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Contents

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Original Paper

Health Behavior Theory in Physical Activity Game Apps: A Content Analysis

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Abstract

Background: Physical activity games developed for a mobile phone platform are becoming increasingly popular, yet little is known about their content or inclusion of health behavior theory (HBT).

Objective: The objective of our study was to quantify elements of HBT in physical activity games developed for mobile phones and to assess the relationship between theoretical constructs and various app features.

Methods: We conducted an analysis of exercise and physical activity game apps in the Apple App Store in the fall of 2014. A total of 52 apps were identified and rated for inclusion of health behavior theoretical constructs using an established theory-based rubric. Each app was coded for 100 theoretical items, containing 5 questions for 20 different constructs. Possible total theory scores ranged from 0 to 100. Descriptive statistics and Spearman correlations were used to describe the HBT score and association with selected app features, respectively.

Results: The average HBT score in the sample was 14.98 out of 100. One outlier, SuperBetter, scored higher than the other apps with a score of 76. Goal setting, self-monitoring, and self-reward were the most-reported constructs found in the sample. There was no association between either app price and theory score (P=.5074), or number of gamification elements and theory score (P=.5010). However, Superbetter, with the highest HBT score, was also the most expensive app.

Conclusions: There are few content analyses of serious games for health, but a comparison between these findings and previous content analyses of non-game health apps indicates that physical activity mobile phone games demonstrate higher levels of behavior theory. The most common theoretical constructs found in this sample are known to be efficacious elements in physical activity interventions. It is unclear, however, whether app designers consciously design physical activity mobile phone games with specific constructs in mind; it may be that games lend themselves well to inclusion of theory and any constructs found in significant levels are coincidental. Health games developed for mobile phones could be potentially used in health interventions, but collaboration between app designers and behavioral specialists is crucial. Additionally, further research is needed to better characterize mobile phone health games and the relative importance of educational elements versus gamification elements in long-term behavior change.

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KEYWORDS

health and fitness apps; mobile phone; behavioral health; theory; content analysis; physical activity

Introduction

Serious games, or games whose primary purpose is to educate rather than entertain [1], have become a popular research focus because of their potential application in fields such as education, military, business, and health and wellness [2]. Games appear to be an emerging option for behavioral change, especially health behaviors, as serious games address innate psychological needs while offering intrinsic motivation in the form of fun [3]. Serious games may also have potential to impact health behavior change on a widespread level because of their appeal and the popularity of gaming. Furthermore, 59% of Americans play video games, and the average household owns at least one game console, PC, or mobile phone [4]. Serious games have been increasingly utilized in public health interventions [5], and many have shown promise in changing behavior in areas such as tobacco cessation, violence prevention, and mental health [6-8].

Serious games for public health have typically been developed as video games [9,10]. Exergames, or video games that require physical movement in order to play, are a particularly popular tool for health professionals especially as physical activity among the US population has decreased and chronic diseases such as obesity have increased [11-13]. While serious games were initially designed for personal computers and more recently for gaming systems, mobile phones are another increasingly viable platform for health and physical fitness games for several reasons. First, mobile phones are widely used; mobile phone use increased 22% over the year 2013 alone, and among US households that own a device to play video games, 53% play games on a mobile phone [4]. Second, game-like elements are already frequently utilized by health app developers. Lister et al found that elements of gamification, or the "use of game design elements in non-game contexts" [14], appeared in a large percentage of health and fitness apps [15]. Third, the use of apps in health interventions is already prevalent among public health professionals [16-18], and interventions using serious health games on mobile phones are emerging as well [19-21]. The few health behavior change interventions that have utilized serious games developed for a mobile phone platform have shown to improve health outcomes in areas such as diabetes management and healthy eating [19-21].

Much research suggests that health interventions designed around health behavior theory (HBT) are more effective in changing behavior than those which are not [22-25]. Many content analyses of health apps indicate that such apps generally contain low levels of HBT or are not adequately designed for long-term behavior change [26-31]. For example, Breton et al [32] noted in a content analysis of weight-loss apps that most contained few evidence-based practices, and Cowan et al [28] reported in a content analysis of physical activity apps that the sample contained low levels of HBT, suggesting that the lack of behavioral components may have been due to the widely varying professional backgrounds of app developers. Conversely, in a content analysis of physical activity video games, Lyons et al [33] reported that the games contained a relatively high percentage of health behavior constructs [33]. It may be that serious health games in general contain high amounts of HBT, whether HBT is consciously included or because games by design are more conducive to inclusion of HBT, though there has not been enough research conducted to determine whether this is true.

As health professionals are increasingly using mobile phone apps in interventions to increase physical activity, research on the content of such apps is important. Although many content analyses for health and fitness apps have been recently conducted [26-31] and analyses of exergames are emerging [33], currently, no studies have been conducted to investigate HBT in serious games developed for mobile phones. The purpose of our study was to identify the currently available most popular physical activity health games developed for mobile phones and to conduct a content analysis of HBT in these games.

Methods

Study Design

Our study was a content analysis of HBT contained in physical activity game apps selected from among the apps available in the iTunes App Store's Health and Fitness category. Two graduate students trained in HBT coded the apps.

Sample Identification

The sample was collected from the Apple App Store in the fall of 2014. Apps designed for iPhone use were chosen, because many similar app content analyses have used Apple's App store for sample selection [27,28,30,31]. This sample contained apps categorized under the health and fitness section of the App Store and were related to physical activity. Physical activity mobile phone games were selected for two reasons: (1) physical activity is both an impactful and neglected health behavior [12,13], and (2) interventions utilizing physical activity apps are a growing area of interest for health researchers [34-37]. There were 42 key search terms that were established prior to the sample collection, using key phrases for both physical activity and games. Keywords included fitness terms such as "running", "walking", "workout", "exercise", and others related to these behaviors, as well as game keywords, including "challenge", "adventure", and "interactive" (Table 1).

Table 1. Search terms.

Physical activity terms	Gamification terms
Dance	Game
Exercise	Avatar
Fitness	Reality game
Run	Virtual
Fit	Challenge
Team	Race
Train	Quest
Trainer	Adventure
Goal	Interactive
Walk	Simulator
Track	Augmented reality
Tracker	Running
Trek	Workout
Health	Cycling
Aerobics	Cardio
Weight training	

We have formal training in public health and health behavior and adapted the search terms from a previous content analysis of health theory in fitness apps [28]. Search terms were entered into the Apple App Store on iPads, as iPads allow filtering of results. Search results were narrowed by (1) iPhone only, (2) health and fitness, and (3) popularity. Previous content analyses of apps ordered search results by popularity to ensure that the apps that were reviewed were highly used [15,28].

The first 500 most popular apps were chosen for each search term, as the app store does not sort by page number. Additionally, as adapted from Lister et al [15], searching through a set number of primary results is enough for an adequate sample, because users do not typically search beyond the first few search pages [38,39].

The detailed written descriptions for the first 500 apps that appeared in the search results under each topic were analyzed to assess whether each app met the criteria for a serious health game. The definition for serious game was taken from definitions provided by Michael and Chen [1] and Shegog [19] and required that the app was primarily intended to educate, rather than entertain, as well as change a health behavior; additionally, each app needed to either (1) contain a fantasy storyline or narrative, or (2) include the possibility of failure.

The initial search revealed 86 apps that were originally selected as meeting the criteria. After reviewing all of the apps, 52 were identified for final inclusion. Apps were excluded that required special equipment (e.g., bikes, treadmills, pedometers, heart rate meters, GPS) (8), could not be located in the App Store upon subsequent searches (5), failed to operate (8), or upon further investigation did not meet the criteria for a physical activity game (13).

Coding Procedure

Each app selected for final inclusion was coded into an initial sampling rubric using Qualtrics online survey software. The coders downloaded each app to an iPad or iPhone and played each game for a minimum of 30 minutes or until completing one level to increase familiarity with the user interface and available functions. The coders then used a theory-based instrument to conduct the content analysis for each app.

Measurement

The instrument and methodology used for coding was adapted from an instrument used by Cowan et al [28] designed to assess theoretical content of physical activity apps. A similar rubric was used, with the addition of more questions about social networking sites utilized in the apps, expanding the options for type of exercise utilized in the app, and tailoring the items for a serious game setting.

Each app was coded using a rubric with 100 theoretical items, containing five questions each for 20 different constructs, as used by Cowan et al [28]. The coding rubric required choosing 0 points when the construct was not present in the app, 1 point for generalized information on the construct, 2 points for assessing user's knowledge relating to the construct, 3 points for providing feedback about user's knowledge on the construct, 4 points for general assistance relating to the construct, and 5 points for individualized assistance to improve relative to the construct. The points for each construct were added together for each app. This resulted in a HBT score ranging from 0 to 100.

We also coded for gamification elements. The specific gamification elements coded for were selected from an instrument used by Lister et al [15] and from the definition adapted from Michael and Chen [1] and Shegog [19] (Table 6).

Analysis

Coded data were imported from Qualtrics and analyzed using SAS Studio. To verify the level of interrater reliability, both coders independently coded 10 common apps, approximately 12% (10/86) of the original sample and 19% (10/52) of those retained for final inclusion. A Cohen's kappa coefficient, a method commonly used in content analysis research, was calculated to measure interrater agreement (κ=.60) with 97% agreement [15,28]. This is categorized as high-moderate agreement, which ranges from .41 to.60 and is an acceptable level of interrater agreement [40]. Descriptive statistics were used to report on the integration of HBT into physical activity mobile phone games. A Spearman correlation was used to determine whether there was an association between HBT and price, as well as HBT and total number of gamification elements.

Results

Sample Characteristics

Characteristics of the sample are shown in Table 2.The mean HBT score was 14.98 out of 100 points. One of the apps, SuperBetter, was an outlier with a much higher theory score than the rest of the sample (HBT score of 76 out of 100). Four of the apps (GPS Invaders, MotionMaze Holiday Adventure, Mapventures, and TrezrHunt Free) contained no HBT elements as dictated by the coding rubric. Walking (56%, 29/50) and running (42%, 22/50) were the most common exercises incorporated into apps (Table 3).

Table 2. App characteristics.

App name	HBT score	App name	HBT score
SuperBetter	76	Rare Candy—Epic Habit and Goa	12
Yoga Retreat	37	Rare candy free	12
Zombies, Run! 5k Training	35	Wokamon	12
iBelly Workout	29	Silk Road Walk	12
The Walk	29	Runno	11
Workout in a Bag—for kids	29	Box the Bag	9
Yes, Drill Sergeant!	28	Block Sports	9
RunAlice	28	Walky	8
Walk it!	24	AR Basketball	8
Zombies Run!	24	Battlesuit Runner Fitness	8
Ninja Fitness Free	24	Jump Boy	8
Streetquest—run a game	23	iBowl	8
Walk n' Play	22	MotionMaze Trick or Treat	7
Burn Your Fat with Me!	21	Hike the World—GPS Tracker	6
PushUp Club Free	20	MotionMaze	6
NFL Play 60	19	Paranoid	5
Habit Monster	17	treasure island GPS,	5
Turfly	17	AR Soccer	4
Daily Spartan	17	Keep Moving	4
Walkr—Galaxy Adventure in You	16	Pygmalions Challenge	1
FitQuest Lite	16	GPS Fun Lite	1
RunZombieRun	16	Gigaputt	1
7 Min Workout Zombie Survival	15	GPS Invaders	0
HuntedApp	14	MotionMaze Holiday Adventure	0
TapCloud	13	Mapventures	0
Superhero Workout	13	TrezrHunt Free	0

Table 3. Exercise type in apps.

Forms of exercise	n	%
Walking	29	56
Running	22	42
None/general movement	17	33
Weight lifting/bodyweight exercises	13	25
Other	9	17
Stretching	8	15
Jumping	5	10

Presence of Specific HBT Constructs

Table 4 shows the mean score (0-5) for the presence of HBT constructs measured in the sample, as well as the overall score (0-100). Goal setting, self-monitoring, and self-reward were the most-reported constructs found. Only self-monitoring and goal-setting had a median score greater than zero. For both, the median score was 5.

Table 4. HBT score by construct (N=52).

HBT		n (%)	Median	Mean	SD
Overall score		52 (100)	12.5	14.98	12.92
Capacity					
	General information	20 (38)	0	1.48	1.99
	Self-monitoring	30 (58)	4	2.25	1.99
	Stress management	3 (6)	0	0.23	0.94
	Time management	5 (10)	0	0.33	1.08
	Learning	4 (8)	0	0.27	1.03
Motivation					
	Incentives	13 (25)	0	0.65	1.37
	Barriers	7 (13)	0	0.44	1.26
	Risks	10 (19)	0	0.62	1.39
	Goal-setting	36 (69)	4	2.25	1.87
	Self-reward	23 (44)	0	1.77	2.01
	Readiness	9 (17)	0	0.5	1.18
	Self-talk	4 (8)	0	0.31	1.08
	Self-efficacy	9 (17)	0	0.63	1.46
	Norms	3 (6)	0	0.17	0.79
Opportunity/trigger					
	Peer pressure	18 (35)	0	1.33	1.89
	Modeling	16 (31)	0	0.83	1.50
	Relapse prevention	2 (4)	0	0.10	0.57
	Follow-up	6 (12)	0	0.38	1.09
	Guilt	4 (8)	0	0.19	0.79
	Stimulus control	4 (8)	0	0.25	0.95

Price and HBT

There was no association between price and HBT (Spearman correlation coefficient R_S=0.09641, P=.5010) (Figure 1). However, SuperBetter, which had the highest HBT score, also had the highest price (Figure 1, Table 5).

Figure 1. Price and HBT score.

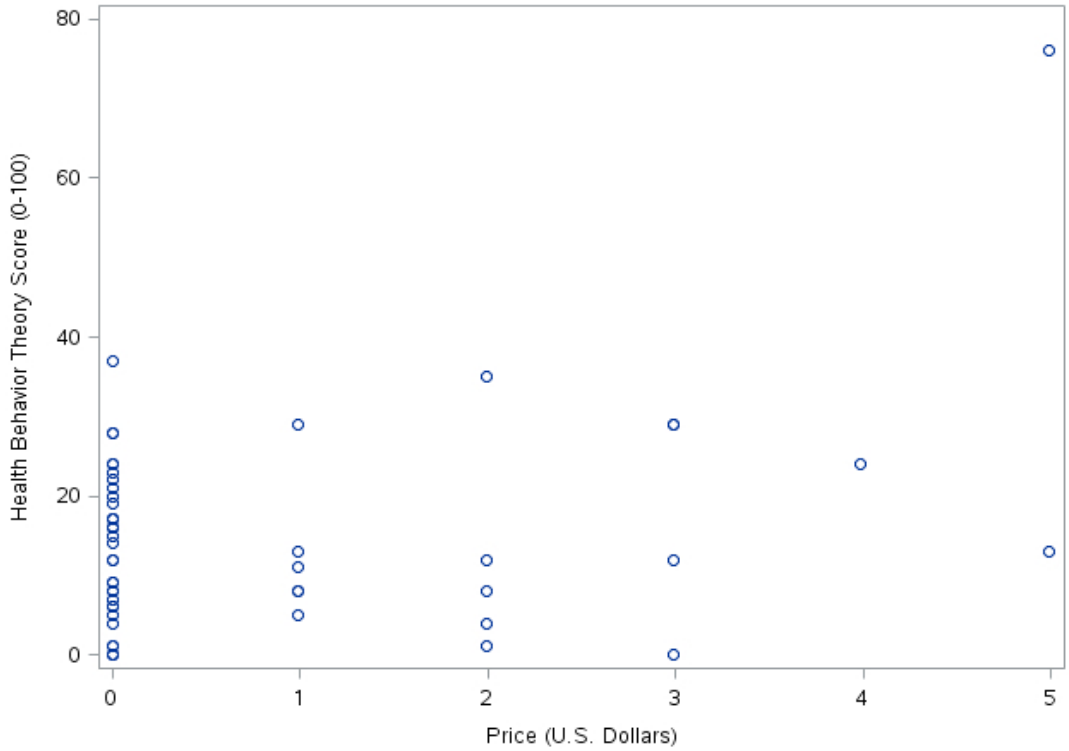


Table 5. Physical activity games by price.

Price (US$)	Apps
0	34
0.99	6
1.99	5
2.99	4
3.99	1
4.99	2

Gamification Elements and HBT

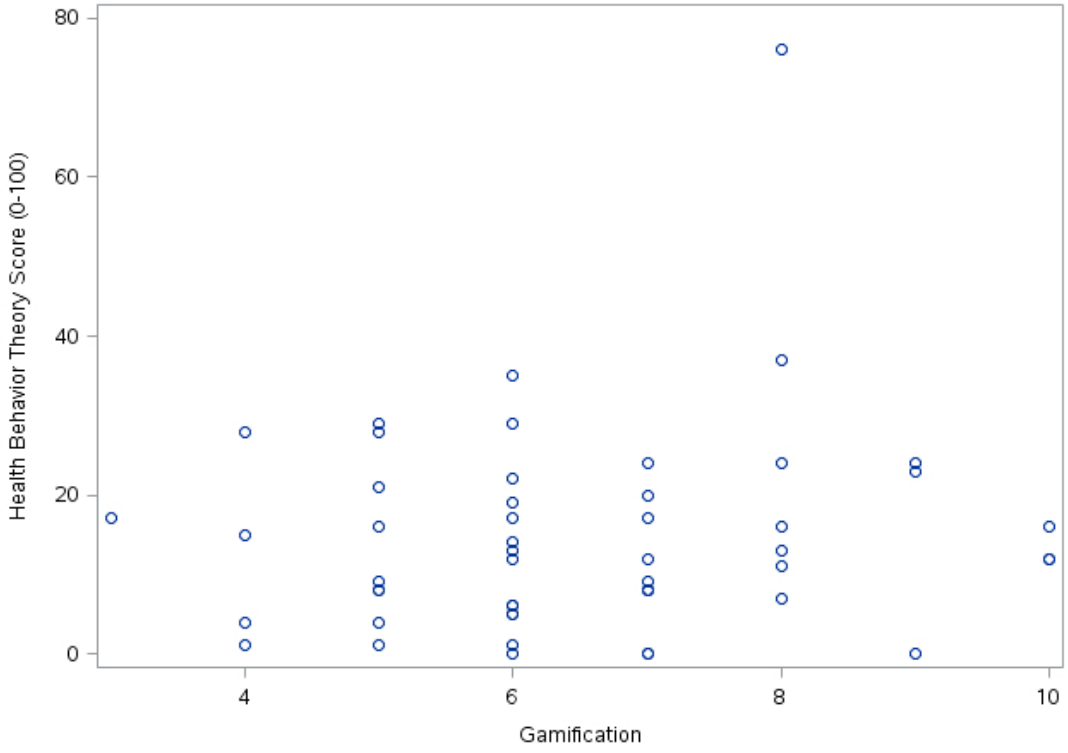
The number of elements of gamification was not associated with HBT score (Spearman correlation coefficient R_S=.094, P=.5074; Figure 2).

All of the elements of gamification were present in the sample, except for real-world prizes. The most common gamification elements in the sample were fantasy environment (96%, 50/52), whereas storyline was present in half of the sample (50%, 26/52). Rankings or standings (19%, 10/52) and leaderboards (29%, 15/50) were the least commonly utilized feature of gamification in the sample (Table 6).

Table 6. Gamification elements (N=52).

Gamification elements	n (%)
Storyline	26 (50)
Fantasy environment	50 (96)
Competition	31 (60)
Possibility of failure	43 (83)
Leaderboards	15 (29)
Clear expectations	49 (94)
Score	38 (73)
Ranking or standing	10 (19)
Levels	24 (46)
Real world prizes	0 (0)

Figure 2. Gamification and HBT score.



Discussion

Principal Findings

The purpose of our study was to determine the presence of HBT in physical activity games developed for a mobile phone platform. This study also analyzed (1) the prevalence of specific health behavior constructs, (2) the association between price and presence of HBT, and (3) the association between elements of gamification and HBT in these same apps.

The presence of HBT in this sample varied and many of the apps contained low levels of HBT, but HBT levels were higher on average than HBT levels in analyses of non-game health apps. The average HBT score of this sample was 14.98 out of 100, with SuperBetter, an outlier, yielding the highest HBT score at 76. Excluding SuperBetter, the next highest HBT score was 37, and the average HBT score became 13.78. In other content analyses of non-game mobile phone apps that utilized the same coding rubric as this study, the average HBT score was lower; in a sample of physical activity apps, Cowan et al [28] reported an average HBT score of 10.01 out of 100, with a high score of 28. Similarly, West et al [30] reported in a sample of diet apps an average HBT score of 6.19 out of 100, with a high score of 26. Other content analyses of health and fitness non-game apps, including smoking cessation and weight loss apps, similarly demonstrate low levels of evidence-based health behavior change techniques [31,32,41]. There exist few content analyses of serious games for health, let alone serious health games developed for a mobile phone platform, but exergames in general may contain relatively high levels of HBT. Lyons et al [33] conducted a content analysis of physical activity

video games and found significant levels of HBT elements present, such as performance feedback and modeling. Given the limited research on HBT in non-game and serious game health apps developed for mobile phones, it is difficult to determine at present whether the latter contain higher levels of HBT, though this study provides evidence to support this hypothesis.

SuperBetter, an app used for achieving nonspecific health goals, was an outlier with a much higher HBT score than the sample average. SuperBetter was unique in its heavy inclusion of educational elements, including individually tailored assistance; it required feedback on not only whether users completed each exercise, but also how well users completed each exercise, as well as tips for improvement [42] (Figure 3).

SuperBetter stands in stark contrast to physical activity app games focused more on entertainment with few educational elements, such as GPS Invaders (Figure 4).

Despite the differences in content, both SuperBetter and GPS Invaders are considered serious games as determined by the inclusion criteria of this study. It should also be noted that the coding rubric and inclusion criteria utilized in this study emphasized the importance of educational content, in conjunction with the definition of serious games as primarily intended to educate, rather than entertain [1,19]; other definitions of serious games exist that place even less of an emphasis on educational elements [43]. It is unclear whether serious games for health require high levels of education in order to be efficacious. While games like SuperBetter contain higher levels of educational content and HBT and research suggests that interventions based in theory are more likely to lead to lasting behavior change, it is worth considering whether entertainment-based games such as GPS Invaders [44] could be more effective in changing behavior than educational games, as they may be more popular and engaging in the long-term. The interplay between educational and entertainment elements is an important area of study for serious game researchers [45]. There must be a balance between educational and entertainment elements in games to maximize player motivation and engagement [46]. Further research on the relative importance of educational versus entertainment elements in serious games for health in long-term behavior change should be conducted.

The most prevalent health behavior constructs (after gamification elements) included goal setting, self-monitoring, and self-reward. In a review of mobile apps utilized in health interventions, Payne et al [47] found that self-monitoring was the most commonly utilized health behavior construct, followed by cues to action and feedback. The use of self-monitoring in physical activity interventions has been found to be one of the strongest predictors of success in behavior change [48], and goal-setting is commonly utilized and shows promise in physical activity and obesity interventions [49]. Lyons et al [33] also found that some of the most common HBT elements in physical activity video games included feedback, modeling, rewards, and self-monitoring. While many of the apps in this sample scored fairly high in HBT and contained many HBT components shown to be effective in health behavior change, it is unclear whether the app designers consciously designed the physical activity games with behavioral theories in mind. Payne et al [47] noted in a sample of apps utilized in physical activity and diet interventions that almost all (93%) were designed with some preconceived behavioral theory or construct. However, despite the relatively high levels of HBT in this sample, it is likely these apps were not designed around HBT, especially as it appeared the majority were not designed for formal health interventions. Additionally, as suggested by Cowan et al [28], app developers come from varied backgrounds and may not have formal training in HBT. It may be that app-based serious games lend themselves well to inclusion of HBT by virtue of design, whether it is consciously included or not.

Paid apps were no more likely to include elements of HBT than free apps. However, the sample of paid apps was small and these results should be interpreted with this limitation in mind. West et al [31] and Cowan et al [28] conducted a similar content analysis of paid health and fitness apps and reported that apps exceeding US $0.99 in price were more likely to contain elements of behavioral theory [28,31]. Similarly, Abroms et al [41] found in a content analysis of tobacco cessation apps that paid apps were more likely to include evidence-based practices for tobacco cessation, suggesting that there may be a relationship between quality and price for apps. While there was no overall association between price and HBT in this study, SuperBetter, which had the highest HBT score, was also the most expensive app. It is important for consumers and health professionals to avoid assuming that paid fitness games associated with a well-known or popular organizations are more efficacious. Affiliation with a professional organization does not always imply validity. Given the wide variance in expertise of app developers, research and evaluation of health apps by both industries and independent researchers are important to determine how to design apps that will change health behaviors in the long-term. Furthermore, health app designers would do well to partner with health behavior experts.

There was also no significant association between elements of gamification and presence of other HBT constructs—that is, having more game elements did not increase the overall HBT score. Researchers disagree on definitions of serious games, and the number and type of gamification elements needed to merit the classification of a serious game vary [50]. Many legitimate serious games may not contain high levels of traditional game-like elements. Current research indicates that available health and fitness apps contain significant amounts of gamification elements [15], but these same apps do not appear to contain high levels of HBT [28,30,31]. There appears to be a difference in HBT content between physical activity games apps and non-game apps, but it seems this relationship is not linear (it is not the case that the more gamified the app, the more behavioral theory components it contains). Assuming it is true that serious health game apps are naturally better suited for HBT than nongame apps, it is unclear how many elements of gamification a game must have, or which specific gamification elements are required, for this relationship to hold true.

The findings of our study are significant for practical use in public health, especially as mobile apps are being increasingly utilized in health interventions [47]. While some researchers argue that current health behavior models are flawed [51],

historically, designing theory-based public health interventions has been widely accepted as essential for lasting health behavior change [23]. Similarly, researchers indicate that mobile phone health interventions that incorporate health behavior elements are more efficacious than non-theory based interventions [51-53]. Riley et al argues that it is essential to utilize health behavior models in even the simplest of mobile phone interventions, such as a text message reminder intervention to increase attendance to medical appointments. Although this intervention incorporates built-in cues to action, if theoretical constructs such as perceived benefit of and barriers to attending appointments are not also addressed, the app will likely not be enough to prompt behavior changes [51]. It could be argued that mobile phone games—far more complex than text message interventions—may also require a theoretically based orientation for effectiveness in changing health behavior, though as mentioned previously, the dual nature of serious games as both educational and entertainment tools may complicate this relationship.

Figure 3. SuperBetter.

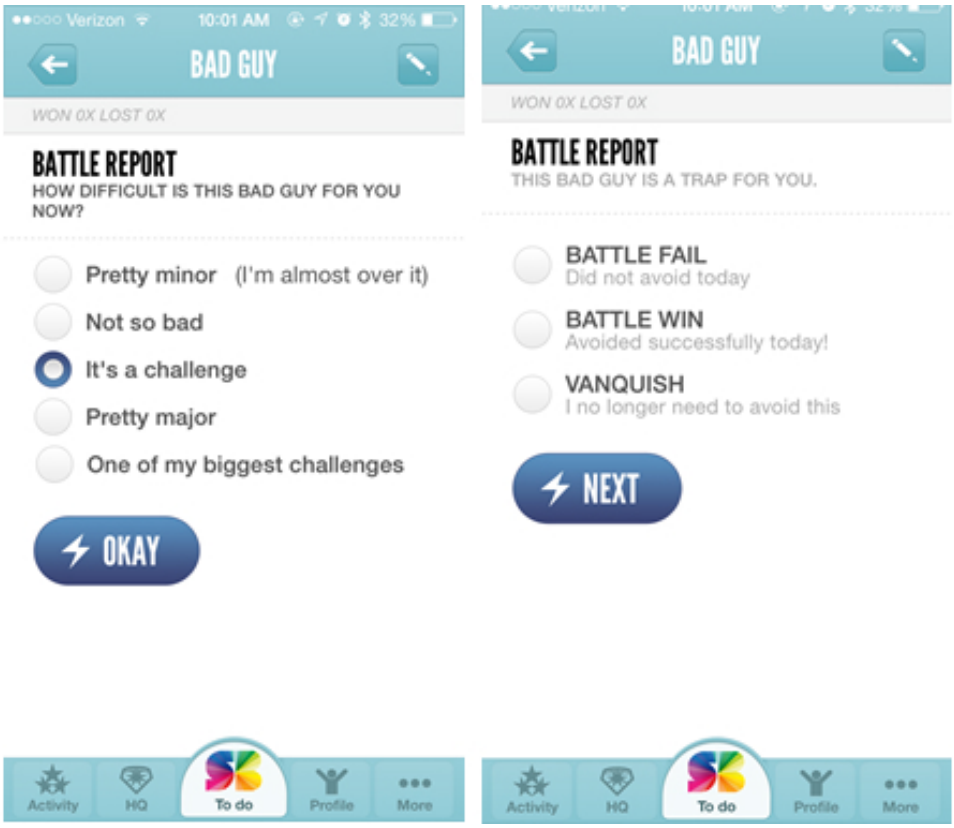
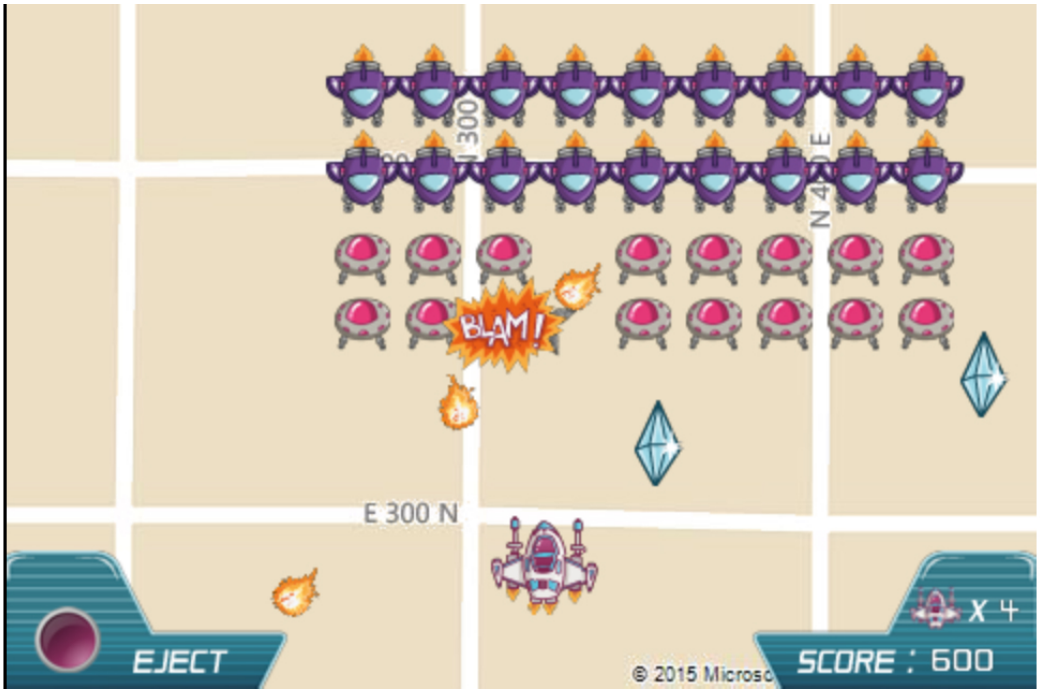


Figure 4. GPS Invaders.



Limitations

The findings of our study should be interpreted in the context of some limitations. First, the coders only used the mobile phone for either 1 level or 30 minutes to code for HBT elements. It is possible that some HBT components were missed by limiting use to this time frame, though unlikely; a recent study demonstrates that while mobile phone and app use is increasing, average app session length has stayed constant at about 5.7 minutes [54]. The coders spent over five times that amount coding each app, so the chances of missing unique or important HBT components appear low. Additionally, the final sample size was small, though this was difficult to avoid, as health app games are still a recent development. The coders conducted a thorough search, including the first 500 apps for every search term, to capture as many existing physical activity games as possible. While the sample could have been expanded upon to include other app games related to health (e.g., diet, nutrition), exclusively physical activity apps were chosen because previous content analyses of health apps have been similarly restrictive in scope [28,30], and addressing only physical activity games was more conducive to direct comparison between both these previous content analyses and studies of exergames.

The coders analyzed only app descriptions to determine if each app qualified as a health game, and it is possible that some games were missed due to inadequate descriptions. The coders attempted to compensate for this limitation by selecting a sample (10 apps) that appeared in the search but did not appear to meet the description of a game via the description; the coders found that none of these games fit the definition of a serious game, so the likelihood that apps were overlooked due to weaknesses in the description appears low. Finally, it should be noted that the definition of a serious game is not consistent across research; a number of legitimate serious exercise games exist that do not fulfill the criteria we proposed. Legitimate exergames (according to other researchers) may have been excluded from our sample. In this particular study, we were more interested in games emphasizing education, though content analyses of serious games with different criteria would be interesting for future research.

Conclusions

Physical activity health games developed for mobile phones are a potentially viable option for health interventions, though further research and development of such games should continue. Further research should be conducted to determine whether these health games are efficacious in health interventions, and the extent to which educational and gamification elements impact efficacy should be further assessed as well. Collaboration between app designers and behavioral specialists is also crucial to help promote lasting behavior change. Investigations into whether serious app games for health are more conducive to inclusion of HBT and whether they universally contain more elements of HBT is valuable in order to assess whether such games can improve individual and community health in the long-term.

Conflicts of Interest

None declared.

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Original Paper

Using a Virtual Environment to Deliver Evidence-Based Interventions: The Facilitator's Experience

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Abstract

Background: Evidence-based interventions (EBIs) have the potential to maximize positive impact on communities. However, despite the quantity and quality of EBIs for prevention, the need for formalized training and associated training-related expenses, such as travel costs, program materials, and input of personnel hours, pose implementation challenges for many community-based organizations. In this study, the community of inquiry (CoI) framework was used to develop the virtual learning environment to support the adaptation of the ¡Cuídate! (Take Care of Yourself!) Training of Facilitators curriculum (an EBI) to train facilitators from community-based organizations.

Objective: The purpose of this study was to examine the feasibility of adapting a traditional face-to-face facilitator training program for ¡Cuídate!, a sexual risk reduction EBI for Latino youth, for use in a multi-user virtual environment (MUVE). Additionally, two aims of the study were explored: the acceptability of the facilitator training and the level of the facilitators' knowledge and self-efficacy to implement the training.

Methods: A total of 35 facilitators were trained in the virtual environment. We evaluated the facilitators' experience in the virtual training environment and determined if the learning environment was acceptable and supported the acquisition of learning outcomes. To this end, the facilitators were surveyed using a modified community of inquiry survey, with questions specific to the Second Life environment and an open-ended questionnaire. In addition, a comparison to face-to-face training was conducted using survey methods.

Results: Results of the community of inquiry survey demonstrated a subscale mean of 23.11 (SD 4.12) out of a possible 30 on social presence, a subscale mean of 8.74 (SD 1.01) out of a possible 10 on teaching presence, and a subscale mean of 16.69 (SD 1.97) out of a possible 20 on cognitive presence. The comparison to face-to-face training showed no significant differences in participants' ability to respond to challenging or sensitive questions (P=.50) or their ability to help participants recognize how Latino culture supports safer sex (P=.32). There was a significant difference in their knowledge of core elements and modules (P<.001). A total of 74% (26/35) of the Second Life participants did agree/strongly agree that they had the skills to deliver the ¡Cuídate! program.

Conclusions: The results showed that participants found the Second Life environment to be acceptable to the learners and supported an experience in which learners were able to acquire the knowledge and skills needed to deliver the curriculum.

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KEYWORDS

Second Life; multi-user virtual environments; evidence-based interventions; community-based organizations

Introduction

Overview

Imagine a place where you can attend a fully interactive training session with people in different settings from all areas of the country without having to leave your home or office. You could learn about topics important to your work so you could help others in your community. That place is a virtual environment, a computer-generated three-dimensional representation of a space in which users can interact. They can take advantage of current Web 2.0 technologies, which are technologies focused on user-generated content, to deliver accessible and interactive training for communities and organizations. Training needs of community-based organizations (CBOs) and others can range from information sessions to more intensive training sessions to conduct evidence-based interventions (EBIs).

Evidence-based interventions are programs that have undergone rigorous outcome evaluation and have the potential to maximize positive impact on communities [1]. However, despite the quantity and quality of EBIs for health promotion and disease prevention, the need for formalized training and associated training-related expenses, such as travel costs, program materials, and input of personnel hours, pose implementation challenges for CBOs [2,3].

To increase access to EBI training, cost-effective training methods, such as Web-based training platforms, are needed. Accordingly, advances in technology have resulted in the development of multi-user virtual environments (MUVEs) as platforms for social interaction. The creation of a sense of presence among users [4] has many benefits over less dynamic forms of traditional Web-based trainings such as webinars or asynchronous podcasts. While the use of MUVEs is commonplace among gamers and the technologically savvy, the use of MUVEs among community providers is not widespread. Little is known about the acceptance of MUVEs in community settings and agencies whose staff vary in computer experience and in familiarity and comfort level with virtual training environments.

The purpose of this study was to examine the feasibility of adapting a traditional face-to-face facilitator training program for *¡Cuídate!* (Take Care of Yourself!), a sexual risk reduction EBI for Latino youth [5], for use in a MUVE. Facilitators are individuals who are trained in the delivery of the EBI who then deliver the intervention to youth in their communities. In this study, the community of inquiry (CoI) framework [6] was used to develop the virtual learning environment to support the adaptation of the *¡Cuídate!* face-to-face curriculum. The constructs of the CoI framework (ie, social, teaching, and cognitive presence) were then used as a basis to evaluate if the facilitator learning experience in the 2.5-day MUVE training program was acceptable to the learners and supported the acquisition of learning outcomes. Further comparison was conducted with those facilitators trained in the virtual environment and those trained in face-to-face formats. This, in part, addressed two aims of the study: to examine the acceptability of the facilitator training program and to examine the level of the facilitators' knowledge and self-efficacy to implement the training.

Virtual Learning Environment

The CoI [6] is one of the most common frameworks for assessing individual acceptance and comfort with online-learning environments. The model is comprised of three constructs that are core elements of a collaborative constructivist learning environment: (1) cognitive presence—the ability of learners to construct meaning through reflection and discourse, (2) social presence—the ability of participants to feel connected to each other in the absence of face-to-face contact, and (3) teaching presence—the design, facilitation, and direction of processes needed to support learning [7]. Burgess used the CoI survey to determine the extent of social, cognitive, and teaching presence among graduate level technology students in class activities held in Second Life (SL) [8]. These constructs have been positively associated with learning in an online environment. For example, a sense of community has been shown to have a positive relationship with perceived cognitive learning [9] and all three CoI constructs were predictive of perceived learning in online Master of Business Administration (MBA) courses [10]. In another study, Liu and colleagues found social presence was a significant predictor of course retention among students enrolled in community college [11].

The CoI framework and Second Life were purposely chosen to guide the adaption of the *¡Cuídate!* training program because it requires the application of skills and reflection on the work of self and others (cognitive presence), high interaction and social connection among participants (social presence), and real-time feedback from facilitators and peers (teaching presence). These elements are lacking in a traditional online Web-based training environment.

Second Life

Second Life was developed by Linden Lab and is considered one of the most mature and widely used platforms in use, specifically in health care. Through the creation and use of a modifiable avatar (ie, an online, graphical representation of the user), individuals in SL are able to interact with people and objects with the ability to exhibit social cues through realistic gestures [12].

Second Life has been used in a variety of interventions in health education for both practitioners and patients. Second Life is also not new to the area of sexual health; the University of Plymouth Sexual Health Sim was developed in the United Kingdom as a place to provide sexual health education as well as private one-on-one counseling [13]. Studies using SL for practitioner training have found positive results. For example, one study used SL for motivational interviewing (MI) training among physicians [14]. This training included interactive sessions in SL using role play with standardized patients to practice MI skills and was found to have a high degree of user acceptability. Participants (n=13) rated the acceptability of the various components of the course on a range from 4.1 to 4.7 on a 5-point Likert scale. Proficiency scores in MI also improved, with statistically significant improvement seen in four out of five component skills. In a study with paramedic students, which

compared paper-based and SL case scenarios for problem-based learning, participants reported a more authentic and collaborative experience in SL [15]. In addition, 100% of participants surveyed agreed/strongly agreed that SL is a relevant resource for field/clinical work preparation. Similarly, Schwaab and colleagues [16] reported that emergency medicine residents (n=27) participating in mock SL, oral examination case scenarios experienced a high degree of comfort (100%) and realism (92.6%). A majority indicated that SL was easy to navigate (96.3%) and easy to log in to (92.6%), and preferred the SL oral examinations over the traditional format (66.6%). A recently published systematic review of the use of virtual worlds in health care [17] found 11 studies published in the area of professional education, including using virtual worlds for medical education for diabetes [18], delivering bad news to patients [19], and improving patient safety [20].

Given the success of SL in training health care providers and the capacity to create a collaborative and realistic experience for learners, SL was deemed a useful environment to increase dissemination of EBIs among communities. This feasibility study could provide valuable information on the viability of using a MUVE such as SL and on creating a framework for others to use in designing training programs.

Methods

Overview

This was a descriptive comparative study to evaluate the feasibility and acceptability of the SL environment, and to compare SL training to face-to-face training. The study protocol was reviewed by the Institutional Review Board at the University of Michigan and was deemed exempt and not regulated.

To examine feasibility and acceptability, data were obtained from the participants (ie, facilitators) who participated in the SL *¡Cuídate!* Training of Facilitators. For comparison with the face-to-face training process, evaluation data were obtained from the Centers for Disease Control and Prevention (CDC) through Danya International, Inc (personal communication, Danya International, Inc, 2014).

Training in Second Life

The *¡Cuídate!* Training of Facilitators Manual [21] was used to adapt the 2.5-day, face-to-face training program into a combination of self-paced, prelearning podcasts and live virtual sessions in SL [22]. The *¡Cuídate!* training program was previously only offered as a face-to-face training program; a trainer conducted the 2.5-day session to teach the facilitators (ie, the study participants) how to deliver the curriculum to Latino youths in their communities. The facilitators were asked to review the *¡Cuídate!* curriculum and all the associated activities prior to attending the virtual training sessions. The six modules of the curriculum included the following: (1) Introduction/Overview, (2) Building Knowledge about Pregnancy, Sexually Transmitted Diseases (STDs), HIV, (3) Understanding Vulnerability to Pregnancy, STDs, HIV, (4) Attitudes and Beliefs about Pregnancy, STDs, HIV, (5) Building Condom Use Skills, and (6) Building Negotiation and Refusal Skills. The facilitators received a hard copy of the entire curriculum approximately two weeks before their SL session by Select Media. Each facilitator was assigned to facilitate (ie, role play) several of the activities in the SL *¡Cuídate!* training sessions. Two master trainers, or expert *¡Cuídate!* trainers, conducted the virtual training sessions and previously conducted face-to-face training sessions. These master trainers facilitated the entire training session in SL in English, similar to the face-to-face training sessions.

The training was designed to allow facilitators to deliver and practice facilitating activities in the curriculum, and to receive feedback from their peers and *¡Cuídate!* master trainers similar to what would be experienced in a face-to-face *¡Cuídate!* training session. Specific curricular activities were selected to utilize the capabilities of the interactive virtual environment. Unlike face-to-face training sessions, not all of the activities in every module were completed in the virtual training sessions. Those activities that overlapped in structure and format were minimized in order to demonstrate activities that might be challenging to conduct in real life. Throughout the training session, facilitators were encouraged to interact with each other and the *¡Cuídate!* master trainers by providing feedback to one another and acting as participants (ie, adolescents) during the role play sessions (ie, teach backs). Facilitators were oriented to the SL environment prior to the training sessions and processes; technical support in SL was provided before and during training to minimize any technical issues that might arise during training [23].

Sample

A total of five *¡Cuídate!* training sessions were conducted in the SL environment (see Figure 1) with 35 facilitators (ie, participants) representing 24 agencies across the United States. These facilitators were recruited via networking and social media from CBOs across the country. Each training session group met three times. The first session was a 2.5-hour overview of the *¡Cuídate!* curriculum and overview of key SL features, followed 1 week later by two more sessions—4 hours and 3 hours in length, respectively—of *¡Cuídate!* content.

Facilitators ranged in age from 20 to 59 years, with the majority being female (24/35, 69%) and nearly half of Hispanic/Latino ethnicity (17/35, 49%). Education levels varied widely among the facilitators with a large number (28/35, 80%) having earned a bachelor's degree or higher.

Comparisons were made with data from facilitators who participated in face-to-face training sessions (4 cohorts, 55 facilitators) held in St Louis, Philadelphia, Atlanta, and Memphis. These training sessions were held prior to the implementation of the SL *¡Cuídate!* training program. A total of 55 facilitators (41/55, 75% female) were trained in the face-to-face settings in Atlanta (19/55, 35%), St Louis (16/55, 29%), Philadelphia (12/55, 22%), and Memphis (8/55, 15%). Of the 55 trained facilitators, 44 (80%) surveys were collected from St Louis (14/16, 88%), Philadelphia (10/12, 83%), Atlanta (13/19, 68%), and Memphis (7/8, 88%) (personal communication, Danya International, Inc, 2014).

Figure 1. ¡Cuídate! training room in Second Life.

Surveys

Facilitators in both the face-to-face and virtual training sessions were asked to complete pre- and posttraining surveys. These surveys included items measuring attitudes toward implementing *¡Cuídate!*, self-efficacy in working with Latino youth and in implementing *¡Cuídate!*, and overall evaluation of the *¡Cuídate!* training program. In addition, facilitators who participated in SL training were also asked to complete a modified version of the CoI survey. These items are described below.

Evaluation of the Virtual Learning Environment

The community of inquiry framework survey instrument is a 34-item questionnaire measuring the three areas of cognitive presence, social presence, and teaching presence [10]. Original subscale alphas were found to be .94 (teaching presence), .91 (social presence), and .95 (cognitive presence). Further validity and reliability of the original instrument has been demonstrated through other studies [7,24].

Because the original instrument was designed for use in online courses, the CoI survey was adapted and reduced to 12 statements to measure the items that related to the *¡Cuídate!* Training of Facilitators. The items were scored on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Questions were retained in each of the three subscales. The first subscale—social presence—included six questions which measure the ability of facilitators to feel connected to each other in the absence of face-to-face contact. The teaching presence subscale was comprised of two questions that refer to ratings of the design, facilitation, and direction of processes needed to support learning. Finally, four questions measured cognitive presence which determine a learner's ability to construct meaning through reflection. The modified CoI survey was administered only to the facilitators of the SL training. Cronbach alphas were high for each of the subscales: social presence (alpha=.89), teaching presence (alpha=.84), and cognitive presence (alpha=.85). Table 1 lists each of the statements from the survey.

Two questions were also asked to evaluate the overall experience in SL: (1) SL experience was an effective learning activity and (2) SL experience was a positive experience. These questions were rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Qualitative data were collected through a series of open-ended questions, several of which focused on aspects of the training in SL, as part of a debriefing survey. Specifically, facilitators were asked what they liked/disliked about the SL *¡Cuídate!* training program, what were the advantages/disadvantages to training in SL versus face to face, and how likely they were to participate in another or similar training program in SL.

To compare the face-to-face and SL training sessions, questions posed to facilitators in SL training sessions matched questions posed to facilitators trained in face-to-face sessions. These questions included evaluation of the training (eg, length and pace) and self-assessment of knowledge and skills (eg, knowledge of core elements and six modules, ability to respond to sensitive questions, and ability to help facilitators recognize how Latino culture supports safe sex). Items were scored on a 5-point Likert scale ranging from 1 (not confident) to 5 (very confident). Two additional questions were asked of SL facilitators to determine mastery of the curriculum and skills necessary to deliver the program (see Table 2 in the Results section)

All surveys for the SL facilitator training sessions (5 cohorts) were conducted using Qualtrics (Qualtrics, LLC). Links to each of the surveys were sent to facilitators via an email from the research team following completion of the training. Email reminders were sent to ensure a high response rate (35/35, 100%) and timely completion. Original surveys completed by the facilitators at the face-to-face sessions were scanned and sent via email to the research team.

Table 1. Community of inquiry survey statements (n=35).

Variables and statements	Second Life training score[a], mean (SD)	Total subscale score, mean (SD)
Social presence		23.11 (4.12)
I am comfortable conversing through an online medium.	3.77 (1.03)	
I felt comfortable participating in training discussions.	4.17 (0.66)	
I felt comfortable disagreeing with other facilitators while still maintaining a sense of trust.	4.06 (0.64)	
Getting to know other facilitators gave me a sense of belonging.	3.86 (0.81)	
Online or Web-based communication is an excellent medium for social interaction.	3.34 (1.08)	
I was able to form distinct impressions of some course participants.	3.91 (0.92)	
Teaching presence		8.74 (1.01)
The trainer helped keep facilitators on task.	4.31 (0.58)	
The trainer provided feedback in a timely fashion.	4.43 (0.50)	
Cognitive presence		16.69 (1.97)
I can describe ways to apply the knowledge I learned in training.	4.23 (0.55)	
I was motivated to explore content-related questions.	4.14 (0.60)	
Learning activities helped me construct explanations/solutions.	4.11 (0.58)	
Reflection helped me understand fundamental concerns in training.	4.20 (0.63)	

[a]Scores are on a scale from 1 to 5, with 1 being strongly disagree and 5 being strongly agree.

Analysis

To evaluate the facilitators' experience in the MUVE and examine if a learning environment was acceptable and supported the acquisition of learning outcomes, the CoI survey responses and qualitative responses in each of the three constructs—social presence, cognitive presence, and teaching presence—were analyzed together. To analyze the modified CoI survey and overall SL questions, descriptive statistics and frequency distributions were analyzed using SPSS version 21 (IBM Corp). A content analysis approach was used to analyze the nine open-ended questions with NVivo10 (QSR International) to code and organize the qualitative participant responses from the SL surveys.

For comparisons of face-to-face surveys and SL training sessions, responses from the four face-to-face sites (ie, St Louis, Philadelphia, Atlanta, and Memphis) were combined because there were no significant differences among training sites on any of the outcome variables (P>.05). Univariate frequencies of outcome variables were run and the Mann-Whitney U test for nonparametric data was used to make bivariate comparisons of the face-to-face and SL outcomes, as the data did not follow any specific parameterized distribution.

Results

Evaluation of the Virtual Learning Environment

Social Presence

Results indicate that most respondents experienced a moderately high level of social presence—in other words, they were able to feel connections with other participants. The subscale mean was 23.11 (SD 4.12) out of a possible 30. The highest ranking questions were “I felt comfortable participating in training discussions” (mean 4.17, SD 0.66), “I felt comfortable disagreeing with other facilitators while still maintaining a sense of trust" (mean 4.06, SD 0.64), and “I was able to form distinct impressions of some course facilitators” (mean 3.91, SD 0.92). Qualitative comments supported the survey findings. When asked what they most liked about SL, participants/facilitators noted particular aspects of the training that they liked best: “...very interactive and fun to see” and “...very interactive, very engaging.” Additionally, several comments reflected social connections—an indication of social presence—with others in the training session as an aspect of what they liked about SL training: “...interacting with people across the country” and “...interacting with other facilitators and getting feedback.”

Despite the positive comments, facilitators indicated that the lack of being able to see facial expressions was a disadvantage. For example, “The element of watching individual’s body language & facial expression is priceless...only thing MISSING” and “You can’t see everyone and their body language which is important when facilitating training but it [SL training] was very good.”

Teaching Presence

In general, facilitators reported a high perception of teaching presence. The subscale mean was 8.74 (SD 1.01) out of a possible 10. High mean scores were reported for items related to the trainers’ skill in keeping facilitators on task and also trainers’ ability to provide feedback in a timely fashion (mean 4.31, SD 0.58 and mean 4.43, SD 0.50, respectively). Qualitative comments supported a strong teaching presence: “A good

balance between lecture and interactive activities was provided"—indicates design and facilitation—and "...getting feedback on our teach backs"—indicates facilitation. These comments indicated that the facilitator constructed activities in a way that supported learning in the environment.

Cognitive Presence

Cognitive presence was also highly rated. Cognitive presence supports the ability of learners to construct meaning through reflection and discourse. Overall, the subscale mean was 16.69 (SD 1.97) out of a possible 20. The majority of respondents were in agreement with statements indicating that they felt able to describe ways to apply knowledge learned in training (mean 4.23, SD 0.55), they were motivated to explore content-related questions (mean 4.14, SD 0.60), learning activities helped them construct explanations and solutions (mean 4.11, SD 0.58), and reflection helped them understand fundamental concerns in training (mean 4.20, SD 0.63). Qualitative comments that supported the survey findings were as follows:

> *Good to get better understanding from what is expected from the curriculum, sometimes you don't know what the developer was thinking.* [Understands the objectives of the course]
>
> *Reinforcement of cultural values. Activities that reinforced the materials throughout* [Understanding of the importance of how the cultural values are threaded throughout the curriculum]
>
> *I definitely learned a lot—facilitation skills—appreciated knowledge everyone else brought* [Met the objective of learning skills]

The responses on the overall SL questions found that 69% of the participants (24/35) agreed/strongly agreed that SL was an effective learning activity and 77% of the participants (27/35) agreed/strongly agreed that SL was a positive experience.

Acceptability of Second Life Training

The survey responses from the face-to-face and SL training sessions are presented in Table 2; bivariate comparisons between the face-to-face and SL training sessions are presented in Table 3.

A total of 80% of the participants (28/35) responded that the length of the training in SL was "about right" and 83% (29/35) responded that the pace of the training was "about right." When asked about their self-assessment of knowledge and skills in every category—core elements, six modules, challenging questions, and recognize how Latino culture supports safer sex—over 50% of the participants in the SL training program reported, at a minimum, being confident with those skills.

Table 2. Comparison between Second Life training and CDC[a] face-to-face training.

Variables and survey responses	CDC survey (n=44), n (%)	Second Life survey (n=35), n (%)
Evaluation of training		
Appropriateness of training length		
Too long	1 (2)	1 (3)
A little too long	6 (14)	2 (6)
About right	29 (66)	28 (80)
A little too short	8 (18)	3 (8)
Much too short	0 (0)	1 (3)
Pace of the training		
Much too slow	0 (0)	0 (0)
A little slow	4 (9)	3 (8)
About right	28 (65)	29 (83)
A little fast	9 (21)	2 (6)
Much too fast	2 (5)	1 (3)
Self-assessment of knowledge and skills		
Knowledge of core elements		
Not confident	0 (0)	0 (0)
Little confident	0 (0)	0 (0)
Somewhat confident	2 (5)	11 (32)
Confident	16 (37)	19 (54)
Very confident	25 (58)	5 (14)
Knowledge of six modules		
Not confident	0 (0)	0 (0)
Little confident	0 (0)	0 (0)
Somewhat confident	1 (2)	6 (17)
Confident	21 (49)	24 (69)
Very confident	21 (49)	5 (14)
Respond to challenging or sensitive questions/situations		
Not confident	0 (0)	0 (0)
Little confident	0 (0)	0 (0)
Somewhat confident	3 (7)	3 (8)
Confident	17 (40)	16 (46)
Very confident	23 (53)	16 (46)
Help participants recognize how Latino culture supports safer sex		
Not confident	0 (0)	0 (0)
Little confident	0 (0)	0 (0)
Somewhat confident	3 (7)	3 (9)
Confident	16 (38)	17 (48)
Very confident	23 (55)	15 (43)
Mastery of *¡Cuídate!* curriculum		
I have mastered content of program as written in manual		
Strongly disagree	N/A[b]	0 (0)

Variables and survey responses	CDC survey (n=44), n (%)	Second Life survey (n=35), n (%)
Disagree	N/A	2 (6)
In the middle	N/A	14 (40)
Agree	N/A	18 (51)
Strongly agree	N/A	1 (3)
I have mastered skills to deliver program as written in manual		
Strongly disagree	N/A	0 (0)
Disagree	N/A	1 (3)
In the middle	N/A	8 (23)
Agree	N/A	20 (57)
Strongly agree	N/A	6 (17)

[a]Centers for Disease Control and Prevention (CDC).

[b]Not applicable (N/A).

Table 3. Nonparametric comparisons of participant ratings between CDC[a] face-to-face training and Second Life training.

Variable	CDC training score (n=44), mean (SD)	Second Life training score (n=35), mean (SD)	Mann-Whitney U test	*Z* score	*P* [b]
Appropriateness of training length	3.00 (0.62)	3.03 (0.65)	765.50	-0.06	.96
Pace of the training	3.21 (0.68)	3.03 (0.51)	643.00	-1.41	.16
Knowledge of core elements	4.53 (0.59)	3.83 (0.66)	353.50	-4.35	<.001
Knowledge of six modules	4.47 (0.55)	3.97 (0.57)	441.50	-3.56	<.001
Respond to challenging or sensitive questions/situations	4.47 (0.63)	4.37 (0.65)	692.50	-0.67	.50
Help participants recognize how Latino culture supports safer sex	4.48 (0.63)	4.34 (0.64)	649.00	-0.98	.33

[a]Centers for Disease Control and Prevention (CDC).

[b]*P* values (significance) based on two-tailed analysis.

Comparison of Face-to-Face and Virtual Training Experience

There were no significant differences between participant ratings of the length or pace of training in SL as compared to face-to-face training (*P*=.96 and *P*=.16, respectively). Further, results indicate no significant difference between SL and face-to-face participant self-assessment of their ability to respond appropriately to sensitive questions and to recognize how Latino culture supports safer sex decisions (*P*=.50 and *P*=.32, respectively). There was a significant difference between reported knowledge of the components of the six *¡Cuídate!* modules (*P*<.001). Those facilitators who participated in face-to-face training sessions had higher knowledge scores (mean 4.44, SD 0.56) as compared to those who participated in SL training sessions (mean 3.97, SD 0.57).

Additionally, there was a significant difference (*P*<.001) between SL and face-to-face participant ratings of their ability to describe the six core elements of the *¡Cuídate!* curriculum. Facilitators who participated in the face-to-face training sessions rated their level of confidence in their knowledge of the core elements and six modules significantly higher (mean 4.47, SD 0.62) compared to those in the SL training sessions (mean 3.83, SD 0.67). However, of the SL participants, 54% (19/35) agreed/strongly agreed that they mastered the content of the program as written in the manual, and 74% (26/35) agreed/strongly agree that they mastered the skills to deliver the program as written in the manual.

Discussion

Principal Findings

MUVEs hold promise for delivering training in the future without the training-related travel costs, thereby increasing the use of these crucial programs that have widespread and critical influence on population health and health outcomes. It is always challenging to deliver training in a Web-based environment when you cannot physically see the facilitators, particularly when training requires active participation rather than passive receipt of knowledge. Part of the *¡Cuídate!* Training of Facilitators curriculum [21] requires facilitators to conduct teach backs, necessitating engagement with others. Consequently, the use of a MUVE such as SL over a noninteractive format (eg, webinar) is essential to support the interaction necessary to

support the role-play interaction. Results of this study indicate that SL is an acceptable and feasible way to deliver training and achieve outcomes that lead to learning success.

The results of this study indicate that the three constructs of social, teaching, and cognitive presence were present in the SL environment. The facilitators also rated the SL experience as positive and effective. Specifically, the facilitators experienced a moderately high level of social presence in the SL environment. This connectedness to others has been shown to be a predictor of success in online courses [11]. Although virtual environments will never duplicate the social presence found in face-to-face environments, the comments demonstrated how engaged and immersed in the environment the facilitators were when responding (eg, “interacting with people across the country"). The facilitators only "met" or interacted in SL, yet they felt a connection to others with whom they trained. This is consistent with what was seen in other studies using SL [14-16].

In relation to cognitive presence—an indicator of how well our facilitators achieved the learning objectives—facilitators agreed the activities were helpful and they felt capable of applying the knowledge gained in training. Facilitators had access to all six modules and all the activities in the training manual; they were asked to review all modules/activities as part of their prelearning work prior to coming to training. Also noted in the training survey, the majority of the participants agreed they had mastered the skills to deliver the curriculum, and over half agreed they had mastered the content of the program. This is consistent with the study by Schwaab [16] in which MI skills improved after training in SL. Teaching presence was also supported by the SL environment. Facilitators rated the trainers high in keeping them on task and providing them with timely feedback, while comments supported a good balance of activities. Comparison studies did not rate the quality of teaching presence.

There were no differences between face-to-face- and SL-trained facilitators in their confidence levels regarding their ability to respond to challenging or sensitive questions when delivering the curriculum, which is important to the mastery of the curriculum. This is essential to meeting the aim of ensuring facilitators have the ability to deliver the curriculum effectively. The significant difference between participants' self-assessment of their abilities to identify the core elements and modules was not surprising. During the face-to-face training sessions, facilitators were given an overview of the six modules, whereas facilitators in the virtual environment were required to review all materials ahead of time as part of the prelearning work. Given the complexities and multiple priorities of the facilitators, they may have not reviewed the materials or did not thoroughly review them prior to the virtual training. Further work is needed to ensure facilitators complete all prelearning materials. This can be done by requiring interaction with the modules as they are being presented or with a postmodule quiz.

The high ratings on the mastery indicate that although participants did not experience all learning in SL, they did feel they had the skills to deliver the content. This finding supports the efficacy of conducting training in SL. Educators should consider this when trying to minimize time spent in training while ensuring mastery of the content and various learning methodologies. Eliminating extra time in training will assist with efficient use of the limited resources available to community-based organizations or other groups pursuing training.

Conclusions

As it becomes more challenging to access training to deliver EBIs, alternative methods like training in virtual worlds need to provide access to training in a manner that is both effective and acceptable to those receiving the training. This will then open a way to increase access to even remote areas, provided there is Internet access and a willingness to engage in a virtual training environment. This study demonstrates that training can be effectively delivered in a virtual world and the training environment in SL can be designed and delivered in a manner that is acceptable to the participants. SL was an effective training environment for the facilitators to achieve the ability to learn the skills needed to deliver the *¡Cuídate!* curriculum, including demonstration of the teach backs that are essential to being able to effectively deliver this successfully to Latino youths.

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Conflicts of Interest

None declared.

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Abbreviations

CBO: community-based organization
CDC: Centers for Disease Control and Prevention
CoI: community of inquiry

EBI: evidence-based intervention
MBA: Master of Business Administration
MI: motivational interviewing
MUVE: multi-user virtual environment
N/A: not applicable
SL: Second Life
STD: sexually transmitted disease

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Original Paper

Training Vegetable Parenting Practices Through a Mobile Game: Iterative Qualitative Alpha Test

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Abstract

Background: Vegetable consumption protects against chronic diseases, but many young children do not eat vegetables. One quest within the mobile application Mommio was developed to train mothers of preschoolers in effective vegetable parenting practices, or ways to approach getting their child to eat and enjoy vegetables. A much earlier version of the game, then called Kiddio, was alpha tested previously, but the game has since evolved in key ways.

Objective: The purpose of this research was to alpha test the first quest, substantiate earlier findings and obtain feedback on new game features to develop an effective, compelling parenting game.

Methods: Mothers of preschool children (n=20) played a single quest of Mommio 2 to 4 times, immediately after which a semi-structured interview about their experience was completed. Interviews were transcribed and double coded using thematic analysis methods.

Results: Mothers generally liked the game, finding it realistic and engaging. Some participants had difficulties with mechanics for moving around the 3-D environment. Tips and hints were well received, and further expansion and customization were desired.

Conclusions: Earlier findings were supported, though Mommio players reported more enjoyment than Kiddio players. Continued development will include more user-friendly mechanics, customization, opportunities for environment interaction, and food parenting scenarios.

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KEYWORDS

mobile games; games for health; serious games; pediatric nutrition; parenting

Introduction

Vegetable consumption is protective against several chronic diseases [1,2]. Children's dietary practices tend to track into adulthood [3], and parents play an important role in establishing healthy dietary habits in their young children [4], but often report difficulty getting their child to eat vegetables [5,6].

Because traditional interventions to increase child vegetable intake have had little or no effect [7], innovative approaches are needed. Serious games provide a behavioral intervention opportunity to increase child vegetable intake, which has had a positive impact on health-related behavior change [8]. A mobile game, *Mommio*, designed to teach parents of young children about vegetable parenting practices [9] is currently under development. Games for health predicated on a combination of social cognitive [10] and self-determination

theories [11] are believed to increase likely effectiveness in promoting behavior change. According to social cognitive theory, a game that provides a player with relevant knowledge, skills, self-efficacy, and motivation is likely to result in behavior change [12]. In self-determination theory, personal values are an aspect of relatedness; fulfilling values should increase intrinsic motivation [12]. In *Mommio*, targeted desired behavior includes use of appropriate vegetable parenting practices [13]. A recent meta-analysis revealed that games were most likely to contribute to learning and behavior change when end users were involved as testers of game mechanics (A. DeSmet, written communication, January, 2015). The purpose of this alpha test was to obtain feedback from mothers of preschoolers on *Mommio* game mechanics at an early stage when changes could still be made.

A prototype version of *Mommio*, *Kiddio*, was tested by mothers who were similarly interviewed about their experience [14]. Substantial changes (eg 3D environment replacing a 2D environment, enhanced recipe selections, additional interactive items) were made. The current alpha test (ie testing game features when changes can still be made) of one *Mommio* quest was to reaffirm conclusions drawn from *Kiddio* testing [14], as well as obtain feedback on new, more sophisticated features to produce an effective game that trains vegetable parenting practices among mothers of young (3-5 year old) children.

Methods

Sample and Recruitment

Mothers of 3-5 year old children were recruited after obtaining approval from the Baylor College of Medicine's Institutional Review Board. Mothers who reported no difficulty getting their child to eat vegetables or were not 20-40 years old were excluded. Recruiting took place through digital and printed flyers distributed throughout the Texas Medical Center, and from the Children's Nutrition Research Center's volunteer list. All mothers (n=20, demographics described in Table 1) provided informed consent.

Game Description

Mommio is a first-person role playing video game that simulates a mother interacting with her preschool age child (called "Kiddio"). Kiddio hates veggies. Players can customize their Kiddio's name, gender, skin, and hair color. The game takes place in a 3D world that includes the player's virtual house, complete with working kitchen and numerous common distractions, such as a begging family dog and booming televisions. The player navigates by double-tapping the ground to move inside the world and using an onscreen thumb stick to change perspective. Single tapping a character (Kiddio or the dog) or a game object (refrigerator, food item, etc.) starts an interaction. At mealtime, Kiddio prompts the player to action by exclaiming "I'm hungry." The player must then select a vegetable recipe from the kitchen's recipe box as a side dish for lunch. The recipe box features simple recipes for a variety of vegetables, and non-veggie recipes (eg macaroni and cheese) which result in a loss if selected. Once the player and Kiddio are seated at the kitchen table, the player tries to get Kiddio to eat the vegetable, and Kiddio refuses.

Mommio is not an easy game to win. The player can try different food parenting strategies, such as choosing from effective and ineffective statements to say to Kiddio, or modifying the environment (eg turning off the television). The variety of statements that can be selected to say to Kiddio could be modified by voice tone (gentle, firm, or harsh) and facial expressions (happy, neutral, concerned, or angry). If the player makes an effective move, she comes closer to winning the game. If she selects ineffective ways for dealing with the child, she moves toward losing the game. At the conclusion of each *Mommio* quest, Kiddio either tastes the vegetable to signify a victory, or runs out of the room, indicating a loss.

At the conclusion of the quest, players are led through a series of screens that asks them to select a parenting value that is important to them, from which tailored motivational messages will be delivered, as well as a plan for strategies to use at home to increase vegetable consumption based on the selected value.

Table 1. Demographics.

Demographics		n (%)
Child Gender		
	Boy	13 (65%)
	Girl	7 (35%)
Highest Education Completed		
	High School graduate or GED	1 (5%)
	Technical school	2 (10%)
	Some college	7 (35%)
	College graduate	5 (25%)
	Post Graduate Study	5 (25%)
Annual Household Income		
	Less than $30,000	4 (20%)
	$30,000 to $60,000	8 (40%)
	Over $60,000	8 (40%)
Ethnicity		
	Hispanic	9 (45%)
	African American	6 (30%)
	White	3 (15%)
	Asian-Non Vietnamese	1 (5%)
	American Indian	1 (5%)
Employed		
	Yes	14 (70%)
	No	6 (30%)
Primary Responsibility for Feeding the Selected Child		
	Me	13 (65%)
	Shared among multiple people	7 (35%)
Marital Status		
	Married or living with a significant other	13 (65%)
	Single, Never married	6 (30%)
	Divorced. Separated, or Widowed	1 (5%)

Procedures

Mothers scheduled one hour time slots at their convenience to play *Mommio* on an Apple iPad tablet under researcher observation. Qualitative interviews about their experience followed, conducted by a trained interviewer. Participants were provided a player tutorial guide upon starting their game session, and were encouraged to ask questions. The interview contained 27 questions, with additional probes and prompts (Textbox 1). At the conclusion of the interview, participants were thanked and compensated $25.

Textbox 1. Interview questions.

1. What do you think the game is about?
2. What, if anything, did you like about playing the game?
3. What, if anything, did you not like about playing the game?
4. What do you think about the name of the game?
5. What did you think about personalizing the child character?
6. What did you think about being able to pick different things to say to the child character?
7. What did you think about the child character's reactions to your statements?
8. What did you think about being able to choose recipes to offer the child character?
9. What things did you do in the in the game that you could use with your own child?
10. What did you think about the artwork or graphics for the game?
11. What did you think about moving around the house?
12. What did you think about interacting with items in the game environment?
13. How do you think you can win this game?
14. What did you think about the possibility of game points?
15. What do you think about receiving feedback at the end of gameplay?
16. What did you think about the game's question about "What is most important to you"?
17. What did you think about the "most important to you" choices offered?
18. What are your thoughts on receiving tips to practice at home?
19. What did you think about having a website as an additional resource?
20. Today you played the "lunch" level of the game. The finished game will include other situations like car trips, dinners, grocery stores, and fast food restaurants. Would you play a game like this?
21. Do you read nutrition labels while at home or in the grocery store?
22. If the game was a free app game how likely would you download it to play?
23. How much would you be willing to pay for this app game?
24. If you had to pay for this app game, how likely would you download it to play?
25. On a scale of 1 to 3, where 1 is "not difficult" and 3 is "very difficult," how difficult is it to get your child to eat vegetables?
26. Using a 1 to 4 STAR rating scale, how would you rate the game?
27. Before we finish, is there anything else you want to tell me that you haven't had an opportunity to say?

Data Analysis

Interviews were audio-recorded and transcribed in full. All transcriptions were double-checked against the original recording before importing into NVivo (Version 10.0, 2012, Doncaster, VIC, Australia). Thematic analysis [15] was used to code each response within the questions posed. Transcripts were double coded to ensure reliability. Differences between coders were adjudicated by discussion and consensus.

Results

Game Elements

Most mothers completed three iterations of the game. On average, gameplay consumed 20 (SD 7) minutes. Patterns emerged in regard to the design of the *Mommio* game. These themes reflected on game look and feel, as well as mechanics not related to vegetable parenting.

A majority of the sample (12/20, 60%) found navigating the game environment frustrating. This was largely due to the thumb stick, which was felt to be *"overly sensitive"* and *"very hard to control"* (see Figure 1). Over half of the mothers (12/20, 60%) found the circle thumb stick difficult to use, and a few (2/20, 10%) found the feature to be a deterrent to engagement. For some (6/20, 30%), the thumb stick mechanic was a learning curve that *"took me a while to get accustomed to."* A handful of mothers (3/20, 15%) suggested using direction arrows instead of or in conjunction with the thumb stick, or to maneuver by dragging *"not the circle, just with your finger."* Less than a quarter of mothers (4/20, 20%) mentioned liking the thumb stick feature.

Nearly all mothers (19/20, 95%) enjoyed the ability to personalize the look of the child character, although some (5/20, 25%) wanted more hair options while others (7/20, 35%) wanted more clothing options, which *"would feel more like it's my child."* Nearly all participants (19/20, 95%) enjoyed naming the character after their own child, which increased the realism

of the story. A majority of participants (16/20, 80%) would have liked to pick the child's personality (ie temperament [16]) in the game, as this would be

> *more realistic to what parents or guardians have to deal with when they're trying to encourage a kid with a certain type of personality to eat their vegetables, because all kids are not the same.*

The main action of the game took place in the kitchen of the home. Perhaps due to this, nearly half of the mothers (8/20, 40%) were not aware that the navigable 3D environment included the entire house and yard. This was reflected in comments such as

> *I wish we would have been able to move more around the house to make it a little interesting*

and

> *I didn't try to go out past the kitchen. But I'm sure that's the only place you'll be able to go*

Most (16/20, 80%) thought that double tapping the floor to move in the environment was either good or fine. Four mothers thought this countered some of the difficulty experienced with the thumb stick feature, saying "I thought that made it easier, a lot easier".

However, a few (3/20, 15%) mothers did not understand or use this feature.

Thirteen mothers liked interacting with items in the game environment, with 25% (5/20) mentioning that this feature made the game more realistic. However, three mothers were

> *unclear whether doing any of those things has any impact on the game, like turning off the TV. Is it important to do that as part of the process or are these just things that are there for no particular reason?*

All participants opened and closed cupboards in the kitchen environment, and 35% (7/20) enjoyed seeing the contents of the kitchen and nutrition labels of food. Almost half of all participants (9/20, 45%) wanted more available interactions with items in the kitchen, saying things such as

> *I did try to get a box of something off one of the cabinets, but that didn't work either. So just having the option would be good.*

Many participants liked interacting with the environment in other ways, such as turning off the television (9/20, 45%) and speaking to the dog (5/20, 25%), which increased the realism of the environments and was "something extra to do…it was neat".

Three quarters of participants said that they liked the graphics and looks of the game. About one third of all parents thought that the home and kitchen looked modern or realistic (6/20, 30%), liked the bright colors used (5/20, 25%), and thought that the art looked professional (5/20, 25%); though a minority mentioned (2/20, 10%) that the art looked like cartoons tailored for preschoolers. A few participants (3/20, 15%) thought the art was passable, but unremarkable, such that they were

> *not sure it would win awards necessarily, in terms of its, like, graphic ability, but it was totally fine.*

The kitchen and home environment were noted as "nice and cute" and about a quarter of participants (4/20, 20%) mentioned enjoying exploring and interacting with the realistic kitchen, which was stocked with grocery items.

All mothers agreed receiving feedback at the end of gameplay would be beneficial. The majority (13/20, 65%) thought that feedback should occur at the end of each episode (level), although a few (3/20, 15%) thought that it should occur after a few episodes taking place in one sitting. The most commonly preferred method of delivery was in-app, followed by email. Common requests for feedback content included points earned, quality of food choices made, tips to improve gameplay, and evaluations of parenting statements selected. Some participants (7/20, 35%) wanted to see a tie-in to the learning goals of the game through feedback,

> *because if I'm going to take time to play the game, then I would want to receive something from it beneficial that I could use.*

Figure 1. Joystick mechanic.

Learning Content

For the video game to be effective, it must adequately express and incorporate vegetable parenting messages. Several themes were found from participant discussion of learning content.

All mothers enjoyed being able to select statements to say to Kiddio and found the available statements realistic (see Figure 2). Several (6/20, 30%) mentioned the variety of statements available to them, which

> *was great because there were some things I wouldn't necessarily say to my child. But I found something that fit me and my personality on how I would respond in the situation.*

Others (4/20, 20%) thought the selectable statements were limited and should be expanded to not get repetitive in future levels.

Every mother interviewed found statements that she would use or has used with her own child. Most commonly mentioned statement types noted as effective in the game were encouragement to try a vegetable or take a few bites and trying or preparing vegetables with the child. The most frequently mentioned ineffective strategies were bribing with food or activities after eating and telling the child that he should sit at the table until he eats his vegetables.

Many players thought that the child character's reactions were realistic (17/20, 85%) and similar to their own child (15/20, 75%). A few mothers mentioned liking the character's realistic attachment to a favorite toy (3/20, 15%), as well as Kiddio's responses to player actions. Many (8/20, 40%) pointed out differences between the child character and their own child, including differences in stubbornness (3/20, 15%) (the child character was perceived as both more and less stubborn than a parent's own child), responses to bribery (2/20, 10%) (the character does not respond well to bribery, real child does), and activity level (4/20, 20%) (own child talks and fidgets more, including eating items on plate to avoid vegetables).

While a large majority of mothers (17/20, 85%) thought Kiddio responded mostly as expected, three participants found that there was not enough variation of child animations to portray appropriate reactions, as

> *it seemed as if it was always stuck on a certain, 'I don't want it, I don't want to do it' kind of look.*

All but one mother found the child's reactions helpful in knowing how well they were doing in the game, as "you can read by the facial expressions" The mother who did not find the child character's reactions helpful cited a lack of variation in expression, similar to the reasons for the child character's unexpected reactions.

Upon first playing, game goals and objectives were unclear to many participants. Some (8/20, 40%) "had no clue what to do," which resulted in confusion or frustration. Mothers who expressed this either consulted the provided user guide or asked the researcher for help before making strides in game progression.

Most mothers (19/20, 95%) liked the vegetable recipes provided through the in-game recipe box and that recipes included instructions and nutrition information. Some (8/20, 40%) pointed out real-world benefits for including this information, and that the recipes may

> *help me to learn like what's healthy, what's not healthy. I guess it's going to be good for kids as well.*

The vast majority of mothers (18/20, 90%) said they would be interested in using the recipes at home with their own child, or already do. Nearly all mothers (18/20, 90%) said they would be interested in learning how to make the recipes at home. A minority of mothers (2/20, 10%) found the recipes too simple and thus already knew how to make them.

Almost half of mothers (9/20, 45%) would prefer to receive game recipes though an in-game recipe box with an option to select individual recipes to send to their email. Other preferences included only the in-game recipe box, a combination of email and website, featured in the app but outside of gameplay, and on a website. Frequent responses to ideal recipe content, aside from ingredients, included calorie count, instructions, nutrition content, and serving size.

Nearly half of all participants (9/20, 45%) thought the player wins the game by getting Kiddio to eat vegetables. Several additional mothers focused on the parenting strategies as ways to win, such as watching one's tone while speaking (6/20, 30%), selecting the right parenting statement (4/20, 20%), and using generally effective communication strategies (2/20, 10%). Three mothers did not mention parenting strategies, but indicated that picking healthy foods was the way to win.

Figure 2. Playing a meal.

Real World Application

A series of questions asked participants to reflect on personal values regarding parenting practices. This included a game prompt, which asked participants to practice vegetable parenting based on a parent-selected value. Participants generally were open to a real-life crossover, given their current values and habits.

A game storyboard featured a question asking players to select what value (e.g. being a role model, being spiritual) was most important to them given multiple options. Half of all mothers interviewed (n=10) thought this question was good or okay. However, six mothers found it confusing, commenting "I didn't relate this to the game really," and "I wasn't really sure of exactly what the point was there". The vast majority (17/20, 85%) understood the question, although two mentioned they needed more context to understand what the question was asking.

A quarter of participants (5/20, 25%) found selectable value options to be good or okay. A handful of mothers (4/20, 20%) agreed that

> *being spiritual-even though it may be important to you, but I think it's just so far and apart from the game*

and would have liked to see this value replaced with something that fits better with the game and other available options. Most (15/20, 75%) said the selectable options made sense to them, but a couple said they were not sure how to answer given provided choices. All mothers interviewed thought at least one of the listed values applied to them, though five would have liked to select more than one value.

All mothers indicated they would be willing to try out game tips with their own child, largely willing to consider parenting practices that could help with their parenting, saying "if you can get advice and help from others, it's always a plus". All but one mother agreed that receiving tips to practice at home would be helpful, as

> *it helps that you have those tips and that you've practiced, and you have some information under your belt and ready.*

The mother who disagreed thought that a game was not the best format for receiving parenting tips. Preferred methods of parenting tip delivery and scheduling time to practice were email, electronic calendar app or other mobile scheduling program, in-game only, and text message.

All participants indicated at least one food parenting practice from the game they either had used in the past with their own child or would use in the future. Popular responses include being aware of vocal tonality or facial expressions when speaking to the child (see Figure 2), staying positive or encouraging, sitting down at the table with the child for meals, role modeling healthy habits, choosing healthy vegetable recipes, involving one's child in the meal preparation process, and general communication strategies.

Fourteen mothers reported reading nutrition labels in the grocery store. Those who read labels used the information because they wanted to feed their child healthy foods, prevent disease related to unhealthy eating, be aware of what is in their food, make choices between similar products, and limit certain nutrition elements, such as sugar.

When reading nutrition labels, mothers said they looked for numbers for sugar or carbohydrates, calories, sodium, fat, protein, and portion size. Five mothers reported looking at ingredient lists in addition to nutrition panels. Several of these components were listed on nutrition labels provided for each recipe in the game. About half of mothers interviewed (11/20, 55%) thought all recipes in the game should have these nutrition panels, and even more (14/20, 70%) wanted to see the ingredients of a recipe in the recipe box before making a selection.

Future Production

Evaluations of the game as a whole and thoughts about its future were presented over the course of each interview. More than half of mothers interviewed (13/20, 65%) thought that a companion website would be good or helpful. Mothers suggested the website include recipes with nutrition tips, parenting tips, forums or user generated content, links to external resources, and the game itself.

A larger, more complex game that featured several mealtime contexts was of interest to a large majority of mothers (17/20,

85%). Those interested in playing said that variety would make the game more interesting and would be helpful delivering parenting tips for different scenarios. A few mothers (3/20, 15%) mentioned wanting grocery store help specifically, while a few others (2/20, 10%) mentioned tips for car trip food parenting.

All but one mother said a game that varied in context would seem more like their real life. One mother said that it would not, due to the fact that nearly all meals her family consumed were in the home.

Most mothers (15/20, 75%) said they would likely play multiple meals in a row in the proposed expanded version of the game. Those who mentioned not wanting to do this commented that "trying to remember too much at the same time is not going to be effective, either," and that playing the game in small chunks would let them retain tips and information for future use.

When asked how likely they would be to download the game if it were free, the large majority of mothers (17/20, 85%) said that they would very likely do so. Reasons included it "would be beneficial" or useful to parenting, that the game supports interactive time with one's own child if they play together, and curiosity. Two mothers who would not download the game for free reported not liking any types of games, and the remaining mother was not sure whether or not she would download the game until it was expanded further.

Two mothers reported being slightly less likely to download the game if they had to pay for it than if it was free. Three would not pay for the game, with one mother citing that she'd rather "research for free versus paying for something that I feel I....can gain for free".

When asked for a rating of "hated it, didn't like it, liked it, or loved it" most mothers (13/20, 65%) said they liked the game. Three mothers did not like the game. Four mothers said that they loved it, "because it was educational and it was fun. And it kept my attention".

Mothers who did not say that they "loved" the game were asked what could be changed to make them love it. Suggestions included expanding the game across contexts and functionalities (as discussed in the question about game expansion). Mothers also requested clarification of game goals/objective, perhaps through the use of a tutorial, as well as improvement to game navigation by modifying the thumb stick feature. More things to do in the kitchen, such as picking up pantry items or cooking were requested. Mothers also felt additional recipes and feedback after gameplay would make the game better, as well as the addition of audio.

Discussion

Results were generally consistent with earlier findings [14]. Both studies uncovered initial confusion by players about the game's objective, but understanding of the game's primary goal after at least one level was played [14]. Mechanics and navigation were considered difficult in both studies [14], although they had been modified after the earlier test. Customization was appealing for both the child character as was the ability to choose what to say and do in the game environment [14]. Feedback was a desirable in-app feature across both studies, as was Kiddio's animations and reactions, though both samples suggested ways they could be improved [14]. Both studies found that while asking players to choose a value was fine, mothers had a difficult time selecting only one parenting value given the options displayed, though these options were different in form and number for each study [14].

Some findings between *Kiddio* and *Mommio* differed [14], perhaps due to enhancements in the game itself. *Mommio* participants rated the game higher; with more saying they "loved" the game [14]. Many more *Mommio* than *Kiddio* players were interested in playing the game if it were free or if it had a small cost, suggesting the changes made enhanced its appeal.

Aspects of social cognitive and self-determination theories were endorsed. Participants reported gaining knowledge through situated learning and environmental exploration; transferable real-world skills were learned through parenting statement selection. Self-efficacy was experienced through personal success in winning the game and expressed by vocalized interest in trying new methods at home. Intrinsic motivation for selecting effective vegetable parenting practices was enhanced through motivational messages tailored to parent-selected value statements. All these findings support the likelihood that *Mommio* will influence behavior change.

Repeated testing of an evolving serious game is valuable. Many earlier findings were supported, strengthening their original import. Differences between the studies demonstrated that game has evolved in an effective way. Several changes will be made to address issues raised (Textbox 2). Trouble with mechanics will be resolved through the discarding of the thumb stick in favor of finger-sweep controls. A tutorial level and more overt Kiddio expressions will be added to address confusion with these game elements.

Textbox 2. Directives for future changes to Kiddio.

- Change or delete onscreen circle thumb stick feature
- Expand game across additional levels and contexts
- Expand recipes
  - Add more recipes
  - Add "send to email" feature
  - Keep nutrition panel with carbs, fat, sodium, protein, calories and portion size
- Add a tutorial level
- Add feedback, occurring at the end of each game, in the app itself, that includes parenting tips
- Add more interaction to kitchen items, such as ability to select food from the cabinets
- Add a broader range of Kiddio facial expressions, especially for mealtime interactions
- Add more customization of the child character's physical appearance (clothes, hair)
- Keep tone/expression mechanic and selectable statement variety
- Keep value statement, but add a sentence for more context
  - Either replace "spiritual" answer or add many more selectable values that add balance

Increased customization of player experience was desired. This will be addressed by adding more options to modify Kiddio, such as hairstyles, and more ways to interact with the kitchen. *Mommio's* new features, such as inclusion of recipes and more environment interactions, were well received. Thus, recipes will be increased in number and detail, and made available for home use. Mothers liked the idea of expanding the game, and reported expansion would increase their desire to play. The final *Mommio* game will expand across environments such as the car and grocery store.

Both samples wanted feedback and tips, thus feedback will become more detailed in future versions of the game. Current positively evaluated features included selectable statements, voice tone selection, and value statements, which will be kept in future versions of *Mommio*. However, the mechanic for selecting values may evolve.

This study's limitations include a small sample, and only one game quest of one episode of the game was tested. The game was presented on a tablet, which was familiar to some, but not to others, and may have served as a barrier to engagement.

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Conflicts of Interest

Richard Buday, President of Archimage, is the commercial developer of the *Kiddio* and *Mommio* video games.

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Original Paper

Effects of Social Network Exposure on Nutritional Learning: Development of an Online Educational Platform

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Abstract

Background: Social networking sites (SNSs) such as Facebook have the potential to enhance online public health interventions, in part, as they provide social exposure and reinforcement.

Objective: The objective of the study was to evaluate whether social exposure provided by SNSs enhances the effects of online public health interventions.

Methods: As a sample intervention, we developed Food Hero, an online platform for nutritional education in which players feed a virtual character according to their own nutritional needs and complete a set of virtual sport challenges. The platform was developed in 2 versions: a "private version" in which a user can see only his or her own score, and a "social version" in which a user can see other players' scores, including preexisting Facebook friends. We assessed changes in participants' nutritional knowledge using 4 quiz scores and 3 menu-assembly scores. Monitoring feeding and exercising attempts assessed engagement with the platform.

Results: The 2 versions of the platform were randomly assigned between a study group (30 members receiving the social version) and a control group (33 members, private version). The study group's performance on the quizzes gradually increased over time, relative to that of the control group, becoming significantly higher by the fourth quiz (P=.02). Furthermore, the study group's menu-assembly scores improved over time compared to the first score, whereas the control group's performance deteriorated. Study group members spent an average of 3:40 minutes assembling each menu compared to 2:50 minutes in the control group, and performed an average of 1.58 daily sport challenges, compared to 1.21 in the control group (P=.03).

Conclusions: This work focused on isolating the SNSs' social effects in order to help guide future online interventions. Our results indicate that the social exposure provided by SNSs is associated with increased engagement and learning in an online nutritional educational platform.

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KEYWORDS

nutrition requirements; obesity; public health; social networking sites

Introduction

Online Public Health Interventions

With the significant amount of time people spent engaging with digital media [1], the Internet presents an ideal opportunity for health education. Research on Internet-delivered public health interventions is an emerging field that has gained momentum in recent years [2]. While most studies of online interventions (computer games, Internet sites, Facebook applications; mobile apps, etc) have focused on evaluating the overall effect of the intervention, very few studies have tried to isolate the effects of specific intervention characteristics [2,3].

Leveraging Social Networking Sites for Public Health Purposes

Social networking sites (SNSs) are a major component of Internet use by young adults [4], partly due to their ability to engage the human need for social reinforcement [5]. The use of these networks involves an element of "social exposure," in which users observe and exchange feedback on one another's activities. For example, social exposure has been used to successfully and dramatically increase organ donation registration [6]. The specific impacts of social connections on weight [7], and of social support on obesity preventing behavior [8] have been previously demonstrated outside the framework of SNSs.

Currently, the most popular SNS in the world is Facebook [9], which reports over 1.2 billion active users [3]. As much as 57% of American adults have a Facebook account, with each individual connected to an average of 338 friends in the network [10].

There is a tremendous opportunity to leverage the potential of SNSs to promote public health issues in general, and obesity prevention in particular. Obesity is associated with many of the most common and costly medical problems in Western society [11,12], reaching epidemic proportions and affecting roughly one-third of US young adults aged 20-39 [13]. In light of these alarming trends, there is a critical need for interventions aimed at preventing obesity in young adults. Although the direct association between nutritional knowledge and dietary behavior is debated [14], it is plausible that such knowledge is required once an individual aspires to improve his or her nutrition. A statement by the American Heart Association argues that social networks may be critical to shaping young people's eating behaviors, and emphasized the scarcity of interventions targeting SNSs [15].

A literature review from 2010 identified only one controlled intervention study on social media and health outcomes [16]. There are 2 systematic reviews published recently that found only 16 studies overall exploring the influences of SNSs on health behavior change [17,18]. Most of these studies reported some significant influence, but with considerable heterogeneity. Yet, the vast majority of these studies evaluated the overall effectiveness of an intervention involving a component of SNSs, but did not isolate the specific effect of social exposure within the SNSs.

Objective

The goal of this study is to evaluate whether the social exposure provided by SNSs can increase the effect of online public health interventions, specifically by evaluating its influence on the learning curve for nutritional knowledge.

Methods

The Food Hero Platform for Nutrition Education

In order to conduct this study, we developed a game-based educational platform called *Food Hero*, focused on nutrition education. The Facebook network was chosen as the SNS for developing the app due to its widespread popularity [3].

In the *Food Hero* platform, the user begins by choosing a virtual character. During each game day, the user must assemble an optimal food menu for the virtual character, based on the user's real-world caloric and nutrient composition needs (calculated according to the user's sex, age, weight, and exercise habits). The user is presented with a selection of food items for each of 3 meals and 1 snack, along with detailed nutritional information cards for each item (Figure 1). During menu selection, the user is able to monitor the progress of daily requirements through a set of status bars (Figure 2). After assembling the menu, the user receives feedback on his or her performance, including a numerical score of performance-based points. The user may perform repeated attempts to select the optimal menu for each game day, until the user is satisfied. At the end of each game day, the user is given the opportunity to complete a set of virtual running, cycling, and swimming challenges. The character's ability to complete these challenges is directly dependent on both the speed with which the user presses specific keys on the keyboard in order to make the character move and the quality of that day's menu selections; too much or too little food, or an imbalanced diet will slow the character down in the sports challenges. The user can also use accumulated performance points to acquire accessories for the virtual character, thus further assisting in completing the various sports tasks.

Figure 1. Feeding screen of Food Hero guided by nutritional information cards.

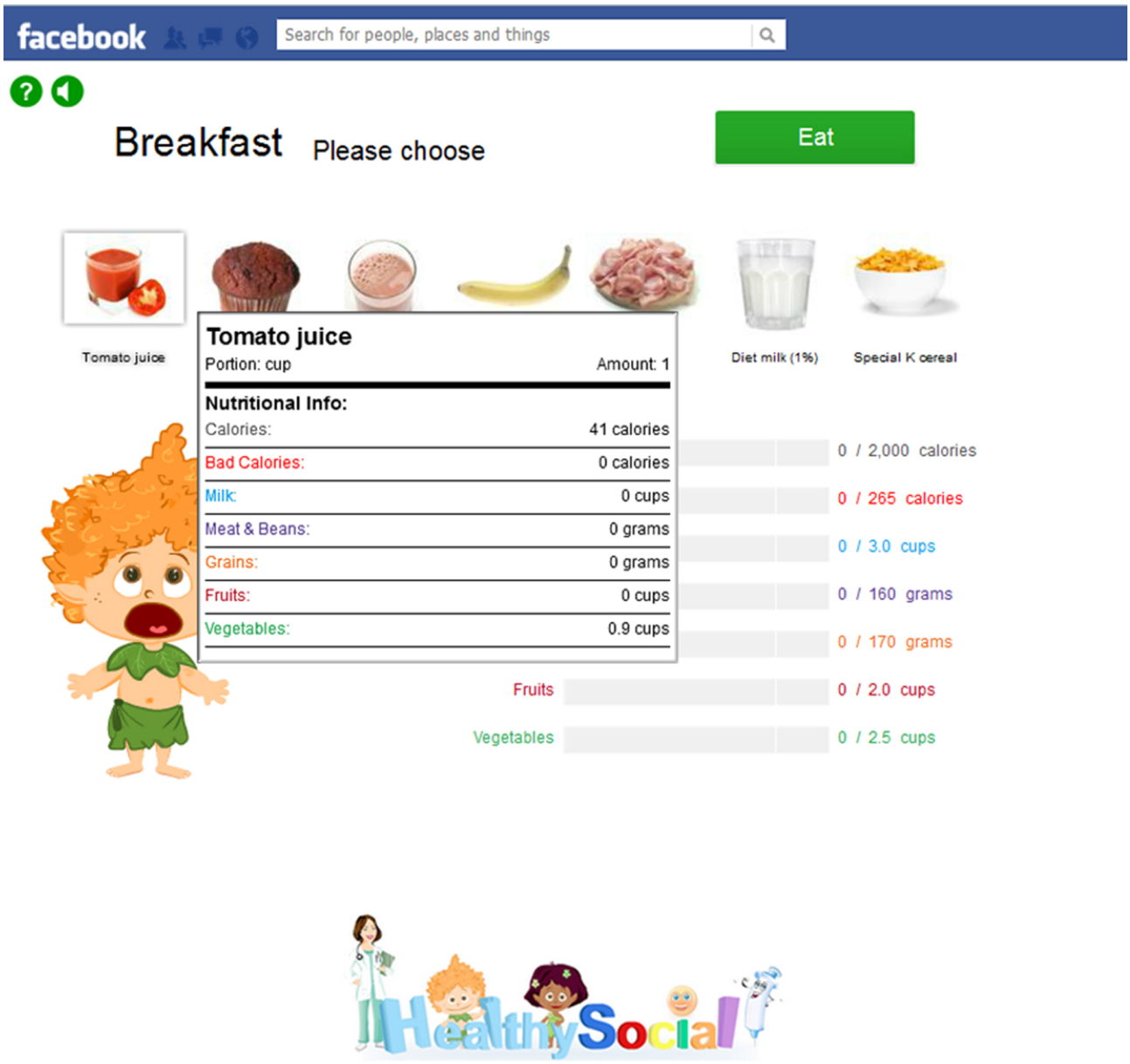
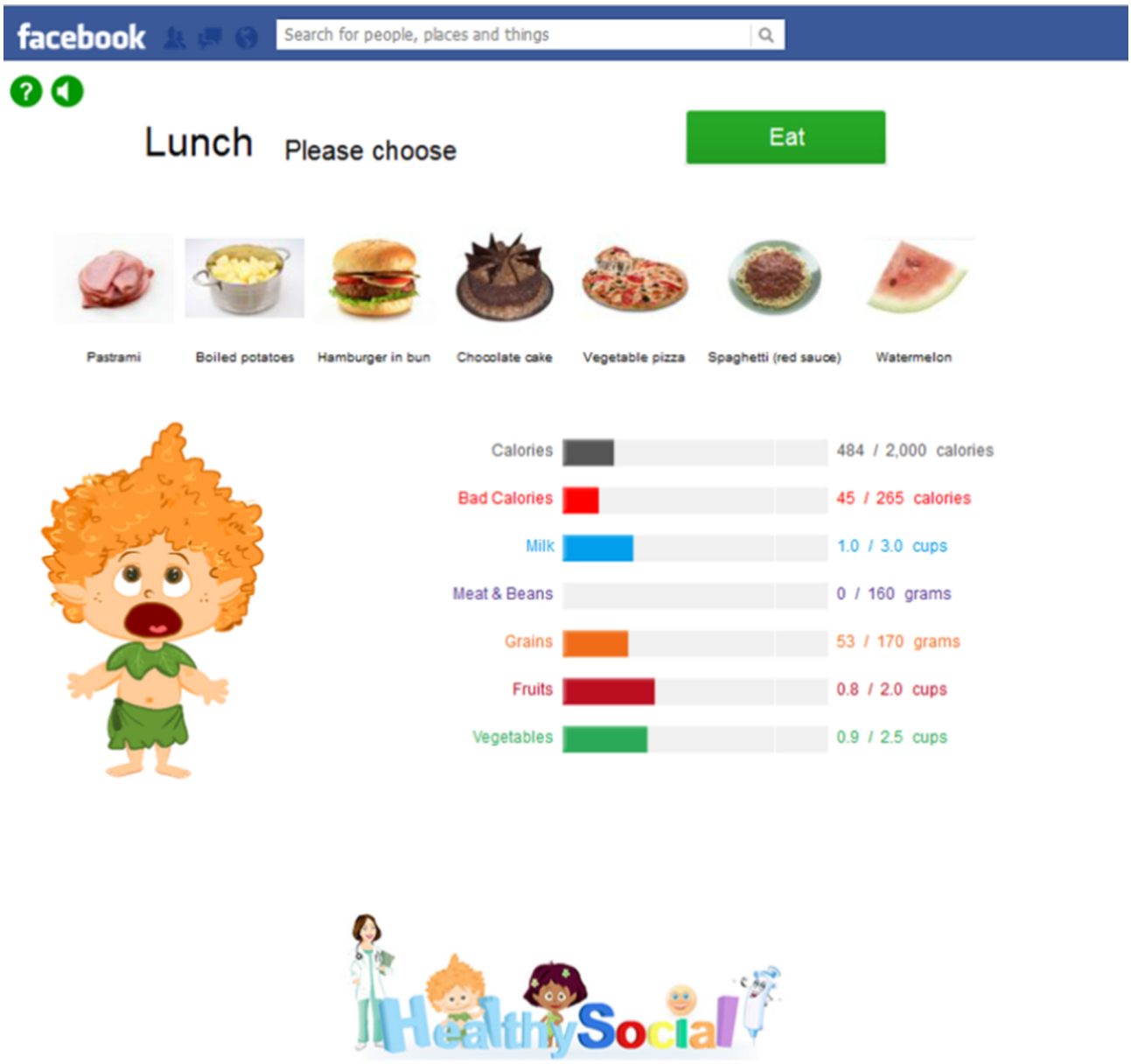


Figure 2. Feeding screen of Food Hero guided by status bars.



Study Groups

We developed 2 different versions of the platform, a “private version” and a “social version,” and assigned these versions randomly to different users. In the private version, only the user's own score is presented, without any information about the performance of other players. In the social version, the user’s performance is presented in the context of other players, a high-score bar shows the scores of the 5 best players, while another shows the top 5 scores from within the user's Facebook friends (Figure 3). The social version also shows pop-up messages any time one of the user's friends successfully completes a level. Users randomly assigned to the social version comprised the study group, whereas users randomly assigned to the private version formed the control group. Additional screen shots of the *Food Hero* platform are provided in Multimedia Appendices 1-13.

Figure 3. Home screen of the social version, showing the high-score bars.

Nutritional Information

Nutritional information was obtained from the US Department of Agriculture's official database for dietary guidelines, "My Pyramid." This information included the definition of the 5 food groups, a list of food items along with their nutritional value, and the formulas to calculate the proper intake of calories and desired level for each food group (adjusted for sex, age, weight, and exercise habits) [19,20].

Study Participants and Recruitment Process

Participants were Facebook users who chose to install the platform and agreed to join the study by completing a consent form presented as part of the app installation process. For reasons of legal consent, all study participants were older than 18 years of age, as stated in the participation consent form. Exclusion criteria included users that did not provide consent to participate in the study, users that did not report their age or reported an age younger than 18 years, and users that installed the software, but did not actively start to use it (ie, did not complete the first game day).

The distribution of the platform took place over a 2-month period, starting in April 2012, and was spread through the SNS by peer-to-peer message dissemination. The distribution was initiated by a single message recommending *Food Hero*, published by a seed individual, one of the research team members, to a group of Facebook friends. The rest of the distribution was based on users recommending the platform to their friends, and on automatic messages published by the platform on users' Facebook walls. This method of distribution was chosen to ensure that study members would have Facebook friends among the study population, expecting that watching the performance of known acquaintances will have more social impact than that of strangers' [21].

Data Collection

All data for the study were collected electronically within the *Food Hero* platform. During the platform installation process,

each user was presented with a consent form for participation in the study, and a personal information form including age, sex, weight (in kilograms/pounds), height (in centimeters/inches), mother tongue, education level, hours of weekly physical activity, and smoking status. To address the research question, it was necessary to track the users' nutritional knowledge throughout the course of the study's follow-up period. For this purpose, we developed 4 quizzes, each containing 8 different multiple-choice questions that had not been seen by the user before, and were based on information introduced within the platform before the relevant quiz. The quizzes were presented to users during game days 2, 6, 10, and 14. A secondary variable to assess user nutritional knowledge was the score of the first menu assembly attempt on 3 fixed game days—days 4, 8, and 12—during which the user was required to build a menu in an unguided manner, without the help of the usual nutritional information cards and status bars. In order to measure user engagement with the educational platform, we recorded the time spent choosing each menu, the number of repeat attempts to build the menu in each game day, and the number of sport challenges the user tried to complete in each game day.

On the 15th game day, at the end of the follow-up period, a final questionnaire was presented to evaluate each user's impressions of how the SNS influenced his or her use of the platform and the effect the platform had on approach and behavior regarding nutrition. Participants who did not complete the full follow-up period received a request to answer the questionnaire by email. Questions regarding the social network influence were presented to the control group members hypothetically—what effect they would expect if they could have seen their friends' performance. The final questionnaire is provided in Multimedia Appendix 14.

Statistical Analysis

Descriptive statistics and comparison of groups were performed using SPSS Statistics 18.0. Comparison of quantitative variables between study groups was performed using the *t* test, or the nonparametric Mann-Whitney test (M-W) when the sample size was small and was not normally distributed. The connection between 2 qualitative variables was evaluated using the chi-square test, or the Fisher exact test in cases of limited number of observations in a cell. All the statistic tests were two-tailed, and a *P* value of 5% or less was considered statistically significant.

Study Approval

The Ethics Committee for Human Studies of the Hebrew University of Jerusalem approved the project.

Results

Study Participants

Of the 70 Facebook users who installed the platform successfully during the 2-month distribution period, 7 were excluded from the data analysis (2 did not enter their age, 5 did not start active use of the app). A total of 63 users, of which 30 belonged to the study group and 33 to the control group, were included in the analysis. No significant differences were found between the basic characteristics (age, sex, body mass index; BMI, etc) of the study participants in both groups (Table 1).

Table 1. Study participants' character by study group.

Participants' character		Study group	Control group
Number		30	33
Age (average in years)		29.0	31.4
Sex (male percentage), n (%)		13/28 (46)	10/33 (30)
BMI[a] (average)		22.0	23.2
Mother tongue (rate from study group), n (%)			
	Hebrew	26/30 (87)	27/33 (82)
	English	2/30 (7)	4/33 (12)
	Other	2/30 (7)	2/33 (6)
Education level (rate from study group), n (%)			
	Did not complete/completed high school	3/30 (10)	1/33 (3)
	Studying for/completed first degree	15/30 (50)	14/33 (42)
	Completed graduate degree	12/30 (40)	18/33 (55)
Physical activity (rate from study group in weekly hours), n (%)			
	0-0.5	8/30 (27)	7/32 (22)
	0.5-2	6/30 (20)	7/32 (22)
	Over 2	16/30 (53)	18/32 (56)
Smoking status (rate from study group), n (%)			
	Nonsmokers	25/30 (83)	28/32 (88)
	Former smokers	3/30 (10)	2/32 (6)
	Current smokers	2/30 (7)	2/32 (6)
Facebook friends playing *Food Hero* (average)		2.9	2.6

[a]BMI was calculated according to height and weight reported by users.

Application Use

Study participants played an average of 8.8 game days, with no significant difference between persistence rates in both study groups (P=.25, t test). The full follow-up period of 15 game days was completed by 32% (20/63) of the participants. A total of 40% (25/63) of study participants answered the final questionnaire. Naturally, more quiz grades and unguided menu assembly scores were accumulated for participants that completed more game days. Statistical analysis of these variables included all the participants that reached the game day in which they were examined.

Change in Nutrition Knowledge by Study Group

As stated, quiz grades were chosen to be the primary variable to assess knowledge change with platform use. The average grade of the first quiz, presented to players in the second game day in order to document the basic knowledge of the users, was practically identical between study groups, with both groups answering 57% (average of 4.6/8 correct answers) of the questions correctly. The later quiz grades were analyzed by calculating a set of quiz grade improvement variables, measuring the improvement of each quiz score relative to the first quiz the player had answered. Analysis of these variables revealed a trend of greater improvement over time among the study group. For control group members, the average of the second quiz improvement variable was positive, meaning improvement relative to the first quiz, but in further quizzes there was a gradual decrease in performance (Figure 4). For members of the study group, however, average scores for quizzes 2-4 were improved relative to quiz 1, with the greatest improvement present in the final quiz (Figure 4). The difference between the improvement variables of both study groups increasingly diverged over time (Figure 5), becoming statistically significant by the fourth quiz (P=.02, t test).

As with quiz grades, unguided menu assembly scores were analyzed by calculating the improvement relative to the performance of each player on the first unguided menu assembly day. These scores were then converted to standardized z-scores, because the original scores ranged in unlimited scale, including negative numbers. The study group exhibited a positive improvement in both the second and third unguided menu assembly scores, whereas the control group exhibited deterioration in performance over time. The average z-score of the second and third unguided menu assembly days was 0.18 above the first menu assembly day in the study group, compared with -0.26 in the control group.

Figure 4. Average quiz grade improvement by study group (relative to the first quiz grade). Each point includes all participants that answered the relevant quiz, in comparison to the grade the same participants received in the first quiz. (a) *P*=.02 (t test).

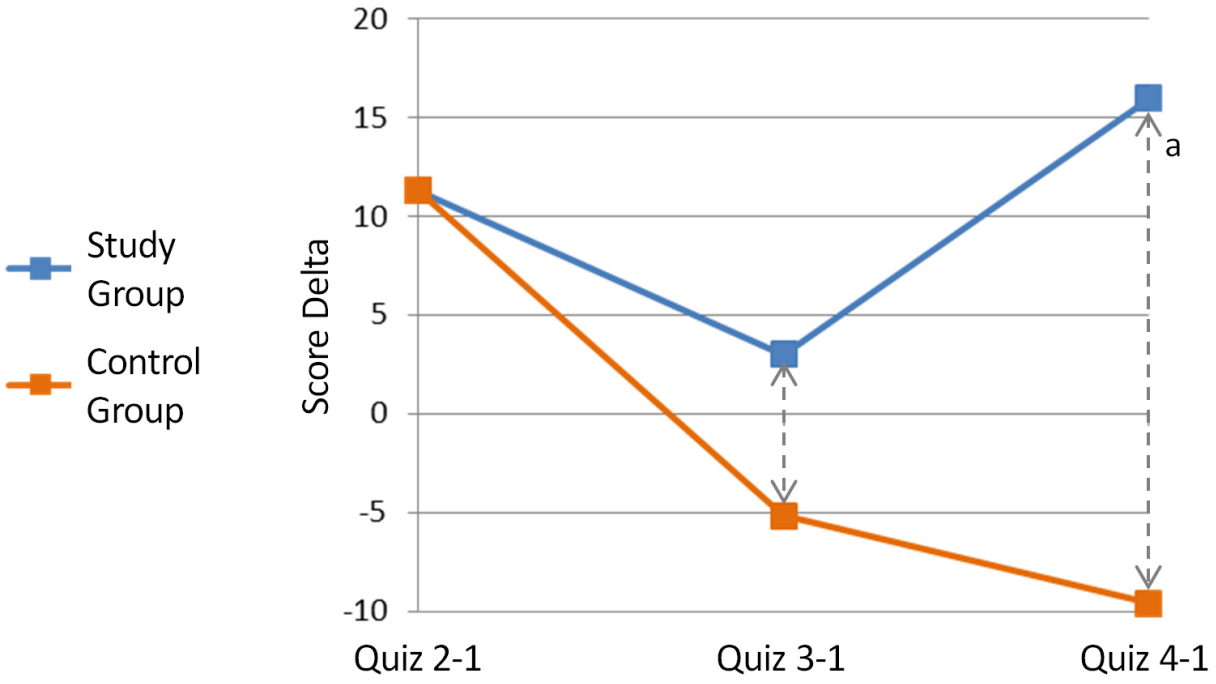
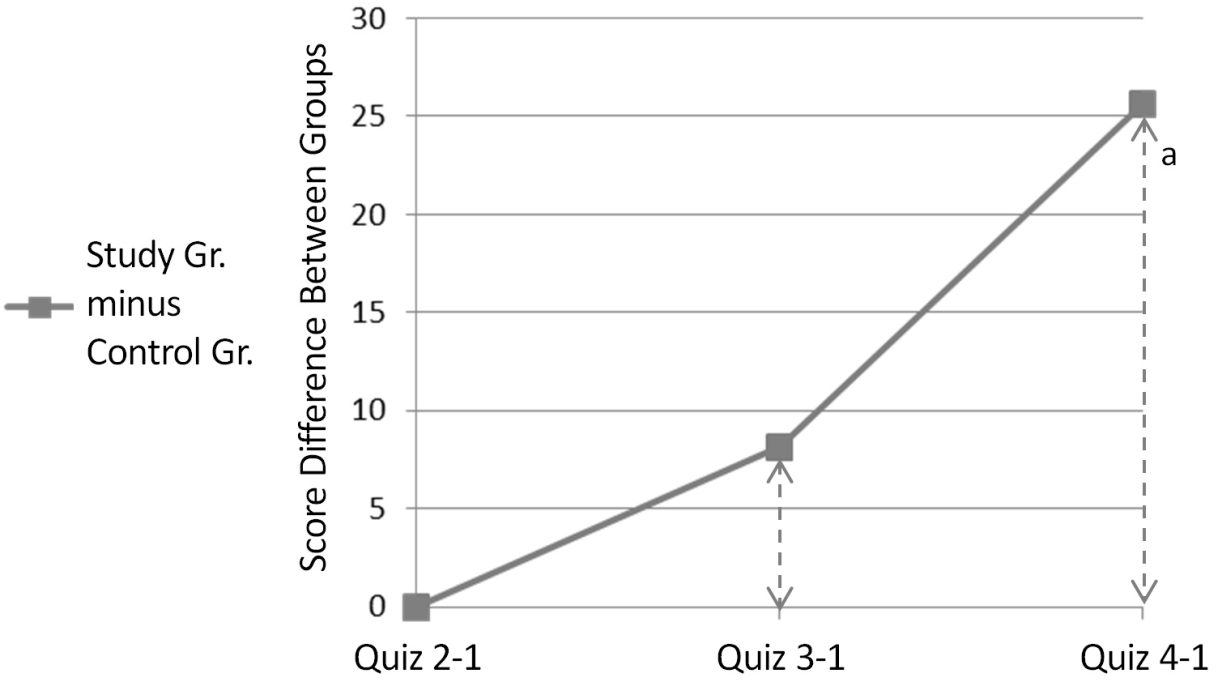


Figure 5. Difference between average quiz grade improvement between study groups. (a) *P*=.02 (t test). Gr.= Group.



Platform Engagement by Study Group

Members of the study group also invested greater time and effort trying to progress through the stages of the educational platform, and they spent an average of 3 minutes and 40 seconds on each menu assembly, as opposed to 2 minutes and 50 seconds in the control group. In addition, study group members performed an average of 1.42 attempts to build the menu on each game day, compared with 1.37 attempts in the control group. The average

number of sport challenges the user tried to complete in each game day (reflecting the user's motivation to advance through the game levels) was 1.58 in the study group and 1.21 in the control group (P=.03, M-W).

Participants' Perception of the Social Networking Sites' Effect

The final questionnaire demonstrated that most participants, from both study groups (with no statistically significant difference), perceived that being able to watch other players' performance can encourage engagement with the platform. Overall, 64% (14/22) of respondents expressed a medium or high level of agreement with a statement that they were interested in other players' performance. A total of 67% (14/21) expressed a medium or high level of agreement that other players' performance encouraged their engagement with the platform and increased their motivation to succeed. Almost all respondents (95%, 20/21) expressed a low level of agreement with a statement that other players' performance discouraged engagement with the platform.

Platform Effects on Nutritional Approach and Behavior

The questionnaire also included statements designed to obtain an initial indication of whether *Food Hero* also has effects beyond changes in knowledge. Players' answers suggested that the platform may have the potential to influence individuals' nutritional approach and behavior (with no statistically significant difference between study groups): 43% (9/21) of all respondents answered that the platform had highly affected their desire to improve their eating habits, and another 38% (8/21) answered they were moderately affected. On questioning whether the platform actually improved eating habits, 32% (7/22) and 45% (10/22) answered they were affected to a high or moderate degree, respectively. Questions exploring specific behavioral changes received the highest levels of positive responses: 73% (16/22) and 55% (12/22) of respondents stated that their attention to food composition and caloric values were highly improved, respectively.

Discussion

Principal Results

The results of this study indicate that users of an online educational platform who were exposed to the performance of their friends on the social network exhibited increased improvement in their nutritional knowledge, as well as increased engagement with the platform, compared to those who were not exposed to their friends' performance. It is plausible that these players' greater engagement with the platform is due not only to their ability to see their peers' performance, but also to their understanding that their performance is equally visible to their peers.

Many studies have examined the potential correlation between nutritional knowledge and dietary behavior, with many studies reporting that no such correlation was found [14]. Although not the main purpose of this study, we attempted to obtain an initial indication of whether an educational platform like *Food Hero* could also potentially lead players to improve their nutritional habits. A substantial rate of respondents reported that the platform positively affected their desire to improve their eating habits, and positively affected their actual eating habits. Although it is widely accepted that the reliability and validity of self-reported health habits is limited [22,23], these results encourage further research on the effects of this educational platform and SNSs in general on changes in eating habits.

Comparison With Prior Work

Although using online social media for promoting public health has been increasingly studied in recent years [17,18,24], we found very few studies that tried to characterize which specific factors make online public health interventions successful. Specifically, we found that most SNS health-related studies did not isolate the social effect of the SNS. Bramlett et al [25] found that a Facebook page had greater impact on food-safety attitudes and practices, compared to a traditional lecture, but did not study the SNS's effects as opposed to other online interventions. Graham et al [26] did compare 2 online interventions for smoking cessation, but the arm of the study that included a social network also included other added elements such as tailored content, thus masking the isolated effect of the SNS. Cavallo et al [27] attempted to isolate the effect of the SNS. They compared the effect of an educational website encouraging physical activity to a combination of the website with a Facebook group meant to provide support. This study did not find an added effect of the Facebook group, a fact the writers partially attribute to the participants' recruitment process that did not include individuals along with a subset of their existing friends. In our study, participant recruitment occurred using peer-to-peer messaging, and thus ensured that each participant had an average of 2.75 Facebook friends enlisted in the study, which may have enhanced the social element and contributed to the difference between the study groups. Foster et al [28] did manage to isolate the SNS's effect and demonstrate its advantage by comparing 2 groups of 5 formerly acquainted nurses using a pedometer, with and without the ability to see the number of steps performed by their peers. We expect that characterization of specific successful elements of online interventions, as we attempted to do, will be the focus of more future studies. A study is currently being conducted by Cobb et al [29] to study the factors affecting the diffusion of an online intervention for smoking cessation through Facebook.

Limitations

There are several limitations of this study. First, we did not focus on broad participant recruitment, but rather on the natural diffusion of the app through Facebook. The effects were large enough to produce statistically significant differences between study groups, and future work will further study factors that increase the distribution of the platform, building on relevant prior work such as that of Cobb et al [29]. The authors recognize that developing a successfully "viral" online product is a challenge even for commercial organizations such as professional game companies, so realistic expectations for a scientific research project are set accordingly. Second, our study population was relatively homogeneous in terms of education level and native language, probably because the app was

distributed by peer-to-peer messaging to ensure that participants had existing friends in the study. Finally, due to requirements of research consent, the study excluded participants under the age of 18. Future studies will explore ways to study younger populations such as teenagers within the consented research framework.

Conclusions

In this study, we sought to evaluate whether SNS exposure can be used to enhance online public health interventions by isolating the effects of the SNS component. The results indicate that when people have the ability to see the performance of their peers, and assume their performance is similarly exposed to their peers, the engagement with the online nutritional educational platform increases, and they gain more knowledge in the process. These findings strengthen the motivation to leverage the enormous time spent on SNSs for beneficial purposes such as health promotion. Further research is needed to include more participants from heterogeneous populations and other age groups in order to increase external validity, and to assess the effect of SNSs on actual behavioral change. While not every attempt at online health promotion intervention will gain popularity and become widely used, once the initial investment is made and a successful intervention is developed, the potential number of individuals impacted can be very large. Therefore, understanding how to maximally leverage the power of social networks to make online interventions as effective as possible has the potential to have a significant impact on public health.

Acknowledgments

The authors thank Yehuda Neumark for his early input on this study. This work was funded in part by the National Library of Medicine grant 5R01LM009879.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Food Hero screen shot: Consent and personal information form.

[JPG File, 41KB - games_v3i2e7_app1.jpg]

Multimedia Appendix 2

Food Hero screen shot: Character selection screen.

[JPG File, 34KB - games_v3i2e7_app2.jpg]

Multimedia Appendix 3

Food Hero screen shot: Home screen of the private version.

[JPG File, 70KB - games_v3i2e7_app3.jpg]

Multimedia Appendix 4

Food Hero screen shot: Home screen of the social version.

[JPG File, 58KB - games_v3i2e7_app4.jpg]

Multimedia Appendix 5

Food Hero screen shot: Popup message (exists only for the social version).

[JPG File, 47KB - games_v3i2e7_app5.jpg]

Multimedia Appendix 6

Food Hero screen shot: Feeding screen (guided by nutritional information cards and status bars).

[JPG File, 40KB - games_v3i2e7_app6.jpg]

Multimedia Appendix 7

Food Hero screen shots: Example of menu assembly process for a full day (including three meals and one snack).

[JPG File, 93KB - games_v3i2e7_app7.jpg]

Multimedia Appendix 8

Food Hero screen shot: Menu assembly feedback screen.

[JPG File, 53KB - games_v3i2e7_app8.jpg]

Multimedia Appendix 9

Food Hero screen shots: Different examples of menu assembly feedback screens (according to different outcomes).

[JPG File, 118KB - games_v3i2e7_app9.jpg]

Multimedia Appendix 10

Food Hero screen shot: Accessories shop screen.

[JPG File, 70KB - games_v3i2e7_app10.jpg]

Multimedia Appendix 11

Food Hero screen shot: Sport challenges selection screen.

[JPG File, 70KB - games_v3i2e7_app11.jpg]

Multimedia Appendix 12

Food Hero screen shots: Different sport challenges (running, swimming and cycling challenges).

[JPG File, 102KB - games_v3i2e7_app12.jpg]

Multimedia Appendix 13

Food Hero screen shot: Quiz screen.

[JPG File, 74KB - games_v3i2e7_app13.jpg]

Multimedia Appendix 14

Final Questionnaire.

[PDF File (Adobe PDF File), 32KB - games_v3i2e7_app14.pdf]

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Abbreviations

BMI: Body Mass Index
M-W: Mann-Whitney test
SNS: social networking site

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Original Paper

Exposure to "Exergames" Increases Older Adults' Perception of the Usefulness of Technology for Improving Health and Physical Activity: A Pilot Study

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Abstract

Background: High rates of sedentary behaviors in older adults can lead to poor health outcomes. However, new technologies, namely exercise-based videogames ("exergames"), may provide ways of stimulating uptake and ongoing participation in physical activities. Older adults' perceptions of the use of technology to improve health are not known.

Objective: The study aimed to determine use and perceptions of technology before and after using a 5-week exergame.

Methods: Focus groups determined habitual use of technology and the participant's perceptions of technology to assist with health and physical activity. Surveys were developed to quantitatively measure these perceptions and were administered before and after a 5-week intervention. The intervention was an exergame that focused on postural balance ("Your Shape Fitness Evolved 2012"). Games scores, rates of game participation, and enjoyment were also recorded.

Results: A total of 24 healthy participants aged between 55 and 82 years (mean 70, SD 6 years) indicated that after the intervention there was an increased awareness that technology (in the form of exergames) can assist with maintaining physical activity (P<.001). High levels of enjoyment (Physical Activity Enjoyment Scale [PACES-8] score mean 53.0, SE 0.7) and participation rates over the whole study (83%-100%) were recorded.

Conclusions: Older adults' have low perception of the use of technology for improving health outcomes until after exposure to exergames. Technology, in the form of enjoyable exergames, may be useful for improving participation in physical activity that is relevant for older adults.

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KEYWORDS

health care reform; postural balance; pleasure; exercise; perception

Introduction

Adequate levels of physical activity are a primary factor contributing to the maintenance of physiological and psychological health, yet many older adults are physically inactive [1-3]. Insufficient levels of physical activity have been reported in as much as 62% of the older population (ie, not meeting the recommended guidelines of 30 minutes moderate activity on most days of the week) [4]. As well, they also reportedly spend a major proportion of their day in activities that use very little energy expenditure and would be classified as sedentary. Sedentary behavior levels in Australia are reported to be as high as 40% for adults aged between 65 and 74 years

[3,5]. The magnitude of this health issue is set to increase with the changing demographics of our population with the Australian Bureau of Statistics [6] predicting that the portion of the population aged 65 years and older will increase to 29% by 2051.

The health benefits of adequate levels of physical activity and regular exercise include improvements in lower limb strength, balance, and mobility, which may provide a reduction in the risk of accidental falls in older adults. As well, a reduction in incidence in a range of chronic health conditions is seen with changes from sedentary behaviors to more active behaviors. Overcoming barriers and identification of facilitators that will improve uptake of positive health behaviors and encourage long-term participation of such behaviors forms the thrust of current population-based health research.

Advances in technology, both hardware and software, has enabled increased accessibility of technology-based exercise interventions to a vast number of consumers [7]. The design of exercise-based videogames ("exergames") provides activities that balance enjoyment, ability, and intensity levels to a large market audience [8]. Enjoyment of an activity has been identified as one of the predictors of the effectiveness of an exercise program and, because of this, interactive exercise-based technology, or exergaming, is becoming an increasingly popular strategy for the implementation of physical activity [7-9]. Incorporating the use of interactive games into home-based exercise programs addresses several access barriers around transport and leaving the home, while at the same time providing enjoyable activities may improve ongoing participation in physical activities [7]. The feasibility of trialing exergaming interventions in an older population will rely on acceptance of this type of technology, but evidence about older adults' attitudes toward using technology to improve physical activity and health more generally is mixed.

The assumption that interest in technology decreases with age is misleading [10] and the small amount of literature available in this area is conflicted. Several studies report negative attitudes and limited use of technology by older people [11,12], whereas others report that older people are enthusiastic about the potential for eHealth and are increasingly adopting these technologies [13-15]. Despite this diversity in findings, there is strong evidence to suggest that older adults are more likely to use applications that they perceive as being user-friendly, engaging, and meeting a current need [13,15]. Miller et al [16], in their review of the literature focusing specifically on home-based exergaming systems used by older adults, suggest that the evidence supporting positive benefits is "relatively weak, with a high risk of bias." However, older adults have been reported to find exergaming appealing [17] and that it provides improved motivation for activity [18]. As well, perceived enjoyment has been correlated to improved physical well-being during an exergame intervention [19].

From the age of 45 years onward, balance control function declines [20]. Exercise has been shown to improve balance and exercise programs that include a high dose of balance training (without a walking component) reduce fall rates by up to 38% [21]. Although balance training has been recently included in guidelines for exercise for adults older than 65 years [22], many older adults do not participate in balance training as part of their habitual exercise, with only 6% performing balance training and 27% undertaking balance-challenging activities [23]. A recent review of exergames to improve balance in older adults found improvements in at least one facet of postural balance occurred in 10 of 13 of them [24]. Although many of these studies were small, this provides some evidence that balance-related exergames may be useful in assisting older adults meet this component of the exercise guidelines.

The primary aim of this study was to determine the perceptions of the use of technology for health before and after the use of an exergame intervention designed to improve postural balance and to record perceptions of enjoyment after the intervention.

Methods

The small number of participants involved in this pilot project and the exploratory nature of the research lent itself to a methodology that enabled researchers to explore participant responses in some depth. Heinz et al [25] suggested that opinions of technological developments can be achieved through focus group research, where researchers can relatively easily gain information from older adults. Therefore, a qualitative descriptive study was utilized based on data analysis from 3 focus groups [26].

Participants

Eligibility criteria of the participants included targeting older adults (>50 years), classified as low risk according to the American College of Sports Medicine guidelines, and currently participating in a previously established Pilates program established at the Exercise Physiology Clinic at the Newnham campus of the University of Tasmania. No participants were excluded.

Procedure

Potential participants were invited to participate in a focus group held 1 week before initiation of the 5-week exergame intervention. From this focus group, a survey was developed and administered before and after the intervention.

Focus Group

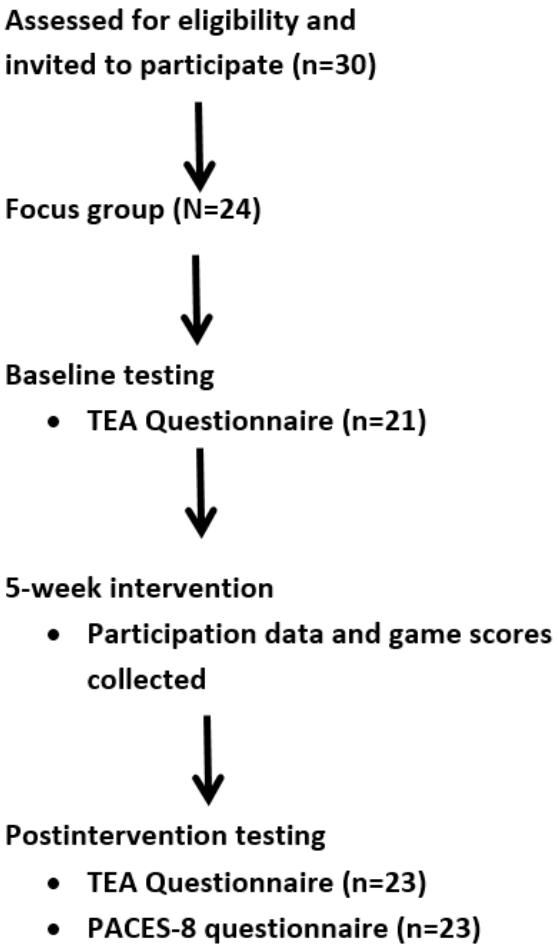
The focus group was run as an open discussion forum with one experienced researcher directing the group and asking questions, while another trained research assistant took notes and recorded the session for later analysis. Structured open-ended questions were used in the focus groups to elicit information regarding current use and access to technology and the types of technology that this cohort currently engaged with. The whole team was involved in the development of the questions; this has been shown to enhance the validity of the research in the design stage [27]. Current physical activity and perceptions of the impact on physical activity when using technology were explored. The forum was designed to gather qualitative information regarding each person's current health and physical activity levels, their reasons for exercise, and their technology use and knowledge. This included perceptions and awareness of using technology for health. This information was used to develop a questionnaire

by the research team that quantitatively assessed perception of how useful technology can be for a range of health parameters and physical activity: the Technology Engaging Activity (TEA) questionnaire. Pretesting of questions was undertaken to ensure validity of survey questions. Before commencing the intervention, this questionnaire was administered and participants were invited to familiarize themselves with the intervention.

Throughout the study, the intervention was set up as a 2-minute station during the Pilates classes for voluntary and independent access by the participants at any time throughout the hour-long timeframe supervised by 2 research assistants. The technology was available for 5 weeks, which included a total of 10 Pilates sessions. After the conclusion of the intervention, participants were invited to complete the same questionnaire and the 8-item Physical Activity Enjoyment Scale (PACES-8) questionnaire. The exergame was introduced as an individual 2-minute station in a circuit class (see Multimedia Appendix 1). This allowed for maximum engagement of the exergame, but did not require any extra effort from the participants. Research assistants implemented the program, which was the game "stack 'em up" contained within the "Your Shape: Fitness Evolved 2012" (Ubisoft) exergame package for the Microsoft Xbox 360 Kinect game console. The level of difficulty throughout the intervention was set at easy and was not adjusted throughout the study. Game scores were collected for each participant after the game was completed. Comments while performing the game were collected by the researchers.

Ethics approval from the Social Science Human Research Ethics Committee (H0013878) was gained before commencement of the study. Participant flow through the study and data collection time points are outlined in Figure 1.

Figure 1. Study flow diagram.



Measures

Perceptions of Technology Enhancing Physical Activity

Participant's perceptions of technology usage were gauged through the TEA questionnaire. This questionnaire was composed of 5 questions and responses were measured on a Likert scale of 1 to 5, in which a score of 5 represented a strong agreement and a score of 1 indicated a strong disagreement. This was developed by the research team and established from participants' responses in the focus group. Two research assistants administered the survey. Specifically, the questionnaire asked participants to rate their level of agreement/disagreement with the following statements:

1. I think technology can keep me active.
2. I think technology is useful in my life.
3. I think technology is enjoyable.
4. I think technology helps me be more active.
5. I think technology can improve my postural balance.

Exergame Enjoyment

The PACES-8 [28] is a validated and reliable modified version of the original 18-item PACES questionnaire, which describes enjoyment of physical activity within the older adult population. For each of the 8 questions, a score of 7 represents maximal enjoyment and a score of 1 represents minimal enjoyment for each subsection, resulting in a total possible score of 56.

Data Analysis

The data analysis drew on semantic thematic analysis to identify explicit surface meanings within the data. Thematic analysis is appropriate for questions seeking to explore people's views or perceptions [29,30]. Because this evaluation sought user opinions and perceptions, the methods of thematic analysis were considered appropriate.

Thematic analysis of focus group data was undertaken from both recordings and notes from the sessions using a phenomenological approach. Recordings were analyzed in a group session. Each researcher listened to the material and individually noted common responses. These were then discussed as a group until consensus about common patterns was reached and these were used as a basis for manual coding of data. In addition to identifying common patterns, the range of views for each pattern was identified with examples across the spectrum recorded as anonymous quotations.

Microsoft Excel was used to analyze the quantitative data from the surveys, which was reported as mean and standard error of means. Pre- and postintervention data were analyzed using paired *t* tests.

Results

Participants

A total of 24 participants (5 male, 19 female) aged between 55 and 82 years (mean 70, SD 6 years) were recruited to participate in the focus groups and technology engaging intervention for older adults study. Although the number of attendees participating in the exergames session in the circuit class varied over the duration of the intervention, participation rates increased from week 1 (20/24, 83%) to all participants in week 4 (24/24, 100%) with a slight drop seen in week 5 back to 21 participants (88%).

Focus Group

The focus group identified that this active group of older adults primarily used technology for pragmatic purposes and the majority indicated little exposure to using technology for enjoyment (23/24) or games (18/24). In fact, the game-based technology that they currently engaged in encouraged sedentary behaviors.

The focus group established that, before exposure to the intervention, the majority (23/24) of participant's engagement with technology was for mainly pragmatic reasons, such as communication (eg, mobile phones, email, and use of Skype to communicate with family members) and simple information gathering (eg, timetables and location of services). Although this majority indicated that technology was "not used for enjoyment" and "only do what I need to do," a few people (2/24) identified enjoying interacting with new technology and provided positive responses such as "I'm a gadget baby" and "very useful when needed."

When asked about technology and games, participants only identified participating in technology-based games, such as Solitaire and FreeCell. Generally, participants seemed unaware that it was possible to use gamed-based technology for improving health outcomes, indicating that the computer-based games they currently participated in reduced activity and were not positively related to health. Two of 24 participants indicated that they had at one time (but did not regularly) played with a Nintendo Wii console with their grandchildren.

Participants indicated strong engagement in a variety of exercise activities over many years. It was established that participants engaged in both structured and unstructured exercises daily and mostly of moderate intensity. Many in the group described their preferential involvement toward exercise in a social environment (eg, dancing, swimming, and bushwalking groups), whereas other participants focused on more individual activities (eg, gardening, walking, and riding) with each participant indicating that the autonomy of exercise selection enhanced participation. Participants described that they engaged in multiple types of physical activity throughout the week, including both social and individual activities regularly. Participants expressed that exercise in their life was related to being "habitual" and to maintain or improve their health.

Perceptions of Technology Enhancing Physical Activity

Pre- and postsurvey data indicated that participants significantly increased their positive perceptions of the use of technology to keep active and improve postural balance (P<.05) (Table 1).

Table 1. Survey responses pre- and postintervention (N=24).[a]

Statement	Preintervention, mean (SE)	Postintervention, mean (SE)	*P*
I think technology can keep me active	2.95 (0.21)	4.00 (0.23)	<.001
I think technology is useful in my life	3.90 (0.17)	3.94 (0.19)	.44
I think technology is enjoyable	3.48 (0.21)	4.00 (0.21)	.04
I think technology can help me be more active	3.38 (0.23)	3.78 (0.22)	.05
I think technology can improve my postural balance	3.76 (0.17)	4.22 (0.19)	.03

[a] Based on a 5-point Likert scale (5=strongly agree, 1=strongly disagree).

Exergame Enjoyment

The postintervention PACES-8 enjoyment questionnaire focused solely on the chosen exergame used throughout the intervention. Participant mean results identified that all the questions received a score of 6 or higher. From the PACES-8 questionnaire, an overall score of 56 signifies the maximal score that can be achieved per individual. The mean pooled response from participants was 53.0 (SE 0.7).

Game Scores

Game scores increased from week 1 (mean 892, SE 65) to week 5 (mean 1579, SE 112). Researchers observed that participants endeavored to increase their scores over the time of the study.

Discussion

The primary aim of this study was to determine the perceptions of older adults to technology for health before and after participating in an exergame intervention. This group initially indicated commitment to nontechnology-based physical activity; however, a significant change in attitude was seen after the intervention with improvements in understanding about the health and activity benefits of using technology in the form of exergames. High levels of enjoyment and perceived personal benefit were also identified. This study adds to the evidence supporting the use of exergames as enjoyable and engaging methods for older adults to improve participation in physical activity.

Pragmatism to Participation

The responses from the focus group identified strong emerging themes associated with attitudes toward the use of technology for pragmatic purposes and the participants' attitudes about life-long commitment toward physical activity. Although there are positive health outcomes associated with digital video gaming for older adults, our participants were not aware of this before the intervention [31]. When initially questioned regarding their perceptions about technology and games, all participants immediately responded with the idea that these involved limiting physical activity. The impact of sedentary behaviors associated with screen-based technology use is a concern across the life span [32].

Technology and Activity

Before the intervention, there was a lack of familiarity in these older adults with the concept of utilizing technology as a form of exercise. There were positive changes to responses on both items on the questionnaire relating to physical activity after the intervention. After the intervention, participants indicated that they thought that technology was able to assist in maintaining physical activity levels. There was an increase in the perception that technology was useful to improve physical activity, but this difference did not meet statistical significance (P=.05). Specifically, with respect to postural balance, the usefulness of this form of exercise was perceived to increase. The use of technology to enhance physical activity in older adults is receiving attention in current literature as a motivator for improving physical activity, especially to meet the needs of that part of the population.

There was a strong response that indicated maintaining health was a key reason to exercise. One participant stated they felt that "exercise is a part of life," with the other 7 people in that group affirming that concept. Another participant in a different group described exercise in their life as "habitual". Although it was identified that the focus group participants used some form of technology on a daily basis, there was only limited exposure to any form of exergame activity. The literature suggests that older adults are more willing to use technologies that they perceive as meeting a current need in a more convenient way than other options [12,14,33-36]. Before the intervention, participants did not view the exergame as meeting their need for regular exercise. However, this perception changed after their participation in the program.

Technology, Enjoyment, and Engagement

The high levels of enjoyment recorded by the participants augur well for the future of this form of technology to improve physical outcomes using this modality.

Enjoyment has been identified as an important implementation factor in physical activity programs [37]. As well, the literature suggests that older adults who find enjoyment in physical activities tend to perform them for longer periods of time [19]. Overall enjoyment and levels of satisfaction have been shown to be better predictors of physical activity participation and adherence than any other factors [38,39].

Indication of engagement with this form of exercise is supported by high voluntary participation rates throughout our study. Researchers noted that participants strategically challenged themselves to gain a higher overall score and continued to engage in the exergame over the period of the intervention. The researchers also identified that scores needed to be monitored and recorded for each participant to further challenge the participants and retain and reinforce enjoyment levels.

The social context of this study design (ie, being part of a group and having the ability to compare scores with others) contributed to the engagement of this group in the intervention. Future research needs to identify the types of people who would engage with this technology in their own home, without face-to-face social contact, if we want to use exergames as part of a widespread intervention to overcome many barriers to physical activity that older adults have in leaving their home. Technology that links virtual groups may overcome the potential barrier of social isolation and may be of benefit for both improving physical activity within a virtual social network for those people unable to mobilize easily outside the home. In the future, home-based preventive health care using technology may be leveraged off current research exploring in-home rehabilitation using motion capture software and technology [40].

A limitation of this study was the selection and use of a convenience sample of participants who were currently physical active (ie, attending Pilates classes regularly). This limits the generalizability of these results and precludes application to sectors of the community that are more sedentary and perhaps a better target for interventions such as these. Future research should endeavor to use higher best practice dosage to improve postural balance. Because of the short intervention period, it is

important to note that adherence and enjoyment levels may have changed after the 5-week period.

Conclusion

Exposure to and participation in a balance-focused exergame resulted in older adults dramatically increasing their perception of the usefulness of technology for improving several health outcomes, including physical activity levels and postural balance. High rates of enjoyment and adherence to this program were reported. Technology, in the form of enjoyable exergames, may be useful for improving participation in physical activity that is relevant for the needs of older adults.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

(A) Screenshot of intervention for training postural balance. (B) Using the game for training postural balance.

[PDF File (Adobe PDF File), 397KB - games_v3i2e8_app1.pdf]

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Abbreviations

PACES: Physical Activity Enjoyment Scale
TEA: Technology Engaging Activity

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Original Paper

Engaging Elderly People in Telemedicine Through Gamification

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Abstract

Background: Telemedicine can alleviate the increasing demand for elderly care caused by the rapidly aging population. However, user adherence to technology in telemedicine interventions is low and decreases over time. Therefore, there is a need for methods to increase adherence, specifically of the elderly user. A strategy that has recently emerged to address this problem is gamification. It is the application of game elements to nongame fields to motivate and increase user activity and retention.

Objective: This research aims to (1) provide an overview of existing theoretical frameworks for gamification and explore methods that specifically target the elderly user and (2) explore user classification theories for tailoring game content to the elderly user. This knowledge will provide a foundation for creating a new framework for applying gamification in telemedicine applications to effectively engage the elderly user by increasing and maintaining adherence.

Methods: We performed a broad Internet search using scientific and nonscientific search engines and included information that described either of the following subjects: the conceptualization of gamification, methods to engage elderly users through gamification, or user classification theories for tailored game content.

Results: Our search showed two main approaches concerning frameworks for gamification: from business practices, which mostly aim for more revenue, emerge an applied approach, while academia frameworks are developed incorporating theories on motivation while often aiming for lasting engagement. The search provided limited information regarding the application of gamification to engage elderly users, and a significant gap in knowledge on the effectiveness of a gamified application in practice. Several approaches for classifying users in general were found, based on archetypes and reasons to play, and we present them along with their corresponding taxonomies. The overview we created indicates great connectivity between these taxonomies.

Conclusions: Gamification frameworks have been developed from different backgrounds—business and academia—but rarely target the elderly user. The effectiveness of user classifications for tailored game content in this context is not yet known. As a next step, we propose the development of a framework based on the hypothesized existence of a relation between preference for game content and personality.

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KEYWORDS

gamification; framework; elderly; older adults; eHealth; telemedicine; adherence; engagement; classification; player type; personality

Introduction

It is expected that 25% of the European population will be older than 65 years in 2050 because of global population aging [1]. Current socioeconomic structures cannot provide enough work force and capital to meet the needs of this rapidly growing elderly population [2]. Telemedicine refers to health services that enable patients to receive treatment in their daily living environment, whereby distance is bridged by information communication technology (ICT) and at least one health care professional is involved, alleviating the increasing demand for elderly care by extending the time of autonomy and independence [3]. Although telemedicine technology seems promising, practical implementation still leaves much to be desired. Several studies have shown that adherence to telemedicine interventions, such as therapy supporting a healthy lifestyle, is low [4] and decreases over time [5], even though these studies showed a significant effect on health outcomes [6]. Clearly, there is a need for strategies that motivate elderly people to use, and keep using, the technologies offered.

Gamification, the application of game elements to nongame fields, may be such a strategy [7]. There is a rapid growth in the number of initiatives that use gamification, illustrating a variety of approaches developed from various viewpoints, including education, behavior change, physical health, and mental health. However, a lack of a refined conceptualization of this strategy exists in these disciplines, and gamification, for elderly people in particular, remains an even further underexplored area. In general, it is not yet known which one of these approaches is the best for the durable engagement necessary for better adherence.

Choice and personalization of content [8], or tailoring, is known to be beneficial for intrinsic motivation [9], which in turn increases long-term engagement needed for adherence. To provide this tailored content, insight is needed into how users should (or want to) be addressed through gamification and how these needs can be classified is required. To our knowledge, information on the practical implementation of existing classifications is not yet available. We believe that once an overview of existing frameworks for gamification and user classification is established, a gamification strategy that is effective in realizing long-term engagement for the elderly user can be developed.

For this purpose, the aim of the paper is to (1) provide an understanding of the theoretical background of gamification, including existing frameworks for developing gamification both in general and specifically for the elderly population, and (2) explore existing user classification theories that may serve for the tailoring of game content to the target user. Because of the newness of this field of research, we opt for a broad view on activities in gamification that occur not only within but also outside of scientific research. In future research, we will work toward a user classification of the elderly population that can be used to develop evidence-based gamification strategies and tangible design guidelines for gamification in health care.

Methods

In a succession of 3 Internet searches, a broad approach to the subject of gamification was taken to gain insight into the many developments in gamification that occur both inside and outside of the scientific world. We performed a search in the scientific search engines PubMed, Scopus, and Google Scholar and in diverse nonscientific sources: from game designer blogs and conference videos to MOOCs (massive open online courses) and YouTube videos. In this paper, gamification is defined as the use of elements from games in nongame contexts to improve user experience and engagement without making that system a full game as is the case with serious games including exergames (combination of exercise and gaming) [10,11].

First, we have researched the conceptualization of gamification from a theoretical perspective (see Multimedia Appendix 1). Keywords used in combination with gamification were used, including derivatives of these words: “theory,” “definition,” “concept,” “framework,” and “analysis.” In addition, keywords (and derivatives of these) implying practical use were used: “method,” “application,” and “gamify” (singular). Then, a search for gamification combined with “criticism,” “downsides”, and “negative” was performed. Second, we investigated the use of gamification in applications for the elderly population (see Multimedia Appendix 1), entering the following combinations of keywords: “gamification,” “gamif*,” “game,” and “gaming” with “elder*,” “elderly,” “senior,” “old*,” and “aging.” Finally, through the same search method, we have researched user classifications that categorize users by their motivation or stimulant to play in order to gain insight into the user and further determine how to tailor content to the user (see Multimedia Appendix 2). Keywords used were “[user, player, gamer]” combined with “[type, taxonomy, classification, model, style].”

Included in the results were articles and other works that present a theoretical basis for the development of gamification, defined as the presence of a framework that is either theoretical and/or based on established scientific foundations or proven effective through evaluation in practice. Therefore, beyond the scope of our paper are numerous works on gamified applications with a black box design.

Results

Gamification Frameworks

This section demonstrates the current state of gamification, starting with the concept of gamification in a broader sense and then focusing on gamification for elderly people. We provide an overview of existing frameworks for gamification along with their contexts and backgrounds. With this, we aim to define the status quo in research and provide a deeper understanding of the concept and its use and misuse.

The Conceptualization of Gamification

Gamification has gained popularity in diverse fields such as (interactive) marketing and scientific applications, generating different definitions of gamification. Currently, there is no consensus about a definition, mainly due to the underlying perception of what the game elements are exactly in terms of

level of abstraction and whether the gamified application is game-like or not. Gamification is often roughly defined as the use of elements from games in nongame contexts; a more refined definition regards gamification as the identification of that which makes games captivating and engaging followed by the transfer of this knowledge to nongame contexts, increasing user enjoyment [12,13]. While some see gamification as a way to act upon psychological principles as certain game techniques do [14], others define gamification as applying gameful interaction or design with a specific intention without creating a full-fledged game [10] or as the process of improving a service with gameful experiences that support the value creation of the user [15]. In the middle of these definitions, we see gamification as the use of game elements that create a game-like experience in a nongame context without creating a full game.

We found a couple of approaches toward the conceptualization of gamification. One emerges from business practices, such as marketing, customer loyalty, and employee engagement; the other from academia and not sales driven, often specifically aiming to incorporate theories on motivation, engagement, and behavior change. Table 1 illustrates this division of the found articles by author, grouped according to their focus.

Table 1. Frameworks for gamification in business and academia.

Business	Academia
Cunningham and Zichermann (2011)	Aparicio et al (2012)
Werbach and Hunter (2012)	Nicholson (2012)
Duggan (Badgeville, 2012)	Sakamoto et al (2012)

In business-oriented, or corporate, gamification, the number of successful initiatives, in terms of increased user engagement or revenue, that use gamification has been rapidly increasing in the past few years [16]. It is estimated that the market spend on gamification solutions will grow exponentially until 2016, and at that time 40% of the world's top market value companies will be using gamification [17,18]. In gamification for the marketing of consumer products, a well-known success story is that of Nike+ by Nike. This gamified running log app, currently used by 5 million players to track their daily exercise goals, caused revenues in the running category to increase by 30% in 2011 alone [19]. An example of successful enterprise gamification is that of software company SAP. After SAP launched a new, gamified version of their online employee and customer community platform, employee usage increased by 400% and community feedback by 96% [20]. Gamification appears to be more than a fad, illustrated by the existence and ongoing success of companies such as Badgeville [21,22], which provides a platform for gamification of enterprise applications and serves major companies such as Samsung, Deloitte, and Dell [23].

There are several authors within this business orientation, such as Cunningham and Zichermann [12], who provide guidelines for gamification by listing game elements and mechanics such as feedback, achievement, social engagement loops, reinforcement, and status, including practical examples. Werbach and Hunter [14] simplify gamification and consider it a tool for business strategy. Their method offers practical guidelines on how to dissect existing games and use them to gamify other applications. Although this approach lacks intricate game mechanics, gamification is used as a comprehensible tool, presenting game elements as a set of building blocks that, used together, can provide the gamified application.

However, the way gamification is applied in business context receives a lot of criticism as analysts estimate that the bigger part of current gamified applications will not meet their business objectives, mainly due to poor design [24]. Game designers criticize the Cunningham and Zichermann method, stating that the mechanics presented do not contribute to a gameful experience [25,26]. Robertson [25] states that gamification turns into "pointsification" when game elements are simply stripped from games and placed in another application. With this, structural components of games are perceived and used elsewhere to function as core mechanics, ignoring the fact that these mechanics should be the inner workings of games. Bogost criticizes this practice using the term "exploitationware" in an article [26] and blog entry titled "Gamification is Bullshit" [27] and states that gamification disassociates the practice from games created for the sole purpose of making an easy profit. A design may be poor as well when it extensively uses external conditions or reinforcements, as known from operant conditioning [28]. These reinforcements often function as main mechanisms to manipulate behavior and usually present in the form of point and reward systems. A shift from intrinsic to extrinsic motivation can occur through offering external awards, known as the overjustification effect [29], which may lead to an early loss of interest of the user. The initial interest in the (gamified) activity may also disappear once the rewards are no longer, or insufficiently, offered [30], an effect called the "hedonic treadmill" [31]. From this we observe that the development of a good game design concept is often disappearing into the background in corporate gamification initiatives, while it is as essential for creating an engaging experience as it is for traditional games.

Scientific research from within academia, the second approach we distinguish, includes few frameworks on the theoretical foundations of gamification. Aparicio et al [32] developed a framework focusing on intrinsic motivation by incorporating concepts from self-determination theory [33]. According to this theory, intrinsic motivation can increase by satisfying the following psychological factors: competence, autonomy, and relatedness. The framework procedure tells us to (1) identify the main objective, (2) identify which intrinsically motivating factors should be included, (3) determine which game mechanics should be used according to these factors, and (4) evaluate the framework in its final application. Nicholson [34] presents a complex framework for meaningful gamification, integrating user-centered design [35] in combination with

self-determination, situated motivational affordance [36], situational relevance [37], and universal design for learning [38]. From these core theories, Nicholson [34] suggests how to provide more intrinsically motivating gamification leading to meaningful engagement. Self-determination can be found along with the transtheoretical model of behavior change [39] in the framework of Sakamoto et al [40], describing a value-based framework. The authors present 5 core values (informative, empathetic, persuasive, economic, and ideological value) that, when used with other game mechanics, can be used to create attractive and intrinsically motivating gamification services.

Several differences between the frameworks from business and academia (Table 2) can be observed. The business frameworks are very concrete; they are simple, provide practical guidelines, and, most importantly, have proven their success in this context. In academia, gamification has not yet reached this state of maturity. The frameworks found on both sides are contradictory: those from academia are conceptual and complex and provide methods that are much more difficult to apply. Therefore, among these are no empirically supported frameworks showing their effectiveness in practice. The frameworks from business are simplified, therefore lacking depth, which may suffice for marketing purposes but possibly not for long-term goals needed for telemedicine applications.

Table 2. The contrast between business and academic frameworks.

Business	Academia
Applied	Conceptual
Simplicity	Complexity
Practical guidelines	Methods inexplicit
Proven worthy in practice	Earlier stage of development, less empirical support
Lacking depth, oversimplified	Solid scientific foundation
Short-term engagement suffices	Aiming for durable motivation
Immensely popular	Mostly unknown

Gamification for Elderly Users

While gamification is gaining popularity in telemedicine [41], limited information was found on appropriate designs for engaging elderly users. Our search for gamification frameworks did not return any information on how to address the elderly users. We therefore present existing literature that describes explorations of designing gamification for this population group (Table 3). Gerling and Masuch [7] indicate that gamification holds significant potential for elderly users, particularly in gamifying physical and cognitive therapy. The authors state that the main challenge for developing such apps lies within the unfamiliarity of older adults with games, making it difficult to draw content from existing digital games. Link et al [42] face a similar challenge after examining a set of game mechanics (points, status, and badges) and concluding that these have the desired impact on youth but not on older adults.

By contrast, Minge et al [43] see gamification as an opportunity to decrease feelings of fear and frustration that elderly people have toward technology. However, the authors emphasize that success depends on careful design. For example, the study participants did not enjoy aspects of quantification and comparison, which are otherwise very common elements of games.

IJsselsteijn et al [44] also state that digital games hold significant positive potential for elderly users, including therapeutic value and social bonding. Elderly users are underrepresented as consumers of digital games because the games offered are not in line with their accessibility and usability demands or their interests and needs. Design requirements are needed to offer the elderly engaging content. According to IJsselsteijn et al [44], however, no empirical data are available on the categorization of elderly gamers that is necessary to do so, including how this would translate into game content.

Table 3. Overview of papers described.

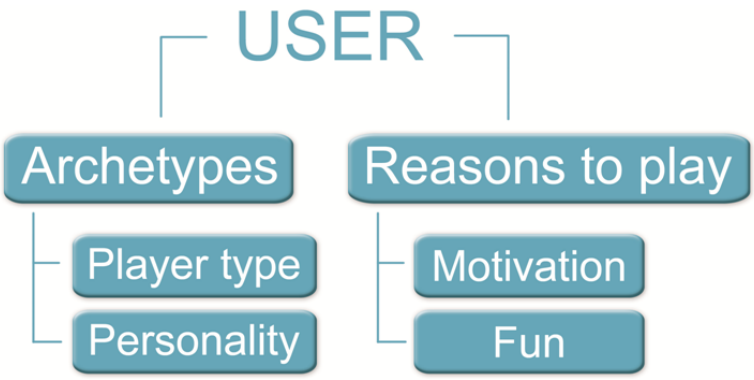
Source	Topic
IJsselsteijn et al (2007) [44]	Design opportunities for engaging games for elderly
Gerling et al (2011) [7]	Potential of gamification for engaging (frail) elderly
Minge et al (2011) [43]	Attitude of elderly toward gamification
Link et al (2014) [42]	Effect of game elements on motivation of elderly

Classifying Users: Player Taxonomies

User classification holds a key role in the development of tailored game content, as it gives thorough insight into the preferences that individuals or subgroups within a target group may have [45]. However, there are limited valid methods to describe people regarding their gaming preferences [32], and none were found for the elderly user in particular [44]. In this section, we discuss several approaches for classifying users in general, broadly divided into archetypes and reasons to play. Archetypes, player types [46,47] (Bartle, Marczewski), and gaming personality (types) [48] (Vandenberghe) describe the

player characteristics while reasons to play, player motivation [49,50] (Yee), and kinds of fun [51,52] (LeBlanc, Lazzaro) take motivating elements as a starting point. In Figure 1, these various approaches are visualized in a diagram. At the end of this section, we summarize and compare these user taxonomies in a chart.

Figure 1. Approaches to classify the user.



Archetypes

The earliest and most cited player taxonomy in a gaming context is the Bartle player type theory. It was developed for the first virtual multiuser environment, text-based dungeons (multiuser dungeons, or MUDs), by observing and analyzing player patterns. Bartle proposes 4 player types (Figure 2) based on two primary interests in gameplay: between the emphasis on players or on the environment and between acting (to) and interacting (with). Achievers are interested in actions on the world and find mastery of the game and competition most compelling; explorers like to interact with the world and enjoy discovery. Socializers are most interested in interacting with other players and enjoy the game for friendships and contacts, while killers are interested in acting on other players, demonstrating their superiority. According to Bartle, a good MUD contains the 4 player types in equilibrium [46]—not necessarily of equal number—and the player types were created to balance the design of these multiplayer games to accommodate for all player types' play style. The application of this model outside its context is something Bartle himself advises against [45], especially for use in gamification. Furthermore, this model has been criticized for lacking proper validation with empirical data and means to assess players to a type [53,49] and for missing similarity between the virtual world of the MUD and the gamified application. Bartle suggests that the types are exclusive but, in practice, they can be overlapping or mixing [12].

Similarly, but in the context of enterprise gamification, Marczewski [54] proposes a conceptual taxonomy choosing intrinsic motivations from different theories—autonomy; purpose and mastery; change—and the extrinsic motivation, rewards. This results in 6 player types (Figure 3). The axes are equal to the Bartle model but replace player for user and world for system.

Another approach to create player archetypes is through personality. Personality traits have been extensively studied and researched since the 1880s [55] and, although thousands of traits can be found to describe personality [56], a statistical factor analysis demonstrated 5 main factors that many psychologists believe are sufficient [57,58]. The five-factor model (FFM), or Big Five, is currently the most popular and has shown to be reputable, predictive (even normally distributed), reliable, crossculturally tested, and universal [59-63].

In the context of games and gaming, several attempts on predicting the effectiveness of the application of FFM showed inconsistent results [64,65]. In one study, personality traits have been related to preference for game genres [66]. A low predictive capability was found, which may be caused by a lack of evidence on whether the FFM is a valid method to measure personality in a game or not [67,68]; however, direct correlations between the FFM and gaming were researched and described by Vandenberghe [48]. He states that personality is very accurately predictive of gaming preferences and that people play with the same motivations they have in real life or look to express a particular part of personality that is unsatisfied in real life. In his model, the 5 domains of play, a translation of the original FFM traits is made into aspects of gaming motivation (Table 4). Each player is ranked on a linear scale on each of the 5 domains, thereby creating a character description rather than a categorization into a single player type. At the same time, the domains provide insight into the type of content that satisfies the player.

Table 4. Five-factor model traits and corresponding gaming motivation traits (deduced from Vandenberghe [48]).

Low score	Trait	High score
Cautious, predictable	Openness to experience	Inventive, curious
Repeating, conventional	*Novelty*	*Open, imaginative experiences*
Careless, impulsive	Conscientiousness	Efficient, organized
Low effort and self-control	*Challenge*	*High effort and self-control*
Reserved, solitary	Extraversion	Energetic, outgoing
Relaxing, low social engagement	*Stimulation*	*Exciting, high social engagement*
Analytical, detached	Agreeableness	Friendly, compassionate
Competition, defeating	*Harmony*	*Cooperation, helping*
Confident, secure	Neuroticism	Nervous, sensitive
Cheerful, comforting	*Threat*	*Gloom, horror, high tension*

Two examples illustrate specific gaming elements derived from motivation facets. First, the imagination of the user correlates with a preference for either fantasy or realism: someone who scores high on imagination will tend to prefer games that take place in exotic worlds, whereas someone with a low score will prefer games that take place in a world much like ours. Second, scoring high on adventurousness correlates with a preference for exploration and a desire for encountering new things, much like the Bartle type explorer, whereas a low score indicates a preference for local play styles such as building or farming that do not involve leaving the boundary of the known [69].

Figure 2. Bartle's player type model.

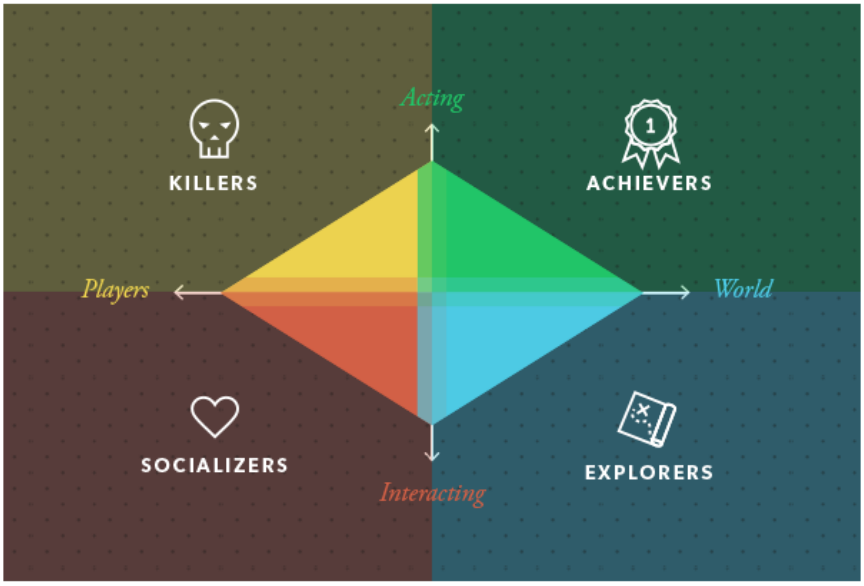


Figure 3. Marczewski's player type model.

Reasons to Play

Yee [70] proposes a taxonomy based on users' reasons to play and used a long-term, qualitative analysis and factor analytical approach to create a taxonomy based on player motivations in MMORPGs (massive multiplayer online role-play games). The model by Yee consists of 10 subcomponents factored into 3 main components with which they are most correlated (Figure 4). Each subcomponent is linked to game elements from which players derive satisfaction. He finds that the killer must be omitted and merged into his component of achievement and the original explorer type must be divided into mechanics and discovery. The Yee model is similar to Bartle's but overcomes several of its weaknesses. For example, the components of Bartle types are not highly correlated, the types overlap and are not distinctive, and a practical way to assess users is lacking. However, similar to the Bartle typology is its narrow focus on massive online gaming.

A taxonomy of game aesthetics, or what makes a game fun, can be found in the mechanics, dynamics, and aesthetics framework by LeBlanc et al [51]. As much as 8 kinds of fun are defined: sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission. These aesthetics are used to describe why certain players engage with certain games and more regard the game than categorize the player. Similarly, also focusing on fun as a reason to play, Lazzaro [52] conducted a study to clarify how to address emotions in games without using a storyline by learning what (adult) players found were good gaming experiences. The "4 keys" to fun are

- *Hard fun:* players like challenge, strategy, problem solving, experiencing frustration.
- *Easy fun:* players like intrigue and curiosity and enjoy immersion.
- *Altered states:* players search for internal sensations such as excitement.
- *The people factor:* players use games for social experiences.

Figure 4. Yee's model motivations of play in MMORPGs: the components and subcomponents.

Achievement	Social	Immersion
Advancement Progress, Power, Accumulation, Status	**Socializing** Casual Chat, Helping Others, Making Friends	**Discovery** Exploration, Lore, Finding Hidden Things
Mechanics Numbers, Optimization, Templating, Analysis	**Relationship** Personal, Self-Disclosure, Find and Give Support	**Role-Playing** Story Line, Character History, Roles, Fantasy
Competition Challenging Others, Provocation, Domination	**Teamwork** Collaboration, Groups, Group Achievements	**Customization** Appearances, Accessories, Style, Color Schemes
		Escapism Relax, Escape from RL, Avoid RL Problems

Overview of Taxonomies

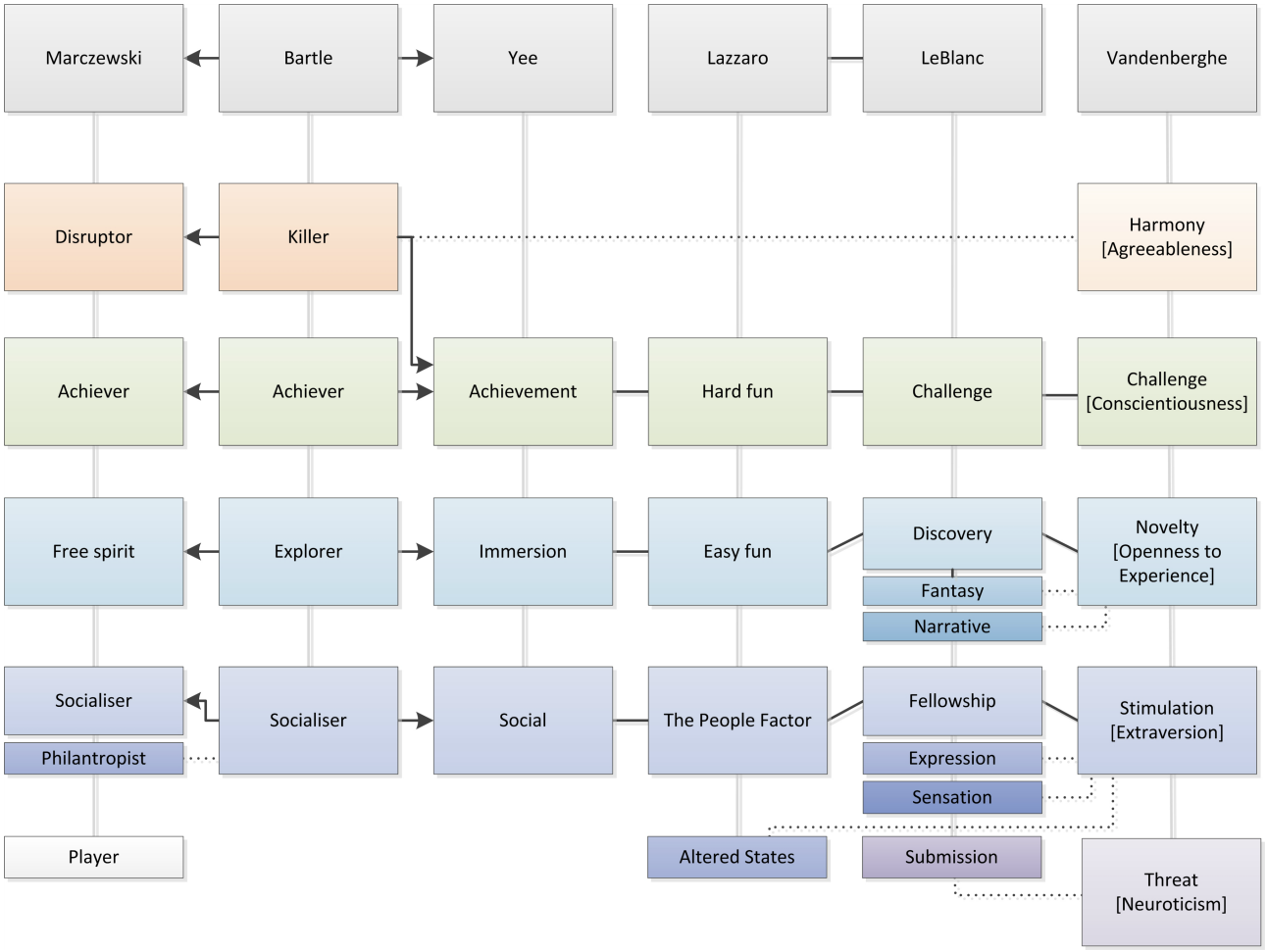
Although the taxonomies aforementioned appear very different concerning the types of classes, many parallels can be found between the characteristics of each class. We present the results in an overview chart (Figure 5). The top row in gray shows the author of the model, and under each author the defined classes (types, motivations, facets, etc) are shown. Arrows indicate a direct derivative of a model, as explained in the previous section; black lines indicate which classes show highly similar characteristics. The dotted line indicates that classes only have several characteristics in common. The colors indicate which classes belong to the same group. This overview shows that there is great connectivity between the models and highlights that the model of Vandenberghe covers all class properties of the other models (except for the player in the Marczewski model).

In the models of Marczewski and Yee, which both have Bartle as point of reference, we see a clear analogy between the achievers and socializers and also in the attributes of the free spirit (interacting with the system, autonomy), the explorer (interacting with the world), and immersion (discovery, exploration). Although Yee does not have a separate type for the killer or disruptor, provocation and domination are present in achievement. Linking to Lazzaro and LeBlanc, achievement is similar to the concept of hard fun and challenge; easy fun (which includes the motive of immersion) and discovery are similar to exploring; and the people factor and fellowship and expression relate to the social aspect. The model of Vandenberghe not only seems all-embracing, but it also adds a dimension to each personality trait. The killer can be linked to a very low score on harmony, the achiever to a high score on challenge, the explorer to a high score on novelty, the socializer to a high score on stimulation. The trait threat is quite unique and only linked to submission. According to Vandenberghe, this trait may not be pointing out what keeps a player playing but what makes the player decide to stop playing.

None of the taxonomies presented target the elderly user specifically. Furthermore, we do not know of any methods regarding the mapping of this target group on the existing taxonomies, mainly because the gaming industry does not focus on this group as a consumer for video games. Moreover, the

taxonomies are in most cases designed for use in a specific application, such as enterprise gamification or MMORPGs, and it is not known how suitable they are for application in telemedicine interventions. We can identify many parallels between the models, and we consider that the 5 domains of play stand out from the rest. Unlike the other models, an individual is not given a singular class label or a combination of those. Instead, a complete character description can be created based on preference for certain aspects or elements of games. What makes this theory even more attractive is that it describes the user based on personality, a universal understanding regardless of age.

Figure 5. Chart of connections between taxonomies (arrow: direct derivative of, line: high similarity in concept, dots: closely related concepts).



Discussion

Principal Findings

The first objective of this study was to provide an overview of theoretical frameworks for the application of gamification and of methods for gamification that specifically target the elderly user. Second, we have explored user classification theories, which are needed to gain insight into the user and serve as a tool to effectively tailor content. We have found that current frameworks for gamification rarely target the elderly user. The effectiveness of the use of user classifications for tailored game content is not yet known, neither are there indications for classifying the elderly user with these theories. How can we use these results to systematically design effective gamified telemedicine applications for elderly?

Frameworks for gamification emerge from two main approaches. First, there is a business-oriented approach, with examples of success in practice, using an easy-to-apply framework to gamify applications. However, the frameworks from this approach may also be oversimplified, which suffices for marketing purposes but possibly not for long-term engagement needed in telemedicine. Second, frameworks created within academia target for higher causes, such as better education and health outcomes. These frameworks often make use of established theories but are complex, and, at the time of writing, not used in practice. In both approaches, no appropriate framework was found to design gamification for elderly users and application in telemedicine. Therefore, a new framework should be created that is of sufficient depth but applicable in practice and supported by empirical data on its effectiveness. To do so, we would position our future research in academia and take example of the studies presented within this approach. Just like the authors discussed [32,34,40], we would aim for qualitative, long-term engagement and focus on stimulating intrinsic motivation.

Our study showed two approaches for user classification theories: archetypes, where classes are user types with associated preferences, and reasons to play, where classes are based on attributes that describe the user preference. None of the found

taxonomies seem to be applicable in telemedicine for elderly users due to the very different context and audience for which they have been developed and the fact that we are not familiar with the use of these taxonomies in practice. However, a high level of understanding of the target group will greatly contribute to designing effectively engaging content. This can be achieved by a taxonomy for game design specifically for elderly users. Creating such a taxonomy and corresponding game content can be difficult, because older adults may relate to video games differently than younger users as they might not be able to draw from earlier experience with video games. To create such a classification, it would be most desirable to observe the behavior of intended users in games, but the scarcity of elderly gamers (and limited availability of games for elderly people) does not provide sufficiently representative subjects for the whole target group.

Although from the taxonomies found none seem directly suitable for creating our future framework, the 5 domains of the play model [48] exceed the stereotypical classes of the other models by providing a detailed insight and overview of motivations users may have. The model provides an overview of both player and preferences (where others use, for example, game genres, which are ambiguous, not clearly outlined, and differing for each producer of video games) and is moreover based on a universally applicable psychological concept that may help in overcoming the particular challenge of mapping a group of users onto a taxonomy who have not been exposed to games at a young age. Therefore, we believe the model by Vandenberghe advances on earlier classifications, thus making it unique and worthwhile to explore further for use in game design for elderly users.

Advantages of creating a framework within the academic approach are the possibility of using solid scientifically established theories and incorporating existing motivational theories and instruments that relate to the objective of gamification to motivate and engage. Serious games and exergames for elderly users [71,72] were not included in our study because our present focus is on improving adherence to existing health interventions by means of gamification, and serious games are full games that require a different approach. However, gamification in persuasive (game) design [73-75] or vice versa and gamification for behavior change [76] [77] deserve to be explored. Furthermore, because a well-designed game concept is essential for creating a motivating experience for the user, relevant game design principles that consider the aspect of experience on engagement such as flow [78,79], immersion [50], and customization [8] can prove useful in reaching our goals. Furthermore, we emphasize the necessity of a good game design concept to successfully gamify an application for engagement. The framework we aim to develop in the future should always leave room for the creative process that is involved. We may be able to predict the preference of a user for different types of content but how content is then designed according to these preferences to appeal to the player could be more art than science.

Conclusion

We suggest developing a framework for gamification that is based on solid scientific foundations and includes a user classification that specifically assesses the elderly user. We base this classification on the 5 domains of the play model that predicts the existence of a relation between preference for game content and personality. In a study, we need to explore this relation as well as opportunities for use for the intended target group and context. When we know more of these aspects, a gamification framework can be developed by which the classification of the elderly user is used to effectively create tailored, engaging game content. Subsequently, the framework needs to be put to practice and evaluated for empirical support of its effectiveness.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Keywords first search.

[PDF File (Adobe PDF File), 8KB - games_v3i2e9_app1.pdf]

Multimedia Appendix 2

Keywords second search.

[PDF File (Adobe PDF File), 6KB - games_v3i2e9_app2.pdf]

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Abbreviations

FFM: five-factor model
ICT: information communication technology
MMORPG: massive multiplayer online role-play games
MOOC: massive open online course
MUD: multiuser dungeon

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