved by designing for figural transfer by the use of metaphorical recontextualization was tested. The experiments proved that these so-called second class of transfer types of games can actually lead to learning or behavioral change, but at the same time revealed a number of contextual prerequisites. Conditional for a successful learning experience in a nonmimetic game-like environment is the preservation of in-game conceptual continuity defined by the congruence of fidelity-elements, which emphasizes the importance of the quality and inventiveness of the game design itself.

Further research is needed into the classification of what can and cannot be learned through second class transfer games for Health. Creative problem-solving approaches, decision making, lateral thinking, solution-oriented learning, identity development, and cognitive self-regulation are promising concepts for figural manifestations in games for Health and game-like simulations, but this is by no means a comprehensive list. A mapping to specific medical and Health topics has not yet been

created and should be included to find more targeted application areas.

Another question is whether metaphorical recontextualization suits every target group, especially if it seems to concern metacognitive skills in particular. The assumption at the time of writing is that this is not the case. Further consideration should be given to appropriate transfer types in respect of characteristics of the receiving target group.

Finally, it remains necessary to further test the GTM in several Health projects, preferably in studies in which prototypes - in terms of the LiSMD- reach the solution space. Here we will be able to determine whether the early predictors of success from the design space actually result in user patterns with associated data and lasting learning effects.

Game on.

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Hellblade: Senua's Sacrifice (2017)

Set in the Viking age, a broken Celtic warrior embarks on a haunting vision quest into Viking Hell to fight for the soul of her dead lover. Created in collaboration with neuroscientists and people who experience psychosis, Hellblade: Senua's Sacrifice will pull you deep into Senua's mind.

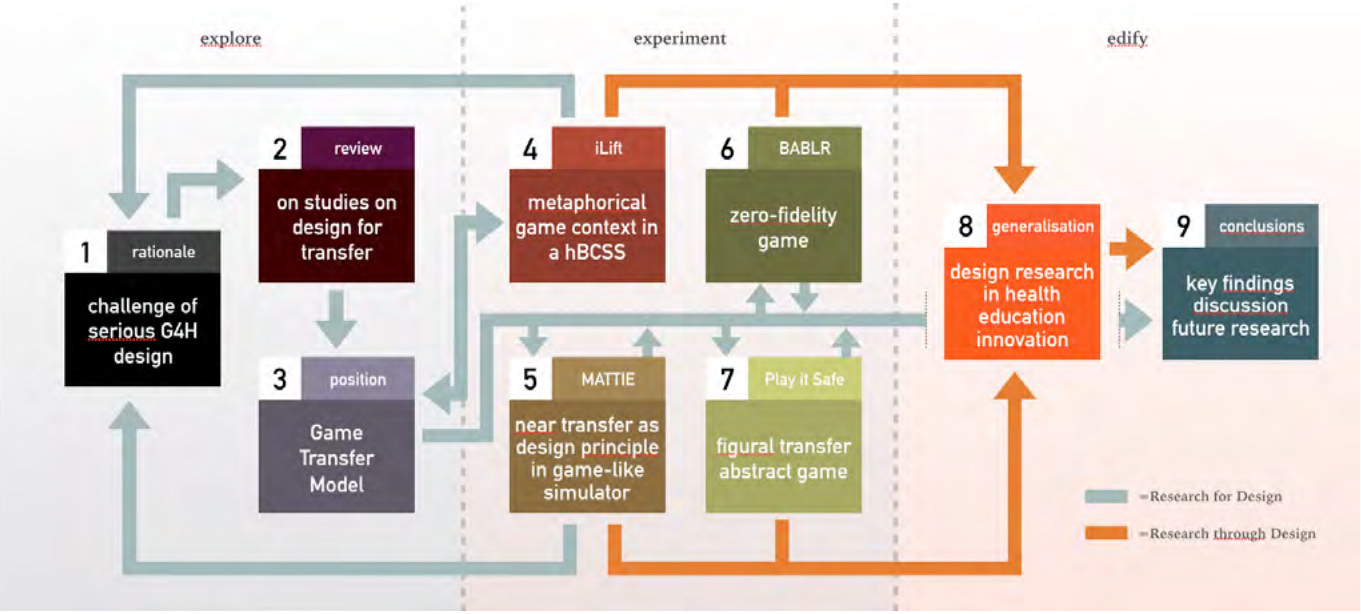
Hoofdstuk 10: Nederlandse samenvatting, Conclusies en Perspectief

Epitoom

In de literatuur over serious games wordt vaak gerefereerd aan de serious game oxymoron. Een oxymoron is een uit het Grieks afgeleide stijlfiguur waarbij twee woorden worden gecombineerd die elkaar in hun letterlijke betekenis tegenspreken, hier oxus (scherp) en mōros (stomp). Abt (1970) was de eerste die de serious game als oxymoron typeerde, vanwege de spanning in het nastreven van serious goals met een inherent niet-serieus medium. Bijna 50 jaar aan onderzoek later worden de eigenschappen van en bijbehorende kansen voor leren middels digitale serious Games for Health (GfH) nog steeds als veelbelovend gezien, maar is de inzet ervan in onderwijs geen gemeengoed. Specifieker: de digitale games en game-like interventions binnen Health die wel ingezet worden, zijn veelal simulaties, waarin gelijkenis met de werkelijkheid voorwaardelijk lijkt.

Dit proefschrift vertrekt vanuit de stellingname dat deze, al dan niet bewuste, design rationale de serious game oxymoron mede in stand houdt. Naast deze voornoemde simulaties van een letterlijke, herkenbare

Figuur 1: een schematisch overzicht van de hoofdstukken van dit proefschrift en hun onderlinge samenhang.



realiteit, bestaan er games van een andere aard en verschijningsvorm, games waarin figuratieve, metaforische contexten dragers zijn van de game ervaring. Het is dit type game dat vaak aangehaald wordt om de serious gaming belofte voor leren en gedragsverandering te onderstrepen.

In een systematic review binnen medische databases is vastgesteld dat games van deze laatste categorie vrijwel niet voorkomen in de Health context. Voortbouwend hierop, biedt het redeneren in termen van onderwijskundige transfer een theoretische basis voor het ontwerpen en toepassen van dit onontgonnen type serious games for Health. De gedachte dat de verschijningsvorm (het ontwerp zelf) van de serious game een voorafschaduwing is van het verwachte transfer type waarmee de game effectief zou moeten zijn, vormt de basis van het Game Transfer Model (GTM), zoals geïntroduceerd wordt in dit proefschrift. In een 4-tal studies is het design for transfer perspectief leidend geweest voor het ontwerp van serious gaming prototypes voor Health met een niet-letterlijk karakter.

Twee sporen

Figuur 1 toont de twee sporen die door dit proefschrift lopen. De blauwe route gaat over de verkenning, conceptualisering en toepassing van transfertheorie in het ontwerp van games en game-achtige interventies met betrekking tot uiteenlopende serieuze doelen in Health contexten. Het zijn de bevindingen en conclusies uit het blauwe spoor (Research for Design) die de kern van dit proefschrift vormen.

Voor het uitvoeren van de experimenten is een eigen design research proces doorlopen om meerdere varianten van de game-like interventies te onderzoeken op geschiktheid en effect door middel van prototypes. Juist deze toegepaste manier van onderzoek in verschillende Health contexten leverde interessante bijvangsten op, aangeduid in Figuur 1 met het oranje spoor. Deze bijvangsten zijn echter niet toevallig en worden opgevat als resultaten van Research through Design [1].

Om het doorlopen design research proces van de in dit proefschrift beschreven prototypes inzichtelijk te maken, is het Layers in Serious Media Design framework (LiSMD) ontwikkeld. Waar het GTM vanuit een onderwijskundig perspectief een nieuwe design rationale expliciteert, biedt het LiSMD-framework een inrichting voor een design research proces voor serious game-like interventions, met inachtneming van wederzijdse waarden vanuit Health Science en Design Practice.

De bevindingen in dit proefschrift zijn van belang voor ontwerpers van serious games voor Health en onderwijsinnovators omdat: a) serious gaming instantiaties gericht gekoppeld kunnen worden aan specifieke leer- en/of gedragsverandering vraagstukken, en dat b) het arsenaal van in te zetten serious games en game-like interventies binnen Health educatie aanmerkelijk vergroot kan worden. Daarnaast vraagt dit proefschrift ruimte voor design research en abductieve onderzoekstechnieken in Health curricula om toekomstige uitdagingen het hoofd te kunnen bieden.

Deel I: Blauw (Research for Design)

Games en game-like interventies worden in het algemeen gezien als een kansrijke richting voor leren, en worden zelfs getypeerd als een nieuw paradigma voor e-learning. Hoewel het nut en de mogelijkheden van deze technologie niet betwijfeld wordt en er voldoende steun vanuit wetenschappelijk onderzoek blijkt, is brede inzet van games for Health geen gemeengoed. Natuurlijk speelt de acceptatie van dergelijke media als educatief instrument een rol, maar, zeker in Health zijn er, afgezien van simulaties voor opleidingsdoeleinden, zelden aansprekende voorbeelden te vinden van serious games. Er is geen sprake van een brede adoptie van games en game-achtige interventies binnen Health curricula.

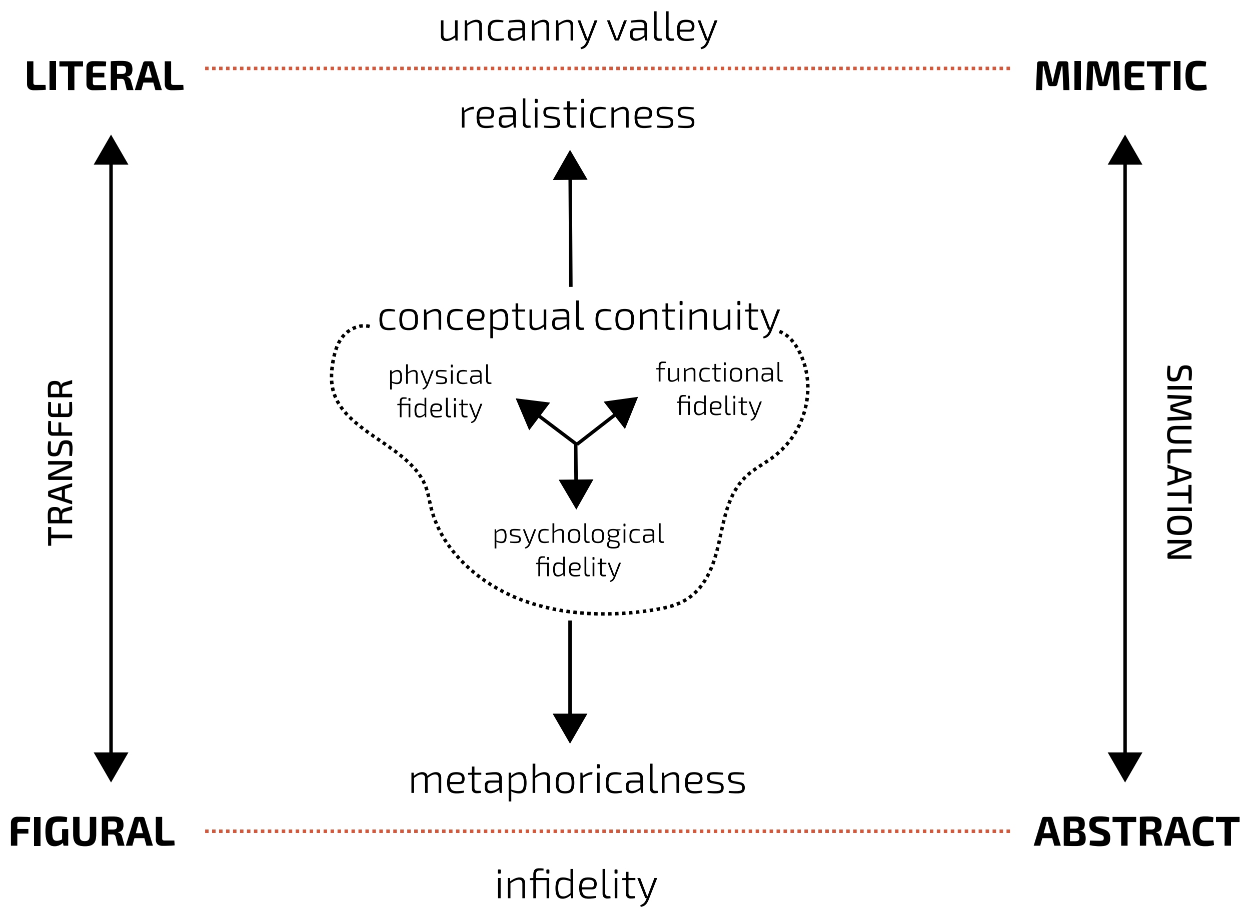
Het lijkt een wicked problem om serious games te ontwerpen die de unieke en motiverende eigenschappen behouden die games als leermiddel interessant maken. Vanuit een analytisch perspectief bestudeert wetenschappelijk game-onderzoek de successen van grotere speltitels en concludeert dat serious games een aantal kenmerken hebben overgenomen, maar niet de echte look en feel van 'een goed spel' hebben. Ontwikkelingsbudget wordt genoemd als een belangrijke factor hiervoor, maar dat is niet altijd een houdbaar argument: zelfs bij de ontwikkeling van indie games worden aantrekkelijke en effectieve games ontwikkeld tegen een fractie van het beschikbare budget voor educatieve instrumenten in het algemeen.

Dit onderzoek verkent een mogelijk nieuwe educatieve invalshoek over hoe leren en gedragsverandering in een serious game kunnen worden ingebed. Transfertheorie biedt hiervoor een interessant uitgangspunt. In het bijzonder het idee dat een game bewust ontworpen kan worden om via een bepaald transfertype serieuze doelen te bereiken. Serious games in het algemeen zijn vaak letterlijke games, bij voorkeur high fidelity simulaties van de gekende werkelijkheid. Deze letterlijke benadering van games for Health berust, al dan niet bewust, op een (een vorm van) literal transfer. De sleutel voor literal transfer is de mate van gelijkenis van de simulatie met de beoogde doel context: natuurgetrouwheid is dan voorwaardelijk voor de verwachte effectiviteit.

Deze redenering lijkt dominant in het denken over de verschijningsvorm (instantiaties) van games for Health. Wat zou er gebeuren als andere vormen van transfer, uit de zogenaamde second class transfertypes, ingezet worden die andere, niet-letterlijke uitingen van serious games mogelijk zouden maken? Game-types die niet letterlijk de werkelijkheid vertegenwoordigen of niet een direct herkenbare link met de werkelijkheid hebben, worden zelden overwogen als serious games voor leer- of gedragsverandering

Hoofdstuk 2 beschrijft een systematic review, uitgevoerd binnen medische databases, naar specifiek abstracte, niet-letterlijke games of game-like interventies. Uit bijna 20.000 artikelen over serious games for Health vonden we drie studies naar serious games met een niet-letterlijke weergave van de werkelijkheid. Verder laat deze studie zien dat in artikelen over game-like interventies for Health, transfer wordt gezien als een wenselijk effect, niet als een uitgangspunt voor het ontwerp ervan. Er blijkt uit geen van de studies een bewuste keuze voor gebruik van de zogenaamde tweede klasse transfertypes, de categorie waarbij transfer op een niet-letterlijke wijze verloopt. Games en simulaties for Health leunen wat betreft verwachte effectiviteit op de condities voor transfer uit de eerste klasse transfertypes: de adoptie van tweedeklas transfertypes blijkt schaars. Eén van de drie gevonden studies met een niet-letterlijke serious game benadering heeft de design rationale toegelicht. De overige studies beschrijven niet waarom of op welke gronden voor een specifieke ontwerp is gekozen.
De vraag is of deze voorkeur voor letterlijke instantiaties van serious games een bewuste rationale kent of dat deze voortkomt uit het niet kennen of overwegen van alternatieve transfertypes. Daarnaast kan de in dit

Figuur 2: Het Game Transfer Model koppelt transfertypes aan verschijningsvormen van simulatie, lopend van werkelijkheidsgetrouw tot metaforisch.



hoofdstuk aangetoonde eenzijdige transferbenadering in het ontwerp van serious games for Health worden beschouwd als een obstakel in het streven om serious content in een game te verankeren: de beruchte serious gaming oxymoron [2].

Het verliezen van tijds-, zelf- en omgevingsbewustzijn, verhoogde vaardigheden, controle en zelfstandigheid, het bieden van een autotelische ervaring en het fenomeen suspension of disbelief (het toelaten van de verbeelding) zijn zeer gewenste, door wetenschap toegedichte, kenmerken van games. Deze eigenschappen zijn gekoppeld aan motivationele aspecten en worden vaak aangetroffen in games waarin spelers ondergedompeld worden in imaginaire

werelden, met fascinerende narratieven en uitdagende quests. Deze games kunnen als serious worden gezien op het moment dat handelen, gedrag of opgedane ervaringen in de game betekenisvol zijn voor de doel context. Het expliciteren van deze betekenisvolle acties wordt voor of na het spelen van een game gedaan, en wordt getypeerd als het motivational of reinforcement paradigma [3]. Pre- of debrief sessies vormen hierbij een essentieel onderdeel van het ontwerp van de game en vragen een educatieve inbedding. Het is belangrijk om erop te wijzen dat de opvatting over hoe het geleerde transfereert naar een doel context een sturend mechanisme lijkt te zijn bij het ontwerpen van games of game-achtige interventies. Daarmee houdt het verband met de eenzijdige aanpak bij het ontwerpen van games. Dit proefschrift gaat over het verkennen en toepassen van de tegenhanger van de meestal ingezette, letterlijke simulatie van de werkelijkheid en stelt dat, afgestemd op wat en door wie er geleerd moet worden, het een bewuste ontwerpkeuze kan zijn om te kiezen voor een niet-letterlijke instantiatie van een serious game. Onderwijskundige transfertheorie ondersteunt deze designbenadering door het onderscheid in letterlijke en figuurlijke vormen van transfer.

In **Hoofdstuk 3** worden inzichten vanuit verschillende wetenschappelijk disciplines (media- en cognititieve psychologie, toegepaste onderwijskunde, game design research) samengebracht in het Game Transfer Model (GTM, Figuur 2). Dit model vormt het theoretische framework en tevens de design hypothese onderliggend aan een aantal prototypische games en game-achtige interventies, waarmee experimenten zijn uitgevoerd met design voor figural transfer.

Figuur 3: De protagonist, enkele momenten voor het verliezen van zijn partner.

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Passage

Een goed voorbeeld van een game met een metaforische, abstracte vormgeving is Passage. Passage is een side-scroller game, met een zeer minimale vormgeving, en slechts een speeltijd van een paar minuten. In het spel ben je een avatar, die zich een weg moet proberen te vinden door een tweedimensionaal doolhof. Tijdens het spelen dringt langzaam het besef door dat je leven verstrijkt. Kleuren worden fletser, je ontmoet en verliest een partner en je eigen lichaam vertoont steeds meer uiterlijke kenmerken van aftakeling. Dit alles voltrekt zich erg snel en je hebt nauwelijks tijd om te begrijpen wat je aan het overkomen is. Door de vooraf bepaalde speeltijd en de continue degradatie van de avatar, eindigt het spel, los van de keuzes van de speler, in een onvermijdelijke dood. In het spel doorloopt de speler in slechts 5 minuten de gehele levensloop van de avatar, maar dit blijkt ruim voldoende voor een heftige emotionele reactie op het ervarenere. Passage is een voorbeeld van een spel dat bewust met minimale middelen maximale impact bereikt. Ook al is deze game niet ontworpen als een serious game, het draagt wel degelijk een aantal lessen in zich. De betrekkelijkheid van het leven, het belang en waarderen van de ander nu het nog kan, en zelfs een diepe reflectie op het huidige leven worden genoemd als belangrijke resultaten.

Een game is een context is een metafoor

In **Hoofdstuk 4, 6 and 7** wordt het Game Transfer Model (GTM) gebruikt als uitgangspunt voor het ontwerpen van game-like interventies in verschillende Health contexten. In deze projecten is het GTM gebruikt met als doel de beoogde serious goals te behalen middels tweede klasse transfertypes. Zoals geïntroduceerd in **Hoofdstuk 3,** is metaforische recontextualisatie hiertoe ingezet. In ieder experiment is, samen met content experts, getracht de essentie van het leer- of gedragveranderingsvraagstuk te vangen om vervolgens de mogelijkheden voor een niet-letterlijke aanpak te exploreren. In alle studies is een design research aanpak gebruikt, onder andere voor het ontwerpen van de best passende metaforen voor de betreffende doelgroep en beoogde doelen. Het bewaren en streven van de in dit hoofdstuk beschreven conceptual continuity ter voorkoming van fidelity dissonance was voorwaardelijk. De iLift game ervaring (**Hoofdstuk 4**) is ontworpen voor zorgprofessionals om via figural transfer til- en verplaatsingstechnieken (LTTs) aan te leren middels een zorgvuldig geconstrueerde en gekalibreerde metafoor. De game begeleidt en ondersteunt de spelers' in-game (beweeg)gedrag door het aanbieden van recontextualiseerde statische LTTs in een nieuwe context. In dit onderzoek hebben we kunnen

aantonen dat, in termen van Health Behavioral Change Supporting Systems (hBCSS), compliance en behavioral change zijn opgetreden. In retrospectie, mede door het verloop van het project, heeft het gaming artifact niet door louter figural transfer effect gesorteerd, maar was er sprake van blended transfer. De LTTs werden door het herhaaldelijk spelen op een natuurgetrouwe wijze geautomatiseerd, waardoor sprake was van low road [4], first-class transfer. Het bewust worden van het belang van het toepassen van de juiste LTTs voor de eigen gezondheid, werd getriggerd door figural elementen. In **Hoofdstuk 5** heeft de Design for Transfer rationale geleid tot een ontwerp voor een game-achtige simulator voor het trainen van sociale- en probleemoplossende vaardigheden bij adolescenten met een lichte verstandelijke beperking, als aanvulling op de bestaande psycho-educatie. Een specifiek kenmerk van een lichte verstandelijke beperking (MID) is dat transfer (van leren) bij deze doelgroep nauwelijks optreedt. Oorzaak-gevolg relaties worden nauwelijks gelegd en eventueel geleerde lessen transfereren niet naar nieuwe contexten. Bestaande psycho-educatie wordt gegeven in een therapeutische setting, waarbij transfer (in welke vorm dan ook) naar de doel context als vanzelfsprekend wordt beschouwd. De literatuur over MID beschrijft dat abstracties (en dus mogelijk metaforen) te complex zijn voor deze doelgroep om te doorgronden en dat het leren zoveel mogelijk in lijn moet liggen met de eigen belevingswereld. In het ontwerp hebben we daarom de transfer condities geoptimaliseerd door te streven naar een zo authentiek en realistisch mogelijke game. De gebruikte video cases waren zeer realistisch qua toon, avatars en scenario. Ook de timing van het aanbod via de eigen mobiele telefoon in de persoonlijke, niet-therapeutische setting droeg bij aan de transfer conditie. Het behoud van de conceptual continuity stond centraal in het succesvolle ontwerp voor near transfer: een first class, literal transfertype.

Zoals vermeld in **Hoofdstuk 3**, is conceptual continuity een belangrijke succesfactor voor een goede serious game. Congruentie in fidelity types is daarbij voorwaardelijk. Om de mogelijkheden van het ontwerpen voor figural transfer verder te onderzoeken, is een experiment met een prototypische game-achtige simulator uitgevoerd, zoals beschreven in **Hoofdstuk 6**. Deze studie, die de grenzen van de inzet van low fidelity opzoekt, gaat over een zero-fidelity stimulator, voortbouwend op bestaande theorieen over het reduceren van fidelity. Meestal gaat fidelity over het abstraheren van fysieke en functionele elementen. Maar er is nog een derde vorm van fidelity, die het hart van de spelervaring vormt: psychologische fidelity. In de literatuur krijgt psychologische fidelity beduidend minder aandacht, hoewel het sterk samenhangt met het verliezen van tijds-, zelf- en omgevingsbewustzijn en het ervaren van suspension of disbelief. De BABLR simulator reduceert fysieke en functionele fidelity tot een minimum (vandaar de term zero-fidelity) en verkent het gebruik van psychologische fidelity als de voornaamste facilitator van een authentieke leerervaring. Opgedane leerervaringen binnen de zero-fidelity simulator kunnen, door het gebrek aan zowel fysieke als functionele fidelity, alleen worden toegeschreven aan transfer via een figural, tweedeklas transfertype (high road, backward reaching).

Hoofdstuk 7 beschrijft de ontwerpkeuzes en het theoretisch construct onderliggend aan de ontwikkeling van een serious game voor veiligheidsbewustzijn op de werkvloer, genaamd Play it Safe. In eerste instantie aarzelde ik om dit hoofdstuk in dit proefschrift op te nemen omdat de beoogde resultaten niet zijn behaald. Er zijn geen vroege voorspellers van succes gevonden die kunnen wijzen op het optreden van transfer vanuit in-game acteren naar een vergroot situationeel bewustzijn bij de kandidaten. Toch is het artikel opgenomen, omdat het experiment met het ontwerpen voor een tweede klasse transfertype van waarde is geweest voor het bereik van het Game Transfer Model (GTM). Play it Safe is een tower-defense game die gebruik maakt van situationele gegevens (waargenomen mogelijke onveilige situaties op de werkvloer) die door werknemers tijdens hun dagelijks werk zijn verzameld om de parameters van het spel te beïnvloeden. Deze gegevens werden verzameld door middel van een veiligheidscampagne genaamd Count Yourself Lucky (CYL), waarmee het aantal keren dat medewerkers het meegeleverde STAR-veiligheidsprotocol (Stop Think Act Review) inzetten, zijn gekwantificeerd. Play it Safe richtte zich op het verbeteren van het situationeel bewustzijn van werknemers, het creëren van een gedeeld mentaal model en aanzetten tot bottom-up verantwoording, veiligheidsgedrag te verbeteren en dit op elkaar te laten afstemmen. In het spel wordt real-life data voor besluitvorming in de werkomgeving gerecontextualiseerd, met de aanname dat de training van het STAR-protocol en resulterende besluitvorming in de praktijk onbewust zou worden versterkt.

Het grootste probleem met het spel was dat de gebruiks- en gebruikerscontext onvoldoende gekend is in het spelontwerp en dus in de recontextualisering richting het gaming artefact. De belangrijkste reden voor het gebruik van een metafoor werd niet ingegeven door de wens om bewust te ontwerpen voor een specifiek transfertype, maar door het idee dat een generieke metafoor geschikt zou kunnen zijn voor allerlei beveiligingsvraagstukken. Dit resulteerde in een spelmetafoor die voor de eindgebruiker verre van herkenbaar was,

waardoor het geen relatie had met de situationele data, noch met de doelcontext en daarmee niet-transferabel. Deze conclusie vormt een belangrijke les in het ontwerpen voor niet-letterlijke transfer: de metafoor moet gebruiks-, gebruikers- en technologische context [5] samenbrengen in een consistent geheel en daarbij het juiste vraagstuk adresseren.

Samenvattend kan worden geconcludeerd dat metaforische recontextualisatie effectief is als ontwerpprincipe voor het ontwerpen van serious games en game-like interventies voor Health. Een belangrijke notie hierbij is dat leren of gedragsverandering plaatsvindt middels second class transfer types, specifiek via figural transfer. De belangrijkste reden voor het overwegen van design voor figural transfer in het denken over serious game design is dat het mogelijkheden biedt om dicht bij de aard van wat een game kan zijn te ontwerpen. In een aantal Health contexten zijn experimenten uitgevoerd met game ontwerpen gericht op figural transfer. Omdat (het optreden van) transfer moeilijk meetbaar is, wordt deze vaak gemeten aan de hand van mere knowledge (in de vorm van expliciete, reproduceerbare kennis), veel voorkomend in serious games: het gedecontextualiseerd aanbieden van expliciete kennis in een gamified vorm. Dit zijn de games waarin serious goals niet of nauwelijks samengaan met de systemic affordances (inherent begeerlijke eigenschappen om games te overwegen als tool) van games, resulterend in onnatuurlijk aanvoelende games.

Als een serious game wordt opgevat als een context in zichzelf, moeten de serious goals op een betekenisvolle manier worden gerecontextualiseerd met geoptimaliseerde transfercondities, al dan niet op een metaforische wijze. Het bewaken van de conceptual continuity, het zorgvuldig afwegen van fidelity types in overeenstemming met de te bereiken doelen en een bewuste, vooraf bepaalde keuze voor het entertainment-educational blending paradigm [3], zal leiden tot betere serious games. De introductie van figural transfer in het ontwerp van serious games geeft vanuit onderwijskundig perspectief een nieuwe (of onontgonnen) wijze om serious content te benaderen en stelt game designers in staat om serious content op een meer game-eigen manier te integreren.
Het is bekend dat transfer moeilijk te meten is, vooral omdat het nooit precies duidelijk is wanneer en in welke vorm het zich zal manifesteren. Het meten van de effecten van onderwijs beperkt zich daarom vaak tot het meten van louter leren, of ‘geheugentests’ versus ‘verschillende leerervaringen’ [6].

Het gebruik van een metafoor is een bekend didactisch principe en waarschijnlijk zo oud als de mensheid zelf. Het Griekse woord μεταφορά (metafoor) betekent eigenlijk ‘over te dragen’ of ‘te overbruggen’. Een metafoor is een ontworpen context waarin alles met elkaar verbonden is, betekenis heeft en waarin waarheden zijn verpakt, in afwachting van verkenning of ontdekking. Een game leent zich er bij uitstek voor om een dergelijke, ontworpen context te zijn.

Key findings

1. Bij het ontwerpen van serious games of game-like interventies for Health wordt de transfer van kennis of vaardigheden slechts als een wenselijk effect gezien, niet als een leidend principe om naar te streven.
2. De bewuste inzet van second class transfer komt niet voor bij het ontwerpen van serious games of game-like artefacten in Health, waardoor de meest immersieve en succesvolle speltypen worden uitgesloten.
3. Het optreden van transfer van leren is problematisch om te vast te stellen, daarom zijn effectmetingen vaak beperkt tot het vaststellen van mere learning. Om dat te kunnen faciliteren, vindt het leren in serious games bijna altijd plaats in letterlijke of gedecontextualiseerde instantiaties van serious games.
4. De toepassing van metaforische recontextualisatie is een complexe en creatieve stap in het vertalen van ontwerpkeuzes naar een manifestatie van het game-like artefact. Gebaseerd op onderwijskundige uitgangspunten met betrekking tot second class transfer, breidt het Game Transfer Model de mogelijkheden van serious game design for Health uit met een type games wat ontworpen kan worden met behoud van inherente eigenschappen van het medium zelf.
5. Moderators voor het triggeren van leerervaringen zoals wishful identification, parasocial interaction, narrative transportation, immersion en presence, flow experience, mastery of challenges en suspension of disbelief zijn bijzonder geschikt om te worden gefaciliteerd door abstracte, second class transfer games.

Deel II: Orange (Research through Design)

Het Game Transfer Model (GTM) biedt een aantoonbaar praktische aanvulling op het discours rond het ontwerp van serious games for Health. De experimenten uit dit proefschrift resulteren in voldoende vroege voorspellers van succes om verder onderzoek te rechtvaardigen naar de inzet en consequenties ervan. In hypothetische vorm blijft het echter een theoretisch construct,

Figuur 4: De Re-Mission video game gemaakt door HopeLab, gericht op jonge kankerpatienten.

Afbeelding: © Realtime Associates / Hopelab, All Rights Reserved.

zonder tastbare implicaties. Het doel van dit proefschrift is om de waarde van de design for transfer-ontwerphypothese in verschillende Health contexten te beoordelen. **Deel I** van dit hoofdstuk beschrijft deze contexten en hun conclusies, **Deel II** rapporteert over bijvangsten, in het bijzonder met betrekking tot de modellen die ontwikkeld zijn om de kloof tussen Health en Design te overbruggen.

Onderzoek en ontwikkeling van interactieve digitale gezondheidsinterventies, zoals games for Health, vereisen expertise in het identificeren van gebruikersbehoeften, het gebruik van abductieve design technieken en verlangen de inzet van prototypes als onderzoeksinstrument om toe te werken naar uiteindelijk bewezen effectieve interventies. De twee centrale expertisegebieden zijn Health (breed gedefinieerd) en Design. Bij het uitvoeren van de experimenten (Deel I) bleek dat deze twee werelden elkaar nog veel te brengen hebben. Ik zal dit proberen te illustreren met een voorbeeld.

Hoofdstuk 2 beschrijft een systematic review waarin de aanwezigheid en toepassing van figural transfer in serious games for Health is verkend. Voorafgaand aan de review wisten we van het bestaan van de game Re-Mission [7], een goed voorbeeld van een game for Health met overduidelijke abstracte en gerecontextualiseerde eigenschappen. Re-Mission is ontworpen voor kinderen met leukemie, en wordt vaak aangehaald als een voorbeeld van een succesvolle en effectieve serious game. Het spel draait om het vernietigen van kankercellen en het leren omgaan met veelvoorkomende behandelingsgerelateerde bijwerkingen. De speler bestuurt de microscopische nanobot Roxxi om kanker in het lichaam van een fictieve kankerpatiënt te bestrijden. Ze doet dit door slechte cellen te beschieten met een chemo-blaster en met behulp van met medicijnen geladen raketten, al zwevend door het lymfesysteem. Re-Mission maakt overduidelijk gebruik van een metaforische benadering van de werkelijkheid en is effectief, vanuit het perspectief van dit onderzoek, door second class transfer. In een aantal studies is het effect van het spel overtuigend aangetoond, in termen van verhoogde therapietrouw en zelfredzaamheid bij de doelgroep. De studies over Re-Mission kwamen echter niet naar boven in onze systematic review, zelfs niet na verbreding van de reikwijdte van de gebruikte zoekstrategieën. Een nadere beschouwing, buiten de review om, van de belangrijkste studies over Re-Mission toonde een focus op de effecten van het spel. Deze werden gemeten door ze te vergelijken met een kennistest in een controlegroep: het testen van kennis, of, zoals eerder genoemd mere learning. Een genoemd ingrediënt voor de verwachte effectiviteit van het spel werd gevonden in de self-modeling theory [8], zonder dat verder is onderzocht of beschreven hoe deze theorie heeft geleid tot het ontwerp van het spel. Studies over Re-Mission beschrijven niet waarom het spel eruit ziet zoals het doet, noch geven ze aanwijzingen of ontwerpprincipes voor toekomstige serious games for Health.

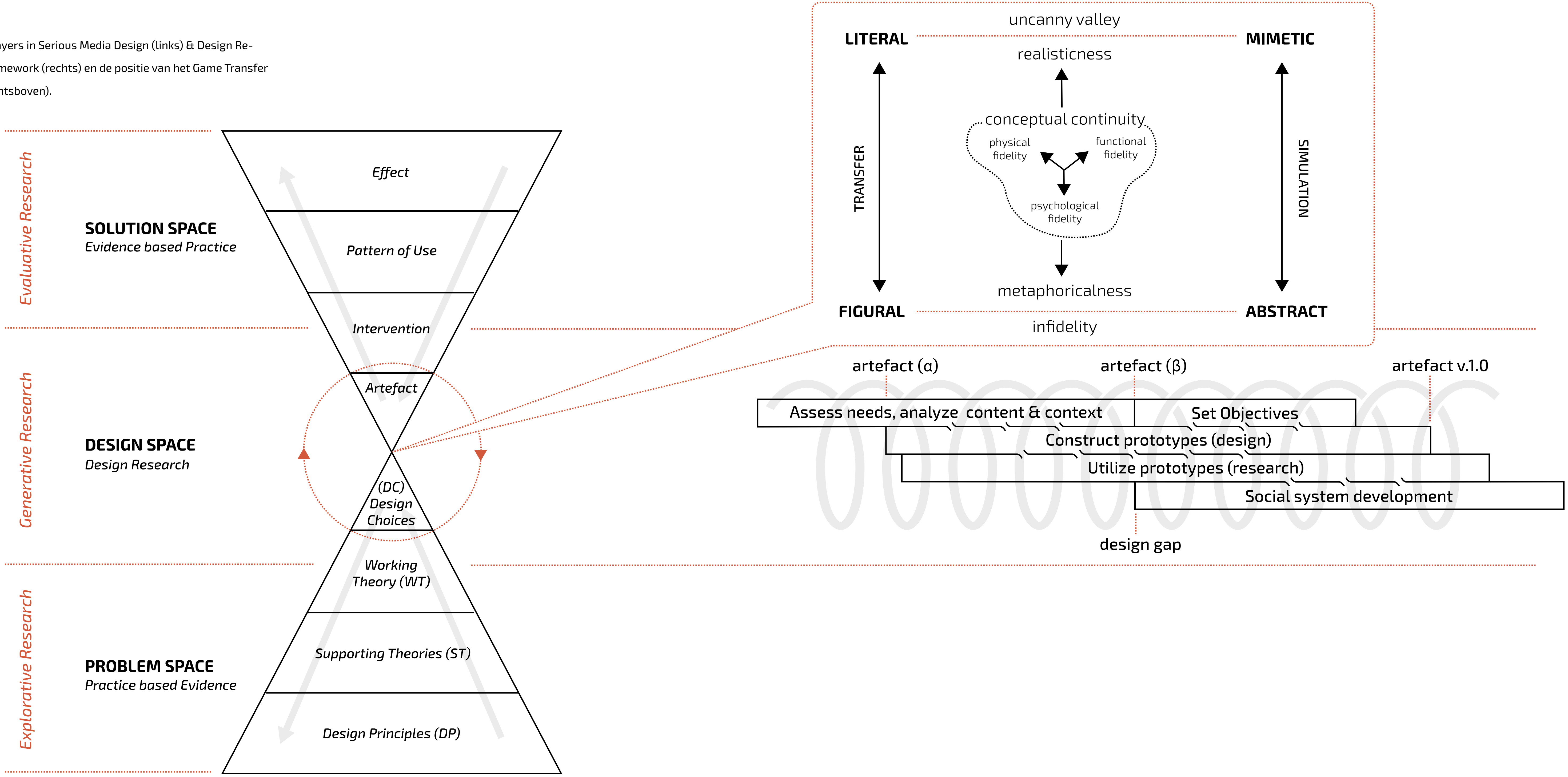
Door het niet expliciteren van het ontwerp van Re-Mission, kan het idee ontstaan dat de uiterlijke verschijning van de game op toeval berust of er niet toe doet. Dit blijkt niet het geval, omdat in Re-Mission 2, in de opvolger van de eerste game, de puur op kennis gebaseerde educatieve elementen zijn gereduceerd en de focus vooral ligt op waar de eerste versie succesvol in is gebleken: het stimuleren van positieve emoties, het verhogen van zelfvertrouwen en veranderende houding ten opzichte van de te ondergane chemotherapie.

Hoewel Health en Design in onderzoeksmethoden zeker overeenkomsten kennen, levert interdisciplinair ontwerponderzoek steevast uitdagingen op: waarden, aannames, terminologie, methodologie en cultuur maken samenwerking uitdagend, wat vaak resulteert in suboptimale projectresultaten [9]. Het testen en valideren, op en met de werkvloer, van de Design for Transfer hypothese, zoals geconceptualiseerd in het GTM, vergde een gemeenschappelijke taal om begrip, acceptatie en uitvoering van ontwerponderzoek mogelijk te maken in de context van Health innovation.

Het streven om deze verschillen te adresseren, heeft geleid tot de ontwikkeling en toepassing van een overkoepelend model: het Layers in Serious Media Design framework (LiSMD, Figuur 5). Waar het Game Transfer Model (GTM) een specifieke, nog niet onderzochte verbinding legt tussen educatieve transfertheorie en serious game design en daarmee een explicitering van ontwerprichtlijnen binnen de design space vormt, biedt het LiSMD een framework voor het gefundeerd ontwerpen, testen, afstemmen en integreren van (digitale) serious artefacten. Het LiSMD-framework wordt opgevat als het resultaat van Research through Design (oranje spoor) en bewaakt zowel het iteratieve en incrementele karakter alsook de vereiste rigor-relevante balans binnen het ontwerponderzoek.

In **Hoofdstuk 6** wordt het LiSMD in zijn geheel gepresenteerd en ingezet in het kader van het BABLR prototype. In de eerdere experimenten zijn de eerste ideeën en voorlopers van het framework gebruikt. **Hoofdstuk 8** is gewijd aan het verschil in Health en Design cultuur en geeft verdere duiding aan het LiSMD als een in-between object. Het LiSMD-framework kent een aantal facetten. Ten eerste kan het gebruikt worden als communicatiemiddel, bedoeld om de onderzoeksperspectieven van Health en Design samen te brengen. Naast de professionele, culturele en beroepsmatige verschillen is er een belangrijk onderscheid in onderzoeksfilosofie [9,10]. Het LiSMD positioneert explorative, generative en

Figuur 5: Layers in Serious Media Design (links) & Design Research Framework (rechts) en de positie van het Game Transfer Model (rechtsboven).



evaluative research in eigen spaces, elk met eigen specifieke focus met bijbehorende methoden en positie in het totale ontwerponderzoek proces. Ten tweede kan het LiSMD als leidraad in het ontwerponderzoek worden gebruikt door de lagen in de ruimtes te interpreteren als (niet noodzakelijkerwijs opeenvolgende) stappen die in het proces moeten worden gezet. Het documenteren van de gebruikte methoden en de daaruit voortvloeiende bevindingen per laag zorgt voor de explicitering en onderbouwing van het ontwerpproces. Het iteratieve en incrementele karakter van het onderzoek zoals dat plaatsvindt in de Design Space wordt geïllustreerd door het Design Research Framework. Dit framework geeft verdere invulling aan de wijze waarop ontwerpend onderzoek de geleidelijke vorming van een artefact onderbouwt. Ten derde zorgt het LiSMD ervoor dat evidence-based kennis een duidelijke plaats krijgt in het ontwerpproces. In lijn met de serious intent van het te ontwerpen artefact, vormen de actieve ingredienten uit een passende, bestaande Health interventie of -theorie het uitgangspunt. Het doel is echter niet om een digitale, game-like vertaling van een reeds bestaande, analoge benadering te bieden, maar om een nieuw artefact te creëren met een innovatieve benadering van het probleem in combinatie met kritische beoordeling vanuit Health en het abductieve karakter van Design.

Samengevat, biedt het LiSMD-framework een domeinoverstijgend perspectief met een overzicht van de sleutelgebieden voor het komen tot een innovatief en effectief serious artefact. Naast de theoretische onderbouwing en het gebruik van practice-based evidence uit de problem space, legt het model de nadruk op de design space, waarin iteratief en incrementeel ontwerponderzoek naar vroege voorspellers van succes wordt ingezet. Dit proces leidt tot een blauwdruk van een artefact dat niet alleen de drager is van de werkzame bestanddelen in een nieuwe vorm, maar ook een concept dat getest is op geschiktheid en bredere acceptatie, alvorens de solution space te betreden. Op deze manier is het artefact optimaal passend om zowel te beantwoorden aan de serious goals alsook om als interventie geadopteerd te kunnen worden door de sociale contexten waarvoor ze bedoeld is. Dit alles geeft een nieuwe lading aan wat nu implementeren wordt genoemd.

Key findings

1. Het LiSMD biedt een framework waarbinnen gedeelde taal, perspectieven op onderzoek en design praktijk wordt gecombineerd en biedt een ondersteunende rol in (het discours over) ontwerpgerichte onderzoeksprocessen gericht op het ontwerpen van artefacten met een serious goal, zoals games for Health of digitale innovaties in het algemeen.
2. In Health innovatieprojecten ontbreekt vaak de design-in-the-large fase, waarbij een traditionele opvatting over implementatie deze cruciale fase van social system design vervangt. Design-in-the-large omvat het social system design en behoort binnen de Health innovatie gericht op artefact ontwikkeling een integraal onderdeel te zijn van een ontwerpproces.
3. Ontwerpers van Health curricula en professionals werkzaam binnen Health innovatie worden opgeroepen om gericht aandacht te hebben voor een domeinoverstijgend perspectief. Met name de adoptie en inzet van design research voor het komen tot innovatie en het vinden van oplossingen voor wicked problems verdienen aandacht. Creative confidence, abductive reasoning en een designer's mindset zijn eigenschappen die behoren tot de Health professional van de toekomst.
4. Studies naar bewezen effectieve games of game-like interventies for Health zouden onderliggende design rationales moeten toelichten, zodat generaliseerbare ontwerpkennis bruikbaar wordt voor toekomstige G4H. Succesvolle game-like interventies zijn het resultaat van een goed uitgevoerd ontwerponderzoek, waaruit lessen moeten worden getrokken om Health innovatie te bevorderen.

Future work

'Designerly ways of knowing' klinkt misschien onbeduidend, maar is precies waar Health naar zou moeten kijken in haar zoektocht naar innovatie middels serious digitale interventies. Health research kent een rijke geschiedenis in de wetenschappen: het bestuderen van de natuurlijke wereld met gewortelde culturele waarden als objectiviteit, rationaliteit, neutraliteit en een streven naar de waarheid. De waarden van Design zitten in praktische uitvoerbaarheid, vindingrijkheid, inlevingsvermogen en streven naar passendheid [10]. Om deze waarden en geschikte onderzoeksmethoden te beheersen, is de manier waarop mensen worden opgeleid even belangrijk als de inhoud die wordt overgedragen. Het bovenstaande is in zichzelf al een wicked problem binnen Health curricula voor de toekomst, temeer omdat het in de huidige curricula niet een punt van aandacht lijkt. De waarden van Design zijn makkelijker te begrijpen in het licht van bijvoorbeeld het zelf ontwikkelen van serious games for Health of e-Learning toepassingen. Met een ouder wordende wereldpopulatie en een toenemende afhankelijkheid van (zorg)technologie vormen deze waarden een onmisbaar fundament voor denken over toekomstbestendige zorg.

Zoals besproken in **Hoofdstuk 6**, biedt probleemgestuurd leren (problem-based learning), opgevat als leren dat voortvloeit uit het proces van werken aan het begrijpen en oplossen van een vraagstuk [11], aanknopingspunten. Health studenten in multidisciplinaire teams laten werken aan authentieke en ill-defined activiteiten met betrekking tot echte, relevante ontwerpvraagstukken [12] kan problem-based leerprincipes verbinden met design research.

Verder moet gesteld worden dat Health, opgevat als een subcultuur, de handschoen zou moeten oppakken: kijk verder dan de eigen gebruiken, protocollen en zienswijzen. Natuurlijk heeft Health een rijke historie met gegronde waarden, onmiskenbare noodzaak en statuur, maar daar waar het gaat om het ontwerpen en innoveren binnen deze context, zijn deze waarden eerder een belemmering dan bevorderend. Feit is dat er nauwelijks tot geen aandacht is voor het expliciteren van de design rationale achter serious games for Health. Zolang wetenschappelijke publicaties louter op de effectvraag van serious games in gaan, zal de kennis van het effectief ontwerpen van serious games marginaal blijven. Maar het is breder: dit is een oproep aan eenieder die zich in Health contexten bezighoudt met het initiëren en ontwikkelen van onderwijs- en technologische innovatie, om zich open te stellen voor verworvenheden buiten de Health Research context. Als er gedurende de experimenten binnen deze dissertatie op dit punt één ding duidelijk is geworden, is dat heersende opvattingen over onderwijs en onderzoek een rem vormen op vooruitgang.

Een andere suggestie die mogelijk behulpzaam kan zijn bij het beschouwen, ontwerpen en embedden van game-like artefacten en serious games for Health is de innovatieve pogingen die gedaan worden om dit doel te bereiken te zien als boundary objects. Hoewel er verschillende theorieën bestaan over wat boundary objects zijn en hoe ze werken [13,14], bevordert het idee dat een gemeenschappelijk object door verschillende activiteitensystemen wordt geduid, de dialoog en wederzijds begrip. Toekomstig onderzoek moet uitwijzen of het LiSMD-framework in huidige vorm een rol als boundary object kan vervullen of dat het moet worden verfijnd door verdere beproeving in nieuwe contexten. Ik zou dit punt willen afsluiten met de titel van **Hoofdstuk 8**: don't jump to conclusions. Benader dit onderwerp zelf als een ontwerpvraag, een wicked problem. Het feit dat het Design Research Framework, zoals dat in dit proefschrift wordt gebruikt en besproken, gebaseerd is op een specifiek educatief ontwerpmodel [15], zou dit doel kunnen ondersteunen.

Vervolgens zijn er voor toekomstig onderzoek naar design for transfer een aantal duidelijke onderzoeksrichtingen te formuleren. Dit proefschrift legt uit en onderbouwt hoe design for transfer kan worden gezien in literal en figural serious gaming instantiaties. Het Game Transfer Model (GTM) wordt geïntroduceerd als een instrument om serious game design uit te breiden van high-fidelity simulaties tot metaforische fantasiewerelden. Dit laatste is van belang omdat het de mogelijkheden van serious game design aanzienlijk kan uitbreiden en beter doet aansluiten bij de inherente eigenschappen van een videogame. Door middel van game-like prototypes werd de design hypothese getest dat meaningful play kan worden gefaciliteerd door te ontwerpen voor figural transfer door het gebruik van metaforische recontextualisatie. De experimenten toonden aan dat deze zogenaamde second class van transfertypes in serious games daadwerkelijk kunnen leiden tot leren of gedragsverandering, maar tegelijkertijd een aantal contextuele randvoorwaarden aan het licht brachten. Voorwaarde voor een succesvolle leerervaring in een non-mimetic serious game is conceptual continuity, gedefinieerd door congruentie in fidelity types, waarmee het belang van de kwaliteit en inventiviteit van het spelontwerp zelf benadrukt wordt.

Verder onderzoek is nodig naar een classificatie van wat wel en niet geleerd kan worden via second class transfer games for Health. Creatieve probleemoplossende benaderingen, besluitvorming, lateraal denken, oplossingsgericht leren, identiteitsontwikkeling en cognitieve zelfregulering zijn veelbelovende concepten voor figural manifestaties in games for Health en game-like simulaties, maar dit is geenszins een volledige lijst. Een mapping naar specifieke medische en gezondheidsthema's is nog niet gemaakt en moet worden opgenomen om meer gerichte toepassingsgebieden te identificeren.

Een andere vraag is of metaforische recontextualisatie geschikt is voor iedere doelgroep, vooral als het lijkt te gaan om voornamelijk metacognitieve vaardigheden. De veronderstelling op het moment van schrijven is dat dit niet het geval is. Er moet verder worden nagedacht over de passendheid van transfer types met betrekking tot de kenmerken van een potentiële doelgroep.

Tot slot blijft het noodzakelijk om het GTM verder te testen in verschillende Health gaming projecten, bij voorkeur in studies waarin prototypes - in termen van het LiSMD - de solution space bereiken. Hier zullen we kunnen vaststellen of de vroege voorspellers van succes uit de design space daadwerkelijk resulteren in gebruikspatronen met bijbehorende data en blijvende leereffecten.

Game on.

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Propositions

DESIGN FOR TRANSFER

Figural Transfer through Metaphorical Recontextualization in Games for Health

1. Studies on games or game-like interventions for Health that have proven effective should explicate their design rationale, so generalizable design knowledge becomes usable for future G4H. Successful game-like interventions are the result of a well-executed design research process, from which lessons must be learned to advance the field of Health Innovation (this thesis).

2. The one-sided transfer approach in the design of G4H, as substantiated in this dissertation can be regarded as an obstacle in the endeavor to embed serious content into a game, consequently maintaining the notorious serious gaming oxymoron (this thesis).

3. The design-for-transfer rationale expands and advances the possibilities of G4H design in accordance with the innate properties of video games and thus opens up a hitherto unexplored plethora of possibilities for the design and application of game-like interventions (this thesis).

4. The intentional application of second class transfer does not occur in the design of serious games or gamelike artifacts in Health, which excludes the most immersive and successful game types (this thesis).

5. Psychological fidelity should be considered a key moderator for triggering learning experiences e.g. wishful identification, parasocial interaction, narrative transportation, immersion and presence, flow experience, mastery of challenges, and suspension of disbelief. These aspects are particularly suited to be enhanced through abstract, second class transfer game types (this thesis).

6. The DIS/DIL perspective should be an integral part of a design research process that focuses on digital health innovation and provides a novel understanding of the concept of implementation by merging artifact appropriation and social system development (this thesis).

7. The LiSMD-framework presented in this dissertation functions as a boundary object with the aim of identifying, interpreting and structuring the differences in language and values of Health research and design research and is prerequisite for the advancement of digital innovation (this thesis).

8. With a single poetic detail, the imagination confronts us with a new world. From then on, the detail takes precedence over the panorama, and a simple image, if it is new, will open up an entire world (Bachelard).

9. What is your conceptual continuity? Well, I told him right then (Fido said), it should be easy to see, the crux of the biscuit is the apostrophe (Zappa).

10. The greatest thing by far is to be a master of metaphor; it is the one thing that cannot be learnt from others; and it is also a sign of genius, since a good metaphor implies an intuitive perception of the similarity in the dissimilar (Aristotle).

11. Real science studies and makes accessible that knowledge which people at that period of history think important, and real art transfers this truth from the domain of knowledge to the domain of feelings (Tolstoy).

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Ik heb oprecht, in welke vorm of mate dan ook, veel aan jullie gehad.

Zed (2019)

Revelation, regret and redemption in the twilight dreams of an aging artist. Set against surreal landscapes spanning one man's life and career, ZED is a desperate quest to reconnect fading memories and create a final work for a very special person.