

# Architecture and Evaluation Design of a Prototypical Serious Game for Business Information Visualization

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**Abstract.** Poorly visualized business reports may lead to wrong decisions caused by incomprehensible or misleading data. However, many companies still do not strive for adequate business information visualization (BIV), which may be due to a lack of knowledge about how to achieve it. To support managers in avoiding the pitfalls of incomprehensible reports, we are currently developing a serious game that helps players to learn about guidelines for adequate BIV. In this so-called “Dashboard Tournament”, players compete across several minigames that address specific BIV guidelines. The aim of this paper is to provide an understanding of the prototype’s architecture and to propose an experimental design for its evaluation. Researchers and practitioners may hence increase their understanding of how to design and evaluate serious games in the domain of business and information systems engineering.

**Keywords:** Serious Games, Business Information Visualization, Game-based Learning, Prototype.

## 1 Introduction

Poorly visualized business reports may lead to wrong decisions due to incomprehensible or misleading data [1]. Despite these threats, many companies still do not strive for proper business information visualization (BIV) [2]. One explanation for this is the lack of knowledge about adequate BIV practices and guidelines [3]. Experiential learning might be a way to sustainably increase this knowledge and therefore improve the way reports are designed [4]. Serious games are one form of experiential learning that has been used for decades to successfully convey business-related content by engaging players [5]. However, despite the plethora of different serious games described in literature, BIV has thus far not been a dedicated aspect of them [6, 7]. To fill this gap, we are developing a serious game called “Dashboard Tournament” that aims to increase BIV capabilities among players by letting them compete across several minigames [7]. Each minigame confronts players with insufficient BIV like pie charts, traffic lights, or crowded tables in reports. After describing the concept of the game in prior research [7], we aim to present its architecture and propose an experimental design for its evaluation in this paper. This may provide researches and practitioners with insights about how to develop and evaluate serious games in the domain of management reporting.

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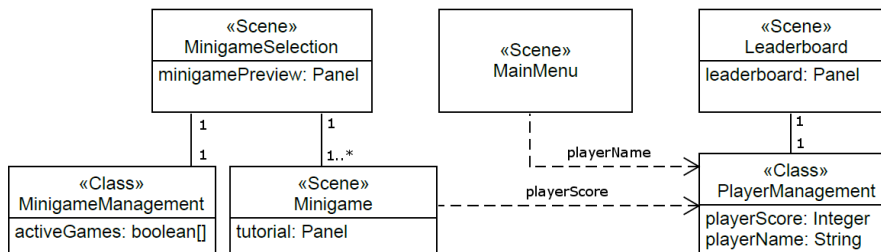
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## 2 Theoretical Background and Development Method

Since serious games are concerned with improving player capabilities as well as providing an entertaining experience [8], both learning and motivation theories are used in literature to explain the benefits of serious games [9]. For instance, they are often described as a form of experiential learning [4]. To explain the motivational effects of our game, we draw on self-determination theory [10]. According to this theory, video games in general foster intrinsic motivation by enabling perceived competence, autonomy, and relatedness [11]. We hence also expect to increase intrinsic motivation with our game by satisfying these needs. Perceived competence may be fostered by players succeeding in the different minigames and earning points for doing so. Relatedness may be achieved by letting players compete in the same room and using leaderboards that allow comparisons with other players. Last, a sense of autonomy may be achieved by players being able to choose their own approaches of how to succeed in the minigames. To develop the Dashboard Tournament, we employ the human-centred design process [7]. In the following, we describe the architecture of an evolutionary prototype that resulted from the first iteration of this development process.

## 3 Architecture of the Dashboard Tournament

The prototype of the Dashboard Tournament currently features a singleplayer mode that comprises four minigames [7]. To implement the prototype, we used the game engine Unity with C# as the programming language. An overview of the game's architecture is provided in Figure 1.



**Figure 1.** Architecture of the Dashboard Tournament

The game comprises different scenes (i.e., screens that players will access during the course of the game), classes that store the data necessary for the scenes to operate as well as several panels (i.e., graphical elements inside the scenes). First, players enter the main menu (“MainMenu”) where they can enter their nicknames, which will be stored in the “PlayerManagement” class. Afterwards, a scene where the next minigame gets selected at random (“MinigameSelection”) is shown. The different minigames are represented as “minigamePreview” panels in this scene. After the minigame that has to be played is selected, players access the respective scene for that minigame (“Minigame”). Each minigame features a tutorial panel that provides players with

information regarding the objective of the current minigame and how to play it. When the minigame is finished, scores are saved in the “PlayerManagement” class and players enter a scene for displaying leaderboards (“Leaderboard”). Here they will find their score on a leaderboard panel. Afterwards, they return to the scene “MinigameSelection” as long as there are minigames left to be played. This information is stored in the “MinigameManagement” class. Although gameplay data is currently only available at runtime, a log file is going to be available on the server in later versions of the game for analysis purposes. Due to the prototype’s component-based architecture, minigames may be added or removed in future iterations of the development process. In addition, multiplayer functionality will be added by defining one instance of the game as a host that selects minigames and keeps all clients synchronized.

#### 4 Evaluation of the Prototype and Conclusion

To evaluate the game after its development will be finished (i.e., multiplayer functionality is added), we plan to conduct a laboratory experiment using a multivariate 1x3 between-group design (see Table 1). Power analysis revealed that for statistically significant results ( $d = 0.8$ ;  $\alpha = 0.05$ ;  $1 - \beta = 0.95$ ), each group should consist of 35 participants who are randomly assigned from a pool of students in business and economics programs (i.e., prospective managers and report designers).

**Table 1.** Experimental Design of the Evaluation

Group	Pretest	Treatment	Post-Experience	Posttest
1	Suggestions	Competition	Intrinsic Motivation	Suggestions
2	Suggestions	Singleplayer	Intrinsic Motivation	Suggestions
3	Suggestions	Presentation	Intrinsic Motivation	Suggestions

The treatments differ in how they aim to increase BIV capabilities. In the first treatment, participants play the Dashboard Tournament in a competition. The second treatment uses a modified version of the game, where there is no competition at all. This condition is used to isolate the effect of providing a competition: If the singleplayer version leads to the same benefits, the game may be easier to use in practice, since it would not require several managers to attend the same session. Last, there is a treatment with only a presentation about BIV guidelines, serving as a control group. To assess the motivational benefits of the game, we conduct post-experience questionnaires regarding perceived competence, autonomy, and relatedness as well as intrinsic motivation of participants by using the intrinsic motivation inventory [12]. To assess learning outcomes, pre- and posttests are going to address participants’ BIV capabilities. For this purpose, participants are provided with different examples of business reports and are requested to suggest improvements. The provided reports suffer from inadequate BIV that is addressed by the guidelines covered in the different treatments. We can hence check whether improvements suggested by participants comply with the BIV guidelines. The pretests also help in determining prior knowledge of participants (e.g., courses or practical experience).

By comparing the post-experience questionnaires of all treatments, we may investigate whether playing the game leads to increased motivation compared to hearing a presentation. To examine the effect of setting up a competition, we may look for differences in motivation between providing a competition between players and simply playing the minigames (first and second treatment). We may also compare the learning outcomes in all treatments to see whether participants who play the game actually show increased BIV capabilities compared to participants only hearing a presentation. Last, we intend to examine correlations between motivation and learning outcomes.

In summary, this evaluation may show that the Dashboard Tournament leads to increased motivation as well as increased learning outcomes. This may encourage both researchers and practitioners to consider using serious games in the domain of management reporting. Since our approach appears to be the first serious game about BIV guidelines [6, 7], we intend to investigate its usage in this domain in future research. Especially the importance and effects of competition can be examined in further studies. By describing an architecture as well as proposing an evaluation of our game, we also aim to support building and evaluating these games.

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