# Do You Think This is a Game? Contrasting a Serious Game with a Gamified Application for Health

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## Abstract
The general promise of employing the motivational power of games for serious purposes, such as performing physiotherapy exercises, is well-established. However, game user research discusses both the approach of *gamification*, i.e. adding game-elements on to a task-focused application and of *serious games*, i.e. injecting task-focused elements into a more fully-fledged game. There is a surprising lack of empirical work that contrasts both approaches. We present both a *casually gamified application* and a *serious game* with purpose-driven mechanics that provide different frontends to the same underlying digital health application. This application aims at supporting physiotherapy sessions for chronic lower-back afflictions. Results from an explorative pre-study contrasting both approaches indicate a clear preference for the *serious game* version, capturing higher perceived motivational components (autonomy and relatedness), as well as higher immersion and flow relative to the *gamified* version.

## Author Keywords
Games for Health; Exergames; Serious Games; Gamification; Motivation; Motion-based Games; Gameful Design

## ACM Classification Keywords
K.8.0 [Personal Computing]: General - *Games*

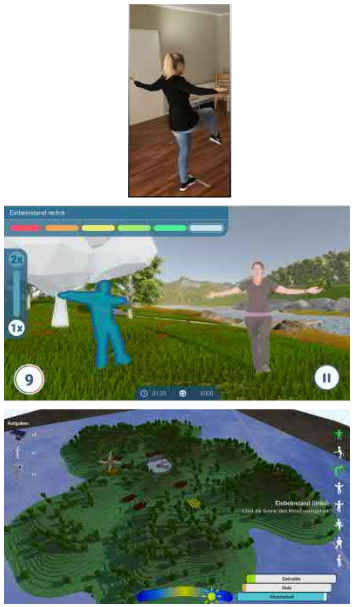

**Figure 1:** The *stand on one leg* exercise in both versions. **CGA** *(top)* displays the users outline and rewards the exercise execution quality with points. In **MMW** *(bottom)* this exercise shifts the position of sun and moon to control day and night time, building up the *alacrity* resource.

## Introduction

Harnessing *the power of games to draw players in and keep them spellbound* [8] to motivate exercising for fitness or therapy has developed from tinkering prototypes to commercial developments and a frequently studied subfield. While other aspects are also receiving attention, motivation is arguably the defining outcome for most research efforts and developments [9]. A central design decision that has to be tackled in every individual approach to utilize this motivational power is then whether to (a) consider a game predominantly and *add exercises in*, or to (b) consider the exercises predominantly and to *add game elements on*. This decision also applies to other contexts (e.g. education) and following the terminology by Deterding et al. [5], would result either in (a) a *serious game*, or (b) *gamification*. While the differences in design approaches and expected outcomes have been discussed in related work, there is a surprising lack of empirical work based on contrasting literature or different implementations.

In this paper we present the motion-based game for health *Move My World (MMW)* that features rich resource-based world-building strategy gameplay with therapy exercises 'added in'. In a pre-study MMW is compared to a more *casually gamified application (CGA)* where players follow movements presented by an instructor figure while placed in an appealing virtual environment and receiving ratings, badges, etc. Based on related literature and *self-determination theory* (SDT) [8] we hypothesize that MMW should lead to higher motivation (especially regarding autonomy as an aspect of intrinsic motivation) and immersion / flow [3].

The outcomes provide first evidence that – while participants liked both applications – MMW did indeed result in higher perceived freedom / autonomy and was clearly preferred in a free-to-choose final play session. We contribute both to motion-based games for health, presenting a serious game with purpose-driven game mechanics, as well as to more general *game user research* (GUR), furthering debates on *shallow* vs. *deep* gamification and serious games.

## Related Work

Taxonomies have been developed in the larger GUR space to facilitate more nuanced discussion and growing a structured understanding of the different approaches. Deterding et al. [5] define gamification as *the use of game design elements in non-game contexts* and provide a delimitation between gamification (using parts of games) and (serious) games (full-fledged or whole games). The potential and benefits of serious games in general and motion-based games for health in particular are beginning to be more well-understood and researched [9]. However, it is important to notice that the terms are frequently used interchangeably or with a different understanding and it is surprising to see that although many applications with a focus of motivating motion-based exercises are self-proclaimed serious games, or games for health, and although the categorization is not always entirely clear, using the terminology by Deterding et al. many fall under the label of gamification (e.g. [1, 2, 6]). Our *CGA* can be seen as roughly representative of such a common approach to gamified motion-based health applications. While it can be argued that typical gamification elements (such as scores, badges, etc.) are also parts of many full-fledged games and thus they are not mutually exclusive from serious games, or could simply be understood as different *levels of gamification*, we argue that there are important differences in the approaches, as discussed by Deterding et al. and that it is important to establish, whether these theoretical differences result in measurable and predictable outcomes. Notably, there can indeed be different levels or intensities with which gameful

| Exercise | Game Impact |
|---|---|
| *rotation* | Raises the height of a helicopter to get an overview of the island. |
| *boxing* | Commands the villagers to gather resources by chopping wood. |
| *bend to toes* | Trigger rain (water fields). |
| *stand on one leg* | Raises/sets the sun/moon. |
| *circle hips* | Brings up wind (run windmills). |
| *side step* | Operates crane (erect buildings). |
| *walking in place* | Raise the speed of all villagers. |

**Table 1:** In-game effects triggered when executing the respective exercises in **MMW**.


**Figure 2:** Final screen of **CGA**. The user gets feedback about every individual exercise performance, as well as the total score, represented by stars.

elements are applied to non-gaming contexts (shallow or deeper gameful design), including borderline cases such as 'framification' [7], and with which elements of serious purpose are applied to games (serious game design) that warrant further study but are not subject to comparative study in this work. Since games necessarily need to be understood as inseparable wholes [4] the specific choices regarding these design aspects have to be treated as fixed independent variables in the study design. Similarly, related work also discusses delimitations between *gameful* (or ludic) and *playful* (or paidic) approaches that are not primary subjects of this research while standing in complex interaction with the use of games in action [4].

## Gamification and Serious Game Design

As indicated above, many current exergame applications are either focused on the proper execution of exercises in a rather casually gamified setting, or on the other extreme designed entirely as games for entertainment (e.g. Wii Fit/Sports, Dance Dance Revolution, Kinect Sports, EyeToy Games, etc.), lacking the incorporation of actual therapeutic exercises. To enable the comparative study we employ a gamification and a serious games version of an application for the support of physiotherapy and the application use-case of chronic lower back afflictions. Both applications implement the same configurable as well as exchangeable set of exercises (cf. Figure 1) that represents a subset of a lower back treatment plan developed in cooperation with physiotherapists in the context of the project *Adaptify*.

*CGA* represents a predominantly exercise focused gamification approach. Exercises are presented in a linear order, preceded by a tutorial video. Users have to perform the correct gestures in a given time window in order to proceed, following the guidance of an instructor character that is presented next to the their real-time body outline. Depending on the quality of the execution (i.e., the proximity to the ideal set of movements that constitute the exercise), detected repetitions are displayed in a color-coded fashion, from red (worst performance) to green (best performance). Continuous good executions can increase a multiplier that is used to calculate a total score. Starting with a hidden background, increasing the score unlocks parts of a pleasant virtual scenery. An end-screen rewards users with a number of stars, depending on the performance (cf. Fig. 2).

*MMW* resembles an economy simulation god-game where the user has to take care of the population of a procedurally generated island. Per session, one main mission has to be completed, which is achieved through subtasks, such as *"Provide food for your villagers"* by constructing a set of houses, fields and windmills and make them work. In an embedded, interactive tutorial the mayor of the town presents the exercises required in this session and how they influence the world when executed (cf. Figure 1). The user, however, is free to choose the order in which the subtasks are completed. He can, for example, choose to construct all required buildings first and then perform different exercises subsequently or he can postpone the residual execution of an exercise to a later point of time to focus on other subtasks. The sum of these subtasks corresponds to the underlying set of exercises and is dynamically adapted to changing difficulties/repetitions/holding periods. For example, if the generated mission requires four buildings to be constructed and each building needs wood to be built, then the wood collection time for a single building is calculated by dividing the total time that was defined as required for *standing punches* by the number of buildings in the mission. In that way, the user can e.g. choose to finish *standing punches* halfway, then spend time on other exercises, and finally return to the residual wood for the remaining two buildings. This approach enables freedom of choice while

| Resource | Usage/Source |
|---|---|
| *wood* (accumulates) | Needed to construct buildings. Gained by chopping wood. |
| *alacrity* (acc.) | Needed to enable villagers to work. Gained by sleep (trigger night-time). |
| *wind* (temporary) | Effect to actuate mills/turbines. Produced via *circle hips*. |
| *water* (temp.) | Effect to grow fields. Produced via *circle hips*. |
| *grain/power* (acc.) | Needed to complete the respective main mission. |

**Table 2:** Resources which accumulate in reservoirs and effects that are triggered temporarily in **MMW**.


**Figure 3:** Final screen of **MMW**. Users are incentivized to stick with an exercise plan consistently through unlocks for new buildings, missions, and the possibility of developing an individual island.

still ensuring that the minimal amount of time/repetitions for all exercises is satisfied.

Instead of a score system, *MMW* uses a resource management approach (see Figure 2). The required resources are automatically adjusted to reflect a given set and repetitions / durations of exercises, but players can freely determine the order. The resources are displayed at all times, as well as the progress of each individual exercise, the remaining subtasks and the main goal. If the latter is completed, all villagers come together in the village center to celebrate and thank the player. Afterwards, a final screen is presented, showing the success of the current session and further unexplored content that can be unlocked (see Figure 3). This deep integration between game elements and the serious purpose can be described as purpose-driven (or purposeful) mechanics and aims at producing a predominantly gameplay-driven experience.

Both *CGA* and *MMW* feature a complete sound design and were tested and developed to comparable standards, employing iterative testing for quality assurance, as well as the same underlying technology stack for player tracking, exercise detection, and audiovisual rendering.

## Comparative Exploratory Pre-Study

To compare both approaches in terms of motivational effects and flow, a within-subjects study was conducted in a laboratory setting. The experiment manipulated one independent variable with two conditions: *gamified application (CGA)* and *serious game (MMW)*. Data was gathered through questionnaires and a post-study semi-structured interview with an emphasis on qualitative methods to facilitate capturing unforeseen aspects.

*Measures*

An initial questionnaire asked for demographics and experience in video games and sports. A post-trial questionnaire after each game aimed to capture appreciation, motivation through items based on SDT [8] (asking for perceived competence [perceived performance], autonomy [freedom], relatedness [relatable characters]), as well as flow and immersion [3], all indicated through 7-point-Likert scale statement agreement. In the end, a semi-structured interview invited free responses along the same categories, asking participants to contrast both gameplay sessions. Observational notes about problems, remarks and execution flaws were taken throughout the sessions, indicating no notable technical problems or difficulties executing exercises.

*Setup and Procedure*

Following informed-consent and the pre-study questionnaire participants interacted with both *CGA* and *MMW* in permuted order. In both cases subjects were asked to stand in front of a screen on a marked spot. After completing each regimen that was scheduled to last about 10 minutes and featured the same exercises, they were asked to respond to the post-trial questionnaire. Following the comparative interview after the second trial, where participants were free to add any ideas and thoughts, they were told that a final play session was required. This time they were able to choose whether they wanted to play *CGA* or *MMW*.

*Participants*

The study included 7 convenient subjects (4f, 3m), 20 to 62 years of age ($M$=39.14, $SD$=16.96). They indicated ($M$=7.60, $SD$=7.77) hours of playing video games in a typical week on average. Prior experience with games, sports and physiotherapy is displayed in Table 3.

**Figure 4:** The hardware setup was consistent between both versions. Users faced a 240x135cm screen driven by an ultra-short distance projector. A Microsoft Kinect V2 tracked the users.

**Figure 5:** A villager chopping wood in *MMW*. This behavior is triggered when the user performs the associated exercise *boxing*.

## Results

We report means and standard deviation but omit inferential statistics (low sample size) to avoid misinterpretation, although some results did indicate statistical significance in t-tests. Participants indicated that they liked both games overall (*CGA*: $M$=6.57, $SD$=.53; *MMW*: $M$=6.86, $SD$=.38) indicating that both were well-produced and received. Similar positive ($M >= 6$) ratings were also observed for perceived competence, physical wellbeing during exercise execution, and motivation. In *CGA* ($M$=4.14, $SD$=2.04) participants were less *"able to relate to the virtual characters"* than in *MMW* ($M$=6.14, $SD$=.38). Perceived *"freedom do as I please"* was notably lower in *CGA* ($M$=3.57, $SD$=2.37) than in *MMW* ($M$=6.43, $SD$=.79). Together these results indicate that SDT motivation differed based on aspects of relatedness and autonomy, but not competence.

Regarding how *"appropriate the challenge through the game"* was *CGA* ($M$=4.43, $SD$=2.15) received lower scores than *MMW* ($M$=5.86, $SD$=.69). *MMW* was also rated to feel more immersive ($M$=6.00, $SD$=.82) than *CGA* ($M$=4.43, $SD$=2.23). Accordingly, since balance between challenge and skill, as well as feeling immersed, are important facilitators of flow experiences, the overall experience of having *"a feeling of being in the game flow"* showed a lower mean for *CGA* ($M$=3.71, $SD$=1.80) than for *MMW* ($M$=5.86, $SD$=1.07).

*Interview*

Using their own wording, five participants stated they liked *MMW* more because of the *"deeper game mechanics"*, the *"time spent was perceived shorter"*, the *"nice setting"*, and the *"aspect of free choice"*. Only one participant preferred *CGA* because of the *"clear and linear task representation"*. 6/7 reported a higher level of competence in their exercise execution in *CGA*, because of the constant feedback in form of their silhouette. A sense of making decisions, playing at will, mentally appropriate challenge, immersion and flow appeared predominantly, or even solely, in *MMW*. All subjects stated that both prototypes certainly motivate them to perform physical exercises (in comparison to traditional physical therapy without digital assistance), but they strongly preferred *MMW* (5/7) in terms of expected long-term motivation (2/7 indicated no preference), because of the *"variation"*, *"unlockable game elements"* and the *"individual continuation of the game"*. Following the interview, subjects were asked to pick one of the versions to play a third session. 6/7 picked *MMW*, indicating they did so mostly *"out the curiosity for new buildings"* and the *"opportunity to advance their individual villages"*.

## Discussion and Future Work

The interview responses clearly express an overall preference towards *MMW*, underlining indications from the questionnaires. Both perceived motivation based in SDT and flow / immersion appear increased compared to *CGA*. Since the setup and exercise selection was not varied this indicates a positive impact of a serious game approach with purpose-driven mechanics and exercises 'added in', compared to an exercise sequence presented by an instructor figure with game elements 'added on'. The higher perceived freedom and flow in *MMW* are likely driven by the more free nature of this game version. Players felt like they could choose which tasks they wanted to address and thus, which exercises they would perform. *CGA* provided a clear order of exercises, leading to a lower sense of freedom. Similarly, the fact that players did not have to perform a single exercise for a prolonged time in *MMW* can arguably not only contribute to higher perceived autonomy, but also support self-regulated balancing between the level of challenge and one's own situated skill. When feeling tired or bored, participants could simply choose a different task to pursue.

| | |
|---|---|
| **Gaming experience** | |
| *Non-gamer* | 1 |
| *Casual gamer* | 6 |
| *Advanced gamer* | 0 |
| **Exergame experience** | |
| *No prior experience* | 5 |
| *Prior experience* | 2 |
| **Sport habits** | |
| *0h sports per week* | 3 |
| *0-2h sports per week* | 1 |
| *2-4h sports per week* | 2 |
| *>4h sports per week* | 1 |
| **Membership in a sports group** | |
| *Currently not* | 6 |
| *Currently engaged in a sports group* | 1 |
| *Never been* | 3 |
| *Have been in the past* | 4 |
| **Experience with following an instructor** | |
| *No experience* | 4 |
| *Prior experience* | 3 |
| **Experience with physiotherapy** | |
| *Never received physiotherapy* | 3 |
| *Received physiotherapy before* | 4 |

**Table 3:** Participants' prior gaming and sports experience

The results warrant a follow-up study with larger participant numbers, an extended duration, employing the full psychometric questionnaires. Including a more radically open-ended / player-driven variant of *MMW* might also be promising, as it could extend the scope of the work to encompass more playful approaches. Furthermore, the situated use and the potential influence of player type will be considered in future work.

## Conclusion

We compared a *serious game* and a *gamification* approach for the same underlying purpose of supporting physiotherapy exercises. Regarding motivation, immersion, and flow in a study contrasting the two representative prototypes. The *gameplay-focused resource managing strategy game* was clearly preferred over the alternative with common gamification elements (e.g. points, badges, etc.). Given the specific implementations this may be mainly attributable to the influence of meaningful elements such as making perceived own decisions constantly, relating to the game characters, an increased feeling of flow, and the individual and continuous development of the game world across sessions.

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## REFERENCES

1. Aimee L. Betker, Tony Szturm, Zahra K. Moussavi, and Cristabel Nett. 2018. Video Game-Based Exercises for Balance Rehabilitation: A Single-Subject Design. *Arch. of Phys. Medicine and Rehab.* 87, 8 (2018), 1141–49.
2. J. W. Burke, M. D. J. McNeill, D. K. Charles, P. J. Morrow, J. H. Crosbie, and S. M. McDonough. 2009. Optimising Engagement for Stroke Rehabilitation Using Serious Games. *Vis. Comput.* 25, 12 (2009), 1085–1099.
3. Jenova Chen. 2007. Flow in Games (and Everything Else). *Commun. ACM* 50, 4 (April 2007), 31–34.
4. Sebastian Deterding. 2014. Eudaimonic Design, or: Six Invitations to Rethink Gamification. (2014).
5. Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. From Game Design Elements to Gamefulness: Defining "Gamification". In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments (MindTrek '11)*. ACM, New York, NY, USA, 9–15.
6. Stefan Göbel, Sandro Hardy, Viktor Wendel, Florian Mehm, and Ralf Steinmetz. 2010. Serious Games for Health: Personalized Exergames. In *Proceedings of the 18th ACM International Conference on Multimedia (MM '10)*. ACM, New York, NY, USA, 1663–1666.
7. A. Lieberoth. 2015. Shallow Gamification: Testing Psychological Effects of Framing an Activity as a Game. *Games and Culture* 10, 3 (May 2015), 229–248.
8. Scott Rigby and Richard Ryan. 2011. *Glued to Games: How Video Games Draw Us In and Hold Us Spellbound*. Praeger.
9. Jan D. Smeddinck. 2016. Games for Health. In *Entertainment Computing and Serious Games*, Ralf Dörner, Stefan Göbel, Michael Kickmeier-Rust, Maic Masuch, and Katharina Zweig (Eds.). Lecture Notes in Computer Science, Vol. 9970. Springer International Publishing, Cham, 212–264.