

Supporting Learning in Information Systems by Facilitating Motivation with Games and Game Elements

Kumulative Dissertation
der Wirtschaftswissenschaftlichen Fakultät
der Universität Augsburg
zur Erlangung des Grades eines

Doktors der Wirtschaftswissenschaften
(Dr. rer. pol.)

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Tag der mündlichen Prüfung: 26.06.2018

“Wo kämen wir hin, wenn alle sagten, wo kämen wir hin –
und keiner ginge, um zu sehen, wohin wir kämen, wenn wir gingen?”

Kurt Marti (1921 – 2017)
Schweizer Pfarrer, Schriftsteller und Lyriker

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Note: All essays in this dissertation have been slightly modified compared to their published version to facilitate readability. Modifications include a continuous page count, adapted references to other sections, and a central list of references at the end of this dissertation.

List of Essays

This dissertation is based on multiple scientific essays. In case of essays already published, the corresponding outlet will be shown alongside its current ranking in the “WI-Orientierungslisten der Wissenschaftlichen Kommission Wirtschaftsinformatik im Verband der Hochschullehrer für Betriebswirtschaft e.V. (WKWI) und des Fachbereichs Wirtschaftsinformatik der Gesellschaft für Informatik (GI-FB WI)” as well as the “VHB-JOURQUAL 3 des Verbands der Hochschullehrer für Betriebswirtschaft e.V. (VHB)”. The research highlights of each essay are presented, and for essays with multiple authors, the share contributed by the author of this dissertation is mentioned.

1. Grund, Christian K. (2015): How Games and Game Elements Facilitate Learning and Motivation: A Literature Review. In: Lecture Notes in Informatics (LNI) - Proceedings, Volume P-246, p. 1279-1293.

Highlights:

- A structured overview of learning and motivation theories that explain how games and game elements foster motivation and learning
- Theory-driven design guidelines for serious games and gamification are derived from the theories investigated

Ranking:

WI-Orientierungslisten: Ranked B
VHB-JOURQUAL 3: Ranked C

2. Grund, Christian K.; Meier, Marco C. (2016): Towards Game-based Management Decision Support: Using Serious Games to Improve the Decision Process. In: Proceedings of the Multikonferenz Wirtschaftsinformatik (MKWI) 2016, p. 155-166.

Highlights:

- A structured literature review shows how the decision process of managers can be supported with serious games
- Identifying research gaps for the decision steps “design” and “implementation”, which may lead to the development of new serious games

Ranking (Share: 85%):

WI-Orientierungslisten: Ranked C

VHB-JOURQUAL 3: Ranked D

3. Grund, Christian K.; Schelkle, Michael (2016): Developing a Serious Game for Business Information Visualization. In: Proceedings of the 22nd Americas Conference on Information Systems (AMCIS).

Highlights:

- The development method and concept of a novel and useful serious game for business information visualization is described
- It is shown how business information visualization guidelines may be conveyed with different minigames

Ranking (Share: 80%):

WI-Orientierungslisten: Ranked B

VHB-JOURQUAL 3: Ranked D

4. Grund, Christian K.; Schelkle, Michael; Hurm, Max (2017): Architecture and Evaluation Design of a Prototypical Serious Game for Business Information Visualization. In: Proceedings of the 13th International Conference on Wirtschaftsinformatik (WI 2017), p. 1271-1274.

Highlights:

- Describes how serious games composed of several minigames may be implemented with the game engine Unity
- Proposes an experimental design that may be used to measure the effects of serious games, namely intrinsic motivation and learning outcomes

Ranking (Share: 75%):

WI-Orientierungslisten: Ranked A/B

VHB-JOURQUAL 3: Ranked C

5. Grund, Christian K.; Schelkle, Michael (2017): Visualisieren spielend erlernen – Ein Serious Game zur Verbesserung von Managementberichten. In: Strahringer S., Leyh C. (eds.) Gamification und Serious Games: Grundlagen, Vorgehen und Anwendungen. Edition HMD, Springer, p. 167-181.

Highlights:

- Describes the prototype of a serious game for business information visualization for an audience in industry
- Design decisions regarding the balancing of play, meaning, and reality are presented
- A first evaluation of the prototype shows that motivational outcomes may be achieved and that the learning content is usually recognized

Ranking (Share: 80%):

WI-Orientierungslisten: Ranked B

VHB-JOURQUAL 3: Ranked D

6. Grund, Christian K.; Schelkle, Michael: Developing Serious Games with Integrated Debriefing: Findings from a Business Intelligence Context. Under review in: Business & Information Systems Engineering.

Highlights:

- Compares different versions of a serious game with presentations as a more conventional approach to training
- Serious Games do not necessarily lead to increased motivation, but may improve learning outcomes compared to presentations
- Integrated debriefing is a novel design principle that leads to higher motivation and learning compared to the often advocated post-hoc debriefing

Ranking (Share: 85%):

WI-Orientierungslisten: Ranked A

VHB-JOURQUAL 3: Ranked B

7. Schelkle, Michael; Grund, Christian K.; Aurnhammer, Lena A. E.: Increasing Visualization Compliance in Self-Service Business Intelligence with User Assistant Systems. Under review in: Proceedings of the European Conference on Information Systems (ECIS).

Highlights:

- A novel and useful software artifact concerned with assisting report designers is developed and evaluated in a laboratory experiment
- Results show that this assistance system makes it easier to comply with BIV guidelines and fosters an understanding for their usefulness

Ranking (Share: 40%):

WI-Orientierungslisten: Ranked A

VHB-JOURQUAL 3: Ranked B

8. Grund, Christian K.; Tulis, Maria (2017): Using Elected Elements in Large-Scale Information Systems Lectures. In: Proceedings of the 13th International Conference on Wirtschaftsinformatik (WI 2017), p. 776-787.

Highlights:

- A novel approach for large-scale information systems lectures is introduced: Using missions that allow students to vote for their favorite content
- A preliminary study suggests that intrinsic motivation and the overall evaluation of the approach by students are promising

Ranking (Share: 50%):

WI-Orientierungslisten: Ranked A/B

VHB-JOURQUAL 3: Ranked C

9. Grund, Christian K.; Tulis, Maria: Facilitating Student Autonomy in Large-Scale Lectures with Audience Response Systems. Under review in: Computers and Education.

Highlights:

- The approach presented in essay 8 is now evaluated in a full quasi-experimental field study with two groups of participants: One group was provided choice, and the other group attended predetermined lectures
- The provision of choice leads to a significant increase in perceived influence over the course, indicating that the choice is relevant to students
- There are significant positive relationships between perceived influence and intrinsic motivation, and between intrinsic motivation and perceived learning

Ranking (Share: 60%):

WI-Orientierungslisten: Not ranked

VHB-JOURQUAL 3: Not ranked

1 Introduction

There is little doubt about the importance of learning in information societies. Although it has already been crucial for centuries, current developments such as digitalization and digital transformation emphasize the need to establish successful training procedures for rapidly changing skill sets in organizations (Legner et al., 2017; Matt, Hess, & Benlian, 2015). Learning can thus be considered a so-called “21st century skill” (Romero, Usart, & Ott, 2014) and motivation is often regarded a precondition for sustainable learning (Garris, Ahlers, & Driskell, 2002). However, not all educational approaches are equally successful. For instance, decision makers in companies face the risk of conducting training with questionable quality (Jansen, Pfeifer, & Raecke, 2017). Another example is higher education, where inadequate teaching might lead to dissatisfied students and learning goals left unachieved (Sharp, Hemmings, Kay, Murphy, & Elliott, 2017). At the same time, technological advances provide a plethora of possibilities for education in both domains (Dondlinger, McLeod, & Vasinda, 2016). It is therefore imperative to investigate the effectiveness of technology-supported educational approaches. One promising approach that was shown to support learning and motivation in several areas is using games and game elements (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Faria, Hutchinson, Wellington, & Gold, 2009; Wouters, van der Spek, & van Oostendorp, 2009). When games have an educational purpose and are not played primarily for amusement, we may call them serious games (SG) (Abt, 1987). Using game design elements in non-game contexts (mostly to motivate desired user behavior) is referred to as gamification (Deterding, Dixon, Khaled, & Nacke, 2011). Despite being deemed by many researchers as promising to foster learning and motivation, there are also studies reporting that conventional teaching is superior to game-based learning (e.g., Pierfy, 1977). This seeming contradiction may be resolved by looking not only at the medium itself, but rather at the quality of the individual approach: A well-designed SG is for instance likely to outperform a poorly designed lecture and vice versa.

This immediately raises the question what constitutes good design for SG and gamification to actually increase intrinsic motivation and learning outcomes. Research in the Information Systems (IS) domain may contribute to answering this question by developing and analyzing SG and gamified approaches for educational purposes. This dissertation hence aims to contribute to answering the following research question:

RQ: How should serious games and gamification be designed to increase intrinsic motivation and learning outcomes?

To achieve scientific progress regarding this research question, this dissertation investigates the use of SG and gamification in two specific IS: The first one is management reporting, where knowledge about proper business information visualization (BIV) is often missing, leading to misconceptions and wrong decisions (Beattie & Jones, 2008; Eisl et al., 2015). The second one is higher education in IS, where students often lack motivation in lectures that provide them no choice over their specific content (Beichner, Saul, Allain, Deardorff, & Abbott, 2000; Eison, 2010). By developing and analyzing game-based approaches in both areas, this dissertation aims to increase knowledge about the proper design of games and game elements for educational purposes. The overall methodological approach may hence be described as Design Science Research (DSR) (Gregor & Hevner, 2013; Hevner, March, Park, & Ram, 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) which is concerned with the development of novel and useful artifacts to solve relevant problems. One prominent framework that describes the steps included in DSR is presented by Peffers et al. (2007). This DSR methodology comprises several activities that are depicted in Figure 1.

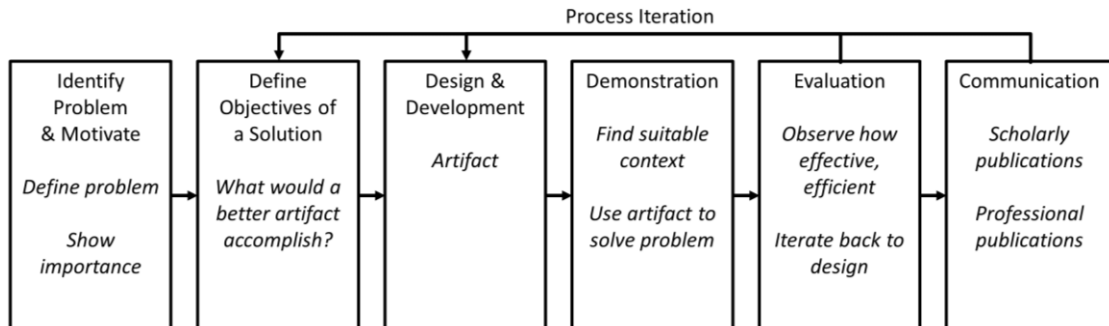


Figure 1: Activities in Design Science Research (adapted from Peffers et al., 2007)

According to Peffers et al. (2007), the first activity of DSR is to identify the problem and motivate the value of finding a solution for it. From this problem, researchers infer objectives that any solution to this problem should satisfy in a second activity. The third activity is concerned with designing and developing an artifact that is supposed to meet the objectives defined prior to its construction. The term „artifact“ is central to DSR, as it is not simply limited to software, but also encompasses constructs, models, methods, or instantiations, with the latter being for instance software (Hevner et al., 2004). Once the artifact is built, its usefulness is first shown by applying it to the problem in a demonstration (activity 4), and second by rigorously evaluating it to compare the achieved results of the artifact with its objectives (activity 5). In the sixth and final activity, the results of DSR are communicated for instance to a scholarly audience. As the DSR methodology proposed by Peffers et al. (2007) is iterative in nature, process iterations are possible from the activities evaluation and communication back to definition of objectives and artifact construction. The reason for this is that evaluation might for instance show that there are new problems emerging or that some aspects have not worked as expected, which informs future artifact development. This iterative nature of DSR is also taken into account in the so-called “three cycle view” proposed by Hevner (2007). It differentiates between iterative cycles that are meant to assure both rigor and relevance of developed artifacts (Hevner, 2007). In a so-called relevance cycle, researchers investigate the environment to make sure they understand problems,

opportunities, but also organizational and technical systems where artifacts might be needed or used. In a rigor cycle, possible design solutions to the problems identified are grounded with theoretical insight or earlier experiences. These two cycles inform the design cycle, where artifacts are built and evaluated based on the insights gained from the other two cycles. An overview of this concept is presented in Figure 2.

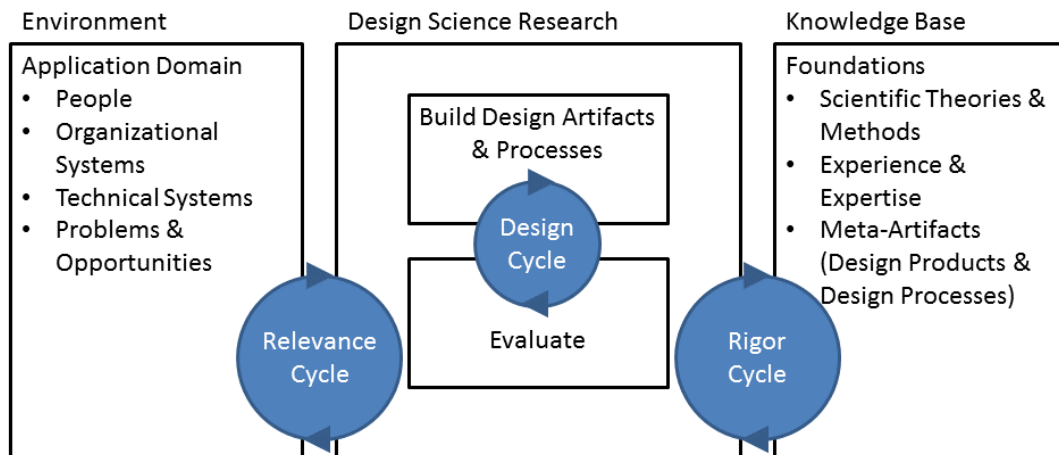


Figure 2: Design Science Research Cycles (adapted from Hevner, 2007)

Using this methodology, this dissertation aims to design and evaluate effective instructional approaches in both industry as well as in higher education in times of digitalization and digital transformation. The remainder of this dissertation is organized as follows: Section 2 features essays concerned with using games and game elements in IS to increase learning and motivation. In section 3, the dissertation closes with a summary of the findings and an outlook on future research possibilities.

2 Essays on Learning and Motivation in Information Systems

In the following, several essays that aim to contribute to answering the research question of this dissertation are presented. Figure 3 provides an overview of these essays grouped by their research topics.

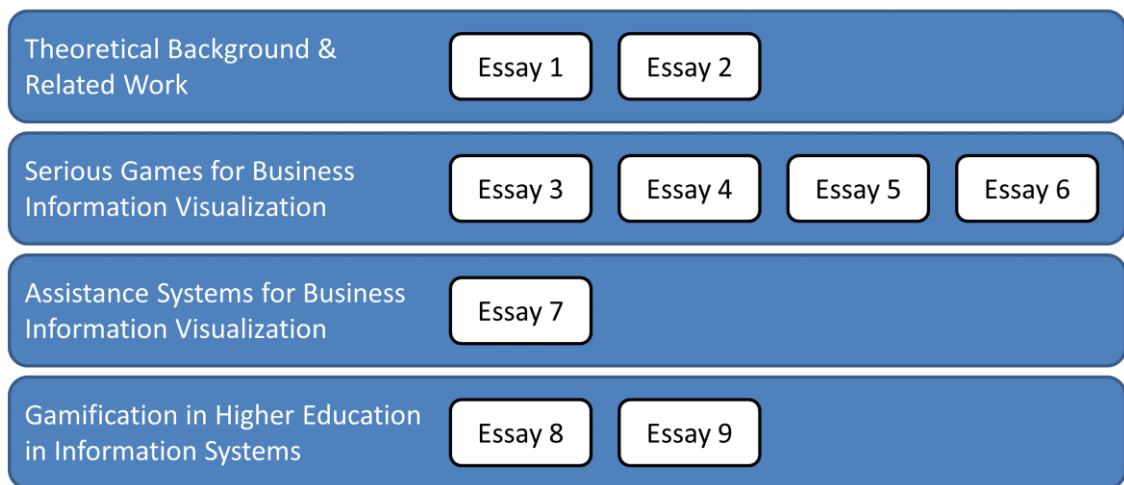


Figure 3: Essays Presented in this Dissertation

The first two essays are concerned with uncovering the theoretical background as well as related work for this dissertation by presenting the results of structured literature reviews in outlets related to IS as well as to game-based approaches. The method used in both essays (i.e., structured literature review) aims to create a firm foundation for advancing knowledge (Webster & Watson, 2002). It is thus appropriate for laying the (theoretical) groundwork for this dissertation. In DSR, this groundwork is important to inform the design of potential artifacts (Hevner, 2007) as it may be attributed to the rigor cycle, when it shows what the theoretical underpinning of an artifact might be (see essay 1) as well as to the relevance cycle, when it shows which problems and opportunities there are (see essay 2). As mentioned earlier, these two cycles are crucial for the design cycle, where artifacts are built and evaluated later on (Hevner, 2007).

Essay 1 investigates which theories have been used in prior research to explain how SG and gamification foster learning and motivation in a structured literature review (Grund, 2015). By carving out the most prominent explanations for the effects of SG and gamification, this first essay lays the theoretical foundation for most of the other essays presented. Results indicate that flow theory, self-determination theory, and experiential learning theory provide the most common explanations for the benefits anticipated when using SG and gamification. Flow theory describes a so-called “flow state”, in which people forget about their surroundings and lose their sense of time (Csikszentmihalyi, 1991). The state of flow is characterized by intense concentration, merging of action and awareness, loss of reflective self-consciousness, a sense that one can control one’s actions, distortion of temporal experience and experience of an activity as intrinsically rewarding. In order to experience the flow state, the challenge of the activity has to be in balance with the skills of the individual: Too much challenge causes anxiety, whereas too little challenge leads to boredom (Nakamura & Csikszentmihalyi, 2002). The main aspects of self-determination theory are motivation and personality, it can thus be called a motivation theory (Deci & Ryan, 1985). Different psychological needs are a central construct of this theory. Every human thus has the needs for competence, relatedness and autonomy. Fulfilling these needs leads to motivation, whereas neglecting them results in discouragement. Last, experiential learning theory underlines the influence of experience on learning success and can hence be called a learning theory (Kolb, 1984). A central construct of this theory is the so-called learning cycle which is composed of concrete experience, reflective observation, abstract conceptualization and active experimentation. It also states that an important precondition for successful learning is going through all stages of the learning cycle. Drawing from these and other theories, the essay derives several design principles that are based on the theories identified. In the case of the theories mentioned above, they include balancing challenge and skill (flow theory), supporting the needs for competence, autonomy, and relatedness (self-determination theory) and enabling players to go through all stages of the learning cycle (experiential learning theory). With a total of 10 proposed design guidelines, this literature review aims

to inform the design of SG based on a solid theoretical foundation. Although all of the theories mentioned above are suitable for conducting research in the area of SG and gamification, this dissertation focuses on self-determination theory later on. The reason for this is that it is a prominent theory in motivational psychology, which means that there might be many suggestions in literature about how to facilitate a motivating activity, which is the goal of SG and gamification. In addition, the authors of this theory already investigated video games in general in combination with their theory, thus providing a solid reasoning for its usage in this domain (Ryan, Rigby, & Przybylski, 2006).

While the first essay encompasses publications that deal with any topic related to IS or game-based approaches in general, the second essay takes a closer look at management decision support with SG (Grund & Meier, 2016). In doing so, publications dealing with SG are examined as to whether they support specific steps of the decision process of managers. For this purpose, we investigated a generic decision process for organizations that was initially proposed by Simon (1965) and extended by Mora, Forgie, Gupta, Cervantes, and Gelman (2003), that is composed of several steps. The first step is the intelligence phase, where decision makers observe reality, gather information and therefore gain an understanding of the problems and possibilities at hand (Mora et al., 2003). In the design phase, they construct a decision model which consists of possible actions, decision criteria, uncontrollable events and relationships between these variables. This decision model serves as a basis for the choice phase, in which decision makers evaluate possible alternatives and hence generate recommended actions. In the implementation phase, decision makers weigh possible consequences and gain confidence about their decision, plan the tasks needed to realize the decision and execute this plan. In order to improve their decision behavior as well as assessing decision situations, decision makers observe the outcomes of the decision and connect it to their decision behavior in the learning phase. Based on these decision steps, this essay shows that SG are suitable to support the decision process of managers in general, since the skills required in this process may be fostered by playing them. It also shows, however, that there are some skills in the decision process that are rarely addressed in prior research,

namely how to design the decision situation (i.e., how to model for instance the alternatives and possible outcomes) and how to implement decisions. Moreover, this review also shows that report design and BIV in particular are not yet addressed by SG in the decision support domain. This lack of SG for BIV alongside the indications that SG are a useful means to support managers is the starting point for the second group of essays concerned with developing a SG for BIV.

Essays 3-6 introduce a SG that aims to foster BIV capabilities among (prospective) managers and students in higher education to improve business reports and decisions based on these reports. This SG is composed of several minigames that confront players with insufficient BIV, which they are supposed to avoid when designing reports. The research methods employed in these essays are manifold, since this project comprises the conception, development, and evaluation of a software artifact. As the design of any artifact should be transparent in DSR, the development method (i.e., the human-centred design process) is described. After presenting the concept of a first prototype (see essay 3), its technical architecture and design principles are shown so that other researchers and developers might engage in creating similar SG (see essays 4 and 5). These two DSR activities belong to the design cycle, where an artifact is built (Hevner, 2007). We then move on to evaluate this artifact, which is also part of the design cycle, by first proposing (see essay 4) and then conducting a laboratory experiment (see essays 5 and 6). To summarize the DSR steps involved in the project of developing the Dashboard Tournament, Figure 4 gives an overview of the DSR cycles involved in each essay up to now. As mentioned earlier, the main idea behind these cycles is that for any artifact developed and evaluated (i.e., design cycle), the knowledge base (i.e., rigor cycle) as well as problems and opportunities in the environment where it is supposed to be used (i.e., relevance cycle) should inform its design (Hevner, 2007). This way, we intended to ensure both rigor and relevance of our artifact.

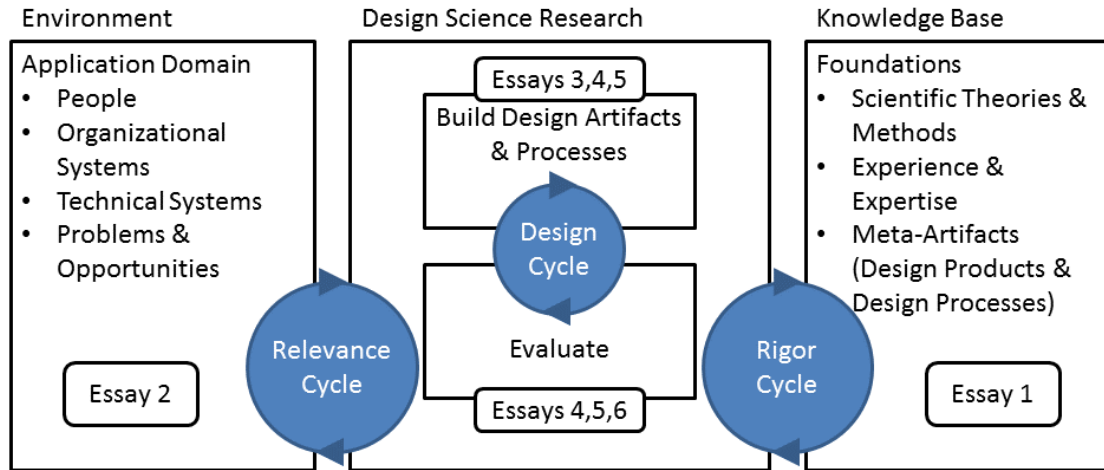


Figure 4: DSR Cycles for the Dashboard Tournament in Essays 1-6 (adapted from Hevner, 2007)

The methods used to analyze the resulting data and therefore to evaluate our artifact include a one-way multivariate analysis of covariance (MANCOVA) which is used to compare the mean values of several groups when intercorrelations between dependent variables as well as covariates are expected (Tabachnick & Fidell, 2013). This was the case with our variables, as different aspects of intrinsic motivation and the required needs for fostering it are not considered independent from each other. Its main advantage compared to other methods used to investigate mean differences between groups (e.g., student's t-test or univariate analysis of variance) lies in comparing the mean values of several groups while taking into account many independent variables. It is thus not affected by α -error-inflation (type 1 error) which would be the case when using several univariate analyses of variance or student's t-tests. Another method used to analyze the data is a dependent t-test, which allows for within-subject comparisons (Tabachnick & Fidell, 2013). In our case, this was necessary to see whether participants' knowledge of BIV guidelines has increased after each treatment. One last method used to analyze the results of our evaluation was a summative qualitative content analysis, which aims at categorizing qualitative responses to gain a deeper understanding than with quantitative responses alone (Hsieh & Shannon, 2005). This way, we identified several aspects that

participants liked about the artifact, but also which ones they were still wishing for, in order to inform the next iterations of artifact development as according to Hevner et al. (2004). In the following, each essay of this project is described in more detail.

Essay 3 introduces the concept of our SG (Grund & Schelkle, 2016). In doing so, it showcases the reasoning for the selection of the BIV guidelines to be included in the game. Although several guidelines for information visualization exist (e.g., Shneiderman, 1996; Tufte, 1997; Ware, 2012), only few focus on elements used specifically in business reports. One framework that highlights the design of business reports and presentations is called International Business Communication Standards (IBCS) (Hichert & Faisst, 2015). This framework comprises specific guidelines that showcase bad examples of BIV alongside their proposed corrections. Hence, these guidelines were included in our SG to enable players to identify inadequate BIV and to suggest reasonable improvements. In addition to laying out the reasoning for the selection of the learning content, this essay also introduces the development method employed. It shows that there does not seem to be an established standard or a thorough evaluation among the many development processes used for creating SG. However, they all concur that for SG to be successful, both educational objectives as well as providing an entertaining experience are important. Since the latter can only be evaluated through actual playing, a development process should encompass several iterations of play-testing with prospective users. For this reason, we employed the human-centred design process specified by ISO (2010) that is prevalent in the domain of human computer interaction (Earthy, Jones, & Bevan, 2001). It comprises the steps of planning the whole development, understanding and specifying the context of use, specifying the users' requirements, producing design solutions to meet these requirements, and evaluating the design against its requirements (ISO, 2010). In summary, this essay shows which learning content was selected, which development process was chosen, and sketches possible minigames.

Building on this foundation, essay 4 lays out the technical architecture of a first singleplayer prototype of our SG (Grund, Schelkle, & Hurm, 2017). In doing so, it describes the 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) created with the game engine Unity and C# as the programming language. The essay shows that the prototype has a component-based architecture that allows for adding or removing minigames in future iterations of the development process. With this technical description, it enables other researchers concerned with developing SG for management support to create similar games. In addition, it proposes an evaluation design that allows investigating the main effects anticipated by using this SG, namely increasing motivation and learning outcomes with regard to BIV capabilities. One key component of this proposed evaluation is conducting a laboratory experiment using a multivariate 1x3 between-group design. It suggests that for assessing the motivational benefits of the game, post-experience questionnaires regarding perceived competence, autonomy, and relatedness as well as intrinsic motivation of participants by using the intrinsic motivation inventory (Ryan & Deci, 2000) should be conducted. To assess learning outcomes, pre- and posttests should address participants' BIV capabilities. For this purpose, participants would be 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. It would therefore be possible to check whether improvements suggested by participants comply with the BIV guidelines. The suggested pretests would also help in determining prior knowledge of participants (e.g., courses or practical experience). In summary, this essay demonstrates the technical configuration of a first prototype of our SG and suggests a design for its rigorous empirical evaluation.

In essay 5, the concept of the game alongside the results of a first evaluation are presented mainly for an audience in industry, to transfer the knowledge established by this research project thus far (Grund & Schelkle, 2017). It also extends the findings from the previous essays by going into detail about the different design choices made during the creation of the SG to balance the components play, meaning, and reality (Harteveld, Guimarães, Mayer, & Bidarra, 2010). The “play” component refers to the game experience of players, like having fun and being immersed, but also to the game elements

used. The “meaning” component includes psychological aspects regarding the learning content, trying to make sure that learning happens successfully. Last, the “reality” component comprises the subject matter that is covered in SG, and represents the real world (i.e., management reporting and report design in our case). These different components lead to so-called design dilemmas and trilemmas and thus have to be traded off in every SG (Harteveld et al., 2010). The reason for this is that any SG may not be able to make abstractions to support gameplay (i.e., play component) and for instance be very realistic (i.e., reality component) at the same time, which is referred to as the representation dilemma (Harteveld et al., 2010). In addition to pointing out how each dilemma and trilemma was addressed in the design of our SG, the essay presents the results of a first evaluation among participants of a management reporting seminar. They indicate that the game may foster motivation and that the learning content is usually recognized among students. However, since it has been conducted in an early development stage, this evaluation should be interpreted as a first feedback of potential users rather than a rigorous evaluation of the whole game. With this first evaluation, the essay thus provides insight into both the design principles as well as one completed iteration of our development process that eventually led to the final version of our SG, which is evaluated in the following essay.

Essay 6 uses the finalized version of the SG for a thorough evaluation in a laboratory experiment. It investigates two main questions: First, is the use of this SG favorable compared to more traditional presentations in terms of motivation and learning outcomes? And second, should the debriefing, which is a crucial part of every SG, be integrated into the game? Especially this second question introduces a novel design principle for SG. Usually, debriefing (i.e., where the learning content is reflected upon by individuals who played the game) is conducted after the SG is finished. However, we expected that this will reduce participants’ feeling of autonomy and thus integrated it into the game (i.e., players received an explanation after each minigame). We hence compared three different groups: Two groups played different versions of the game and one group was attending a presentation about the same learning content, which represented a more conventional

training method. Results indicate that while SG in general do not necessarily lead to increased motivation compared to presentations, they may increase learning outcomes, which is their main purpose. However, simply using any SG may not be enough to achieve this, as results show that it is very important how debriefing is conducted. While our suggestion of integrated debriefing shows clear advantages in terms of motivation and learning compared to a game with debriefing after the experience, this latter setup was even inferior to a conventional presentation. We thus not only show that SG may be helpful to increase BIV capabilities, but also contribute a novel and useful design principle for SG in general: Integrating debriefing into the game.

While game-based learning is one promising approach to improve business reports with appropriate BIV, it is also of interest whether user assistance systems, that support report designers while they perform their task, might be able to achieve this. This is investigated in essay 7, which introduces a user assistance system that automatically detects flawed elements in business reports (e.g., truncated axes that distort perception) and suggests improvements based on established BIV guidelines. The rationale for this system is that users may not be willing to comply with these BIV guidelines as they may perceive it bothersome to check whether their reports are in line with those guidelines (i.e., low ease of use) or that users do not understand the benefit of reports complying with them (i.e., low usefulness). Since a user assistance system makes it both easier to comply with BIV guidelines and provides explanations of the benefits of each specific guideline, we expected this system to increase the intention to comply with BIV guidelines. From a DSR perspective, this essay comprises the rigor and relevance cycles by laying out the need for action and showing the theoretical background of compliance intentions (cf. Figure 2). After developing an artifact in the design cycle, we evaluated it in a first laboratory experiment, where we showed that perceived usefulness and perceived ease of use may be fostered by this system when compared to written guidelines, like they are used in many companies. We also show that both perceived ease of use and perceived usefulness are able to predict the intention to comply with BIV guidelines. To investigate these relationships, we conducted a multiple linear regression analysis, which is used to

explain the relationships between one continuous dependent variable and two or more independent variables (Tabachnick & Fidell, 2013). In contrast to using correlations to identify bivariate associations between variables, multiple linear regression analysis allows to predict dependent variables, thus describing a directional relationship between independent variables and the dependent variable. Although this user assistance system is not an approach directly related to games and game elements, it is concerned with motivating users to engage in specific behavior, which is also the aim of gamification. Hence, it may be investigated how gamification of it fosters BIV compliance in future research.

To see the effects of gamification in higher education in the IS domain, essays 8 and 9 examine large-scale lectures incorporating game elements. The game element used might be called “mission” (i.e., choices along a mandatory path that allow taking into account individual interests). These essays describe an approach where students are able to vote in every lecture which element they wish to be covered in the next lecture with an audience response system. These systems allow students to participate in votes with electronic devices. Depending on the infrastructure of the institution (e.g., wireless LAN), this approach may involve many participants (Lehmann & Söllner, 2014), which makes it applicable in large-scale lectures (100+ students) as well as in smaller lectures. Thus, students perceive influence over the course and that it covers topics they are interested in most, which is supposed to foster motivation and learning. From a methodological viewpoint, these essays might be categorized as quasi-experimental field studies. Questionnaires were used to gather data about students’ experiences, which were later analyzed with several methods. These methods included the analysis of bivariate correlations of constructs, and group comparisons with analysis of covariance (ANCOVA). This method is used to examine the differences in the mean values of the dependent variables that are related to the controlled independent variables (Tabachnick & Fidell, 2013). Since this comparison did not show significant differences between groups, we moved on to structural equation modeling (SEM) to see whether the hypothesized relationships hold true across groups. This method is the combination of

factor analysis and multiple regression analysis, and it is used to analyze the structural relationship between measured variables and latent constructs (Tabachnick & Fidell, 2013). While results may not be interpreted as causal relationships, which may be the case with group comparisons in (quasi-)experiments, this analysis shows whether the hypothesized associations hold true in general, which might be regarded a prerequisite for causal analysis in future research.

Essay 8 describes the results of a preliminary study of this approach with one course of business and information systems engineering students (Grund & Tulis, 2017). As mentioned above, they were provided with choices in each lecture regarding which topics they would like to be covered in the following lecture. The elected elements ranged from choosing between different practical examples to choosing between different software demonstrations. For instance, one week before the lecture about business process modeling took place, students were able to choose between activity diagrams and business process model and notation (BPMN) as additional modeling notations. Although these notations are quite similar regarding how they depict business processes, students may get a feeling to be able to choose between a more universal notation (activity diagram) and a notation specifically designed for business processes (BPMN). This way, certain learning outcomes may be ensured while still providing a sense of influence. After voting, students were shown the distribution of votes between the elected elements. They hence received immediate feedback whether their vote belonged to the majority or not. At the end of the course, students used questionnaires to rate their experience and provide qualitative comments. The results of this preliminary study indicate promising effects on motivational outcomes and show that the approach is received well among students.

In essay 9, results of the main study are described. It features a quasi-experimental evaluation of the approach, where two cohorts attended an identical introductory IS course. However, one cohort was provided with choice and the other one was not. At the beginning of the semester, we gathered students' demographics in a baseline questionnaire. In the 7th lecture, we handed out a questionnaire in both groups to compare their experiences. The reason for this is that the course without choice only comprised

seven lectures due to organizational constraints. In the 13th lecture, we did the same for the group with choice to account for differences over time. With this third measurement, we were able to investigate whether the duration of the treatment had an impact on perceived influence, intrinsic motivation, and learning outcomes. Finally, both groups took an exam with identical questions covering the first seven lectures. The scores of these exams (i.e., test performance) could thus be compared. We were hence able to compare both groups in terms of their perceived influence, motivation and learning outcomes. Results suggest that providing missions in IS lectures might foster motivation and perceived learning, yet apparently has no impact on test scores of students.

In the following, each essay included in this dissertation will be presented in detail. As mentioned earlier, please note that all essays have been slightly modified compared to their published version to facilitate readability. Modifications include a continuous page count, adapted references to other sections, and a central list of references at the end of this dissertation.

2.1 Essay: How Games and Game Elements Facilitate Learning and Motivation: A Literature Review

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Published in:	Lecture Notes in Informatics (LNI) - Proceedings, Volume P-246

2.1.1 Abstract

Games and game elements are increasingly used by organizations to facilitate learning and motivation, often without a clear understanding how they actually achieve these effects. This may lead to the insufficient design and use of serious games as well as gamified applications. Since the development of such applications is usually expensive, high costs and few realized benefits might result. In order to avoid such unfavorable outcomes, it is necessary to understand the underlying mechanisms that lead to learning and motivation. For this purpose, this study reviews research articles describing the use of games and game elements beyond entertainment and outlines their theoretical foundations. Based on the resulting insights, several theory-driven design guidelines for game-based learning and motivation are derived. This study therefore equips researchers with theoretical insights on how games and game elements facilitate learning and motivation, and practitioners with theory-driven design guidelines for their design and evaluation.

2.1.2 Introduction

Games and game elements are increasingly utilized by organizations to facilitate learning and motivation (Liu, Li, & Santhanam, 2013). They are employed for example as “serious games” to create experiential learning environments that fulfill more goals than simply entertaining players (Abt, 1987). Rather, they aim at advancing these players by improving their capabilities or knowledge (van der Zee, Holkenborg, & Robinson, 2012). Another possible use of games and game elements is “gamification” (Deterding et al., 2011). Here, game elements are used in a non-game context in order to achieve motivational effects (Kankanhalli, Taher, Cavusoglu, & Kim, 2012). Beyond that, there are games that solve real-world problems just by being played (von Ahn, Liu, & Blum, 2006). In the game “Peekaboom” for example, players identify objects in pictures and thus enhance a computer vision algorithm (von Ahn et al., 2006).

Despite successful applications already developed, previous research lacks systematic investigations of the mechanisms of gamification (Kankanhalli et al., 2012), or how instructional theories can frame the design of serious games (Charsky, 2010). Without such an understanding, serious games might end up as “drill and practice activities sugar-coated with game characteristics” (Charsky, 2010) and gamification might be perceived as “exploitationware” (Bogost, 2015) instead of intrinsically motivating participants. Since the development of such applications is usually expensive (Borrajo et al., 2010), their insufficient design might result in high costs and few realized benefits. It is therefore necessary to understand how games and game elements lead to learning and motivation, because this understanding helps to frame the design and evaluation of “gameful” experiences for learning and motivation. In contrast to existing theoretical approaches, that focus mostly on motivation theories, this study provides a holistic view on games and game elements, which results in considering both motivation and learning theories.

Hence, this study seeks to provide answers to the following two research questions:

RQ1: How do games and game elements facilitate learning and motivation?

RQ2: How can theory frame the design of game-based learning and motivation?

In order to answer these questions, this study conducts a literature review, as this research method can be used to establish a theoretical foundation for an emerging issue (Webster & Watson, 2002). For this purpose, the theoretical foundations of research articles describing the use of games and game elements beyond entertainment are examined. Based on the resulting insights, this study suggests several theory-driven design guidelines for game-based learning and motivation, thus providing an answer to the second research question.

The remainder of this paper is organized as follows: Section 2.1.3 defines different ways of using games and game elements beyond entertainment. The method and search setup employed are described in section 2.1.4. A review of the theoretical foundation of using games and game elements for learning and motivation is afterwards conducted in section 2.1.5, followed by the resulting design guidelines for game-based learning and motivation in section 2.1.6. The paper closes in section 2.1.7 with a conclusion and possibilities for future research.

2.1.3 Using Games and Game Elements beyond Entertainment

When using games and game elements beyond entertainment, Deterding et al. (2011) propose three basic usage types: Gamification, serious games and games with a purpose. These usage types are described in the following.

Gamification can be defined as using game design elements in non-game contexts (Deterding et al., 2011). Common game elements include points, badges, leaderboards and avatars (Zichermann & Cunningham, 2011). The aim of gamification often lies in motivating a specific behavior of users by implementing different (mostly social) reward structures (Kankanhalli et al., 2012). Considering this intention, gamification is defined in this paper as using game elements in non-game contexts in order to motivate a specific user behavior.

In contrast to using just game elements, serious games employ full-fledged games (Deterding et al., 2011). They are often defined as games that are not limited to the purpose of entertainment (Abt, 1987). Serious games originate from the military, they are hence mostly concerned with acquiring new skills and teaching players educational content (Smith, 2010). In opposition to “educational games” (or “edugames”), this educational content can hardly be separated from the game mechanics, which is why learning takes place while playing the game (Charsky, 2010). Debriefing is also an important activity that fosters reflection on the content when using serious games (Garris et al., 2002). In order to accommodate the different purposes of serious games, they are defined in this paper as games that aim at entertaining players as well as improving their skills or knowledge.

As a last usage type of games and game elements beyond entertainment, “games with a purpose” are defined as games that solve real-world problems just by being played (Deterding et al., 2011). They are being used for example by biologists to predict protein structures with the collective intelligence of players (Cooper et al., 2010).

2.1.4 Method

For conducting a scientifically sound literature review about the theoretical foundation of using games and game elements for learning and motivation, this study employs the review setup suggested by Fettke (2006). This categorization can be used to clarify the characteristics of a review study and is based on several recommendations from literature

(Fettke, 2006). According to this framework, this study presents a review in natural language that focuses on theory, takes a neutral perspective and highlights central aspects on the basis of selective literature (cf. Tab. 1).

Tab. 1: Characterization of this review based on Fettke (2006)

Characteristic		Category			
1. Type		natural language		mathematical-statistical	
2. Focus		research result	research method	theory	experience
3. Aim	Mention	not mentioned		mentioned	
	Content	integration	criticism		central aspects
4. Perspective		neutral		position	
5. Literature	Selection	not explained		explained	
	Scope	key works	representative	selective	exhaustive
6. Structure		chronologically	thematically		methodically
7. Target Audience		common public	practitioners	researchers in general	specialized researchers
8. Future Research		not mentioned		mentioned	

Games are gaining increasing relevance in the Information Systems (IS) domain as so-called “interactive hedonic systems” (Lin & Bhattacharjee, 2010). This review therefore starts with examining publications from this domain. Thus, a manual search of relevant research articles in the AIS Senior Scholars’ Basket of Journals is conducted. Additional sources for the manual search are the journal “Decision Support Systems” (DSS) and a special issue on gamification in “Creativity and Innovation Management” (CAIM). Conference proceedings from the “International Conference on Information Systems” (ICIS) and the annual meeting on informatics in the “Lecture Notes in Informatics” (LNI) are also included in the search. The AIS Senior Scholars’ Basket of Journals is considered since it comprises a widely accepted set of top journals in the field of IS research. The journals DSS and CAIM are selected because of their relevance to business and information systems engineering. Last, the conference proceedings from the ICIS and LNI are considered since they provide current publications from manifold research communities, such as human computer interaction. The investigation period covers the

years 2009 to 2014. Every title as well as (in case of relevant terms) every heading is searched for formulations which indicate that games or game elements are being used beyond entertainment. The result of this manual search consists of 42 relevant publications.

In a next step, journals for a structured literature search are identified by looking up the references of the relevant publications mentioned above for journals that are specialized on the usage of games and game elements. This identification revealed the journals “Simulation & Gaming” (S&G) and “Games and Culture” (G&C). These journals are therefore being used for a structured keyword search considering all publications until 2014. The search terms employed are the usage types of games and game elements beyond entertainment presented by Deterding et al. (2011). Since the term “Serious Gaming” is often used synonymously with “Serious Games”, both search terms are used for serious games. The search terms are depicted in Tab. 2.

Tab. 2: Search terms employed in the keyword search in the journals S&G and G&C

Usage type	Search term(s)
Serious Games	(“Serious” AND “Games”) OR (“Serious” AND “Gaming”)
Gamification	“Gamification”
Games with a purpose	“Games” AND “purpose”

Keyword search in the journals S&G and G&C revealed another 25 relevant publications. Together with the publications already identified by manual search, the literature sample consists of 67 publications. Since Ping, Goh, and Teo (2010) and Goh and Ping (2014) report about the same study, only the more recent publication is considered for the literature sample. Hence, 66 publications remain in the literature sample for this review.

2.1.5 Theoretical Foundation of Using Games and Game Elements for Learning and Motivation

In the literature sample investigated, we can distinguish between theory-based publications and non-theory-based publications. A publication is hereby called theory-based, when it explains how games and game elements facilitate learning and motivation by referring to theories. Only 34 publications can be called theory-based according to this definition. They name 28 different theories, of which 6 are mentioned more than twice. Since this indicates their relevance in the field, these theories are selected and presented in Tab. 3.

Tab. 3: Theories mentioned more than once in the literature sample

Theory	Focus	Number of Mentions
Flow Theory of Motivation	Motivation	17
Self-determination Theory	Motivation	10
Experiential Learning Theory	Learning	6
Goal-setting Theory	Motivation	4
Bloom's Taxonomy	Learning	3
Constructivist Learning Theory	Learning	3

In order to characterize the theoretical foundation of using games and game elements for learning and motivation, these theories as well as the extent to which they are employed in the respective publications are described in the following.

2.1.5.1 Flow Theory of Motivation

Flow theory of motivation is the most cited theory in the literature sample. It describes a so-called “flow state”, in which people forget about their surroundings and lose their sense of time (Csikszentmihalyi, 1991). The state of flow is characterized by intense concentration, merging of action and awareness, loss of reflective self-consciousness, a sense that one can control one’s actions, distortion of temporal experience and experience of an activity as intrinsically rewarding (Nakamura & Csikszentmihalyi, 2002). When

being in flow, an individual operates at full capacity which means they even neglect hunger, fatigue or discomfort in order to continue pursuing an activity (Nakamura & Csikszentmihalyi, 2002). However, in order to experience the flow state, the challenge of the activity has to be in balance with the skills of the individual: Too much challenge causes anxiety, whereas too little challenge leads to boredom (Nakamura & Csikszentmihalyi, 2002). Flow has been described as a part of the gameplay experience in the literature sample (Alklind Taylor, Backlund, & Niklasson, 2012; Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012; Döpker, Brockmann, & Stieglitz, 2013; Haas, Scheiner, Witt, Baccarella, & Leicht, 2013; Kankanhalli et al., 2012; Koops & Hoevenaar, 2013; Liu et al., 2013; Mueller, Hutter, Fueller, & Matzler, 2011; Nadolski, Hummel, Hans G. K., Slootmaker, & van der Vegt, Wim, 2012; Oberdörfer & Latoschik, 2013; Oksanen, 2013; Plennert & Robra-Bissantz, 2014; Romero et al., 2014; Scheiner & Witt, 2013; Wiegand & Stieglitz, 2014; Witt & Robra-Bissantz, 2012; Witt, Scheiner, & Robra-Bissantz, 2011). Bedwell et al. (2012) link various game attributes to learning outcomes. The game attribute “conflict/challenge” can thus lead to a flow state, if the degree of challenge automatically adapts to the skill level of the player. Kankanhalli et al. (2012) reference Chen (2007) who states that flow is important for a game experience. The challenge of a game therefore has to match the player’s skills (Kankanhalli et al., 2012). Koops and Hoevenaar (2013) note that serious games are likely to trigger a flow state. However, they argue that flow might even distract the player from learning, since deeper reflection on the content of the game does not take place while being in flow (Koops & Hoevenaar, 2013). Liu et al. (2013) agree that challenge has to match the player’s skills. However, since their publication focuses on competition in games, they define the challenge of a game as the opposing player’s skills. Hence, they conclude that both players’ skill levels have to match in order to enter the flow state (Liu et al., 2013). Mueller et al. (2011) examine the use of virtual worlds as knowledge management platforms. In their study, they found that users of virtual worlds reported a flow-like state (Mueller et al., 2011). They hence propose that because of the game-like characteristics of a virtual world, a flow state is achieved which in turn leads to important knowledge-

related activities (Mueller et al., 2011). Nadolski et al. (2012) investigate architectures for multiuser learning scenarios and declare flow as the optimal learning state. They conclude that it is important for these architectures to ensure a flow state e.g. by logging player data in order to inform design (Nadolski et al., 2012). Oksanen (2013) refers to flow as one of the seven core game experiences during gameplay and agrees that challenge has to match the player's skills in order to enter the flow state. The remaining publications also mention flow as a part of the gameplay experience and important for player motivation (Alklind Taylor et al., 2012; Döpker et al., 2013; Haas et al., 2013; Oberdörfer & Latoschik, 2013; Plennert & Robra-Bissantz, 2014; Romero et al., 2014; Scheiner & Witt, 2013; Wiegand & Stieglitz, 2014; Witt & Robra-Bissantz, 2012; Witt et al., 2011). In summary, flow can be seen as a core experience of gameplay and is achieved by the challenge of a game corresponding to the player's individual skills.

2.1.5.2 Self-determination Theory

The main aspects of self-determination theory are motivation and personality, thus it can be called a motivation theory (Ryan & Deci, 2000). Different psychological needs are a central construct of this theory (Ryan & Deci, 2000). Every human thus has the need for competence, relatedness and autonomy. Fulfilling these needs leads to motivation, whereas neglecting them results in discouragement (Ryan & Deci, 2000). In the literature sample, publications mention self-determination theory to describe motivational effects of gamified applications (Kankanhalli et al., 2012; Li, Huang, & Cavusoglu, 2012; Liu et al., 2013; Mutter & Kundisch, 2014; Scheiner, 2015; Scheiner & Witt, 2013; Teh, Schuff, Johnson, & Geddes, 2013; Wiegand & Stieglitz, 2014; Witt & Robra-Bissantz, 2012; Witt et al., 2011). However, self-determination theory is not a crucial element in most of these publications; it is rather mentioned among others in their literature overviews. Only Kankanhalli et al. (2012) and Liu et al. (2013) link the psychological needs of self-determination theory with digital video games by referencing Ryan et al. (2006). Following this argumentation, autonomy is achieved in games by letting players choose

sequences of actions (Ryan et al., 2006). Perceived competence is enhanced by tasks within the game that provide optimal challenges, and a feeling of relatedness can be achieved for example in multiplayer games, where players interact with each other (Ryan et al., 2006). Taking a look at competitive elements, Liu et al. (2013) note that competition can have both positive and negative impacts on the enjoyment of the gameful experience: External incentives might for example undermine the feeling of autonomy, since the player is pushed into a certain direction. However, they also claim that competition can satisfy the player's need for competence (Liu et al., 2013). Mutter and Kundisch (2014) agree that external rewards like badges can lower the player's perceived autonomy. While this may lead to an increase in the quantity of player contribution, the contribution quality might suffer (Mutter & Kundisch, 2014). To sum it up, self-determination theory can be linked to video games in general, and also describes how intrinsic motivation in gamified applications can be achieved (Scheiner, 2015; Scheiner & Witt, 2013; Wiegand & Stieglitz, 2014; Witt & Robra-Bissantz, 2012; Witt et al., 2011).

2.1.5.3 Experiential Learning Theory

Experiential learning theory underlines the influence of experience on learning success (Kolb, 1984) and can hence be called a learning theory. A central construct of this theory is the so-called learning cycle which is composed of concrete experience, reflective observation, abstract conceptualization and active experimentation (Kolb, 1984). These stages are attached to corresponding activities (i.e., feeling, watching, thinking, doing) which result in different learning styles (i.e., diverging, assimilating, converging, and accommodating) (Kolb, 1984). Diverging refers to individuals who prefer feeling and watching (e.g., looking at concrete situations from several different viewpoints), assimilating embraces watching and thinking (e.g., thinking through logical explanations for observed phenomena), converging covers doing and thinking (e.g., applying theoretical knowledge to practical applications), and accommodating incorporates doing and feeling (e.g., trying things out rather than thinking them through) (Kolb, 1984).

Taking into account these learning styles might lead to more effective learning (Kolb, 1984). The publications in the literature sample argue that experiential learning is supported by interactivity in games (Alklind Taylor et al., 2012; Bedwell et al., 2012; Koops & Hoevenaar, 2013; Legner, Estier, Avdiji, & Boillat, 2013; Monk & Lycett, 2011; Nadolski et al., 2012). In contrast to other approaches in the sample, Koops and Hoevenaar (2013) directly incorporate elements from experiential learning theory as a part of their “Serious Gaming Lemniscate Model” which consists of a learning cycle and a gaming cycle. Hereby, they provide a link between flow theory of motivation and experiential learning theory: While the gaming cycle corresponds to an experience similar to flow, the learning cycle is consistent with the learning cycle in experiential learning theory. The authors argue that by manipulating a game’s difficulty, a transition between the gaming cycle (i.e., the flow state) and the learning cycle takes place (Koops & Hoevenaar, 2013). Hence, their model provides a first link between learning and motivation theories in the literature sample (Koops & Hoevenaar, 2013). Monk and Lycett (2011) describe a modified (which means strongly simplified) version of experiential learning theory by using a learning cycle that consists only of act, reflect and understand. Alklind Taylor et al. (2012) further simplify experiential learning theory by only stating that practical experience has to precede theoretical discussion of educational content. Nadolski et al. (2012) cite Kebritchi and Hirumi (2008) who link the pedagogical foundations of learning games with experiential learning. Ben-Zvi (2010) and Legner et al. (2013) call games a form of experiential learning without further justification. We summarize that experiential learning can take place in serious games, as long as they provide possibilities to go through the stages of the learning cycle.

2.1.5.4 Goal-setting Theory

Goal-setting theory describes how goals influence motivation and task performance of individuals. Locke and Latham (2002) draw on 35 years of empirical research on goal-setting theory, pointing out goal mechanisms and moderators of goal effects. The four

goal mechanisms described consist of a directive function (goals direct attention toward goal-related activities and away from goal-irrelevant activities), an energizing function (high goals lead to greater effort than low goals), goals affecting persistence (hard goals prolong effort) and goals affecting action indirectly (goals lead to the arousal, discovery, and/or use of task-relevant knowledge and strategies). Especially the last mechanism hints at goals also leading to learning outcomes. One of the most important moderators of goal effects is goal commitment (Locke & Latham, 2002). High goal commitment leads to a strong goal-performance relationship. The more difficult the goal, the more commitment is needed. Goal commitment is supported by the perceived importance of the goal. This perceived importance can be raised e.g. by individuals making a public commitment to the goal or letting them choose their own goals. Self-efficacy is also important for goal commitment, especially when it comes to difficult goals. It can be raised by providing success experiences, finding role-models to identify with, and persuasive communication that the individual can reach the goal (e.g., by providing solution strategies). The remaining moderators of goal effects are feedback (revealing progress in relation to the goals), task complexity (high complexity of the goal requires the ability to discover appropriate task strategies), personal goals as mediators of external incentives (i.e., taking into account personal goals and self-efficacy of a person when assigning goals), and satisfaction (achieving goals leads to satisfaction). In the literature sample, goal-setting theory is used to describe why players want to achieve certain accomplishments in gamified applications (Haas et al., 2013; Mutter & Kundisch, 2014; Oppong-Tawiah, Webster, Staples, Cameron, & Guinea, 2014; Scheiner & Witt, 2013). Mutter and Kundisch (2014) investigate a gamified Q&A-community and argue that goal-setting theory applies to badges in gamified applications, since badges can resemble a valuable goal to players, mostly because of their function as status symbols. Oppong-Tawiah et al. (2014) propose that using specific, difficult and obtainable goals has a strong effect in persuasive gamified applications that foster pro-environmental behavior.

Haas et al. (2013) and Scheiner and Witt (2013) do not refer directly to goal-setting theory, but to self-efficacy, which is part of goal-setting theory. These publications therefore provide a theory-based explanation how goals in gamified applications lead to player motivation and performance.

2.1.5.5 Bloom's Taxonomy

Bloom's taxonomy describes several consecutive steps of the cognitive process that consist of remembering, understanding, applying, analyzing, evaluating and creating (Anderson & Krathwohl, 2001). The publications in the literature sample use Bloom's taxonomy to describe the learning outcomes of serious games (Ben-Zvi, 2010; Legner et al., 2013; Monk & Lycett, 2011). Ben-Zvi (2010) proposes Bloom's taxonomy as an assessment framework for the outcomes of experiential learning. Monk and Lycett (2011) suggest using serious games as a way of testing knowledge in higher education by aiming at the higher levels of Bloom's taxonomy (e.g., analyzing and evaluating). Last, Legner et al. (2013) link the learning outcomes of business simulation games with Bloom's taxonomy. In summary, Bloom's taxonomy is used to define and to assess the learning outcomes in serious games.

2.1.5.6 Constructivist Learning Theory

Constructivist learning theory is rather a philosophical view of comprehension and knowledge in general (Savery & Duffy, 1995). A central construct of this theory is the view that knowledge does not exist on its own but is constructed in each individual's mind (Savery & Duffy, 1995). Several so-called constructivist learning methods stem from this theory (Savery & Duffy, 1995). The publications in the literature sample mention these constructivist learning methods in combination with serious games (Charsky, 2010; Nadolski et al., 2008; Thomas, 2006). Charsky (2010) claims that more and more experts call for constructivist learning methods. Some of these learning methods can thus be fulfilled by serious games. A scientific evaluation of this claim, however, has

still to be executed (Charsky, 2010). Thomas (2006) mentions constructivist learning as one of the concepts on which their so-called “pervasive learning” is based. Nadolski et al. (2008) report a high demand for constructivist learning methods. They justify the link between serious games and constructivist learning methods only by educational experts’ opinions that serious games can meet this demand. The literature sample does therefore not contain any publication that rigorously links serious games with constructivist learning methods or that references such a publication.

2.1.5.7 Summary and Discussion

The literature review disclosed 6 relevant theories used to explain how games and game elements facilitate learning and motivation. It also showed to which extent they are incorporated in the literature sample, reaching from “mentioned in the literature overview” to “substantial part of the publication”. For most of the theories, a sufficient link to games and game elements is provided. As mentioned above, this is not the case for constructivist learning theory. One possible explanation for this is the broad scope of this theory, being rather a philosophical view of understanding and knowledge in general. Although basically being a promising possibility for future theorizing, this theory is taken out of consideration in this paper. The remaining learning theories (i.e., experiential learning theory and Bloom’s taxonomy) show the different stages of the learning cycle (i.e., concrete experience, reflective observation, abstract conceptualization, and active experimentation) and provide a framework for categorizing and assessing the desired learning outcomes (i.e., remembering, understanding, applying, analyzing, evaluating, and creating). The motivation theories (i.e., flow theory of motivation, self-determination theory, and goal-setting theory) show that player motivation depends on the challenge of a gameful experience corresponding to the player’s skills, the player perceiving competence, autonomy, and relatedness, as well as the player trying to reach several goals.

2.1.6 Theory-driven Guidelines for Game-based Learning and Motivation

In the following, 10 design guidelines for game-based learning and motivation are derived from the theoretical insights provided by the literature review. They result from checking every theory presented in section 2.1.5 for ways to enable learning and motivation. A short listing of the suggested design guidelines is presented in Tab. 4.

Tab. 4: Theory-driven design guidelines for game-based learning and motivation

Design Guideline	Theoretical Foundation
Balance challenge and skill	Flow Theory
Enable perceived competence, autonomy, and relatedness	Self-determination Theory
Employ all stages of the learning cycle	Exp. Learning Theory
Consider different learning styles	Exp. Learning Theory
Set specific, difficult, and obtainable goals	Goal-setting Theory
Enable perceived goal importance	Goal-setting Theory
Enable goal-related self-efficacy	Goal-setting Theory
Constantly show progress in relation to goals	Goal-setting Theory
Remind of accomplished goals	Goal-setting Theory
Categorize and assess specific learning outcomes	Bloom's Taxonomy

The first design guideline is called “balance challenge and skill” and corresponds to flow theory of motivation. Thus, the challenge of a game has to match the player’s skills in order to enter the flow state (see section 2.1.5) (Nakamura & Csikszentmihalyi, 2002). This can for example be achieved by automatically adapting the level of difficulty in a game (Bedwell et al., 2012) or by matching players with equal skill levels in a competitive setting (Liu et al., 2013). Players might also be given the possibility to choose a difficulty level by themselves, which may in addition lead to higher goal commitment (cf. goal-setting theory).

For example, a player that chooses a “hard” difficulty setting might feel more obliged to beat the game, than when given no choice. Being able to choose an “easy” difficulty setting may on the other hand help players with low self-efficacy to gain confidence about being able to beat the game.

As described in section 2.1.5, games can foster self-determination and intrinsic motivation by providing the feeling of competence, autonomy, and relatedness (Ryan et al., 2006). It is therefore important for the design of such gameful experiences to promote these feelings, which is expressed by the design guideline “enable perceived competence, autonomy, and relatedness”. Autonomy is achieved in games by letting players choose sequences of actions (Ryan et al., 2006). Perceived competence is enhanced by tasks within the game that provide optimal challenges and a feeling of relatedness can be achieved for example in multiplayer games, where interactions between players can take place (Ryan et al., 2006).

Experiential learning theory supports two design guidelines. The design guideline “employ all stages of the learning cycle” suggests that a gameful experience should encompass every learning activity (i.e., concrete experience, reflective observation, abstract conceptualization, and active experimentation) in order for players to go through the entire learning cycle (cf. section 2.1.5). This can be achieved in games by incorporating different gameplay mechanics (e.g., providing a notepad) and addressing these activities in debriefing. Taking into account different learning styles, for example by offering separate game modes for assimilating (thinking-oriented) or accommodating (action-oriented) learning styles, is addressed by the design guideline “consider different learning styles”.

Goal-setting theory supports several design guidelines. The first one is to “set specific, difficult, and obtainable goals”, since it has been shown that setting a specific and difficult goal leads to higher performance than simply urging players to do their best (Locke & Latham, 2002). These specific goals can for example be badges or quests in gameful experiences. As perceived goal importance leads to higher goal commitment, an additional guideline is to “enable perceived goal importance”. This can be done by letting

players make public commitments to their goals (e.g., by showing their goals to other players) or letting them choose their own goals. Another guideline is to “enable goal-related self-efficacy”, since this also leads to higher goal commitment. Self-efficacy can be raised by providing success experiences (e.g., easier goals for beginners), presenting role-models (e.g., players close in a leaderboard or a coaching system with experienced players), and persuading players that they are able to reach a goal (e.g., by providing hints). According to goal-setting theory, it is also important to “constantly show progress in relation to goals”, e.g. by providing progress bars or quest logs. Since accomplishing goals leads to satisfaction, another idea is to “remind of accomplished goals” to raise player satisfaction.

To help clearly point out the desired learning outcomes of gameful experiences, Bloom’s Taxonomy can be utilized. Before the development of an application/game, the desired learning outcomes may be mapped to the different steps of the cognitive process. This is due to the fact that learning outcomes like “remembering” might need different game mechanics than for example developing the ability to “evaluate”. When assessing the learning outcomes after a gaming session, this categorization can be used again to see if the players actually acquired the respective capabilities (Ben-Zvi, 2010). This design guideline is referred to as “categorize and assess specific learning outcomes”.

In summary, designers of game-based learning and motivation should pay attention to the underlying mechanisms that lead to learning and motivation in order to develop successful applications. It is important to note, however, that these design guidelines are not meant to be mandatory, hence not every design guideline has to be fully executed in every application for game-based learning and motivation.

2.1.7 Conclusion and Future Research

This study provides a basic understanding of how games and game elements facilitate learning and motivation. It also presents 10 theory-driven design guidelines for game-based learning and motivation. In contrast to existing approaches, it examines both motivation and learning theories. Since this study is a first step towards identifying the theoretical foundation of using games and game elements for learning and motivation, a limitation of these results is the restriction of the search space. It is in the nature of this research method, that one single literature review can impossibly cover all relevant publications that exist on the topic. However, this does not affect the usefulness of this paper, since it only means that future works can add to the theoretical foundation identified by this review. Future research may also focus on developing a specific theory for serious games or gamification e.g. by combining the presented learning and motivation theories. In addition, the suggested design guidelines can be empirically evaluated, e.g. by examining if existing games are violating these guidelines and how this affects the intended outcomes. After this evaluation, the presented design guidelines can be used in future research to develop scientifically sound serious games and gamified applications.

2.2 Essay: Towards Game-based Management Decision Support: Using Serious Games to Improve the Decision Process

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Published in:	Proceedings of the Multikonferenz Wirtschaftsinformatik 2016

2.2.1 Abstract

The domain of business intelligence and analytics has seen major contributions concerning the analysis of data, the design of data warehousing infrastructures as well as decision support systems that in essence all share a common goal: Supporting decision-making in organizations. However, surprisingly few publications originating from an information systems perspective deal with decision-makers themselves, leaving a great opportunity for the field to focus on. This study therefore proposes to improve the skills necessary in the decision process by using serious games as a form of experiential learning. For this purpose, we perform a systematic literature review that shows which skills needed in the decision process are already addressed by publications that deal with serious games. This study therefore provides business intelligence researchers with a novel perspective on decision support and shows which specific skills need further investigation. Decision-making practitioners and management education programs might also benefit from this study, because it highlights several serious games that may be used or adapted in order to train decision-making deliberately.

2.2.2 Introduction

Can we become better decision-makers by playing video games? At first, this question might seem controversial, even provocative. This is because video games are rather associated with leisure time than with managerial decision-making. However, games are used in many disciplines to convey knowledge and increase the capabilities of players, which is commonly referred to as “serious games” (Legner et al., 2013).

The domain of business intelligence (BI) and analytics has seen major contributions concerning the analysis of data, the design of decision support systems as well as data warehousing infrastructures that in essence all share a common goal: Supporting decision-making in organizations (Chen, Chiang, & Storey, 2012). However, surprisingly few publications deal with the skills of decision-makers (Debortoli, Müller, & Vom Brocke, 2014), leaving a great opportunity for the field to focus on.

With a vast amount of data available, increasingly dynamic environments, and complex processes (Baars et al., 2014), managerial decision-making has become more challenging than ever. Hence, besides more advanced BI software, the individual skills of decision-makers are getting crucial for success. These skills can be improved by target-oriented learning to help decision-makers cope with the challenges of their environment.

We thus argue that learning and the individual skills of decision-makers should be considered an important topic in the domain of BI and analytics. In addition, we propose the use of serious games as a form of experiential learning, which is often regarded as an effective means to increase knowledge and skills (Liu et al., 2013).

Due to an increasing number of publications concerning gamification, serious games as well as related topics (Blohm & Leimeister, 2013; Liu et al., 2013), there is a need to survey and synthesize prior research. In general, scientific work becomes more and more complex as there is a need to invest more time for investigating literature. Failing this causes a danger to waste valuable resources because of performing the same investigations several times as well as a danger of neglecting crucial facts. Moreover, analyzing patterns in existing literature may reveal new beneficial research questions (Webster & Watson, 2002).

Given the motivation for more people-centric decision support as well as the just described methodological issues, the core of this study is a systematic literature review that addresses the following two research questions:

1. Which skills required in the decision process are often addressed by serious games?
2. Which skills required in the decision process are rarely addressed by serious games and thus reveal a need for further research?

In detail, the literature review indicates which skills needed in the decision process are addressed by publications that deal with serious games. For this purpose, we first outline the theoretical background of this investigation in section 2.2.3. The method of this literature review is explained in section 2.2.4. In section 2.2.5, the results of the review are described. The study concludes with a discussion of results, a conclusion as well as an outlook on future research in section 2.2.6.

2.2.3 Theoretical Background

2.2.3.1 Skills Required for Managerial Decision-making

To identify the skills that are necessary for managerial decision-making, we investigate the underlying decision process. A generic decision process for organizations, that is composed of several decision phases, has initially been proposed by Simon (1965) and was extended by Mora et al. (2003). It consists of five consecutive phases: Intelligence, design, choice, implementation and learning (Mora et al., 2003, p. 63). These decision phases can further be divided into several decision steps (see Table 1).

Table 1: The generic decision process presented by Mora et al. (2003)

Decision Phase	Decision Step
Intelligence	Data Gathering
	Problem Recognition
Design	Model Formulation
	Model Analysis
Choice	Evaluation
	Selection
Implementation	Presentation of Results
	Task Planning
	Task Tracking
Learning	Outcome-Process Link Analysis
	Outcome-Process Link Synthesis

During the intelligence phase, decision makers observe reality, gather information and therefore gain an understanding of the problems and possibilities at hand (Mora et al., 2003, pp. 59–60). In the design phase, they construct a decision model which consists of possible actions, decision criteria, uncontrollable events and relationships between these variables. This decision model serves as a basis for the choice phase, in which decision makers evaluate possible alternatives and hence generate recommended actions. In the implementation phase, decision makers weigh possible consequences and gain

confidence about their decision, plan the tasks needed to realize the decision and execute this plan. In order to improve their decision behavior as well as assessing decision situations, decision makers observe the outcomes of the decision and connect it to their decision behavior in the learning phase.

In this study, we assume that each of the decision steps described above requires one specific skill. Hence, the skills required for managerial decision-making are equivalent to the decision steps mentioned above (e.g., the skill of data gathering or the skill of model formulation).

2.2.3.2 Serious Games and Business Games

Serious games are gaining increasing attention in the domain of business and information systems engineering due to the rising popularity of gamification (Blohm & Leimeister, 2013). Since these two types of using games and game elements for serious purposes are often not clearly differentiated in business practice (Bogost, 2015), they are briefly delineated in the following.

Gamification can be defined as using game design elements (like points, badges and leaderboards) in non-game contexts (Deterding et al., 2011). In contrast to using just game elements, serious games employ full-fledged games (Deterding et al., 2011) that often draw on learning and motivation theories (Grund, 2015). They are commonly defined as games which are not limited to the purpose of entertainment but also focus on improving skills and teaching players educational content (Abt, 1987). In order to accommodate the different purposes of serious games, they are defined in this study as games that seek to entertain players as well as to improve their skills or knowledge. Business games are a specific type of serious game that aims to increase skills and knowledge in the business domain, commonly by simulating whole companies and letting players compete in a virtual marketplace (Faria et al., 2009).

2.2.4 Method

This literature review aims to clarify which of the capabilities required in the decision process of managers are commonly addressed by serious games. In accordance with Webster and Watson (2002), we will first introduce our search strategy in this section, followed by a structured concept matrix for analyzing our results in section 2.2.5. With regard to the taxonomy of literature reviews presented by Cooper (1988), this study aims to identify central issues from a neutral perspective, based on research outcomes in representative publications. It is arranged conceptually and targets general as well as specialized scholars in the domain of BI and analytics.

Since serious games are comprised of technology (i.e., software) and desired learning outcomes, this review draws selectively from multiple research areas, focusing on leading journals and conferences. To cover the technology-related aspects of serious games, the Information Systems (IS) domain is considered. The domain of management learning is included to see to what extent serious games are already used for managerial education. Last, the domain of serious games itself is incorporated because it examines the intersection between the technology used and the desired learning outcomes. In the following, we will describe the selection of outlets from these domains as well as the different search types that result from the domains' focus.

To consider the IS domain, a manual investigation of relevant research articles in the AIS Senior Scholars' Basket of Journals which consists of the "European Journal of Information Systems" (EJIS), the "Information Systems Journal" (ISJ), "Information Systems Research" (ISR), the "Journal of the Association for Information Systems" (JAIS), the "Journal of Information Technology" (JIT), the "Journal of Management Information Systems" (JMIS), the "Journal of Strategic Information Systems" (JSIS), and "Management Information Systems Quarterly" (MISQ) was conducted. Additional sources from the IS domain are the journal "Decision Support Systems" (DSS) and the "International Conference on Information Systems" (ICIS). The AIS Senior Scholars' Basket of Journals was considered since it comprises a widely accepted set of top journals

in the field of IS research. The journal DSS was selected because of its relation to decision making and decision support, which is the focus of this study. Last, the ICIS was considered since it provides current publications from manifold research communities, such as human computer interaction. In this manual search, every publication title as well as (in case of relevant terms) every heading is searched for formulations that indicate the use of serious games.

Since this literature review also aims to address the field of management learning, the journals “Management Learning” (ML) and the “Journal of Management Education” (JME) are additionally investigated. As these journals focus more on education than on technology, we want to identify any publication that suggests the use of games for management education. Hence, the abstracts of these publications are searched for the term “Gam*”, which includes terms from “gaming” to “game-based learning”.

To account for the specific domain of this literature review (i.e., serious games), the journals “Simulation and Gaming” (S&G) as well as the “International Journal of Serious Games” (IJSG) were added to the search space. Since these journals explicitly focus on using serious games and business games, a more narrow type of search was employed. Thus, these journals were used for a keyword search with the terms “Serious Games” and “Business Games”. In order to emphasize recent findings, the investigation period for all searches covers the years 2009 to 2014. An overview of the search setup is provided by Table 2.

Table 2: Search space and sample size of this literature review

Source		Search Type (Period: 2009 – 2014)	# Results	# Articles
Information Systems	AIS Basket	Manual search	1	1
	DSS		5	5
	ICIS		3	3
Management Learning	ML	(Gam*)	0	0
	JME	IN Abstract	7	3
Serious Games	S&G	(“Serious Games” OR “Business Games”)	24	21
	IJSG	IN Keywords	19	16
Total			59	49

As Table 2 shows, the structured search initially yielded 59 results in total. However, 6 publications from the IJSG as well as from S&G have been removed since these are no original articles, and 4 publications from the JME have been removed because these articles do not refer to using games for management education. After these publications have been removed, 49 articles remain in the literature sample for this review, which is analyzed in the following section.

2.2.5 How Serious Games Improve the Decision Process

The results of examining the literature sample for relevant skills in the decision process are depicted in Table 3. A regular entry (i.e., “X”) means that the specific skill is mentioned by the authors, either as a learning goal or as an observed learning outcome. Bracketed entries (i.e., “(X)”) refer to activities players had to fulfill that resemble the decision steps. While these activities might lead to improvements in the respective decision steps, this is not as nonambiguous as opposed to concrete learning goals. Publications that neither aim at improving particular skills nor do mention activities that might lead to their acquisition are removed from the literature sample. In the following sections, we will describe entries in Table 3 grouped by the phases of the decision process.

Table 3: Skills in the decision process mentioned by the publications

Publication	Skills Required in the Decision Process										
	Intelligence		Design		Choice		Implementation			Learning	
	Data Gathering	Problem Recognition	Model Formulation	Model Analysis	Evaluation	Selection	Presentation of Results	Task Planning	Task Tracking	Outcome-Process Link Analysis	Outcome-Process Link Synthesis
Alklind Taylor et al. (2012)	(X)									X	X
Basole, Bodner, and Rouse (2013)	X	(X)				(X)					
Ben-Zvi (2010)	(X)	(X)				(X)	(X)			(X)	
Borrajó et al. (2010)						(X)				X	X
Chorianopoulos and Giannakos (2014)										X	
De Gloria, Bellotti, Berta, and Lavagnino (2014)	X				(X)	(X)		(X)		(X)	
Douma, van Hillegersberg, and Schuur (2012)		X				(X)				(X)	
Enfield, Myers, Lara, and Frick (2012)	(X)	(X)			(X)	(X)	(X)				
Harteveld et al. (2010)	X	X					X				
Imbellone, Botte, and Medaglia (2015)	X	X	X		X	X	X	X	X	X	
Karriker and Aaron (2014)	X					(X)					
Katsaliaki and Mustafee (2014)		X				(X)					
Krom (2012)		X				X					
Lainema (2010)	(X)				(X)						
Legner et al. (2013)		(X)				(X)	(X)			X	X
Lewis and Grosser (2012)							X	X	X		
Lopes, Fialho, Cunha, and Niveiros (2013)							(X)	(X)		X	X
Mayer (2009)		X	(X)		(X)					(X)	
Monk and Lycett (2011)						(X)					
Oksanen and Hämäläinen (2014)						(X)					
Pannese and Morosini (2014)	(X)					(X)		(X)		X	X
Procci, Lakhmani, Hussain, and Bowers (2014)										X	X
Smith (2010)								(X)			
van der Zee et al. (2012)	X				(X)	(X)				X	

2.2.5.1 Intelligence Phase

Publications in the literature sample often include the intelligence phase. However, only 5 publications mention both data gathering and problem recognition. In a training simulation game for levee inspectors presented by Harteveld et al. (2010), data gathering and problem recognition are essential. The player gathers data by measuring symptoms of a levee failure and has to recognize failures, which equals problem recognition. Imbellone et al. (2015) investigate 30 different serious games that each are built to address one specific skill needed in non-routine tasks. Since they also empirically survey the skills that are needed in these situations, this publication directly addresses most skills of the decision process. They describe the skill “initiative”, which includes actively seeking new information (i.e., data gathering) and the skill “openness to change”, which includes realizing the need for change (i.e., problem recognition). By introducing the serious game “Health Advisor”, Basole et al. (2013) provide an approach for letting players experience difficult health-related tradeoffs. Players can access different information resources, which in an empirical evaluation they came to understand and learned how to use best (i.e., data gathering). In addition, players had to assess and monitor healthcare needs of virtual clients, hence problem recognition was also addressed. Ben-Zvi (2010) investigates the efficacy of business games in creating decision support systems. Students have to build a decision support system in a simulated business environment to see how their company performs. They gather data and recognize problems because they analyze the company’s history as well as different management situations. A serious game concerning the diffusion of innovations theory is presented by Enfield et al. (2012). The player has to persuade the staff of a junior high school to adapt peer tutoring. In so doing, they have to look at the personal information of staff members (data gathering) to identify what adopter type the staff members are (problem recognition).

The literature sample contains 6 publications that focus exclusively on data gathering. De Gloria et al. (2014) aim to present the state of the art of serious games for education and training, referencing a study that demonstrated an increased focus on information gathering activities by high-achieving players. Karriker and Aaron (2014) investigate two business games and enforce data gathering by encouraging their students to use different strategic maps in a so-called “Competitive Intelligence” tool. A conceptual modeling framework that supports the creation of simulation-based serious games is presented by van der Zee et al. (2012). They claim that using games may enhance students’ ability to formulate good questions, which is required for data gathering. Alklind Taylor et al. (2012) introduce the coaching cycle in serious games and mention an example of a crime scene investigation, where players have to gather information that the instructor has placed beforehand. Lainema (2010) discusses the role of time in business games, suggesting that players have the task to identify relevant information. Pannese and Morosini (2014) discuss two serious games for training in the health sector, declaring the exploration of situations in order to gain better knowledge (i.e., data gathering) as one of the cores of the games.

The remaining 5 publications concerning the intelligence phase cover only problem recognition. Douma et al. (2012) present a barge handling algorithm to staff at a port by using a simulation game. One of their aims is to enhance a comprehensive understanding of a complex system, which can be interpreted as problem recognition. Katsaliaki and Mustafee (2014) perform a literature review about serious games for teaching sustainable development and hereby cite publications claiming that games lead to increased problem recognition. Krom (2012) uses the social game “FarmVille” to complement an accounting course. They argue that the resulting active learning contributes to comprehension and retention of complex material, which can be seen as problem recognition. Mayer (2009) provides a review of using simulation games in public policy making. He addresses problem recognition by referring to the simulation games “Fish Banks” and “Harvest” that familiarize players with the complexity and urgency of ecological problems.

Legner et al. (2013) propose using business games that are based on enterprise resource planning systems and develop a corresponding curriculum for management education. Players may practice problem recognition by analyzing transactional data from standard reports and BI applications.

2.2.5.2 Design Phase

The design phase is rarely addressed by the publications in the literature sample. Only 2 publications mention the design phase, while solely focusing on model formulation. Imbellone et al. (2015) list the skill of “strategic thinking” which involves identifying opportunities that can increase the organization’s competitiveness. Mayer (2009) mentions the model formulation step as a part of using simulation games for public policy making. He suggests that policy makers should gain an understanding of their decision alternatives as well as the possible states of nature by trying out different solutions in a simulated environment. In this environment, several real persons also take part, since computer simulations often cannot simulate human behavior.

2.2.5.3 Choice Phase

The choice phase is mentioned by many publications in the literature sample, with 4 publications addressing both evaluation and selection. As one of few publications, Imbellone et al. (2015) directly refer to the skills required in the choice phase. They describe the skill “decision making” that includes evaluation of consequences and risks (i.e., evaluation) as well as making good decisions in complex situations (i.e., selection). De Gloria et al. (2014) show that both evaluation and selection are covered by serious games, describing an example from the health sector in which players integrate evidence into decision making (i.e., evaluation) and ultimately take decisions (i.e., selection).

Enfield et al. (2012) address both evaluation and selection in their diffusion simulation game, since players have to first identify and then select efficient diffusion activities. According to van der Zee et al. (2012), players have to make balanced and founded pricing decisions.

The evaluation step is described by 2 publications. Lainema (2010) mentions that players have to identify correct solutions in simulation gaming and Mayer (2009) shows that in political exercises, scenario-based free form games force players to evaluate strategic alternatives in terms of the values at stake.

Last, 11 publications refer to the selection step. Krom (2012) claims that players learn how to allocate costs among products or departments. The remaining publications simply state that players have to make decisions, for example by choosing their next steps (Basole et al., 2013; Ben-Zvi, 2010; Borrajo et al., 2010; Douma et al., 2012; Karriker & Aaron, 2014; Katsaliaki & Mustafee, 2014; Legner et al., 2013; Monk & Lycett, 2011; Oksanen & Hämäläinen, 2014; Pannese & Morosini, 2014).

2.2.5.4 Implementation Phase

Only 10 publications in the literature sample directly address the implementation phase. In addition, only 2 concern all steps of this phase. Imbellone et al. (2015) include the presentation of results in the skill “decision making” (i.e., presenting logical, reasoned, constructive critical comments and arguments). Task planning and task tracking are summarized in the skill “planning”, that includes defining priorities and anticipating progress of actions and resources required. The serious game “Change Game” focuses on difficulties that arise from resistance to change (Lewis & Grosser, 2012). In this classroom game, students are randomly divided into two groups: Managers and workers. The managers’ task is to deploy a new seating order that would result in workers having to change their seats. The workers, however, are incentivized not to do so. Hence, players learn about the importance for communication when leading change and improve their skills in planning and coordination.

Lopes et al. (2013) cover two decision steps as they provide an overview of business games that enhance leadership skills. By briefly describing the interactivity in the selected games, they reveal that in the game LEADER, players have to present the justifications for their decisions and in the game VIRTUAL LEADER, they have to prioritize tasks or define the activities to be performed.

There are 4 publications in the literature sample that only cover the presentation of results. In the training game for levee patrollers presented by Harteveld et al. (2010), presentation of results is important because the correct reporting of failures is vital for the control procedure. Ben-Zvi (2010) describes that students had to present their results in an oral presentation as well as with a written report. In the diffusion simulation game, players can choose between different presentation-related activities, for example giving presentations or using mass media to convince other people about an innovation (Enfield et al., 2012). Legner et al. (2013) asked players to provide justifications for their decisions and present their synthesis to the other teams.

Task planning is emphasized by 3 publications. In the healthcare setting presented by De Gloria et al. (2014), players have to plan changes to cancer-screening delivery. Pannese and Morosini (2014) also describe exploring what to do, in what order and why as one of the cores of the two healthcare games they discuss. In his overview of the history of gaming in military training, Smith (2010) shows that games have been used to plan invasions or attacks.

2.2.5.5 Learning Phase

The learning phase is mentioned by 13 publications, while 6 publications address both steps in this phase. Alklind Taylor et al. (2012) describe debriefing as essential for allowing players to reflect upon and generalize from experience. Borrajo et al. (2010) list analyzing the “cause-effect” relationship of decisions (i.e., consequences of actions taken) as a learning objective. Legner et al. (2013) claim that players can understand the market dynamics and compare themselves to their competitors. Lopes et al. (2013)

specifically address the skill of focusing on the relationship between cause and effect in a decision-making process in games for leadership development. Pannese and Morosini (2014) directly refer to fostering reflection and the player's ability to self-regulate their training. These games also aim to enable good decisions when the player is confronted with a similar real life occurrence. In a serious game for military training, Procci et al. (2014) show players short cinematics of catastrophic failures in decision-making. Thus, players can analyze which actions led to problems and reflect on implications for their lives.

The remaining 7 publications focus only on outcome-process link analysis, which means reflecting about how one's actions affected the decision outcomes. Chorianopoulos and Giannakos (2014) discuss a serious game for teaching basic math to children. They argue that games help players to recognize their exact mistakes and what they could have done differently. Imbellone et al. (2015) stress the need to be able to learn from own experience. The influence of pricing decisions on customer behavior is addressed by van der Zee et al. (2012). In the business game presented by Ben-Zvi (2010), students have to evaluate their decision. In the serious game about healthcare presented by De Gloria et al. (2014), a summary screen indicates which decisions the player has implemented and their effect on the clinic's screening rate, thus allowing reflecting on the decisions afterwards. In the barge handling simulation (Douma et al., 2012), players can experience the consequences of their decisions rapidly. Mayer (2009) emphasizes the usefulness of games in urban planning, as players make decisions in synthetic cities, observe the consequences and make new decisions.

2.2.6 Discussion, Conclusion and Future Research

This review shows that, in regard to research question 1, most of the capabilities required in the managerial decision process may be acquired or improved by playing serious games. These games should hence be considered a viable approach for fostering decision-making skills. Surprisingly, however, only few games actually utilize dedicated BI software when fostering skills in the intelligence phase. Instead, most of the games either use custom-crafted simplified reports (e.g., Basole et al., 2013) or do not specify which kind of reporting is used (e.g., Alklind Taylor et al., 2012). The only game that uses actual BI software is presented by Legner et al. (2013). However, in their proposed curriculum, the focus is set clearly on enterprise resource planning systems. Hence, according to our literature sample, a game that emphasizes BI software and reporting seems to be still missing. Important learning outcomes, like evaluating different reporting tools or proper information visualization, might therefore not be addressed. A possible approach to solve this issue is presented by Ben-Zvi (2010), where students have to build their own decision support systems. However, in this particular study, most students used Microsoft Excel, which shows that they were not introduced to dedicated reporting software. The review also reveals that the decision phases design and implementation are left out many times. In many business games, players do not formulate decision situations by themselves, and the games implicitly assume that any decision made by the player will be executed without any difficulties. Since no single game addresses all of the decision steps, educators who want to improve decision-making with serious games might be left with the problem to fill these gaps.

Referring to research question 2, this study shows the need for future research. First, serious games that focus on BI issues, reporting software, and information visualization might be developed in order to take full advantage of game-based management decision support. Second, there is need for serious games that tackle the decision steps model formulation, model analysis and task tracking, since they are scarcely mentioned in our literature sample. Last, this study invites the field of BI and analytics to broaden its focus and take into account the capabilities of individual decision-makers who decide based on the insights provided by BI software.

A limitation of this study is the focus on selected leading journals and conferences. On the one hand, this should ensure a high quality of findings. On the other hand, a lot of valuable and even more recent facts may be found in other sources with less scientific reputation, in particular results of workshops or working papers. This will be a focus of further research. Regarding the results of this study as well as the highlighted need for future research, we conclude that focusing on learning and the individual skills of decision makers by using serious games might be a fruitful avenue for extending BI and analytics research.

2.3 Essay: Developing a Serious Game for Business Information Visualization

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Published in:	Proceedings of the 22nd Americas Conference on Information Systems (AMCIS 2016)

2.3.1 Abstract

Business information visualization (BIV) is increasingly recognized by companies as being essential to avoid threats and realize opportunities. However, many companies still do not seem to know how to improve their BIV. Serious games appear to be a promising approach to convey this knowledge. To investigate the question whether using serious games to improve BIV skills is beneficial, they should be empirically evaluated. However, we could not identify such games in our literature review. The main goal of this study is therefore to fill this gap by contributing a serious game that aims to improve players' BIV skills. Within the game, players compete across several minigames that each address one specific guideline for achieving adequate BIV. A software prototype of the game is developed using the human-centred design process. After its development will have finished, areas of application and evaluation will include education as well as employee training in companies.

2.3.2 Introduction

Business information visualization (BIV) is increasingly recognized by companies as being essential to avoid threats and realize opportunities (Evelson & Yuhanna, 2012). By effectively using BIV, companies may reduce wrong decisions caused by incomprehensible or misleading data (Ware, 2012). For instance, the accident of the space shuttle Challenger may have been avoided using more appropriate information visualization (Tufte, 1997). However, many companies still do not strive for adequate BIV in their management reporting (Al-Kassab, Schiuma, Ouertani, & Neely, 2014). A possible explanation for this is the lack of knowledge about proper visualization practices (Few, 2012). Since serious games already foster cognitive learning outcomes in many domains (Connolly et al., 2012; Wouters et al., 2009), they appear to be a promising approach to convey this knowledge. The overarching research question of our project is therefore whether it is beneficial to use serious games that improve players' BIV skills, especially compared to more traditional learning methods (e.g., lectures). To investigate this question, serious games that focus on BIV should be empirically evaluated. However, this evaluation would require that these games have already been developed. Since we could not identify such games in literature, this study sets out to fill this gap first by introducing a serious game that aims to improve players' BIV skills. Hence, the research objective of this study is as follows:

Develop a serious game that improves players' business information visualization skills.

This study conforms to design science research (Hevner et al., 2004) and presents a software prototype as its artifact that emerged from the first iteration of the human-centred design process (ISO, 2010). In the following, we will outline the theoretical background and related work as well as the development method. After describing the resulting prototype, the paper closes with a discussion, conclusion, and next steps.

2.3.3 Theoretical Background

Information visualization is defined as “the use of computer-supported, interactive visual representations of abstract data to amplify cognition” (Card, Mackinlay, & Shneiderman, 1999). When information visualization technologies are used to visualize business data or information (e.g., with tables or column charts) it is referred to as BIV (Tegarden, 1999). A possible approach to improve BIV skills is the use of visualization guidelines that support design decisions and draw on insights from cognitive psychology such as gestalt theory (Ware, 2012). Although several guidelines for information visualization exist (e.g., Shneiderman, 1996; Tufte, 1997; Ware, 2012), only few focus on elements used specifically in business reports. One framework that highlights the design of business reports and presentations are the International Business Communication Standards (IBCS) (Hichert & Faisst, 2015). This framework comprises specific guidelines that showcase bad examples of BIV alongside their proposed corrections. We will hence incorporate these guidelines in our serious game to enable players to identify inadequate BIV and to suggest reasonable improvements. These two skills, namely being able to identify inadequate BIV and being able to suggest reasonable improvements, are what we refer to as BIV skills in this study. To acquire them, an understanding of the interactions between symbols, shape effects, colors, etc. (Ware, 2012) is required which is supposed to be fostered by the guidelines used in our serious game.

In contrast to gamification, where game elements are used in non-game contexts (Deterding et al., 2011), serious games constitute whole games that are not limited to the purpose of entertainment but also focus on improving skills and teaching players educational content (Abt, 1987). Since these games aim to improve learning through intrinsic motivation, their theoretical background includes several learning and motivation theories like self-determination theory and flow theory (Grund, 2015).

One specific theory used to describe player motivation in serious games is tournament theory (Liu et al., 2013). It assumes that competition between equally skilled players increases effort, enjoyment and arousal while playing. Hence, competition will be a central aspect of the serious game developed in this study.

2.3.4 Related Work

Prior to developing a serious game for improving BIV skills, we want to characterize the state of the art of BIV as a learning goal or a learning outcome in serious games. Susi, Johannesson, and Backlund (2007) provide a basic overview of serious games, referring to Michael and Chen (2006) who claim that communication skills (i.e., effectively presenting ideas when speaking, writing, etc.) are important for employees in corporations. Although this might include BIV, this learning goal is not explicitly stated. Connolly et al. (2012) investigate empirical evidence on the learning outcomes of computer games and serious games in a systematic literature review. Out of the 129 publications they identified, 17 higher quality studies report knowledge acquisition and content understanding outcomes. However, none of these studies mention BIV as a learning outcome. Another literature review about the learning outcomes of serious games conducted by Wouters et al. (2009) concludes that cognitive learning outcomes (i.e., knowledge and cognitive skills) can be observed in 12 out of the 28 empirical studies investigated. Although they argue that serious games seem to be effective when it comes to cognitive learning outcomes, BIV was again not a learning goal in any of the studies. In a recent literature review about using serious games to improve the decision process, Grund and Meier (2016) show that BIV is not addressed in their sample of serious games that include business reporting. In summary, according to the investigations mentioned above, a serious game that specifically focuses on improving BIV skills seems to be still missing. We intend to fill this gap with the serious game described in the following sections.

2.3.5 Development Method

Several approaches for developing serious games have been proposed thus far (e.g., de Freitas & Jarvis, 2006; Moreno-Ger, Burgos, Martínez-Ortiz, Sierra, & Fernández-Manjón, 2008; Nadolski et al., 2008). Although there does not seem to be an established standard or a thorough evaluation among these development processes, they all concur that for a serious game to be successful, both educational objectives as well as providing an entertaining experience are important. Since the latter can only be evaluated through actual playing, a development process should encompass several iterations of play-testing with prospective users. For this reason, we suggest to employ the human-centred design process specified by ISO (2010) that is prevalent in the domain of human computer interaction (Earthy et al., 2001).

Before going through the design steps of the human-centred design process, the basic structure of the serious game has to be planned. We intend to develop a 2-dimensional game that addresses guidelines for adequate BIV in a competition between players. This competition consists of several minigames that each address one specific guideline. To emphasize the sense of competition, every minigame is loosely based on Olympic sports, hence the name “Dashboard Olympics”.

As a first design step, the context of use needs to be understood and specified. In our case, the target group consists of university students in a management information systems course about business reporting (i.e., prospective BIV professionals and junior managers). The course already features a tutorial on reporting software in the first week that is delivered in a computer room containing 30 workstations in the same network. Hence, this setting will serve as the context of use for the Dashboard Olympics.

Next, we will specify the user requirements. Users include the organization (i.e., university) as well as the players (i.e., students). From an organizational perspective, it is important that players understand the learning content (i.e., how to improve BIV). From a player perspective, an entertaining experience (e.g., having fun, feeling immersed, etc.) is desirable.

The production of design solutions is twofold: First, guidelines from the IBCS are matched with several game mechanics in a brainstorming session to draft minigames for the Dashboard Olympics. This form of ideation leaves room for creativity while still focusing on the learning content. Second, the drafted minigames are implemented as a software prototype using the Unity game engine.

To evaluate the game against requirements, we conduct semi-structured interviews with play-testers. Interview questions include items from the game experience questionnaire (IJsselsteijn, de Kort, & Poels, 2008) that cover player requirements. Additional questions aim to assess the understanding of different ways to improve BIV, which addresses organizational requirements. Last, there is space for play-testers to add individual thoughts and suggest improvements.

2.3.6 Software Prototype

The following software prototype resulted from the first iteration of the human-centred design process described above. It comprises four minigames (i.e., Olympic sports) that each address one specific guideline for adequate BIV from different perceptual IBCS rule sets (i.e., condense, check, express, and simplify) which are for instance based on gestalt theory (Hichert & Faisst, 2015). Since tournament theory suggests that only equally skilled players should compete, the interactions in each minigame are very simple so that for example prior experience with video games is negligible. Players can score between 0 and 100 points per minigame that are displayed in a global leaderboard after finishing. These points serve as a mechanic for achieving motivation, they do not indicate learning success. The game ends when every minigame is finished and the overall winners (i.e., first, second, and third place) are announced. As proposed by Garris et al. (2002), the game is followed by a debriefing session. During debriefing, players exchange their experiences from every minigame and think of implications for improving BIV. This is mainly where learning takes place, i.e. the minigames focus on facilitating experiences that are reflected on during debriefing.

The instructor guides the discussion to make sure the corresponding guidelines are addressed. An overview of the minigames implemented in the software prototype is provided in Figure 1.

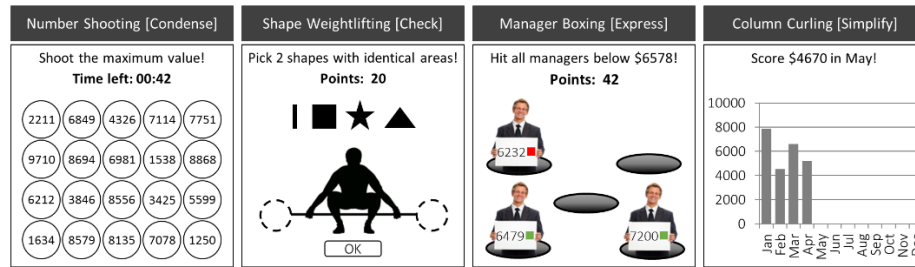


Figure 1: Minigames implemented in the software prototype

The first minigame is called “number shooting” and addresses the guideline CO 4.4 (Hichert & Faisst, 2015). This guideline recommends using graphical elements in tables to easily identify differences in size between numbers. The basic layout of the minigame is a grid of targets with numbers (similar to a table) without any graphical support. There is only a limited time for identifying the maximum value and “shooting” it. Hence, players have to compare the numeric value of every target inside the grid, which causes high cognitive effort. After the time has passed or the right target was shot, the minigame ends.

In the second minigame, which is called “shape weightlifting”, the guideline CH 3.1 is covered (Hichert & Faisst, 2015). This guideline advises against using area comparisons in reports (like it is employed in pie charts) and instead suggests using length comparisons. To experience the difficulty of correctly comparing area sizes, players have to select two shapes with identical areas out of several different shapes and attach them to a weight bar. There are five rounds with decreasing differences between the areas of the shapes, which leads to increasing difficulty.

The next minigame is called “manager boxing” and is concerned with the guideline EX 2.5 (Hichert & Faisst, 2015). This guideline disadvises from using traffic light indicators in reports, since they distract from comprehending the actual numbers. To show this effect, players have to hit all managers holding numbers below a given threshold in a “Whac-A-Mole”-style minigame. At the beginning of the minigame, the traffic lights next to the numbers are consistent with the goal (i.e., showing red when the number is below the threshold). However, inconsistencies arise later in the game, leading to wrong decisions when players blindly trust the traffic light indicators.

The last minigame is called “column curling” and addresses the guideline SI 3.1 (Hichert & Faisst, 2015). This guideline recommends replacing value axes in column charts with data labels. Initially, players face an empty column chart with a target value displayed for the current month. By holding a key, they can “grow” a column for this month. When the key is released, the resulting column is the estimate for the month and a new target value is set for the next month. In doing so, players experience difficulties when estimating the exact height given only a value axis and gridlines.

2.3.7 Discussion and Conclusion

The software prototype described in this study is a first approach to improve BIV skills with a serious game. Due to its modular structure, minigames can be added or removed in forthcoming iterations of the human-centred design process. Since all minigames only use few interaction types (i.e., clicking and dragging), the game might also be ported to mobile devices. A possible limitation of the approach is the use of leaderboards: While they may motivate high-scoring players, they might also potentially embarrass players who “lose” against their peers. In addition, the presented game is fully digital. Since there are empirical investigations that indicate benefits of non-digital games (e.g., board games), these benefits might not be realized by our approach.

After its development will have finished, the prototype will be thoroughly evaluated in a between-subject experimental design. Participants will be asked to suggest improvements in a business report before and after playing the game. When this evaluation shows that the game leads to better suggestions concerning BIV, especially compared to more traditional learning methods, this might indicate that it is beneficial to use serious games to increase players' BIV skills. These games might then be tested in blended learning scenarios that combine both serious games as well as other learning methods for improving BIV skills. After thorough evaluation, the Dashboard Olympics might be used in several areas of application. First, educators in management information systems courses might want to add this game to their curriculum to improve BIV skills. Second, companies might use it to help employees create adequate reports for example with business intelligence applications. After the game has been adopted in practice, differences between students and practitioners (e.g., acceptance or learning outcomes) may be examined.

2.4 Essay: Architecture and Evaluation Design of a Prototypical Serious Game for Business Information Visualization

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Published in:	Proceedings of the 13th International Conference on Wirtschaftsinformatik (WI 2017)

2.4.1 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.

2.4.2 Introduction

Poorly visualized business reports may lead to wrong decisions due to incomprehensible or misleading data (Ware, 2012). Despite these threats, many companies still do not strive for proper business information visualization (BIV) (Al-Kassab et al., 2014). One explanation for this is the lack of knowledge about adequate BIV practices and guidelines (Few, 2012). Experiential learning might be a way to sustainably increase this knowledge and therefore improve the way reports are designed (Kolb, 1984). Serious games are one form of experiential learning that has been used for decades to successfully convey business-related content by engaging players (Faria et al., 2009). However, despite the plethora of different serious games described in literature, BIV has thus far not been a dedicated aspect of them (Grund & Meier, 2016; Grund & Schelkle, 2016). 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 (Grund & Schelkle, 2016). 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 (Grund & Schelkle, 2016), 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.

2.4.3 Theoretical Background and Development Method

Since serious games are concerned with improving player capabilities as well as providing an entertaining experience (Abt, 1987), both learning and motivation theories are used in literature to explain the benefits of serious games (Grund, 2015). For instance, they are often described as a form of experiential learning (Kolb, 1984). To explain the motivational effects of our game, we draw on self-determination theory (Deci & Ryan, 1985). According to this theory, video games in general foster intrinsic motivation by enabling perceived competence, autonomy, and relatedness (Ryan et al., 2006). 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 (Grund & Schelkle, 2016). In the following, we describe the architecture of an evolutionary prototype that resulted from the first iteration of this development process.

2.4.4 Architecture of the Dashboard Tournament

The prototype of the Dashboard Tournament currently features a singleplayer mode that comprises four minigames (Grund & Schelkle, 2016). 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.

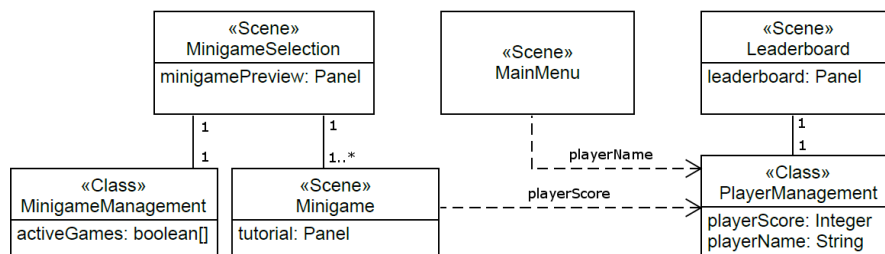


Figure 1: Architecture of the Dashboard Tournament

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.

2.4.5 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 (Ryan & Deci, 2000). 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 (Grund & Meier, 2016; Grund & Schelkle, 2016), 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.

2.5 Essay: Visualisieren spielend erlernen – Ein Serious Game zur Verbesserung von Managementberichten

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Published in:	Gamification und Serious Games: Grundlagen, Vorgehen und Anwendungen. Edition HMD, Springer Reprinted by permission, ©2017 License Number: 4293580853658

2.5.1 Zusammenfassung

Aktuelle Studien belegen, dass viele Managementberichte ihren eigentlichen Zweck – Klarheit in Entscheidungssituationen zu schaffen – nicht ausreichend erfüllen. Eine Ursache hierfür ist die mangelhafte Aufbereitung von Informationen aufgrund der, insbesondere bei Nachwuchsführungskräften, oft unzureichenden Kenntnisse bei der Informationsvisualisierung. Eine vielversprechende Möglichkeit, das Wissen zur zweckmäßigen Gestaltung von Managementberichten nachhaltig zu verinnerlichen, bietet erfahrungsbasiertes Lernen mithilfe von Serious Games. Dieser Beitrag stellt ein entsprechendes prototypisches Serious Game vor. Hierbei treten Teilnehmer im sogenannten „Dashboard Tournament“ gegeneinander an, bei dem sie verschiedene Minispiele bestreiten. Jedes Minispiel adressiert eine spezifische Richtlinie aus den „International Business Communication Standards“, die auf Praxiserfahrungen sowie Erkenntnissen aus der Wissenschaft beruhen. Eine erste empirische Evaluation im Rahmen einer Lehrveranstaltung zeigt, dass das Spiel positiv aufgenommen wird und die vermittelten Richtlinien grundsätzlich erkannt werden.

2.5.2 Informationsvisualisierung in Unternehmen

„Man kriegt ja regelmäßig den Risikobericht, da kann man nachgucken. Und da hat man so eine kleine Ampel drin, mit den drei Farben rot, gelb, grün. Und wenn es grün ist, und der überwiegende Teil war eben im grünen Bereich, (...) dann scheint es so zu gehen“ (zitiert nach Mertens, 2009). Dieser Erklärungsversuch eines Verwaltungsrats für die nicht rechtzeitig erkannte Krise bei der Sachsen LB zeigt, was aktuelle Untersuchungen bestätigen: Viele Managementberichte erfüllen ihren eigentlichen Zweck – Klarheit in Entscheidungssituationen zu schaffen – nicht ausreichend.

So zeigt bspw. die KPI-Studie 2013, dass die Hälfte der Unternehmen im DACH-Gebiet mit ihrem Reporting unzufrieden ist (Gräf, Isensee, Kirchmann, & Leyk). Ursache hierfür ist u.a. die mangelhafte Aufbereitung von Informationen. Hierdurch steigen der Aufwand für die Informationsverarbeitung sowie die Gefahr von gravierenden Fehlentscheidungen durch Missverständnisse und Fehlinterpretationen (Hichert & Faisst, 2014). Zwar sehen Unternehmen laut Forrester Research die Visualisierung von Informationen zunehmend als essenziell an, um Gefahren abzuwenden und Chancen zu ergreifen (Evelson & Yuhanna, 2012). Jedoch haben ca. zwei Drittel der Unternehmen bislang keine Richtlinien zur Darstellung von Geschäftsgrafiken und Tabellen (Proff & Wiener, 2012). Eine Erklärung hierfür ist, dass insbesondere Nachwuchsführungskräfte aus betriebswirtschaftlichen Studiengängen selten wissen, worauf es bei sinnvoller Informationsvisualisierung ankommt. „In der Schule oder Universität gab es schließlich kein Fach oder kaum ein Seminar, in dem gutes Information Design vermittelt wurde“ (Kohlhammer, Proff, & Wiener, 2013).

In der Literatur finden sich dagegen zahlreiche Ansätze, wie Führungsinformationen zweckmäßig dargestellt werden sollten. So beschreiben bspw. Ware (2012) und Tufté (2010) allgemeine Grundsätze für sinnvolle Informationsvisualisierung. Einen konkreten Vorschlag im Unternehmenskontext stellen die „International Business Communication Standards“ (IBCS) dar. Sie beruhen auf Praxiserfahrungen sowie Erkenntnissen aus der Wissenschaft (vgl. Hichert & Faisst, 2015).

Die konkreten Gestaltungsrichtlinien werden mit dem Akronym „SUCCESS“ abgekürzt. Jeder Buchstabe steht für eine Kategorie, auf die bei der Erstellung eines Managementberichts zu achten ist (siehe Abb. 1).



Abb. 1: Struktur der International Business Communication Standards

Diese sieben Kategorien lassen sich in konzeptionelle, semantische und wahrnehmungsbezogene Gestaltungsrichtlinien gliedern. Die konzeptionellen Gestaltungsrichtlinien bestehen aus den Kategorien „Say“ und „Structure“ und beschreiben die strukturierte Wiedergabe von Kerninhalten in Berichten. „Unify“ beinhaltet Richtlinien mit Bezug zur Semantik, insbesondere mit dem Fokus auf einheitliche Notationsstandards. Die wahrnehmungsbezogenen Gestaltungsrichtlinien setzen sich aus den Kategorien „Express“, „Simplify“, „Condense“ sowie „Check“ zusammen und beschreiben das Visualisierungsdesign bei Managementberichten. Um dieses Visualisierungsdesign nachhaltig zu verbessern, stehen die wahrnehmungsbezogenen Gestaltungsrichtlinien in unserem Projekt im Fokus.

Ziel des Projekts „Dashboard Tournament“ ist es, bei Fach- und Führungskräften das Bewusstsein für die menschliche Wahrnehmung und deren Limitationen zu erhöhen, um Missverständnisse und Fehlinterpretationen sowie deren betriebswirtschaftliche Folgen zu reduzieren. Hierfür wird in diesem Beitrag ein prototypisches Serious Game vorgestellt, das wahrnehmungsbezogene Gestaltungsrichtlinien der IBCS vermittelt und zunächst in der Hochschullehre sowie anschließend auch in Unternehmen eingesetzt werden soll. Der Beitrag verfolgt zwei Ziele: Zum einen soll er Praktiker sowie Wissenschaftler für das Potenzial von Serious Games zur nachhaltigen Vermittlung von Lerninhalten im Management Reporting sensibilisieren. Zum anderen soll er die

anspruchsvolle Erstellung dieser Serious Games erleichtern, indem er anhand eines konkreten Ansatzes aufzeigt, wie man mit konkurrierenden Spannungsfeldern bei der Gestaltung von Serious Games umgehen kann.

2.5.3 Serious Games im Management Reporting

In der Wirtschaftsinformatik gewinnen Serious Games als Lernform insbesondere vor dem Hintergrund der zunehmenden Popularität des Forschungsgebiets „Gamification“ an Bedeutung. Gamification beschreibt den Einsatz von Spielelementen in einem spielfremden Kontext (Deterding et al., 2011). Dabei findet hauptsächlich eine Fokussierung auf die Motivation von bestimmten Verhaltensweisen der Spieler statt. Im Gegensatz hierzu sind Serious Games vollständige Spiele, die neben der Unterhaltung der Spieler auch die Weiterentwicklung ihrer Fertigkeiten zum Ziel haben (Abt, 1987).

In der Literatur gibt es zahlreiche Erklärungen, wie Serious Games zum Lernerfolg beitragen (Grund, 2015). Ein oft verwendeter Ansatz ist dabei die Theorie des erfahrungsbasierten Lernens. Demnach sind konkrete Erfahrungen für erfolgreiches Lernen ausschlaggebend (Kolb, 1984). In einem sogenannten erfahrungsbasierten Lernzyklus machen Lernende zunächst eine konkrete Erfahrung und reflektieren diese anschließend. Aus dieser Reflexion bilden sie sich ein abstraktes Modell und experimentieren daraufhin mit ihrer Umgebung, was wiederum zu neuen konkreten Erfahrungen führt. In Serious Games kann genau dieser Lernzyklus systematisch durchlaufen werden, da Spiele durch ihre Interaktivität Raum für konkrete Erfahrungen sowie Experimente mit der Spielumgebung bieten.

Zwar werden Serious Games bereits seit mehreren Jahrzehnten eingesetzt, um betriebswirtschaftliche Lerninhalte zu vermitteln (Faria et al., 2009) und eignen sich grundsätzlich auch für die Verbesserung des Entscheidungsverhaltens von Führungskräften (Grund & Meier, 2016). Ein Serious Game, das die Informationsvisualisierung im Management Reporting behandelt, konnte bislang jedoch nicht identifiziert werden (Grund & Schelkle, 2016). Um diese Lücke zu schließen und

das Potenzial von Serious Games auch in diesem Bereich nutzen zu können, wird im Folgenden ein solches Serious Game vorgestellt. Zunächst wird jedoch auf die verschiedenen Spannungsfelder eingegangen, auf die es bei der Gestaltung von Serious Games zu achten gilt.

2.5.4 Spannungsfelder bei der Gestaltung von Serious Games

Bei der Gestaltung von Serious Games gibt es verschiedene, teilweise konkurrierende Ziele. Im Wesentlichen gilt es, die Themenfelder Realität (zu vermittelnde Inhalte), Spiel (eine erfüllende Beschäftigung) und Bedeutung (Vermittlung von Lerninhalten und Fertigkeiten) zu balancieren (Harteveld et al., 2010). Hierbei ergeben sich mehrere mögliche Spannungsfelder, die von Harteveld et al. (2010) vorgestellt wurden und im Folgenden beschrieben werden (vgl. Abb. 2).

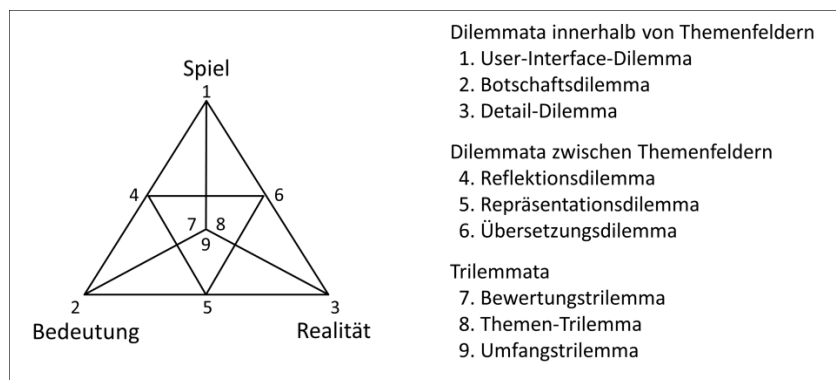


Abb. 2: Spannungsfelder bei der Gestaltung von Serious Games (Harteveld et al., 2010)

Das User-Interface-Dilemma liegt im Themenfeld „Spiel“ und bezieht sich auf die Komplexität der Interaktionsmöglichkeiten der Nutzer mit dem Spiel: Hohe Komplexität führt zu hohem Lernaufwand und verringert die Wahrscheinlichkeit, dass jeder Nutzer das Spiel gerne spielt. Geringe Komplexität limitiert wiederum die Interaktionsmöglichkeiten der Nutzer mit dem Spiel, was zu geringeren Lernergebnissen führen kann. Bei dem Botschaftsdilemma im Themenfeld „Bedeutung“ werden Serious

Games adressiert, die mehrere Botschaften vermitteln möchten. Hier müssen die Lerninhalte priorisiert werden, um den Fokus auf die wichtigsten Botschaften zu legen. Mit dem Detail-Dilemma im Themenfeld „Realität“ wird der Grad an Detaillierung der Spielumgebung angesprochen. Einerseits können Spieler durch einen hohen Detaillierungsgrad Gegenstände und Umgebungen leichter erkennen. Andererseits lenkt zu viel Detaillierung u.U. vom Wesentlichen ab.

Das Reflektionsdilemma beschreibt einen Konflikt zwischen den Themenfeldern „Spiel“ und „Bedeutung“. In einem Spiel konzentrieren sich Spieler idealerweise vollständig auf ihre Aufgabe und vergessen dabei ihre Umgebung („Immersion“). Dies kann allerdings dazu führen, dass die Reflektion über die erlebten Geschehnisse nicht in ausreichendem Maße stattfindet, die Bedeutung des Spielgeschehens also unverstanden bleibt. Im Repräsentationsdilemma, das sich zwischen den Themenfeldern „Bedeutung“ und „Realität“ ergibt, wird die zielgerichtete Vereinfachung der Realität zugunsten von Lernergebnissen beschrieben. Metaphorische Handlungen blenden bspw. komplexe, für die Botschaft des Spiels nicht relevante Handlungen aus. Dies führt im Falle von zu stark vereinfachten Abläufen u.U. dazu, dass Spieler diese nicht in die Realität übertragen können. Zu genau abgebildete Abläufe stören hingegen die Fokussierung auf die Bedeutung. Das Übersetzungsdilemma zwischen den Themenfeldern „Spiel“ und „Realität“ thematisiert die Herausforderung, dass es in Spielen schwierig ist, jeden Aspekt der Realität abzubilden. Wird das Themenfeld „Spiel“ priorisiert, sind unrealistische Ergebnisse möglich. Bei der Priorisierung des Themenfelds „Realität“ wiederum könnte ein Spiel entstehen, das kaum jemand spielen möchte.

Das Bewertungstrilemma geht auf die Bewertung von Spielerleistungen ein. Eine transparente und motivierende Bewertung ist sehr wichtig für die Reflektion über die Lerninhalte. Aus der „Spiel“-Perspektive versprechen höhere Punktzahlen ein besseres Erlebnis, wohingegen geringere Punktzahlen leichter nachzuverfolgen sind. Das Themen-Trilemma bezieht sich darauf, dass das Thema eines Spiels schwierig zu vermitteln sein kann. Dies ist darin begründet, dass die Realität in Bezug auf das gewählte Thema u.U. komplexer ist, als sie in einem Spiel dargestellt werden kann. Im

Umfangstrilemma geht es darum, den Zusammenhang zwischen der Botschaft und dem Umfang des Spiels zu berücksichtigen. So sollte jedes zusätzliche Element des Spiels auch die Spielerfahrung verbessern, zu Lernergebnissen beitragen sowie die Realität in angemessenem Umfang widerspiegeln.

Zusammenfassend können bei der Gestaltung von Serious Games einige Spannungsfelder auftreten, auf die es zu achten gilt. Das im folgenden Abschnitt vorgestellte Serious Game „Dashboard Tournament“ schlägt eine konkrete Möglichkeit vor, wie mit diesen Spannungsfeldern im Anwendungsfall Management Reporting umgegangen werden kann.

2.5.5 Entwicklung und Inhalte des Spiels “Dashboard Tournament”

Das Ziel bei dem „Dashboard Tournament“ besteht darin, Fach- und Führungskräften grundlegende Gestaltungsrichtlinien zur Informationsvisualisierung nachhaltig zu vermitteln. Die Teilnehmer bestreiten verschiedene Minispiele, wobei jedes davon eine spezifische Gestaltungsrichtlinie aus den IBCS adressiert. Im Folgenden werden die Entwicklungsmethode, der Ablauf des Spiels sowie bislang implementierte Minispiele aus dem Dashboard Tournament beschrieben.

2.5.5.1 Entwicklungsmethode

In der Literatur werden einige Entwicklungsmethoden für die Erstellung von Serious Games vorgeschlagen (z.B. de Freitas & Jarvis, 2006, 2009; Kelly et al., 2007; Moreno-Ger et al., 2008; Nadolski et al., 2008). Zwar gibt es unter diesen Methoden bislang keinen etablierten Standard. Sie stimmen jedoch darin überein, dass für die Entwicklung von erfolgreichen Serious Games sowohl die Lernziele als auch unterhaltsame Erfahrungen eine wichtige Rolle spielen. Nachdem letztere nur durch das Spielen selbst evaluiert werden können, sollte eine Entwicklungsmethode mehrere Iterationen zum Testen des Spiels mit potentiellen Nutzern durchlaufen. Daher wird in diesem Projekt der menschenzentrierte Gestaltungsprozess (siehe Abb. 3) angewendet (Grund & Schelkle,

2016; ISO, 2010), der in der Forschungsdomäne „Human Computer Interaction“ (HCI) verbreitet ist (Earthy et al., 2001). Zusätzlich werden die oben aufgeführten Spannungsfelder bei der Gestaltung von Serious Games berücksichtigt.

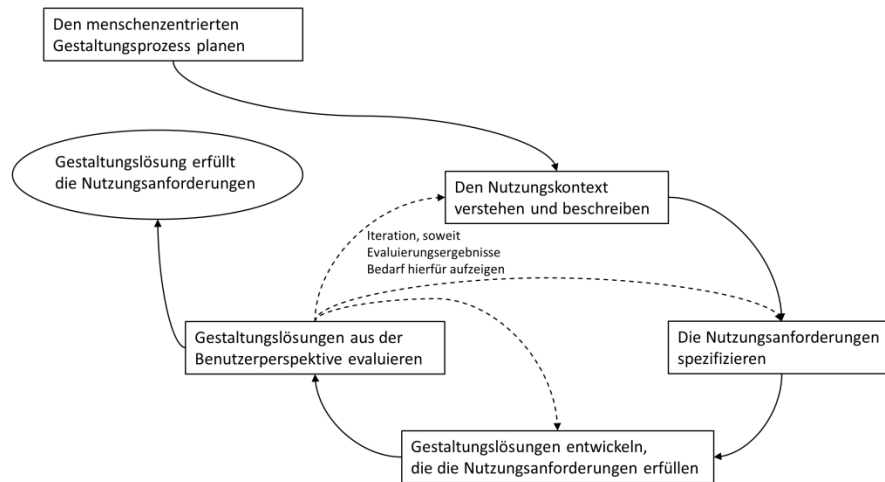


Abb. 3: Menschenzentrierter Gestaltungsprozess (ISO, 2010)

Bevor die einzelnen Phasen des menschenzentrierten Gestaltungsprozesses durchlaufen werden, gilt es, den grundsätzlichen Aufbau des Serious Games zu planen. Das „Dashboard Tournament“ ist ein zweidimensionales Spiel, das Richtlinien für angemessene Informationsvisualisierung anhand eines Wettbewerbs zwischen Spielern vermittelt. Grundlage für die Richtlinien sind die IBCS, die auf übliche Fehler bei der Informationsvisualisierung hinweisen. Der Wettbewerb besteht aus mehreren Minispielen, die jeweils eine spezifische Richtlinie adressieren. Um den Wettbewerbsgedanken hervorzuheben, treten die Spieler dabei gegeneinander an, daher der Name „Dashboard Tournament“.

In der ersten Phase der Entwicklung gilt es, den Nutzungskontext zu verstehen und zu beschreiben. Beim Dashboard Tournament besteht die Zielgruppe aus Studierenden in einem universitären Seminar zum Thema Management Reporting (d.h. zukünftigen Visualisierungsexperten und Nachwuchsführungskräften). Das Seminar enthält in der ersten Woche bereits ein Tutorial zu Reporting-Software, das in einem Computerraum mit 30 Rechnern im selben Netzwerk stattfindet. Daher dienen diese Rahmenbedingungen als Nutzungskontext für das Dashboard Tournament.

Als nächstes sind die Nutzungsanforderungen zu spezifizieren. Als Nutzer werden sowohl die Organisation (d.h. die Universität) als auch die Spieler (d.h. die Studierenden) verstanden. Aus Perspektive der Organisation ist es wichtig, dass die Spieler den Lerninhalt (d.h. Ansätze zur Verbesserung von Informationsvisualisierung) verstehen. Aus Sicht der Spieler ist zusätzlich eine unterhaltsame Erfahrung (z.B. Spaß haben, im Spiel vertieft sein etc.) wünschenswert.

Für die Entwicklung von Gestaltungslösungen werden zwei Schritte durchgeführt: Zunächst werden die IBCS-Richtlinien in einer Brainstorming-Sitzung mit mehreren Spielmechaniken zusammengeführt, um Minispiele zu entwerfen. Diese Form der Ideenfindung eignet sich, um kreative Ideen zu entwickeln und gleichzeitig die angestrebten Lernergebnisse zu berücksichtigen. Anschließend werden die entworfenen Minispiele als Softwareprototyp mit der Spiel-Engine „Unity“ implementiert.

2.5.5.2 Ablauf des Spiels und Auflösung der Spannungsfelder

Zu Beginn des Wettbewerbs befinden sich die Teilnehmer in einem Raum mit mehreren Computern. Nachdem ein Übungsleiter den Ablauf erläutert hat, wird das erste Minispiel per Zufall ausgewählt. Durch die Aufteilung der Richtlinien auf verschiedene Minispiele wird das Botschaftsdilemma aufgelöst: Anstatt mehrere Verstöße gegen sinnvolle Informationsvisualisierung gleichzeitig anzusprechen, thematisiert jedes Minispiel nur eine einzelne Richtlinie. Die Aufgabe des ausgewählten Minispiels sowie die Handlungsmöglichkeiten werden den Teilnehmern anschließend in Form von kurzen

Anweisungen auf dem Bildschirm angezeigt. Da für die Vermittlung von Richtlinien vergleichsweise wenig Interaktion notwendig ist, wurde im User-Interface-Dilemma auf eine sehr einfache Bedienbarkeit geachtet. Die Nutzerinteraktion beschränkt sich auf wenige Klicks, was ebenfalls eine Portierung als mobile Version (bspw. für Tablets) ermöglicht. Sobald jeder Teilnehmer die Anweisungen verstanden hat, beginnt das entsprechende Minispiel, bei dem die Spieler mit mangelhafter Informationsvisualisierung konfrontiert werden. Somit lernen die Teilnehmer diese als ein Hindernis zu verstehen, das es auf dem Weg zum Erfolg zu überwinden gilt.

Bei den Minispielen wurde in Bezug auf das Repräsentationsdilemma auf eine realitätsgetreue Darstellung von vollständigen Managementberichten zugunsten der Lernergebnisse bei der Informationsvisualisierung verzichtet. Die Spieler befinden sich demnach nicht tatsächlich vor Managementberichten, sondern vor abstrakten Aufgaben, die lediglich Elemente aus Berichten verwenden. Die Minispiele verzichten zudem auf rein dekorative Elemente, was das Detail-Dilemma zugunsten von realitätsgetreuen Berichtselementen auflöst. Nachdem jeder Teilnehmer die Aufgabe des Minispiels gelöst hat, endet dieses zunächst mit direktem Feedback auf dem Bildschirm jedes Teilnehmers. Dabei kann in jedem Minispiel eine Punktzahl zwischen 0 und 100 Punkten erreicht werden, die den Teilnehmern mitgeteilt wird. Anschließend zeigt das Spiel ein Leaderboard an, das die Punktzahlen der Teilnehmer miteinander vergleicht. Dieser Wettbewerbsmechanismus wird häufig in Gamification-Anwendungen eingesetzt, um Nutzer zu besseren Leistungen zu motivieren. Sollten bereits mehrere Minispiele absolviert worden sein, wird zusätzlich ein globales Leaderboard angezeigt, das den Gesamtpunktestand der Teilnehmer vergleicht. Damit dienen die dargestellten Punktzahlen mit Bezug zum Bewertungstrilemma nicht dazu, die Realität abzubilden bzw. den Lernerfolg zu reflektieren, sondern um den Wettbewerb aus dem Themenfeld „Spiel“ zu begünstigen. Dieser Wettbewerb soll im Hinblick auf das Reflektionsdilemma einen sog. „Flow“-Zustand bewirken. Gleichzeitig ermöglichen die Herausforderungen in Form von mangelhafter Informationsvisualisierung, dass Spieler die Bedeutung des Spiels reflektieren. Dies hat auch Einfluss auf das Übersetzungsdilemma: Die genaue

Wiedergabe der Realität hat für die Vermittlung von abstrakten Gestaltungsrichtlinien weniger Bedeutung als ein funktionierender Wettbewerb zwischen den Spielern.

Im Anschluss an das Spiel findet eine Diskussion der Minispiele mit dem Übungsleiter statt. Bei diesem sogenannten „Debriefing“ ist das Ziel, dass die Teilnehmer selbstständig erkennen, welche Probleme im Zusammenhang mit schlechter Informationsvisualisierung auftreten können und welche Maßnahmen erforderlich sind, um diese zu verhindern. Nachdem die Teilnehmer selbst überlegt haben, welche Maßnahmen sinnvoll sein könnten, werden ihnen die entsprechenden Richtlinien aus den IBCS vorgestellt. Während des Debriefings wird durch einen Bezug auf Managementberichte auf das Themenfeld „Realität“ sowie durch Reflektion der Erfahrungen aus dem Spiel auf das Themenfeld „Bedeutung“ eingegangen, um das Themen-Trilemma aufzulösen. Das Umfangstrilemma wird in dem Spiel durch einen komponentenorientierten Aufbau aufgelöst, d.h. jeder Übungsleiter kann die zu spielenden Minispiele vor dem Wettkampf auswählen und somit den Umfang sowie die Inhalte an die entsprechende Gruppe anpassen.

2.5.5.3 Exemplarische Minispiele aus dem Dashboard Tournament

Um zu demonstrieren, dass Minispiele für jede Kategorie der wahrnehmungsbezogenen Gestaltungsrichtlinien aus den IBCS (Condense, Check, Express und Simplify) erstellt werden können, wird im Folgenden hierfür jeweils exemplarisch ein bereits prototypisch implementiertes Minispiel aus dem Dashboard Tournament beschrieben.

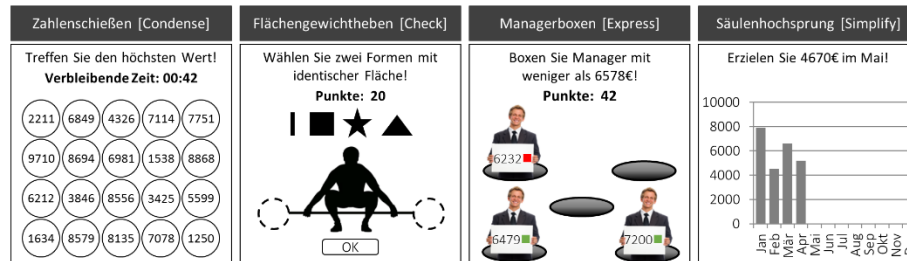


Abb. 4: Aufbau der Minispiele im Dashboard Tournament

Condense: „Zahlenschießen“

Das erste Minispiel trägt den Namen „Zahlenschießen“ und adressiert die Gestaltungsrichtlinie CO 4.4 aus den IBCS. Diese Richtlinie empfiehlt, Tabellen für das leichtere Verständnis des Betrachters mit grafischen Elementen zu versehen. Damit soll auf die Schwierigkeit hingewiesen werden, Auffälligkeiten in Tabellen zu erkennen, die keine grafische Unterstützung anbieten. Der Spieler macht in diesem Minispiel demnach die Erfahrung, dass hoher kognitiver Aufwand entsteht, wenn Zahlen sequentiell miteinander verglichen werden müssen.

Um dem Spieler diese Schwierigkeit zu verdeutlichen, besteht die Aufgabe des Minispiels darin, zwischen mehreren Zielen das Maximum zu identifizieren. Hierfür hat jeder Spieler nur begrenzt Zeit, bevor das Minispiel automatisch endet (vgl. Abb. 4). Am Ende des Minispiels wird dem Spieler seine Punktzahl angezeigt, die von der verbleibenden Zeit abhängt: Die Punktzahl verteilt sich gleichmäßig anhand der verbleibenden Anzahl an Sekunden. Damit erhält der Spieler mehr Punkte, je schneller er die Aufgabe löst.

Check: „Flächengewichtheben“

Das Minispiel „Flächengewichtheben“ bezieht sich auf die Gestaltungsrichtlinie CH 3.1 der IBCS. Sie schlägt vor, Flächenvergleiche in Managementberichten zu vermeiden und stattdessen Längenvergleiche (wie bspw. Säulen- oder Balkendiagramme) zu bevorzugen.

Um dies zu verdeutlichen, machen Spieler in diesem Minispiel die Erfahrung, dass korrekte Vergleiche zwischen Flächen (wie bspw. in Kreisdiagrammen) für die menschliche Wahrnehmung schwierig sind.

Zu Beginn dieses Minispiels sieht der Spieler einen Gewichtheber mit einer Stange ohne Gewichte sowie mehrere verschieden große Formen (siehe Abb. 4). Die Aufgabe besteht darin, zwei Formen mit identischer Fläche an den jeweiligen Enden der Stange zu platzieren. Hierfür kann der Spieler per Drag & Drop mehrere Konstellationen zunächst ausprobieren, bevor er die Auswahl bestätigt. Wählt der Spieler die korrekten Gewichte aus (d.h. Formen mit identischer Fläche), stemmt der Gewichtheber die Stange in einer kurzen Animation und der Spieler erhält Punkte. Sind zwei Gewichte mit unterschiedlicher Fläche ausgewählt, kippt der Gewichtheber in die Richtung des schwereren Gewichts und der Spieler erhält keine Punkte. Insgesamt werden in diesem Minispiel fünf Runden gespielt, wobei in jeder Runde die Anzahl der vorhandenen Formen steigt und der Unterschied zwischen ihren Flächen geringer wird, was den Schwierigkeitsgrad erhöht.

Express: „Managerboxen“

Das sogenannte „Managerboxen“ nimmt Bezug auf die Gestaltungsrichtlinie EX 2.5 der IBCS, die besagt, dass Managementberichte auf Ampeldarstellungen verzichten sollten, da diese nur eine geringe Informationsdichte aufweisen und den Fokus von konkreten Zahlen ablenken. Dies wird in einem Minispiel vermittelt, in dem Spieler die Erfahrung machen, dass das alleinige Vertrauen auf Ampelgrafiken zu Fehlern führen kann.

Zu Beginn des Minispiels sieht der Spieler fünf Löcher, die auf dem Bildschirm verteilt sind, sowie einen Zielwert im oberen Bereich des Bildschirms. Im Laufe des Spiels erscheinen aus diesen Löchern Manager, die Zahlen samt Ampelgrafik (grün oder rot) präsentieren und nach kurzer Zeit wieder in den Löchern verschwinden (vgl. Abb. 4). Der Spieler muss jeden Manager boxen, der eine Zahl präsentiert, die kleiner als der vorgegebene Zielwert ist. Zunächst zeigen sämtliche Ampeln rot an, wenn die Zahl kleiner ist als der Zielwert und grün, wenn die Zahl gleich groß oder größer ist.

Der Spieler lernt hierbei, sich auf die Ampelfarben zu verlassen. Später zeigen jedoch auch Manager, die eine Zahl unterhalb des Zielwerts präsentieren, z.T. eine grüne Ampelfarbe an. Wenn der Spieler also nicht mehr auf die Zahlen, sondern nur noch auf die Ampelfarben achtet, wird er in der zweiten Phase des Spiels Fehler machen.

Für jeden korrekt geboxten Manager erzielt der Spieler Punkte. Gleichzeitig werden Punkte abgezogen, wenn der Spieler einen Manager boxt, dessen Zahl gleich dem Zielwert oder größer ist. Es werden ebenfalls Punkte abgezogen, wenn ein Manager nicht geboxt wird, dessen Zahl kleiner als der Zielwert ist. Der Spieler kann insgesamt jedoch nicht weniger als null Punkte erreichen.

Simplify: „Säulenhochsprung“

Das Minispiel „Säulenhochsprung“ thematisiert die Beschriftung von Säulendiagrammen, was von der Gestaltungsrichtlinie SI 3.1 aus den IBCS aufgegriffen wird. Diese Richtlinie besagt, dass Säulen bei vorhandenem Platz stets mit ihrem Wert beschriftet werden sollten, um Berichtsempfängern eine möglichst genaue Einschätzung der Größen zu ermöglichen. In diesem Minispiel machen Spieler demnach die Erfahrung, dass Werte in einem unzureichend beschrifteten Säulendiagramm nur schwer abzuschätzen sind.

Dem Spieler wird zunächst ein leeres Säulendiagramm angezeigt, das zwölf Monate auf der Abszisse und mehrere Zahlen auf der Ordinate beinhaltet (siehe Abb. 4). Für jeden Monat wird dem Spieler ein Zielwert zwischen 1000 und 9000 im oberen Bereich des Bildschirms vorgegeben, den es zu erreichen gilt. Durch das gedrückt Halten einer Taste kann der Spieler die Säulenhöhe für den aktuellen Monat beeinflussen. Diese Säule wird größer, je länger der Spieler die Taste gedrückt hält. Sobald der Spieler die Taste loslässt, gilt die entstandene Säule als Schätzung für den aktuellen Monat. Anschließend wird ein neuer Zielwert für den nächsten Monat vorgegeben. Dieser Vorgang wiederholt sich, bis alle zwölf Monate mit einer Säule versehen sind (vgl. Abb. 4).

Nach Schätzung aller Monate werden dem Spieler grafisch die Abweichungen zur tatsächlichen Größe der Säulen sowie die erreichte Punktzahl angezeigt. Die Punktzahl für eine Säule verteilt sich gleichmäßig anhand der Abweichung von der korrekten Säulenhöhe. Die Punktzahl für das gesamte Minispiel ergibt sich anschließend aus dem Durchschnitt der Punktzahlen der einzelnen Säulen für jeden der zwölf Monate.

2.5.6 Ergebnisse einer ersten Evaluation

Um die Spielerfahrung sowie die inhaltlichen Aspekte bezüglich der Gestaltungsrichtlinien zur Informationsvisualisierung zu überprüfen, wurde eine erste empirische Evaluation des Spiels durchgeführt. Hierbei nahmen 19 Studierende im Rahmen eines Seminars zum Thema Management Reporting teil. Nach kurzer Einweisung spielten diese das Dashboard Tournament im Einzelspielermodus gegen fiktive Charaktere. Anschließend füllten die Studierenden den in Abschnitt 2.5.5.1 angesprochenen Fragebogen aus. Zur Überprüfung der Lerninhalte enthielt der Fragebogen Screenshots der Minispiele samt der Frage, welche Gestaltungsrichtlinie zur Informationsvisualisierung das jeweilige Minispiel anspricht. Obwohl die Gestaltungsrichtlinien im Spieldurchlauf nicht explizit angesprochen wurden, waren sie ein Bestandteil des Seminars, weshalb Studierende grundsätzlich in der Lage sein konnten, sie zu erkennen.

Im Folgenden werden die deskriptive Statistik der Skalen zur Spielerfahrung sowie deren Reliabilität (Cronbachs α) diskutiert (siehe Tab. 1). Die dargestellten Skalen stammen aus dem Game Experience Questionnaire (IJsselsteijn et al., 2008).

Tab. 1: Deskriptive Statistik der Skalen zur Spielerfahrung und Reliabilität

Skala	N	Min	Max	MW	Std.-Abw.	Cronbachs α
Competence	19	2,00	4,00	3,00	0,50	0,82
Immersion	18	0,40	3,80	1,87	0,94	0,88
Flow	19	0,40	3,80	2,46	0,85	0,80
Tension/Annoyance	19	0,00	2,33	0,75	0,64	0,61
Challenge	19	0,40	3,40	1,77	0,82	0,75
Negative Affect	18	0,00	2,50	0,72	0,71	0,75
Positive Affect	19	1,40	3,80	2,67	0,64	0,81

Wie in Tab.1 zu sehen, weisen sämtliche Skalen außer „Tension/Annoyance“ zufriedenstellende Werte bezüglich ihrer internen Konsistenz auf ($\alpha > 0,7$). Darüber hinaus befinden sich die Mittelwerte der Skalen „Competence“, „Flow“ sowie „Positive Affect“ deutlich über dem Skalenmittelpunkt (Mittelpunkt = 2), was auf eine Zustimmung in diesen Bereichen hindeutet. Die Spieler hatten also tendenziell ein hohes Kompetenzerleben, befanden sich während des Spielens im Flow-Zustand und waren dem Spiel gegenüber positiv eingestellt. Um einen ersten Einblick in die Zusammenhänge zwischen den verschiedenen Skalen zu erhalten, werden die bivariaten Korrelationen zwischen den Skalen zur Spielerfahrung in Tab. 2 dargestellt.

Tab. 2: Bivariate Korrelationen zwischen Skalen zur Spielerfahrung (*p < 0,05;**p < 0,01)

Skala	Competence	Immersion	Flow	Tension/Annoyance	Challenge	Negative Affect	Positive Affect
Competence	1	0,33	0,23	-0,63**	-0,04	-0,31	0,6**
Immersion	0,33	1	0,47*	0,24	0,66**	-0,43	0,72**
Flow	0,23	0,47*	1	-0,01	0,39	-0,7**	0,65**
Tension/Annoyance	-0,63**	0,24	-0,01	1	0,47*	0,36	-0,31
Challenge	-0,04	0,66**	0,39	0,47*	1	-0,16	0,38
Negative Affect	-0,31	-0,43	-0,7**	0,36	-0,16	1	-0,7**
Positive Affect	0,6**	0,72**	0,65**	-0,31	0,38	-0,7**	1

Die bivariaten Korrelationen zwischen den Skalen zur Spielerfahrung sind für einige Skalen statistisch hoch signifikant. Dies legt einen Zusammenhang zwischen der empfundenen Herausforderung und der Immersion während des Spiels sowie mehrere Zusammenhänge mit der positiven Einstellung gegenüber dem Spiel nahe. So hängen das Kompetenzerleben, die Immersion sowie das Erleben eines Flow-Zustands mit der positiven Einstellung gegenüber dem Spiel zusammen. Eine mögliche Erklärung hierfür ist, dass die genannten Empfindungen während des Spielens zu einem positiven Gesamteindruck führen, was sich mit den Aussagen der Literatur in diesem Bereich deckt. Somit könnte die empfundene Herausforderung im Spiel indirekt den positiven Gesamteindruck erhöhen, indem sie die Immersion verstärkt.

Die qualitativen Rückmeldungen, welche Gestaltungsrichtlinien zur Informationsvisualisierung in den verschiedenen Minispielen erkannt wurden, sind in Tab. 3 dargestellt. Dabei wird zwischen korrekt erkannter Richtlinie, korrekt erkannter Problematik und nicht erkannter Richtlinie/Problematik unterschieden.

Tab. 3: Erkannte Richtlinien und Problematiken

	Zahlenschießen	Flächengewichtheben	Managerboxen	Säulenhochsprung
Richtlinie erkannt	6	4	1	2
Problematik erkannt	6	9	8	4
Richtlinie oder Problematik erkannt	12	13	9	6
Nichts erkannt	7	6	10	13

Wie Tab. 3 zeigt, konnten die Teilnehmer nur in wenigen Fällen die konkreten Gestaltungsrichtlinien identifizieren. Da diese allerdings nicht explizit im Spieldurchlauf adressiert wurden, lässt sich hieraus lediglich eine Aussage über das Vorwissen der Teilnehmer ableiten. Die in den Spielen dargestellten Problematiken (wie bspw. eine schwere Vergleichbarkeit von Flächen) konnten Teilnehmer dagegen häufiger erkennen. In den Minispielen Zahlenschießen und Flächengewichtheben wurden Richtlinien und Problematiken häufiger richtig erkannt als in den Minispielen Managerboxen und Säulenhochsprung. Dies deutet darauf hin, dass mit den ersten beiden Minispielen die angestrebten Botschaften deutlicher vermittelt werden als mit den letzten beiden Minispielen.

Neben den qualitativen Rückmeldungen zu den Gestaltungsrichtlinien wurden die Teilnehmer um Verbesserungsvorschläge für die einzelnen Minispiele gebeten. Hierbei hat sich gezeigt, dass im Minispiel Zahlenschießen noch ein höherer Schwierigkeitsgrad gewünscht war (durch mehr Zeitdruck oder mehr dargestellte Zahlen). Darüber hinaus regten die Teilnehmer an, noch mehr Minispiele hinzuzufügen.

Insgesamt zeigt die erste Evaluation des Spiels, dass dieses zu Spaß und positiven Gefühlen sowie zusätzlich zu einem hohen Kompetenzerleben sowie einem Flow-Zustand während des Spielens führt. Darüber hinaus weist der eingesetzte Fragebogen eine hohe Reliabilität auf und kann daher nach Anpassung der Skala „Tension/Annoyance“ auch für zukünftige Evaluationen des Spiels eingesetzt werden. Durch die qualitative Rückmeldung wird ersichtlich, dass Gestaltungsrichtlinien zur Informationsvisualisierung sowie damit verbundene Problematiken zum Teil bereits während des Spielens erkannt werden. Bei dem späteren Einsatz des Spiels werden diese in einem Debriefing explizit angesprochen, was die Lernergebnisse sicherstellen soll.

2.5.7 Limitationen und Ausblick

Der in diesem Beitrag vorgestellte Prototyp stellt einen Zwischenschritt auf dem Weg zum Serious Game „Dashboard Tournament“ dar (Grund & Schelkle, 2016). Bislang können Spieler lediglich gegen fiktive Charaktere antreten. Die zukünftige Entwicklung fokussiert daher den für das Spiel wesentlichen Mehrspielermodus, bei dem Spieler auch gegeneinander antreten können. Eine erste Evaluation hat bereits positive Ergebnisse hervorgebracht, jedoch gilt es nach Fertigstellung des Spiels eine umfangreiche, experimentelle Studie zur Wirksamkeit des Spiels durchzuführen. Dieses soll insbesondere mit herkömmlichen Lehrmethoden, wie bspw. Vorträgen, verglichen werden. Wenn diese Evaluation positive Ergebnisse hervorbringt, soll das Spiel auch in der Unternehmenspraxis erprobt und evaluiert werden.

Eine Limitation des entwickelten Ansatzes ist die eventuell geringe Akzeptanz unter spielaversen Fach- und Führungskräften. Da insbesondere im deutschsprachigen Raum das spielerische Lernen im Management-Bereich noch nicht weit verbreitet ist (mmb Institut, 2016), könnte ein Spiel für diese als nicht ernsthaft missverstanden werden. Außerdem ergeben sich aus dem eingesetzten Wettbewerb u.U. Herausforderungen: So könnten sich Mitspieler mit geringen Punktzahlen gegenüber ihren Kollegen bloßgestellt fühlen. Ein Lösungsansatz hierfür ist, jeden Spieler einen Namen auswählen zu lassen

und so die Möglichkeit für Anonymität zu schaffen. Insbesondere jüngeren Führungskräften, die als Digital Natives an den Umgang mit Videospiele gewöhnt sind, bietet das Dashboard Tournament jedoch eine erfahrungsbasierte und damit effektive Möglichkeit, ihre Fertigkeiten bei der Informationsvisualisierung zu verbessern.

2.6 Essay: Developing Serious Games with Integrated Debriefing: Findings from a Business Intelligence Context

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Under review in:	Business & Information Systems Engineering
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2.6.1 Abstract

Serious games (SG) are recognized in several domains as a promising instructional approach. When it comes to the field of Information Systems (IS), however, they are not yet broadly investigated. Especially in business intelligence & analytics (BI&A), our literature review indicates the absence of SG for proper report design. Such games, however, seem beneficial since many business reports suffer from poor business information visualization (BIV). To address this issue, the scope of this study is twofold: First, we present a SG that aims to foster learning about BIV. Second, we evaluate this SG in a laboratory experiment, comparing it to a more conventional instructional approach (i.e., presentation) and testing two different versions of the game: One version integrates debriefing into the game itself, whereas the other version uses classical post-hoc debriefing. Results indicate that it is favorable to integrate debriefing into the game in terms of motivation and learning outcomes. In the vein of design science research, we thus intend to contribute a useful artifact as well as a novel design principle for this instructional approach: Integrating debriefing into SG.

2.6.2 Introduction

Serious games (SG) are recognized in several domains as a promising instructional approach (Connolly et al., 2012). Examples include health care (Basole et al., 2013), computer science (Papastergiou, 2009), and business (Faria et al., 2009). Among the desired and often realized outcomes of these games are increased motivation and learning (Connolly et al., 2012; Grund, 2015; Wouters et al., 2009). Despite its popularity in other domains, the field of information systems (IS) has not yet broadly investigated this instructional approach, although technology-related learning plays an important role for instance in digital transformation processes in organizations (Legner et al., 2017; Matt et al., 2015). While there are some studies about SG in the field of IS, they are seemingly not yet discussed in publications following the Design Science Research (DSR) paradigm (Grund & Meier, 2016). Hence, there is still a major opportunity for the field of IS to gain insights about how to design effective SG that help organizations to train their employees in IS-related skills.

One of the most prominent IS-related capabilities for future employees is handling the ever increasing amount of information (Chen et al., 2012). This includes analytical skills, business and domain knowledge as well as communication skills (Chen et al., 2012). Especially the latter often seems to be not prominently investigated in the domain of business intelligence & analytics (BI&A). This domain instead focuses mostly on analytical aspects like how to mine big data and not how the resulting findings are best presented to target audiences (Chen et al., 2012). Not surprisingly, many business reports (i.e., where results are communicated) suffer from poor business information visualization (BIV) (Beattie & Jones, 2008). Since decision makers relying on these flawed reports may be misled, it appears beneficial to develop SG with this focus to equip employees with appropriate reporting skills. Although the BI&A domain already provides some studies about SG, none of these games focus on report design and BIV yet (Grund & Meier, 2016).

To fill this gap, we set out to develop a SG that aims to increase BIV capabilities (namely being able to identify inadequate BIV and being able to suggest reasonable improvements) among players by letting them compete across several minigames (Grund & Schelkle, 2016). Each minigame confronts players with insufficient BIV, which they are supposed to avoid when designing reports. While prior research focused mainly on describing the development and architecture of this SG (Grund & Schelkle, 2016; Grund et al., 2017), the current study emphasizes its thorough evaluation. In particular, we are interested in the differences between learners playing our SG, and learners in a more conventional training condition (i.e., a presentation about the same BIV guidelines). Hence, we pose our first research question:

RQ1: Which effects on motivation and learning outcomes has using serious games for business information visualization compared to presentations?

One of the most important concerns of DSR is to generate knowledge about how an artifact is best designed to fulfill its purpose, which often includes designing different alternatives of an artifact (Hevner et al., 2004). For the development of SG, there are several possible design choices that may be investigated, including which game elements to use (Blohm & Leimeister, 2013), how to connect educational content with game content (Charsky, 2010) as well as how to facilitate the reflection on experiences after the game (Lederman, 1992). This last design aspect, which is often referred to as “debriefing”, is considered an essential part of any SG, where instructors discuss the learning content of the game after the experience to ensure learning outcomes (Garris et al., 2002). Many scholars even consider this the most crucial part of SG (Crookall, 1992; Lederman, 1992), since experiential learning has to be accompanied by appropriate learner support for effective learning to happen (Garris et al., 2002; Kolb, 1984). Despite its importance for learning in SG, this design aspect is often not prominently investigated or even ignored by SG scholars (Crookall, 2010). In addition, the conventional approach of conducting debriefing after the game experience may be costly and time-consuming,

since it requires participants of SG to be spatially and/or temporally synchronized with an instructor or so-called “debriefing” (Lederman, 1992). To overcome this drawback, integrating the debriefing into the game itself may be a viable solution. However, prior research has thus far not directly compared integrating debriefing into the game with conducting it in an often advocated post-hoc manner. We therefore pose our second research question to investigate this design principle:

RQ2: Which effects on motivation and learning outcomes has integrated debriefing in comparison to post-hoc debriefing as a design principle for Serious Games?

To address these research questions, we developed a SG for BIV and evaluated it in a multivariate 1x3 between-group laboratory experiment at a German University. Two groups played different versions of the game and one group was attending a presentation about the same learning content, which represented a more conventional training method. In this paper, we present and discuss the results of this experimental evaluation. Hence, this article is structured as follows: First, we describe our terminology and related work in section 2.6.3. Second, the theoretical background alongside hypotheses for the evaluation are presented in section 2.6.4. Section 2.6.5 provides a brief description of the developed artifact which is evaluated in section 2.6.6. The paper closes with a discussion and conclusion as well as an outlook on future research in sections 2.6.7 and 2.6.8.

2.6.3 Terminology and Related Work

In the following, we describe the terminology as well as related work for both SG that foster BIV skills and debriefing in SG.

2.6.3.1 Serious Games for Business Information Visualization

To investigate whether there are similar approaches to our proposed SG, we aim to characterize the state of the art of BIV as a learning goal or a learning outcome in SG. In this context, information visualization is defined as using computer-supported, interactive graphical representations of abstract data to amplify cognition (Card et al., 1999). When information visualization technologies are used to depict business information (e.g., with tables or column charts) it is referred to as BIV (Tegarden, 1999). SG may be characterized as games that have an “explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement” (Abt, 1987). In our case, we thus intend to identify SG that incorporate BIV capabilities as their educational purpose.

In a basic overview of SG, Susi et al. (2007) find that communication skills (i.e., effectively presenting ideas when speaking, writing, etc.) are important for employees in corporations. Although this might include BIV, this learning goal is not explicitly stated. Connolly et al. (2012) investigate empirical evidence on the learning outcomes of computer games and SG in a systematic literature review. Out of the 129 publications they identified, 17 higher quality studies report knowledge acquisition and content understanding outcomes. However, none of these studies mention BIV as a learning outcome. Another literature review about the learning outcomes of SG conducted by Wouters et al. (2009) concludes that cognitive learning outcomes (i.e., knowledge and cognitive skills) can be observed in 12 out of the 28 empirical studies investigated. Although they argue that SG seem to be effective when it comes to cognitive learning outcomes, BIV was again not a learning goal in any of the studies. In a recent literature review about using SG to improve the decision process, Grund and Meier (2016) show that BIV is not addressed in their sample of SG that include business reporting. In summary, according to the investigations mentioned above, SG that specifically focus on improving BIV skills seem to be still missing. We intend to fill this gap with the SG described in section 2.6.5.

2.6.3.2 Debriefing in Serious Games

As mentioned above, debriefing plays a crucial role when it comes to SG. In an experiential learning context, debriefing may be defined as a process that allows participants to process meaningful experiences that happened during an activity, thus facilitating learning (Lederman, 1992). It is important to note that in this definition, debriefing takes place after learners have engaged in a learning activity, often in a guided discussion. This is also reflected in prior research on debriefing in SG.

In a special issue in 1992, the journal *Simulation & Gaming* called for research articles focusing on debriefing, since this topic seemed to be neglected by too many scholars (Crookall, 1992). Following this call, researchers contributed definitions of debriefing (Lederman, 1992), practical recommendations (e.g., Steinwachs, 1992), and technologies for debriefing (Thiagarajan, 1992). Ever since, research on debriefing in SG discussed how to design debriefing sessions and what makes debriefing effective (Der Sahakian et al., 2015; Kriz, 2010; Pavlov, Saeed, & Robinson, 2015; Qudrat-Ullah, 2007; Rudolph, Simon, Raemer, & Eppich, 2008). In an effort to provide a structure for the reflection phase in debriefing, Kriz (2010) lays out several parameters that may be taken into account, including the role of debriefers, the use of media, oral vs. written debriefing, etc. However, whether debriefing is integrated into the activity is not among these parameters. Instead, he only mentions that when the game is too lengthy, several small rounds of debriefing may be performed after each game round. This is, however, not an integration of the reflection into the game itself as debriefing and the gaming activity are still separated. Rudolph et al. (2008) propose that debriefing might be conducted as formative assessment. In contrast to summative assessment, where feedback is given after the activity, formative assessment immediately addresses shortcomings of participants (Rudolph et al., 2008). Although this approach seems similar to integrating debriefing into the learning activity, it focuses on giving feedback to increase participants' performance during the activity, rather than fostering reflection about the meaning of the activity. The literature reviewed above shows that while the importance of debriefing is

undisputed in the field of SG, studies explicitly investigating the differences between integrated debriefing and post-hoc debriefing seem to remain elusive. Hence, we examine this matter by utilizing two different versions of our SG. To lay out our reasoning as to why we expect differences between these two approaches, the theoretical background of this study is described below.

2.6.4 Theoretical Background and Hypothesis Development

Since SG are concerned with improving player capabilities as well as providing an entertaining experience, both learning and motivation theories are used in literature to explain the benefits of SG (Grund, 2015; Ryan et al., 2006; Wu, Hsiao, Wu, Lin, & Huang, 2012). To explain the motivational effects of our SG, we draw on self-determination theory (Deci & Ryan, 1985). One of its central assumptions is that intrinsic motivation (i.e., when individuals engage in behavior for the pleasure and satisfaction that they inherently experience with participation (Deci & Ryan, 1985)) requires the satisfaction of three basic psychological needs: Competence, relatedness, and autonomy. Findings in the context of self-determination theory show that video games in general foster intrinsic motivation by fulfilling these needs (Ryan et al., 2006). In our case, perceived competence may be fostered by players succeeding in the different minigames and earning points for doing so. Since players in a competition are unlikely to form meaningful social bonds, relatedness as it is described in self-determination theory may not directly be established by our SG. However, by having players compete with each other and using a leaderboard that allows for comparisons with other players, they might get a feeling of each other's social presence, which may be regarded a prerequisite for relatedness. Last, a sense of autonomy may be achieved by players being able to choose their own approaches of how to succeed in the minigames. In contrast, participants who only attend a presentation are not expected to experience competence, since they are only passively consuming (i.e., not receiving any performance feedback). Furthermore, we expect participants only attending a presentation to experience less social presence,

because they are not supposed to interact with each other. Last, perceived autonomy is expected to be below the participants in a SG setting, since only attending a presentation does not include influencing the course of actions. Resulting from these anticipated differences, we expect that participants in any SG condition will perceive higher intrinsic motivation than participants not playing the SG, since fulfilling these psychological needs fosters intrinsic motivation (Ryan & Deci, 2000; Sheldon & Filak, 2008). Often accompanied by increased intrinsic motivation is an increase in the perceived task value (Ryan, 1982). In our case, this task value refers to whether participants deem the learning activity as important and adequate for learning about BIV. Hence, we propose that participants who play any version of the SG show increased motivational outcomes compared to participants in a presentation setting according to self-determination theory. This leads to our first group of hypotheses:

- H1a: Participants who play any version of the serious game will experience higher autonomy than participants only attending a presentation.
- H1b: Participants who play any version of the serious game will experience higher competence than participants only attending a presentation.
- H1c: Participants who play any version of the serious game will experience higher social presence than participants only attending a presentation.
- H1d: Participants who play any version of the serious game will experience higher intrinsic motivation than participants only attending a presentation.
- H1e: Participants who play any version of the serious game will experience higher task value than participants only attending a presentation.

When it comes to expected differences between the two versions of our SG, the basic psychological needs described in self-determination theory may be used to provide possible explanations. As mentioned above, the first version of our SG includes debriefing during the gameplay, whereas the second version uses debriefing after the game (“post-hoc debriefing”). Hence, in both versions, players still solve the same tasks

and compete identically, which is why we do not expect differences in either perceived competence or social presence. However, we do expect a difference in perceived autonomy. The reason for this is that players who receive a debriefing after the game may perceive a shift in their locus of control, meaning that they no longer control what is going on after playing. Instead, either the debriefer or a debriefing video determines all following events. In contrast, when the meaning of the exercise is presented during the game, players may still opt to simply close this description after reading it, thus still being able to control what is being displayed and for how long. Since a change in any of the psychological needs may have an impact on intrinsic motivation (Sheldon & Filak, 2008), we further expect the intrinsic motivation of the integrated debriefing group to be higher due to a higher feeling of autonomy. Again, this may also positively impact the perceived task value of the group with integrated debriefing. Hence, we derive our second group of hypotheses:

- H2a: Participants who play the serious game with integrated debriefing will experience higher autonomy than participants who play the game with post-hoc debriefing.
- H2b: Participants who play the serious game with integrated debriefing will experience higher intrinsic motivation than participants who play the game with post-hoc debriefing.
- H2c: Participants who play the serious game with integrated debriefing will experience higher task value than participants who play the game with post-hoc debriefing.

Regarding the desired learning outcomes, prior studies suggest that participants who engage in experiential learning (e.g., playing SG) rather than only attending a presentation, show higher observed learning outcomes (Connolly et al., 2012; Wouters et al., 2009). The theoretical underpinning of this increased learning success is rooted in experiential learning theory (Kolb, 1984). Its main rationale is that individuals learn most effectively when they reflect on concrete experiences and actively experiment based on the resulting conceptualizations (Kolb, 1984). Since SG allow players to go through all

stages of the so-called learning cycle, we expect participants engaging in our SG to show higher observed learning outcomes than participants only attending a presentation. However, this is not the only reason for possible differences between the groups. The anticipated differences in intrinsic motivation may also lead to differences in observed learning outcomes, since several studies suggest a positive relationship between intrinsic motivation and learning (e.g., Kusurkar, Ten Cate, Vos, Westers, & Croiset, 2013; Taylor et al., 2014). Based on the anticipated differences in intrinsic motivation described above, we thus propose our third group of hypotheses:

H3a: Participants who play any version of the serious game will show higher learning outcomes than participants only attending a presentation.

H3b: Participants who play the serious game with integrated debriefing will show higher learning outcomes than participants who play the game with post-hoc debriefing.

To investigate these hypotheses, we will evaluate our SG after briefly describing it in the following section.

2.6.5 Artifact: Dashboard Tournament

To develop the Dashboard Tournament, we employed the human-centred design process (see Grund & Schelkle, 2016 for details). For its implementation, we used the game engine Unity with C# as its programming language. An overview of the game's technical architecture is provided by Grund et al. (2017). In the following, we briefly describe the game's educational purpose as well as its structure (for a more detailed description see Grund & Schelkle, 2016 and Grund & Schelkle, 2017).

2.6.5.1 Educational Purpose

As mentioned earlier, the Dashboard Tournament aims at improving BIV skills of players. A possible approach to improve these skills is conveying visualization guidelines that inform report design decisions. Although several guidelines for information visualization exist (e.g., Ware, 2012), only few focus on elements used specifically in business reports. One framework that highlights the design of business reports and presentations is called International Business Communication Standards (IBCS) (Hichert & Faisst, 2015). This framework comprises specific guidelines that showcase examples of poor BIV alongside their proposed corrections. We hence incorporated these guidelines in our SG to enable players to identify inadequate BIV and to suggest reasonable improvements. These two skills, namely being able to identify inadequate BIV and being able to suggest reasonable improvements, are what we refer to as BIV skills in this study. The specific guidelines included in our SG are described in the following alongside the structure of the game.

2.6.5.2 Game Structure

The Dashboard Tournament is a multiplayer SG featuring a competition across four minigames (Grund & Schelkle, 2016). Each minigame addresses one specific guideline for adequate BIV from different perceptual IBCS rule sets (Hichert & Faisst, 2015). An overview of the minigames implemented in the Dashboard Tournament is provided in Figure 1.

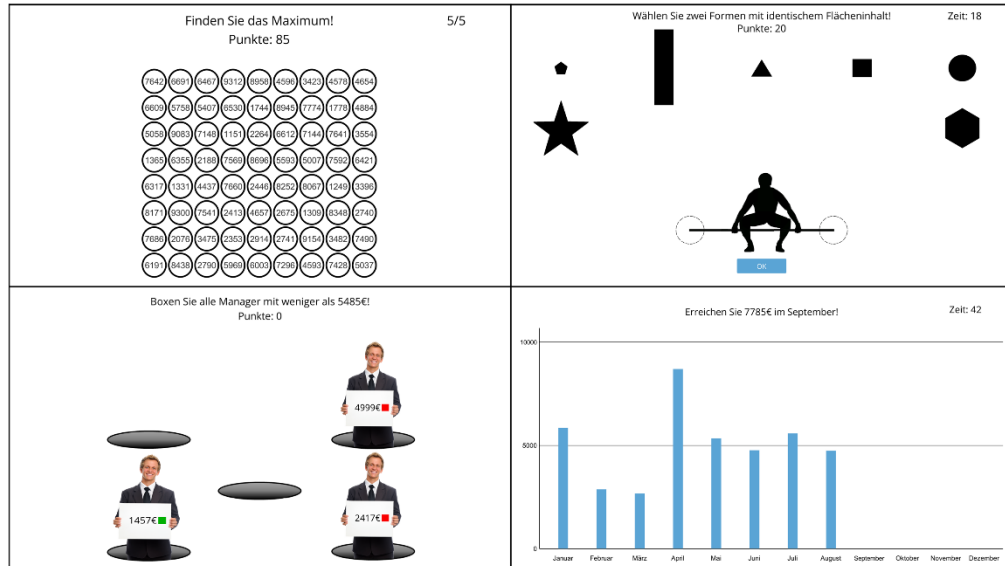


Figure 1: Minigames implemented in the Dashboard Tournament (Screenshots from the software used in the experiment)

The first minigame (upper left image in Figure 1) addresses the guideline CO 4.4 (Hichert & Faisst, 2015). This guideline recommends using graphical elements in tables to easily identify differences in size between numbers. The basic layout of the minigame is a grid of targets with numbers (similar to a table) without graphical support. Players only have limited time to identify the maximum value. Hence, players have to compare the numeric value of every target inside the grid, which causes high cognitive effort.

In the second minigame (upper right image in Figure 1), the guideline CH 3.1 is covered (Hichert & Faisst, 2015). This guideline advises against using area comparisons in reports (which is the case for example with pie charts) and instead suggests using length comparisons. To experience the difficulty of correctly comparing area sizes, players have to select two shapes with identical areas out of several different shapes and attach them to a weightlifting bar.

The next minigame (lower left image in Figure 1) is concerned with the guideline EX 2.5 (Hichert & Faisst, 2015). This guideline disadvises from using traffic light indicators in reports, since they distract from comprehending the actual numbers. To show this effect, players have to hit all managers holding numbers below a given threshold in a “Whac-A-Mole”-style minigame. Inconsistencies between the traffic light colors and the numbers lead to wrong decisions when players blindly trust the traffic light indicators.

The last minigame (lower right image in Figure 1) addresses the guideline SI 3.1 (Hichert & Faisst, 2015). This guideline recommends replacing value axes in column charts with data labels. Players are given a target value and hold a key to “grow” a column with the corresponding height. In doing so, players experience difficulties when estimating the exact height given only a value axis and gridlines.

The experienced difficulties in all four minigames lay the foundation for debriefing, where experiences may be reflected upon (Lederman, 1992). As mentioned in section 2.6.3, literature in the domain of SG suggests conducting a debriefing session after the learning activity took place (i.e., after all minigames are completed). To investigate the differences between this approach and integrating debriefing into the game itself, we developed two versions of the game: The first version shows participants the corresponding IBCS guideline after each minigame, explaining why several kinds of BIV should be avoided in business reports (“integrated debriefing”). In the second version, these explanations are missing and participants only play the minigames. Therefore, in the second version of the game, a conventional debriefing is required after the game for learning to take place (“post-hoc debriefing”). These two versions of the game are used in the experimental evaluation of our artifact which is described below.

2.6.6 Evaluation

To evaluate our artifact, we conducted a laboratory experiment. In the following, we describe the study setup, the development of the measurement instrument, as well as the results of this experimental evaluation.

2.6.6.1 Method, Participants, and Design

Following the DSR paradigm, this study aims to evaluate our developed artifact in order to generate design knowledge (Hevner et al., 2004). The purpose of this evaluation is twofold: First, we aim to evaluate an instantiation of our designed artifact to establish its utility and efficacy for achieving its stated purpose (Venable, Pries-Heje, & Baskerville, 2012), namely increasing motivation and learning. Second, we intend to evaluate our designed artifact in comparison to other designed artifacts' ability to achieve a similar purpose (Venable et al., 2012), as we seek to compare our SG featuring integrated debriefing with our SG using post-hoc debriefing. Since an artificial evaluation environment provides the benefit of controlling for possibly confounding circumstances and since the artifact has already been developed ("ex post evaluation"), we chose to conduct a laboratory experiment using a multivariate 1x3 between-group design, as suggested by Venable et al. (2012). Participants were recruited at a German University and comprised different fields of study. Since our SG is supposed to be used in higher education as well as in industry, this sample reflects both current students as well as prospective junior managers and report designers. In addition, since our SG targets laypersons in report design and since BIV is relevant in many professional domains, the sample was not limited to business students. Every participant received a monetary compensation for being included in the study. The demographics of participants are depicted in Table 1, grouped by the treatments described in the following.

Table 1: Demographics

		Group 1	Group 2	Group 3	Total
Gender	Male	7 (37%)	10 (59%)	9 (56%)	26 (50%)
	Female	12 (63%)	7 (41%)	7 (44%)	26 (50%)
Age	18-24	14 (74%)	14 (82%)	11 (69%)	39 (75%)
	25-34	5 (26%)	3 (18%)	5 (31%)	13 (25%)
Field	Business/Economics	11 (58%)	8 (47%)	8 (50%)	27 (51%)
	Industrial Engineering	3 (15%)	2 (12%)	2 (13%)	7 (13%)
	Law	2 (11%)	1 (6%)	3 (18%)	6 (12%)
	Education	2 (11%)	2 (12%)	2 (13%)	6 (12%)
	Others / Missing	1 (5%)	4 (23%)	1 (6%)	6 (12%)
Education	High School Degree	11 (58%)	12 (71%)	9 (56%)	32 (62%)
	University Degree	8 (42%)	5 (29%)	7 (44%)	20 (38%)

Participants have been randomly assigned to one of three groups: The first group played the Dashboard Tournament with integrated debriefing (i.e., corresponding guidelines were shown after each minigame). The second group played an identical game without the guidelines being shown and with a post-hoc debriefing afterwards. Last, there was a control group only attending a presentation about the same BIV guidelines. To ensure that the debriefing was delivered identically in groups 2 and 3, we used a video of a presentation as debriefing. Although literature usually suggests that debriefing should be personalized to the learners and include active discussions (Lederman, 1992), there are also findings indicating that video-assisted self-debriefing is on par with instructor-guided debriefing (Boet et al., 2011). Since competition and changing leaderboards may confound independency of observations, every participant was shown their own score alongside fictional competitor scores after playing. To assess the motivational effects of each treatment, participants in every group filled out post-experience questionnaires regarding motivational outcomes. For assessing learning outcomes, pre- and posttests addressed participants' BIV capabilities. To see whether these acquired capabilities are sustainable, posttests have been conducted one week after the treatment. A summary of this design is presented in Table 2.

Table 2: Experimental Design of the Evaluation

Group (N)	Pretest	Treatment	Post-Experience	Posttest
1 (19)	BIV skills	Integrated Debriefing	Motivation	BIV skills
2 (17)	BIV skills	Post-hoc Debriefing	Motivation	BIV skills
3 (16)	BIV skills	Presentation	Motivation	BIV skills

The measurement instrument utilized for post-experience questionnaires as well as for pre- and posttests is described in the following.

2.6.6.2 Development and Validation of the Measurement Instrument

The measurement instrument for post-experience questionnaires was mainly based on the intrinsic motivation inventory (IMI) that has been used in many studies to measure basic psychological needs as well as intrinsic motivation after an experience (Ryan, 1982). We included the subscales Interest/Enjoyment (i.e., intrinsic motivation), Competence, Autonomy, and Task Value. Changes have been made to the Autonomy subscale, which has been adjusted to express the amount of control and influence participants felt (Grund & Tulis, 2017). As described earlier, we did not measure relatedness of participants but rather social presence as a potential prerequisite for relatedness. For this, we drew from the Behavioral Engagement subscale of the “social presence in gaming questionnaire (SPGQ)” developed by de Kort, IJsselsteijn, and Poels (2007). To measure participants’ overall appreciation of video games, which may arguably confound their motivational outcomes in the treatments with our SG, we used the “Usefulness, Importance, and Interest” subscale from Wigfield and Eccles (2000). In our study, we refer to it as “Game Value”, since it expresses how each participant values video games in general. All items adapted and derived from other instruments were modified to relate to the context and translated into German. Items were assessed using a 6-point scale, ranging from 1 = *not at all true* to 6 = *very true*, and were randomized across all subscales. In addition to the questionnaire items, students were provided with space for leaving any comments or suggestions.

To validate the psychometric properties of the resulting instrument and to examine the overall model fit of our measurement model, we conducted a confirmatory factor analysis. After minor modifications (e.g., correlated errors, for an overview see Brown, 2015), our measurement model reached a satisfactory model fit according to generally accepted thresholds (Hu & Bentler, 1999). The ratio between χ^2 and df was 1.23, which is below the desired ratio of 3. The root mean standard error of approximation (RMSEA) was .068 and therefore within the range of acceptable model fit of .08. Last, both comparative fit index (CFI) and Tucker-Lewis index (TLI) are above their common suggested minimum value of .90 (CFI=.92 TLI=.91). We may hence conclude that our measurement instrument achieved a satisfactory model fit. In addition, we accounted for reliability of the scales by computing Cronbach's α , which ranges from .82 to .96 and is hence above the desired minimum of .70 (Krippendorff, 2004). To account for discriminant validity, we investigated the square root of the average variance extracted (AVE) of each construct in combination with the correlations between constructs (Fornell & Larcker, 1981; Gefen & Straub, 2005). As shown in Table 3, each inter-construct correlation lies below the square root of AVE of each construct, hence discriminant validity is demonstrated.

Table 3: Square root of AVE (bold) and Inter-construct Correlations

	IMOT	COMP	AUTO	SOP	TASKV	GAMV
IMOT	.74					
COMP	.14	.76				
AUTO	.33	.12	.80			
SOP	-.37	-.10	.48	.71		
TASKV	.47	.18	.31	.09	.80	
GAMV	-.07	.42	.10	-.01	.08	.88

To ensure convergent validity, standardized factor loadings (λ) are investigated for each construct. They range from .55 to .98 and are thus above the recommended minimum of .45 for a fair rating (Tabachnick & Fidell, 2013). Overall, construct validity is shown by confirming both discriminant and convergent validity.

Table 4 summarizes our measurement model in the post-experience questionnaire and shows its psychometric properties.

Table 4: Measurement Instrument (Post-Experience Questionnaire)

Factor	Item	M	SD	λ	α
Intrinsic Motivation (IMOT) (Ryan, 1982)	The session has been fun.	4.94	.85	.89	.82
	I thought the session was boring. (R)	5.21	.78	.72	
	I thought the session was quite enjoyable.	4.92	.84	.56	
	I enjoyed attending this session very much.	5.27	.66	.76	
Perceived Competence (COMP) (Ryan, 1982)	I think I was pretty good in this session.	4.08	.95	.85	.84
	I think I did pretty well in this session, compared to other students.	4.06	.94	.71	
	I am satisfied with my performance in this session.	4.63	.86	.74	
	I was pretty skilled in this session.	3.96	1.00	.71	
Perceived Autonomy (AUTO) (Grund & Tulis, 2017; Ryan, 1982)	In this session I could choose what to do.	2.19	1.21	.70	.86
	In this session I had the feeling to be able to co-determine.	1.98	1.02	.92	
	I had the feeling to be able to influence the session.	2.25	1.27	.66	
	I had the impression to be able to co-determine what happens.	2.04	1.08	.91	
Social Presence (SOP) (de Kort et al., 2007)	During the session, I felt close to the other students.	2.06	.94	.55	.86
	During the session, I sensed the presence of the other students.	2.58	1.29	.91	
	During the session, I sensed the attendance of the other students.	3.02	1.31	.76	
	During the session, I thought of the other students.	2.33	1.28	.65	
	During the session, I was wondering how the other students are doing.	3.02	1.61	.70	
	During the session, I was wondering how easy the task might be for the other students.	3.44	1.78	.63	
Task Value (TASKV) (Ryan, 1982)	I believe this session was of value to me.	4.19	1.16	.89	.91
	I think this session was well-suited for learning.	4.27	1.27	.80	
	I think this session was important to learn something about its content.	4.54	1.15	.87	
	I believe this session has helped me gain a better understanding.	4.19	1.21	.71	
	I believe that this session was beneficial to me.	4.52	1.08	.86	
	I think this session was important.	3.90	1.12	.60	
Game Value (GAMV) (Wigfield & Eccles, 2000)	Video games are interesting to me.	3.67	1.75	.98	.96
	Engaging with video games provides fun to me.	4.17	1.53	.88	
	Video games have a personal utility for me.	2.94	1.59	.87	
	Video games are beneficial to me.	2.48	1.32	.87	
	Being good at video games is important to me.	2.71	1.46	.77	
	Video games are important to me personally.	2.56	1.61	.91	

Learning outcomes have been assessed by comparing participants' initial knowledge of the IBCS guidelines included in our SG with their knowledge about these guidelines after the experiment. For this purpose, participants were provided with different examples of business reports and requested to suggest improvements. The provided reports suffered from inadequate BIV that is addressed by the guidelines covered in the different treatments. To keep participants from simply guessing, we also included obvious other mistakes that were not related to the IBCS guidelines addressed. We could hence check whether improvements suggested by participants complied with the BIV guidelines included in the treatment. If a participant did not suggest an improvement consistent with the IBCS guideline in the pretest but managed to do so in the posttest, we considered this an observed learning outcome of the participant. The flawed business reports presented to participants are shown in Figure 2.

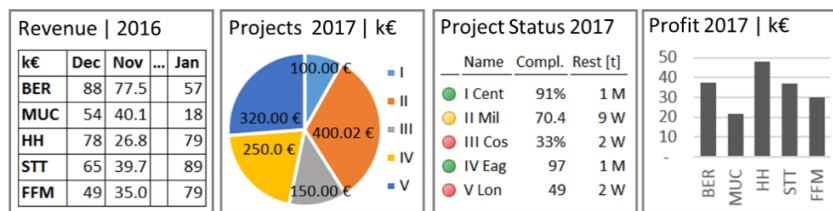


Figure 2: Flawed Business Reports (pre- and posttest of BIV skills)

2.6.6.3 Results

As a first analysis, we were interested in whether the perceived game value (GAMV) affects motivational outcomes (e.g., intrinsic motivation) among participants in SG conditions. To see potential influences of this variable, we investigated bivariate correlations between GAMV and the dependent variables in our first group of hypotheses (H1a-H1e). These correlations are presented in Table 5.

Table 5: Bivariate Correlations with the Control Variable (*p<0.05, **p<.01, ***p<.001)

	COMP	AUTO	SOP	IMOT	TASKV
GAMV (Group 1)	.69**	.17	.09	.30	.41
GAMV (Group 2)	.57*	.47	.28	-.23	-.03
GAMV (Group 1+2)	.59***	.19	.21	-.10	.19

According to Table 5, there have been significant correlations between GAMV and COMP in both groups. This seems reasonable, since individuals who value video games are more likely to have higher skills in them, thus assessing their own competence in a game-based activity as higher. However, this does not seem to influence other motivational outcomes, especially intrinsic motivation does not seem to be affected by GAMV. This might be a first indicator that aversion towards video games in general does not erode the motivational outcomes of the SG.

To investigate differences in motivation between our three experimental groups, we conducted a one-way MANCOVA with planned contrasts to test our hypotheses. This method of analysis is specifically useful when intercorrelations between dependent variables are expected (Tabachnick & Fidell, 2013), which is the case with our variables measuring different aspects of intrinsic motivation. Regarding the requirements for this analysis method, we first checked whether covariance matrices are equal among groups. This is the case, since Box's M test turned out non-significant (p=.45). Next, we used Levene's test for equality of error variances across groups, which turned out to be non-significant for all dependent variables except for perceived autonomy (p=.046). Hence, we adjusted the level of significance for this variable to p=.025 as suggested by Tabachnick and Fidell (2013). After checking for the requirements, we may proceed with our one-way MANCOVA. To account for the possible differences due to GAMV (see Table 5), we included it as a covariate in our group comparison. As dependent variables, we included all motivational outcomes described in our first group of hypotheses (H1a-H1e). The result of this analysis shows that the treatment led to significant differences

between groups with Wilk's $\Lambda=.63$, $p=.016$, and partial $\eta^2=.207$. Our covariate, namely GAMV, also had a significant impact on group differences with Wilk's $\Lambda=.74$, $p=.020$, and partial $\eta^2=.256$. To investigate the nature of these differences, we used planned contrasts in line with our hypotheses.

In a first contrast analysis, we aimed at testing our first group of hypotheses (H1a-H1e), namely whether participants in any SG condition show increased motivational outcomes compared to participants in a presentation. Hence, we used simple contrasts comparing the means of the two SG groups with the control group. The results of this analysis are shown in Table 6.

Table 6: MANCOVA Results for Control Group Comparisons (* $p<.05$)

H	Construct	M_{G1}	M_{G2}	M_{G3}	$M_{G1} - M_{G3}$	$M_{G2} - M_{G3}$	Support
H1a	COMP	3.78	3.56	3.48	.30	.08	Not supported
H1b	AUTO	2.64	2.11	2.35	.29	-.24	Not supported
H1c	SOP	2.27	2.58	2.15	.12	.43	Not supported
H1d	IMOT	3.41	3.04	3.30	.11	-.26	Not supported
H1e	TASKV	2.88	2.82	3.32	-.44*	-.50*	Supported (opposite)

Table 6 shows that, despite theoretically expected differences, there are no significant differences in terms of intrinsic motivation (H1d) and satisfaction of basic psychological needs (H1a-H1c) between the SG conditions and the control group. Surprisingly, H1e was supported in the opposite direction, indicating that participants in the control group found the presentation more important and appropriate for learning. Regarding our control variable GAMV, there was a significant impact on COMP ($p<.001$, partial $\eta^2=.232$). In other words, participants who valued games higher, felt higher competence.

To test our second group of hypotheses, a simple contrast between the two SG groups was used to investigate mean differences. Table 7 shows the results of this analysis.

Table 7: MANCOVA Results for Comparisons between SG Groups (*p<.05)

H	Construct	M_{G1}	M_{G2}	$M_{G1} - M_{G2}$	Support
H2a	AUTO	2.64	2.11	.53	Not supported
H2b	IMOT	3.41	3.04	.37*	Supported
H2c	TASKV	2.88	2.82	.06	Not supported

Although perceived autonomy did not differ significantly between the two groups, the group with integrated debriefing reported significantly higher intrinsic motivation. This is interesting, since there is no significant difference in any of intrinsic motivation's antecedents proposed by self-determination theory. In addition, there was no significant difference in perceived task value.

Regarding the learning outcomes, we were interested in whether participants were able to increase their knowledge about BIV guidelines in each group. As described earlier, an observed learning outcome shows when participants were not able to make a suggestion in accordance with the IBCS guideline in the pretest, but were able to do so in the posttest. Since this kind of comparison is essentially a within-subject analysis, we used dependent t-tests to observe increases in BIV knowledge for each group. Table 8 shows the results of this analysis.

Table 8: Learning Outcomes per Group (*p<.05, **p<.01, ***p<.001)

Guideline	Integrated Debriefing (N=19)			Post-hoc Debriefing (N=17)			Control Group (N=16)		
	M_{PRE}	M_{POST}	ΔM	M_{PRE}	M_{POST}	ΔM	M_{PRE}	M_{POST}	ΔM
CO 4.4	.32	.68	.37**	.12	.53	.41**	.44	.56	.12
CH 3.1	.16	.63	.47**	.24	.35	.12	.19	.69	.50**
EX 2.5	.05	.42	.37*	.00	.35	.35**	.06	.75	.69***
SI 3.1	.26	.74	.47**	.24	.41	.17	.13	.69	.56**

As can be seen in Table 8, participants who played the SG with integrated debriefing were able to significantly increase their knowledge about all four BIV guidelines. For instance, 32% of the participants in this group were already familiar with the guideline CO 4.4 in the pretest. In the posttest, 68% of the participants were able to make the correct suggestion. This increase of 37 percentage points was statistically significant at the $p < .01$ level. Looking at the learning outcomes in the SG group with post-hoc debriefing, we find that only knowledge about half of the guidelines presented could be significantly increased (namely CO 4.4 and EX 2.5). Last, in the control group, knowledge about three out of the four guidelines could be significantly increased. These findings indicate that integrating debriefing into SG may yield the highest learning outcomes. Using SG with post-hoc debriefing, however, seems to be even inferior to conventional presentations. This means that, with regard to hypothesis H3a, we did not find support that using any version of our SG yields higher learning outcomes than providing only a presentation: It is important how the debriefing is integrated into the learning activity. Regarding hypothesis H3b, we found that integrating debriefing into the SG seems superior to conducting it in a classical post-hoc manner, since knowledge about twice as many guidelines could be significantly increased.

Regarding participants' comments on their experiences, we conducted a summative qualitative content analysis (Hsieh & Shannon, 2005). We investigated two different open questions: First, what did participants like about the session? And second, what should be changed about the session? Answers were manually assigned to categories by the authors in a consensual procedure for each of the SG groups. Only comments about the SG and debriefing were analyzed (not, for instance, comments on the questionnaires used). Table 9 shows which aspects have been mentioned by participants.

Table 9: Results of the Summative Qualitative Content Analysis

Group	Participants liked	#	Participants wished for	#
Integrated Debriefing	Debriefing	7	Longer game	1
	Game overall	5	Longer tutorials	1
	Competition	2	More precise tutorials	1
	Tutorials	2	Less waiting time	1
	Interactivity	1	More comparisons	1
	Feeling of success	1	Longer display of results	1
	Variety	1		
Post-hoc Debriefing	Game overall	8	Better video quality	1
	Debriefing	2	Less waiting time	1
	Variety	2	Slower presentation	1
	Competition	1		
	Interactivity	1		
	Tutorials	1		

As can be seen in Table 9, participants in the SG group with integrated debriefing most often mentioned the debriefing as their favorite part of the game, followed by statements that referred to the game itself as a positive experience (without further differentiation). In the group with post-hoc debriefing, however, debriefing was only mentioned by two participants as something they liked about the session. In this group, the game itself received the most positive remarks. This indicates that debriefing was more popular in the group with integrated debriefing. The game overall, however, was apparently appreciated in both groups. Recommendations for improving the game are scattered and span from longer gameplay to improved instructions in the game (i.e., tutorials). They do not indicate a single major issue with the game in both groups. These and other aspects of our results will be discussed in the following section.

2.6.7 Discussion

Looking at the results described above, there are several unexpected findings. First and foremost, contrary to what we expected, we found no differences in intrinsic motivation and satisfaction of basic psychological needs in the SG groups compared to the group only attending a presentation. Although particularly the group with integrated debriefing

showed higher means in these variables, none of these differences turned out to be significant. In addition, the control group reported significantly higher task value than both SG groups. In other words, participants attending a presentation rated it more appropriate for learning about BIV guidelines than both SG groups. A possible explanation for this might be that students are used to presentations as a prevalent method of knowledge distribution. Hence, when they attend an apparently interesting presentation, they rate it as highly appropriate for learning. In contrast, students are usually not used to play games for learning, they may thus be more hesitant to rate them as a very useful activity. Regarding the lack of motivational differences, the effect size of using SG on the basic psychological needs as well as intrinsic motivation may be too small for the present sample size in this study. The effect size of integrating debriefing versus conducting it in a post-hoc manner, however, seems to be higher. This is shown by a significant difference in intrinsic motivation between these two groups. Participants who played our SG with integrated debriefing enjoyed the experience more than participants who played it with post-hoc debriefing. Interestingly, however, this difference may not be explained with the hypothesized difference in perceived autonomy, since it did not turn out to be significant. This finding, alongside the lack of significant differences in satisfaction of basic psychological needs between the SG groups and the control group, may indicate that an additional theoretical lens for describing motivational differences might be beneficial in future studies.

Differences in learning outcomes show that integrating debriefing into SG may not only lead to higher intrinsic motivation, but also to increased learning outcomes. More specifically, participants who played the game with integrated debriefing were able to significantly increase their knowledge about twice as many BIV guidelines compared to participants in the post-hoc debriefing group. This is in line with our expectation that increased motivation in the integrated debriefing group may foster learning outcomes. When compared to the control group, participants in the integrated debriefing group showed slightly higher learning outcomes and participants in the post-hoc debriefing group showed slightly lower learning outcomes. This may indicate that when using SG

with post-hoc debriefing, participants may actually learn less than in a regular presentation. A possible reason for this is the temporal proximity of reflection on the activity. While participants in the integrated debriefing group are asked to reflect about each minigame immediately after they played it, participants with post-hoc debriefing are forced to remember their experiences in each minigame. Although this does not seem like a daunting task, given that only four minigames are played, this form of debriefing apparently leads to less learning. Interestingly, although participants in the control group deemed the session as more important and appropriate for learning, they seem to have fewer learning outcomes than participants in the integrated debriefing group. This indicates that while SG seem to be able to increase learning outcomes compared to conventional training methods, they are not yet recognized as “serious” enough. Regarding the qualitative comments of participants, we also find support for integrating debriefing into SG. While most participants in the group with integrated debriefing mentioned this very debriefing as a positive aspect of the session, only two participants in the group with post-hoc debriefing explicitly mentioned the debriefing as something they liked. However, they did mention the game overall as a positive aspect of the session, indicating that when integrating debriefing into the game, it is perceived as a part of the game instead of a separated learning activity, which may also explain its higher success in fostering learning outcomes.

Regarding the findings discussed above, this study provides several contributions customary to DSR (Briggs & Schwabe, 2011). The first mode of inquiry we employed is applied research and engineering, which leads to instances of generalizable solutions, proof-of-concept prototypes, and evidence that solutions are useful and generalizable (Briggs & Schwabe, 2011). In our case, we developed and evaluated the (according to our literature review) first SG about BIV, thus contributing a novel artifact to the domain of BI&A. In a laboratory experiment, we showed that this SG is useful for increasing knowledge about BIV guidelines and is appreciated by participants judging by their qualitative comments. When compared to a more conventional instructional approach (i.e., a presentation), we did not find significant differences in motivation from the

theoretical lens of self-determination theory. However, providing the SG with integrated debriefing indicates higher learning outcomes than a conventional presentation. Concerning our first research question (i.e., “*Which effects on motivation and learning outcomes has using Serious Games for Business Information Visualization compared to more conventional presentations?*”), we may thus conclude that while not necessarily leading to increased motivation, SG may improve learning outcomes compared to conventional training methods. Regarding the generalizability of these findings, it is important to note that the presentation in the control group was not varied (i.e., we only investigated one specific presentation). To thoroughly compare SG with conventional training methods, we also must alter different aspects of presentations (e.g., length or quality of visual support). This is an opportunity for future research, as we are unlikely to ever conclude that one way of instruction is superior to another, but rather that different designs of each instructional approach lead to different effects and outcomes.

The second mode of inquiry leading to DSR contributions used in this study is experimental research (Briggs & Schwabe, 2011). This mode of inquiry leads to hypotheses, experimental designs, and analyzed data sets (Briggs & Schwabe, 2011). With these contributions, DSR aims to measure the degree to which design objectives have been achieved. In this study, hypotheses have been derived from self-determination theory, which served as the kernel theory for artifact construction. As an important contribution, we developed a measurement instrument that may be used in future studies about SG in the IS domain. Using this measurement instrument, we were able to show that one of the most important dependent variables, namely intrinsic motivation, significantly differed between the groups with integrated and post-hoc debriefing. In addition, learning outcomes seem to be higher when debriefing is integrated into the SG. Being the (according to our literature review) first study that deliberately investigates the differences between integrated and post-hoc debriefing by implementing two different versions of a SG, we contributed to the design of effective SG. Thus, with regard to our second research question (i.e., “*Which effects on motivation and learning outcomes has integrated debriefing in comparison to post-hoc debriefing as a design principle for*

Serious Games?”), we may conclude that integrating debriefing into SG may yield beneficial outcomes in terms of learning and motivation compared to post-hoc debriefing, thus being a promising design principle for SG. One limitation of this finding might be the way that debriefing was conducted in the group with post-hoc debriefing. Although there are studies indicating that video-assisted self-debriefing is on par with discussion-based debriefing with an instructor (Boet et al., 2011), this was not investigated in this study. Hence, future research should deliberately examine whether our findings about integrated debriefing may be replicated when compared to discussion-based post-hoc debriefing.

2.6.8 Conclusion

This study set out to evaluate a SG about BIV, which likely constitutes a novel artifact in the domain of BI&A. In addition, we investigated the role of integrated debriefing in SG, which has thus far not been deliberately examined. Our findings indicate that SG are able to increase BIV skills and are acknowledged by participants. We also found that integrating debriefing into SG may yield significant benefits: It leads to higher motivation and learning outcomes compared to SG with post-hoc debriefing. This might be an important finding, especially since SG still heavily rely on this post-hoc debriefing. In addition, findings indicate that SG with integrated debriefing may enhance learning compared to conventional presentations. SG with post-hoc debriefing, however, seem inferior to these presentations. We thus found evidence that simply using SG will not necessarily increase learning and motivation compared to conventional training methods. Instead, it is important to thoroughly investigate design principles for SG in order to harness their potential. This study hence invites the field of IS to examine SG in the tradition of DSR in future studies. This may not only lead to increased design knowledge about SG, but also help to support ongoing learning processes in organizations facing the challenges of digital transformation.

2.7 Essay: Increasing Information Visualization Compliance in Self-Service Business Intelligence with User Assistant Systems

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Under review in: ECIS 2018 Proceedings

2.7.1 Abstract

Self-Service Business Intelligence (SSBI) is increasingly used in organizations. While enabling laypersons in report design to create their own reports in a timely manner, studies show that Business Information Visualization (BIV) is often inappropriately applied in these reports. This may lead decision makers to wrong conclusions. As a result, companies start to establish BIV governance frameworks, which employees are expected to comply with when designing reports. For this, they often provide employees with documentations about which guidelines to comply with. However, since employees may perceive this as additional effort with limited benefit, they may opt to simply not comply. If they are instead equipped with software that provides the functionality to comply, this software often lacks a description of the benefits of this compliance. To overcome this, user assistance systems (UAS) could be used, since they may both reduce the effort to comply as well as describe the usefulness of compliance. To investigate this issue, we developed a prototypical UAS for BIV, suggest a design for a laboratory experiment, and present findings from a first preliminary study. Results indicate that using UAS for BIV may lead to increased perceived ease of use and perceived usefulness of complying with BIV guidelines.

2.7.2 Problem Identification and Research Objective

To design business reports, Self-Service Business Intelligence (SSBI) is increasingly utilized in organizations (Bange et al., 2017). Here, laypersons in report design may use multiple features (e.g., visualizations) to develop their own business reports in a timely manner and share them with decision makers (Poonnawat & Lehmann, 2014). Due to their lack of report design knowledge, however, they often do not correctly apply Business Information Visualization (BIV) within their SSBI reports (Beattie & Jones, 2008; Eisl et al., 2015), which leads to wrong impressions due to a distorted perception (Arunachalam, Pei, & Steinbart, 2002). Thus, decision makers who receive and rely on these delusive business reports may be misled and conclude inappropriately (Arunachalam et al., 2002; Beattie & Jones, 2008). To avoid these negative outcomes, approximately 75% of companies strive for a standardized reporting (Riedner & Janoschek, 2014). In doing so, they often establish BIV governance frameworks in the organization, which employees are expected to comply with when designing business reports (Bange et al., 2017; Gluchowski, 2014; Russom, Stodder, & Halper, 2015). For this, they often provide employees with documentations about which guidelines to comply with. However, since employees may perceive this as additional effort with limited benefit, they may opt to simply not comply (Riedner & Janoschek, 2014). If they are instead provided with software that provides the functionality to comply, this software often lacks a description of the benefits of this compliance, which in turn may reduce the intention to comply with BIV guidelines. Possible consequences of this lack of assistance with complying and explaining the benefits of compliance are frustration and low efficiency of employees, resulting in overall dissatisfaction (Coch & French, 1948).

It is hence imperative to strive for a solution that makes it both easy for employees to comply with BIV guidelines and raises their understanding for the usefulness of complying with them at the same time. Due to their various applications, a promising approach to achieve these goals is the use of user assistance systems (UAS) (Ludwig, 2015). They help users to perform their tasks better (Maedche, Morana, Schacht, Werth,

& Krumeich, 2016) and hence, may increase the perceived ease of use of complying with BIV guidelines. In addition, when UAS are equipped with informative explanations as to why suggestions are made, they may raise an understanding of the perceived usefulness of complying with BIV guidelines (Morana, Schacht, Scherp, & Maedche, 2017). According to the technology acceptance model (TAM) introduced by Davis (1986), this may in turn lead to an increased intention to comply with BIV guidelines.

In this study, we hence introduce a design science research (DSR) project that aims to develop a UAS that supports employees in complying with BIV guidelines. During the first design cycle, we focused on describing the development of a prototypical artifact, the “BIV Assistant” (Schelkle, 2017). With this current study, we aim to investigate how UAS for BIV may affect the intention to comply with BIV guidelines in management reporting. Having conducted a systematic literature search, based on our sample, we could not identify prior research that explicitly concerns questions whether UAS may actually foster the intention to comply with guidelines (see section 2.7.3). Therefore, we set out to evaluate a prototypical UAS for BIV to answer the following research question:

RQ: To what extent do UAS affect the intention to comply with BIV guidelines in management reporting, in particular in an SSBI environment?

To achieve this, we aim to evaluate this prototypical UAS for BIV in a laboratory experiment. Herewith, we follow the call of Maedche et al. (2016) to study the effects of UAS in the information systems (IS) domain. This research in progress suggests an experimental design for our planned evaluation and provides findings from a preliminary study.

The remainder of this paper is structured as follows. Section 2.7.3 discusses related work followed by the terminology and theoretical background in section 2.7.4. Section 2.7.5 briefly describes the functionality and design of the artifact. The experimental setting and first evaluation results are presented in section 2.7.6. The paper closes with a conclusion and outlook for future research possibilities.

2.7.3 Related Work

To see whether UAS are used to foster acceptance of and intention to comply with guidelines, knowledge and solutions from prior literature have to be discussed (Peppers et al., 2007). Hence, we conducted a structured literature review drawing on the taxonomy of Cooper (1988) (see Table 1).

Table 1: Taxonomy of Literature Reviews proposed by Cooper (1988)

Focus	Research Outcomes	Research Methods	Theories	Applications
Goal	Integration	Criticism	Central Issues	
Perspective	Neutral Representation	Espousal of Position		
Coverage	Exhaustive	Exhaustive & Selective	Representative	Central/Pivotal
Organisation	Historical	Conceptional	Methodological	

We *focus* on the identification of research outcomes on compliance with guidelines by using UAS as applications. The *goal* is to identify central issues in prior research that investigate UAS, which are used to affect the intention to comply with predefined BIV guidelines. Since our aim is to identify existing UAS, which evaluate the intention to comply with guidelines, we adopt a neutral *perspective*. Focusing on UAS as well as BIV as central aspects, we follow a *pivotal* approach. The search is *organized* conceptually, i.e., studies addressing the same idea, UAS used for compliance, appear together.

Since studies related to BIV are fundamentally multidisciplinary, we included literature from prior research in computer science and human visual perception (IEEE Xplore and ScienceDirect) as well as business and management (Emerald Insight) in our literature search. To reflect the AIS Senior Scholars' Basket of Journals and important conference proceedings in the IS field, we added the AIS Electronic Library. To complement the search, we included specific management accounting and IS journals (i.e., HMD Praxis der Wirtschaftsinformatik, Journal of Management Accounting Research, Journal of International Financial Management, and Accounting and Management Accounting Quarterly). We conducted a keyword search comprising title, abstract, and keywords applying the search term "*User Assistance System*" OR "*User Assistant*" OR "*User Support System*" OR "*Assistenzsystem*" to reveal literature in the above-mentioned outlets.

As result, 49 articles that deal with UAS could be identified (Due to length limitations, we are not able to list all identified references. The list can be provided upon request). These range from assistance in healthcare (e.g., Henkemans, Neerincx, Lindenberg, and van der Mast (2006)) and ambient assisted living (e.g., Schneider, Stahl, and Wiener (2016)) to education (e.g., Carlier and Renault (2010)) and many more. However, only one article is related to the information visualization domain and discusses a UAS that suggests to users different mappings between their data and possible visualizations (Guettala, Bouali, Guinot, & Venturini, 2012). Although this study shows the potential of using UAS for BIV, compliance with specific BIV guidelines is not addressed. Six out of the 49 articles are related to acceptance. Four articles present technological aspects of acceptance, such as the importance of dialogues (Henkemans et al., 2006), the acceptance of augmented reality (Bleser, Hendeby, & Miezal, 2011), the acceptance of smart watches versus mobile phones among dementia patients (Schneider, Reich, Feichtenschlager, Willner, & Henneberger, 2015), or pilots accepting a new cockpit assistance system due to its features (Onken & Walsdorf, 2001). The remaining two articles discuss an algorithm for a lecture allocation system at a university, in which students may accept the assigned

lecture (Matsuo & Fujimoto, 2005a, 2005b). As a result, with our conducted search, we could not identify studies that discuss how UAS may affect the intention to comply with BIV guidelines. Although there might be relevant publications in other outlets, we suppose that our literature review has a satisfying degree of comprehensiveness, since researchers argue that a search can be terminated when the authors are confident of the novelty of the identified area (Boell, Sebastian K. & Cecez-Kecmanovic, 2010). Hence, we claim that our search shows a research gap that we intend to bridge with our study.

2.7.4 Terminology and Theoretical Background

To establish a theoretical underpinning for how UAS might affect the intention to comply with BIV guidelines, we may first look at previous work on compliance in IS literature. A domain within IS that strongly focuses on user compliance is security, as there are many security policies that employees are expected to comply with in order to prevent organizations from potentially dire consequences (Bulgurcu, Cavusoglu, & Benbasat, 2010). In this context, it is argued that when it comes to an individual's decision whether to comply with such policies, they take into account both the benefit of complying with the policy as well as the cost of complying with the policy (Bulgurcu et al., 2010). The reasoning for this is rooted in rational choice theory that posits that individuals take these parameters into account for any decision at hand (McCarthy, 2002; Paternoster & Pogarsky, 2009). Hence, in our context, individuals might also trade off their personal benefit of complying with BIV guidelines as well as the effort caused by complying with these guidelines. According to the theory of planned behavior, this has an effect on their attitude towards complying with BIV guidelines which in turn may influence the intention to comply with BIV guidelines (Ajzen, 1991; Fishbein & Ajzen, 1975). Additional important constructs that affect the intention to comply with security policies are self-efficacy to comply and normative beliefs (Bulgurcu et al., 2010).

Self-efficacy to comply describes whether individuals believe they have the abilities and knowledge to comply with the policies whereas normative beliefs express social pressure to comply with these policies. Again, in our context, we expect to observe effects of self-efficacy with regard to complying with BIV guidelines as well as social norms that urge individuals to comply with BIV guidelines.

A prominent theoretical framework that ties these streams of thought together is the TAM (Davis, 1986). It postulates that an individual's intention to use a system (or in our case to comply with BIV guidelines) is determined by perceived usefulness and perceived ease of use (Davis, 1986). Perceived usefulness is defined as the extent to which a person believes that using a particular system will enhance job performance (Davis, 1986), which might in our case be interpreted as the benefit individuals expect from complying with BIV guidelines. The degree to which a person believes that using a particular system will be free of physical and mental effort is defined as perceived ease of use (Davis, 1986), which in our case refers to the individual's cost or effort of complying with BIV guidelines. Thus, when perceived ease of use (i.e., little effort to comply with BIV guidelines) and perceived usefulness (i.e., benefits from complying with BIV guidelines) are high, individuals have a high intention to use a system, or in our case, intention to comply with BIV guidelines.

One promising approach to increase the aforementioned antecedents of intention to comply with BIV guidelines is using UAS. They guide users (e.g., management accountants) while performing a specific task (e.g., designing business charts) (Maedche et al., 2016), thus fostering perceived ease of use of the task at hand. Since UAS provide guidance or advice on a topic (Maedche et al., 2016), for example on how to adequately apply BIV, they might also foster perceived usefulness of complying with BIV guidelines, as the reason why to use them and what benefits this compliance might have are shown. In addition, this may foster self-efficacy about how to appropriately design business reports. Since SSBI users are at some point novices in report design, they are likely to have a low reporting-related self-efficacy (i.e., the belief in one's capabilities to organize

and execute the courses of action required to manage prospective situations (Bandura, 1995)) to design non-misleading reports. Hence, we also investigate how UAS may increase their perceived BIV related capabilities and thus their self-efficacy. Although normative beliefs in general play a role for the intention to comply with BIV guidelines, we do not expect a UAS for BIV to influence social pressure to comply with BIV guidelines, as accepting the system's recommendations is the users' decision. We hence propose the following hypotheses:

- H1: Using UAS for BIV increases the intention to comply with BIV guidelines.
- H2: Using UAS for BIV increases the perceived usefulness of complying with BIV guidelines.
- H3: Using UAS for BIV increases the perceived ease of use of complying with BIV guidelines.
- H4: Using UAS for BIV increases reporting-related self-efficacy.

In line with the propositions introduced in the TAM, we also expect to see positive relationships between the intention to comply with BIV guidelines and its antecedents. We thus propose:

- H5: There is a positive relationship between the perceived usefulness of complying with BIV guidelines and the intention to comply with BIV guidelines.
- H6: There is a positive relationship between the perceived ease of use of complying with BIV guidelines and the intention to comply with BIV guidelines.
- H7: There is a positive relationship between reporting-related self-efficacy and the intention to comply with BIV guidelines.

To investigate these hypotheses, we will propose an experimental design as well as results from a preliminary study in section 2.7.6. First, we will briefly describe the functionality and design of the artifact.

2.7.5 Functionality and Design of the Artifact

2.7.5.1 Desired Functionality

The desired functionality of our UAS called “BIV Assistant” is divided into three steps (Schelkle, 2017). First, it screens business charts for inadequate BIV. This might for example be a truncated axis that exaggerates the magnitude of a trend. Second, a warning is prompted to the user that explains the visual deficiency according to BIV guidelines from the International Business Communication Standards (IBCS) Association. These guidelines describe how to assure appropriate BIV, referring to prominent information visualization literature (Hichert & Faisst, 2015). In consequence, users may perceive adequate BIV as being useful to support decision making, thus fostering perceived usefulness of complying with BIV guidelines. Last, the user decides if the BIV Assistant automatically amends the inadequate BIV by applying the guideline presented in the previous step. Since complying with BIV guidelines in this case is reduced to the click of a button, it may result in increased perceived ease of use. According to the TAM, this may lead to an increased intention to comply with BIV guidelines.

The current prototype of the BIV Assistant detects four different misleading visualization patterns (i.e., truncated axis, inverted timeline, filtered elements on the ordinate axis, and differently scaled axes) (Schelkle, 2017). This refers to Courtis (1997) who examines annual reports on inadequate visualizations and illustrates the above described misleading patterns along with improved versions.

2.7.5.2 Design of the Artifact

With its characteristics, the BIV Assistant provides guidance to users on how BIV guidelines have to be applied. Therefore, we draw on the integrated taxonomy of guidance design features proposed by Morana et al. (2017) to assure a comprehensive design of the artifact. This taxonomy characterizes the dimensions audience, target, mode, directivity, invocation, timing, intention, content, format, and trust-building (Morana et al., 2017).

SSBI is intended to be used by any employee who has to conduct business analyses and design business reports, no matter their expertise. Therefore, we primarily focus on BIV novices as *audience*, since they appear more likely to need assistance.

To increase the perceived ease of use, the *target* of the BIV Assistant is to facilitate to comply with BIV guidelines, which can be seen as engaging in a given activity (Morana et al., 2017). In our case, the BIV guidelines are determined by the IBCS (see above). Hence, as *mode* of assistance we draw on a predefined framework. Since the task to comply with these guidelines can be complex, the BIV Assistant *directs* the user to adhere to the IBCS, which may result in a perceived ease of use of complying with BIV guidelines. UAS ought to reduce users' mental working memory effort and should not additionally burden the user with interruptions at the wrong time (Gregor & Benbasat, 1999). Hence, a user-triggered *invocation* and retrospective *timing* is chosen. Since the BIV Assistant does not constantly interrupt the multi-staged BIV process (Ware, 2012), the user remains in their thought process and gets assistance upon request.

To increase the perceived usefulness of complying with BIV guidelines, the BIV Assistant shows warning messages and thus informs what elements of the visualization can lead to a distorted perception (e.g., avoid truncated axes (Hichert & Faisst, 2015)). The *intention* of the warning is twofold. First, it is used to clarify why a specific inappropriately visualized element is misleading. Second, it provides working explanations and expert knowledge (i.e., terminological *content*), drawing on the know-how from the IBCS. The presentation *format* of these warnings are a combination of text and image. For the textual description of the misleading element, the BIV Assistant

displays explanations provided by the IBCS. Since textual descriptions may have some limitations in terms of comprehension (Kuechler & Vaishnavi, 2006) and bear language barriers (Morana et al., 2017), we complement the warning with an image of the improved business chart.

Trust in assistance, such as receiving guidance on why and how to comply with BIV guidelines, can have a strong effect on users' intention to follow suggestions (Morana et al., 2017). Therefore, we intend to proactively *build trust* and hence increase reporting related self-efficacy by applying guidelines from the IBCS, which describe how to assure appropriate BIV.

In summary, the design aspects, which may lead to an increased perceived ease of use and perceived usefulness of complying with BIV guidelines as well as increased reporting self-efficacy may help to foster the intention to comply with BIV guidelines.

2.7.6 Experimental Evaluation

2.7.6.1 Evaluation Design, Participants, and Procedure

To evaluate the artifact's performance, it should be evaluated against its research objectives (Peffer et al., 2007). With this study, we want to suggest an experimental design that helps to gain insight to what extent UAS affect the intention to comply with BIV guidelines, in particular in an SSBI environment. In addition, we ran a first preliminary study to investigate whether the suggested design works. To determine the evaluation method, we refer to Venable et al. (2012). We chose a laboratory experiment, since the artifact already has been developed (i.e., ex post evaluation) and since an artificial evaluation environment provides the benefit of controlling for possibly confounding variables as well as allows measuring the efficacy of an artifact. More precisely, we chose a within-subject design for this experiment, where participants may experience report design both with and without using a UAS for BIV. Although within-subject designs are susceptible to possible learning effects (Charness, Gneezy, & Kuhn,

2012), we decided to follow such a design, since potential learning effects are of minor relevance when investigating the effects of UAS on intention to comply with BIV guidelines. Moreover, a within-subject experiment requires less participants compared to between-subject designs (Lazar, Feng, & Hochheiser, 2010), which can be a relevant aspect for conducting a preliminary study. Since studies indicate that managers and students behave similarly (Bolton, Ockenfels, & Thonemann, 2012), 14 university students (4 female, 10 male, average age: 22) of an IS course participated in this preliminary study.

To analyze the relationship between using a UAS for BIV (i.e., independent variable) and the intention to comply with BIV guidelines (i.e., dependent variable), we differentiate two measurement settings. In both settings, participants have the task to identify inadequate BIV in four different business charts according to the IBCS guidelines. The settings of the measurements differ in the type of assistance, however. Since BIV guidelines are typically provided in written documents (e.g., Few (2012), Ware (2012), Hichert and Faisst (2015)), the only assistance allowed in the first setting were the IBCS guidelines, which are published via the website of the IBCS Association. In the second setting, participants could use our BIV Assistant to fulfil the requested task.

The experiment was structured in multiple stages (cf. Figure 1). First, participants were introduced to the experiment and got a short training on how to access the BIV guidelines of the IBCS Association website. In the next step, they had to accomplish the above described task according to the first setting. After its completion, they were asked to answer multiple questions on their intention to comply with BIV guidelines. For this, questionnaires with validated items from prior research (Venkatesh & Davis, 2000) were translated into German and adapted to IBCS guidelines. For example, “Assuming I have access to the system, I intend to use it” was adapted to “Assuming I have access to the IBCS guidelines, I intend to use them.” Due to the constructs of interest, the questions from Venkatesh and Davis (2000) comprised items for measuring the intention to use, which in our case is the intention to comply with BIV guidelines (ITC), perceived

usefulness (PU), and perceived ease of use (PEOU). For measuring self-efficacy (SE), we draw on items from Spannagel and Bescherer (2009), who focus on scales of computer user SE. All items were measured on a 7-point scale, where 1 = strongly disagree and 7 = strongly agree.

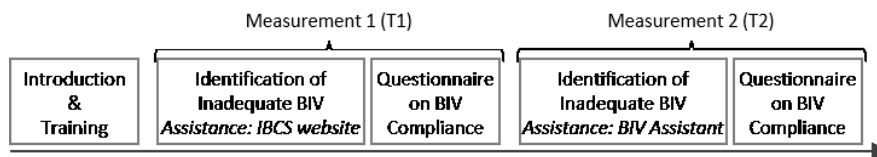


Figure 1: Design of the Within-Subject Experiment

To reduce potential learning effects for the second measurement, we slightly modified the business charts with inadequate BIV and changed the sequential order for the second setting. Here, participants had to fulfil the described task with the opportunity to use our BIV Assistant. To assess constructs related to intention to comply with BIV, the same questions as in the first setting were used.

2.7.6.2 Results of the Preliminary Study

Venkatesh and Davis (2000) as well as Spannagel and Bescherer (2009) show a high reliability (i.e., Cronbach's α) of their measurement scales. However, as we slightly adopted and translated these items, we computed the reliability of our scales to assure an appropriate basis for our analysis using SPSS version 24. The results of this reliability analysis are satisfactory and depicted in Table 2.

Next, we analyzed whether the intention to comply with BIV guidelines as well as its antecedents can be enhanced by the usage of our BIV Assistant. As we used a within-subject design, we conducted dependent t-tests and compared the differences between means of the variables under the conditions at measurement 1 (T1) and measurement 2 (T2). Any significant difference observed indicates an effect of using our BIV Assistant.

The result of this analysis shows that means of all variables increased from T1 to T2. In particular, the increase in report SE was highly significant, and increases in PEOU as well as in PU were marginally significant. However, although there was also an increase in ITC, it was not significant. Hence, while not finding support for H1, we found support for hypotheses H2-4. The results of this analysis are presented in Table 2.

Table 2: Reliability of Scales and Dependent T-Test Results (* $p < 0.10$, ** $p < 0.01$)

Scale	n	Cronbach's α		Dependent t-test			
		T1	T2	Mean at T1	Mean at T2	p	H
ITC	14	0.96	0.69	5.32	5.71	0.290	(H1)
PU	14	0.86	0.87	4.82	5.50	0.052 (*)	(H2)
PEOU	14	0.81	0.94	4.64	5.62	0.061 (*)	(H3)
SE	14	0.84	0.85	4.36	5.14	0.002 **	(H4)

To examine if the propositions from TAM hold in the context of BIV guideline compliance, we conducted a multiple linear regression analysis to compute the influence of the independent variables PU, PEOU, and SE on the dependent variable ITC. Measurements were used from T2, as we intended to see whether the propositions from TAM hold after using our artifact. The R^2 for the overall model was .90 (adjusted $R^2 = .88$) which indicates a high goodness-of-fit according to Cohen (1988). PEOU, PU, and SE were able to statistically significant predict ITC, with $F(3,10) = 32.2$, $p < .001$. However, regression coefficients differ in their ability to predict ITC. While PEOU significantly predicts ITC ($\beta = .70$, $p < .05$), PU was not significant ($\beta = .30$, $p = .19$), which is also the case for SE ($\beta = -.02$, $p = .86$). Hence, while finding support for H6, this is not true for H5 and H7. These findings indicate, that in a BIV context, PEOU is especially important to foster ITC. These outcomes are depicted in Figure 2.

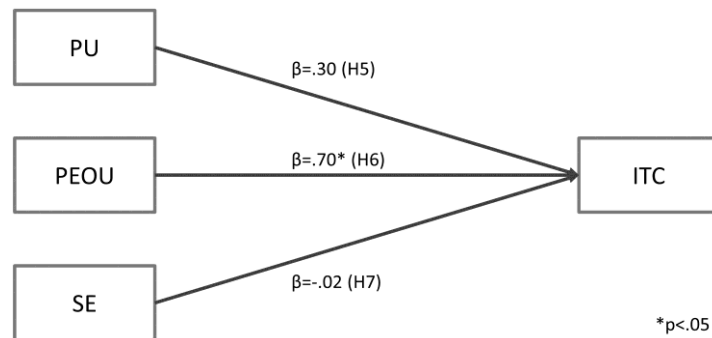


Figure 2: Regression Analysis of Antecedents of ITC

These first results show that using the BIV Assistant may lead to increased perceived ease of complying with BIV guidelines, perceived usefulness of complying with BIV guidelines, and report-related self-efficacy. In addition, they indicate that perceived ease of complying with BIV guidelines appears to be the most important antecedent of intention to comply with BIV guidelines. In the following, we provide a conclusion on these findings and outline possibilities for future research.

2.7.7 Conclusion and Future Research

Following the DSR activities proposed by Peffers et al. (2007), we showed that using UAS may impact compliance in a BIV context. Since we could not identify studies that examine whether UAS may affect the intention to comply with BIV guidelines based on our literature review, we proposed a design of a UAS that aims to improve this intention and introduced the BIV Assistant as a prototypical implementation. According to Briggs and Schwabe (2011), this is a DSR contribution of the applied science and engineering category, since we provide an instance of a generalizable solution in form of a proof-of-concept prototype. The second DSR contribution provided by this study is experimental research, which leads to hypotheses, experimental designs, and analyzed data sets (Briggs & Schwabe, 2011).

Based on a within-subject experiment, we provide indications that the BIV Assistant has a positive impact on complying with BIV guidelines. In addition, the findings indicate that in a BIV context, perceived ease of use of complying with BIV guidelines is especially important to foster the intention to comply with guidelines.

Of course, this research in progress only draws on data from a small preliminary study. However, based on the statistically significant findings provided by this study, we aim to substantiate our results in a next design cycle as proposed by Hevner (2007), using the proposed evaluation design. For this purpose, we intend to further develop the existing prototype to reflect a higher number of BIV guidelines, and seek to also evaluate it among actual decision makers in organizations.

Moreover, we also intend to analyze to what extent UAS can help to train BIV guidelines, since self-efficacy may also be influenced by the degree of a user's knowledge on how to appropriately design reports. With our BIV Assistant, we hope to provide a novel and fruitful avenue for improving BIV in SSBI and thus decisions based on the resulting reports.

2.8 Essay: Using Elected Elements in Large-Scale Information Systems Lectures

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Published in:	Proceedings of the 13th International Conference on Wirtschaftsinformatik (WI 2017)

2.8.1 Abstract

Information systems (IS) lectures often address audiences that consist of over one hundred students. In this setting, it is arguably difficult to consider the individual interests of each participant. This may result in students not being motivated, decreased learning outcomes as well as an overall low effectiveness of IS lectures. Self-determination theory suggests that perceived autonomy increases intrinsic motivation, which may in turn lead to improved learning outcomes. We therefore propose to foster perceived autonomy among students by introducing elected elements (e.g., practical examples and topics) that students can vote for with an audience response system. To investigate this instructional approach and to provide an instrument for its evaluation, we conducted a preliminary study that shows positive associations between perceived autonomy, intrinsic motivation, as well as acceptance among students. Based on these findings, we derive several avenues for future research regarding the use of elected elements in large-scale IS lectures.

2.8.2 Introduction

Undergraduate enrollment in degree-granting postsecondary institutions has continuously grown over the past decades. For instance, in the year 2013, this enrollment has increased by 46 percent in the United States compared to the year 1990 (Kena et al., 2015). This growth results in information systems (IS) lectures that often address audiences consisting of over one hundred students that passively listen to instructors (Lehmann & Söllner, 2014). In this setting, it is arguably difficult to meet the individual interests of each participant for instance in terms of how the knowledge is embedded in practical examples. This may result in students not being motivated, decreased learning outcomes as well as an overall low effectiveness of IS lectures (Beichner et al., 2000; Eison, 2010). Self-determination theory suggests that a possible way to foster students' intrinsic motivation is increasing their perceived autonomy (Deci & Ryan, 1985), i.e. their perception of being able to choose topics and to influence the course of the lectures. However, asking each and every student about how the lectures should unfold is practically impossible in large-scale lectures.

We therefore propose to use pre-fabricated elements (e.g., practical examples, topics, etc.) that students can choose from in every lecture by voting in an audience response system (ARS). The main idea is that every lecture contains both mandatory elements to ensure certain learning outcomes are met as well as elected elements that meet students' interests and provide a feeling of influence on the course. We therefore pose the following overarching question of our research project:

RQ: What are the impacts of providing elected elements in large-scale information systems lectures on students' intrinsic motivation and learning outcomes?

In this paper, we report the results of a preliminary, cross-sectional study conducted in an introductory IS course at a German university, where students were given the choice over several elected elements in each lecture. After the course was finished, different aspects

of intrinsic motivation and perceived autonomy were assessed with a brief questionnaire based on the intrinsic motivation inventory (Ryan, 1982). In the present study we were primarily interested in (a) analyzing the psychometric properties of the items and respective scales to provide a reasonable and valid measurement for a subsequent quasi-experimental field study, (b) exploring the acceptance and practicability of the instructional approach by gathering students' qualitative feedback as well as their ratings on an additional "Desirability" scale, and (c) providing first indications regarding its motivational benefits by examining qualitative feedback and performing correlational analyses of students' self-reported perceived autonomy, intrinsic motivation (in terms of interest/enjoyment), and subjective value (in terms of perceived usefulness) of elected elements. Based on the theoretical assumptions of self-determination theory, we expected positive associations between perceived autonomy and intrinsic motivation on the one hand, and intrinsic motivation and perceived value of elected elements. Due to privacy concerns, we were not able to collect performance data (i.e., learning outcomes) in the present study, which will be included in the subsequent study by using anonymous ID-codes.

The remainder of this paper is organized as follows: First, we provide the theoretical background for this study as well as related work. We then report the setup, method, and results of the preliminary study. Afterwards, these results are discussed and avenues for future research are shown in the concluding section.

2.8.3 Theoretical Background and Related Work

Self-determination theory stems from motivational psychology and provides several explanations for human motivation (Deci & Ryan, 1985). One of its central assumptions is that intrinsic motivation (i.e., the highest level of self-determination; when individuals engage in behavior for the pleasure and satisfaction that they inherently experience with participation (Deci & Ryan, 1985)) requires the satisfaction of three basic psychological needs: Perceived competence, relatedness, and autonomy (Deci & Ryan, 2000). While

perceived competence in lectures is already addressed by approaches that test knowledge and understanding of students (MacGeorge et al., 2008) and relatedness might be covered with peer-reviewing activities (Schlagwein, 2015), perceived autonomy (i.e., being able to influence the course of the lectures) is still rarely addressed by existing studies. While achieving intrinsic motivation among students is one goal of higher education, increased motivation should also lead to better learning outcomes. Indeed, several studies have provided evidence for a link between intrinsic motivation and learning outcomes, such as improved grades (Black & Deci, 2000) or high academic performance through increased study effort and deep learning (Kusurkar et al., 2013).

By using ARS, which are sometimes also called Audience Response Technology, Personal Response Systems, Electronic Voting Systems or simply “clickers” (Moss & Crowley, 2011), students may participate in votes with electronic devices. Depending on the infrastructure of the institution (e.g., wireless LAN), this approach may involve many participants (Lehmann & Söllner, 2014), which makes it applicable in large-scale lectures (100+ students) as well as in smaller lectures. In addition, studies show that technology-savvy students appreciate ARS, which indicates its usefulness in IS lectures (MacGeorge et al., 2008). Several different electronic voting mechanisms have been proposed and used thus far. One popular approach is to distribute designated voting devices to students which they sometimes also have to purchase (MacGeorge et al., 2008). However, since the advent of smart phones and tablets, ARS that allow students to use their own devices promise to lower expenses on infrastructure (Reinhardt et al., 2012). For this reason, we used such an ARS in the present study. Previous studies that investigated the use of ARS to alleviate the consequences of passive listening in large-scale lectures reported increased engagement (Fitch, 2004; Guse & Zobitz, 2011; Lundeberg et al., 2011; Rice & Bunz, 2006), increased overall satisfaction of students (Blackman, Dooley, Kuchinski, & Chapman, 2002; Nicol & Boyle, 2003; Stuart, Brown, & Draper, 2004) as well as increased learning outcomes (Castillo-Manzano, Castro-Nuño, Sanz Díaz, & Yñiguez, 2015; Lundeberg et al., 2011; Stratling, 2017). However, most of these studies only use ARS to test knowledge of students (Castillo-Manzano et al., 2015; Fitch, 2004; Guse

& Zobitz, 2011) or to ask for their opinions regarding the content (MacGeorge et al., 2008). Only one approach we found in literature might facilitate perceived autonomy by utilizing so-called “clicker cases”, where ARS were used by students to choose several actions in a case study (Lundeberg et al., 2011). Although this approach shows how ARS can lead to improved participation, the authors did not examine whether these choices actually had an impact on perceived autonomy of students. Since this theoretical lens may increase our understanding of ways to foster students’ perceived autonomy and ultimately intrinsic motivation in large-scale IS lectures, we focused on perceived autonomy and its associations with other motivational constructs that are described in the following. It is important to note, however, that in this preliminary study we solely address these motivational aspects and the practicability of this specific instructional approach. On the basis of the present findings (improved measurements and instructional approach), the effects of elected elements will be examined in a subsequent quasi-experimental field study with “using elected elements” as independent variable and students’ motivation and performance as dependent variables.

2.8.4 Preliminary Study

2.8.4.1 Implementing Elected Elements in IS Lectures

To investigate the associations between providing elected elements in large-scale IS lectures and students’ perceived autonomy as well as intrinsic motivation, we implemented such elements in an introductory IS course at a German university. The course consisted of 12 lectures that were given weekly over a period of 6 months. At the end of each lecture, students were able to vote which element they wanted to be addressed in the following lecture out of 2-4 options.

To foster student participation, we used an ARS that allowed students to use their mobile devices (e.g., smart phones, tablets) for voting anonymously (Reinhardt et al., 2012). Figure 1 provides a visualization of lectures incorporating elected elements.

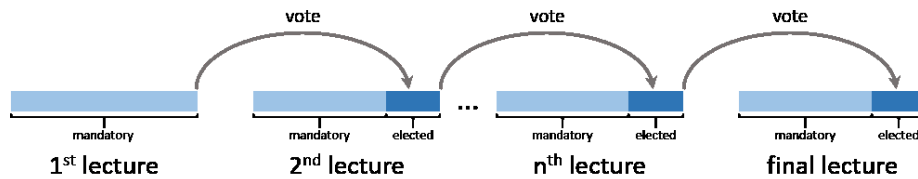


Figure 1: Lectures incorporating elected elements

The elected elements ranged from choosing between different practical examples to choosing between different software demonstrations. For instance, one week before the lecture about business process modeling took place, students were able to choose between activity diagrams and business process model and notation (BPMN) as additional modeling notations. Although these notations are quite similar regarding how they depict business processes, students may get a feeling to be able to choose between a more universal notation (activity diagram) and a notation specifically designed for business processes (BPMN). This way, certain learning outcomes may be enforced while still providing a sense of influence. After voting, students were able to see the distribution of votes between the elected elements. They hence received immediate feedback whether their vote belonged to the majority or not. Due to the fact that every student could participate in many polls, it was very unlikely that they always ended up in the minority, which would arguably reduce their perceived autonomy.

2.8.4.2 Method

At the end of the course, after all lectures were finished, we conducted a paper-based questionnaire (see Appendix) in class. Hence, we followed a cross-sectional design in this preliminary study. Data collection was conducted by the first author. Out of the 64 questionnaires we received, 58 have been valid (i.e., 6 were discarded because of obvious

dishonesty like wrong fields of study or because they could not participate in the polls due to technical errors with their mobile devices). Since the average number of participants in the votes is 57, the dropout rate appears to be low. Participants consisted of 44 males and 14 females, enrolled in two different fields of study (45 participants studied business and information systems engineering and 13 studied computer science). The age was 20.2 years on average ($SD=2.7$).

The questionnaire adapted items from the intrinsic motivation inventory (IMI) that has been used in many studies to measure perceived autonomy as well as intrinsic motivation of participants (McAuley, Duncan, & Tammen, 1989; Plant & Ryan, 1985; Ryan, 1982). For our preliminary study, we chose three items from each of the following subscales: “Interest/Enjoyment” (e.g., “I would describe the elected elements as very interesting”) was used to assess intrinsic motivation, “Perceived Choice” (e.g., “I voted for elected elements because I wanted to”) was selected to measure perceived autonomy, and “Value/Usefulness” (e.g., “I think the possibility to vote for elected elements is important”) was used to gather an overall rating of subjective value of providing elected elements. Judging an activity to have personal value and importance can be seen as (antecedent) part of intrinsic motivation (Deci & Ryan, 1985), and therefore it should be positively related to interest and enjoyment. All items were modified to relate to the context and translated into German. However, since these adapted items did not fully cover our research question, we added two self-developed subscales, each comprising three items. “Perceived Influence” (e.g., “By voting for elected elements I felt that I could influence the lectures”) addressed an additional aspect of perceived autonomy, since the “Perceived Choice” subscale exclusively asked whether students believed that they participated voluntarily in the polls. However, we also wanted to know whether they believed that their votes had an impact on the lectures. Finally, “Desirability” (e.g., “I wish I had the possibility to vote for elected elements in other courses, too”) was added as another way of asking for an overall rating of providing elected elements, since the “Value/Usefulness” subscale only asked whether elected elements are important to students. While this is a possible approach to determine an overall rating, we also wanted

to know whether students thought that providing elected elements makes sense and whether they wish having these elements in other courses, too. Every subscale except for “Value/Usefulness” contained one reversely coded item that was used to identify fraudulent questionnaires (i.e., there should be no contradictions). Each item in the questionnaire was assessed using a 5-point scale, ranging from 1 = *not at all true* to 5 = *very true*, and they were randomized across all subscales. In addition to the quantitative items, students were provided with space for leaving any comments or suggestions on the possibility of voting for elected elements. All subscales as well as their respective internal consistencies (Cronbach’s α) are presented in Table 1. Reliabilities were satisfactory for all subscales, except “Perceived Choice”. Thus, the subscale “Perceived Influence” provided a more consistent measurement of perceived autonomy, and “Perceived Choice” was omitted.

Table 1: Subscales and Cronbach’s α

Subscale	Number of Items	Cronbach’s α
Interest/Enjoyment	3	0.79
Perceived Choice	3	0.43
Perceived Influence	3	0.82
Value/Usefulness	3	0.83
Desirability	3	0.83

2.8.4.3 Results

Confirmatory factor analysis, used to verify the latent factor structure (i.e., subscales) of the measurement instrument, revealed an acceptable fit for the remaining four subscales ($\chi^2=68.19$, $df=48$, $p=0.03$, CFI=0.95, TLI=0.92, RMSEA=0.08). Standardized item loadings were in the range of $\lambda = 0.67 - 0.85$, thus satisfactory. The usual and recommended cut-off scores for RMSEA are ≤ 0.05 for a good fit and ≤ 0.08 for an acceptable fit. CFI and TLI should be ≤ 0.95 for a good fit, and ≤ 0.90 for an acceptable fit (Hu & Bentler, 1999). Hence, all further analyses were based on the four subscales “Interest/Enjoyment”, “Perceived Influence”, “Value/Usefulness”, and “Desirability”.

The descriptive statistics are shown in Table 2. The item numbers indicate the sequence of questions. Bivariate intercorrelations (manifest) also indicate discriminant validity of the different aspects of motivation (see Table 3).

Table 2: Descriptive statistics of the results (N=58)

Subscale	Item No.	Mean	SD	Power	Loading
Interest/Enjoyment	3	3.76	0.84	0.70	0.78
	12	4.03	0.83	0.63	0.79
	15	3.59	0.74	0.57	0.67
	Total	3.79	0.67		
Perceived Influence	4	3.60	0.95	0.64	0.70
	7	3.45	0.95	0.69	0.84
	8	3.86	0.95	0.68	0.76
	Total	3.64	0.81		
Value/Usefulness	9	3.53	0.99	0.60	0.69
	14	3.36	0.96	0.73	0.83
	10	3.40	1.08	0.73	0.85
	Total	3.43	0.87		
Desirability	5	4.12	0.97	0.72	0.79
	16	3.98	0.88	0.60	0.77
	11	4.40	0.83	0.75	0.81
	Total	4.17	0.77		

A closer look at the distributions of these subscales is provided in Figure 2.

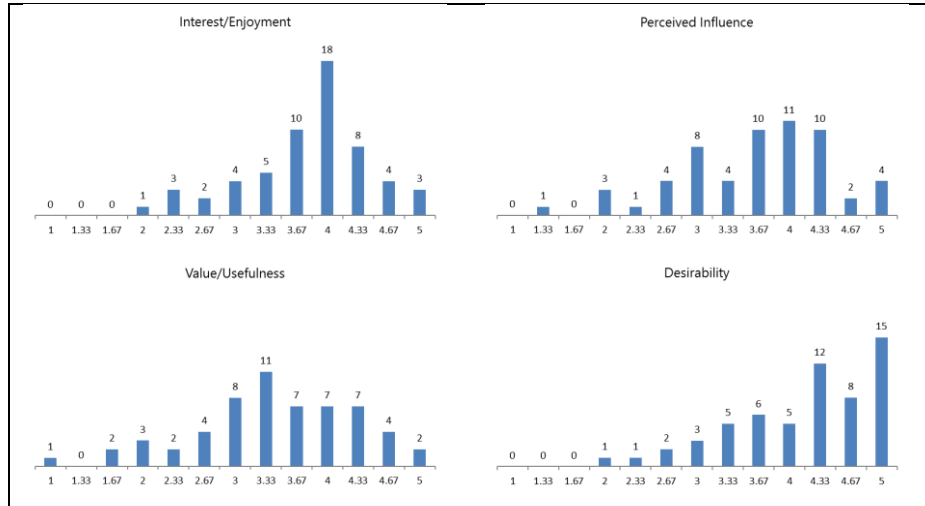


Figure 2: Distribution of each subscale

As Figure 2 shows, particularly the distribution of “Desirability” was more concentrated towards the higher end of the scale (negative skew) whereas the distribution of “Perceived Influence” was rather scattered. Students generally reported rather high levels of interest and enjoyment after using elected elements and they reported a strong desire to have such elements in other courses. Students’ ratings regarding the value and importance of these elements as well as the amount of perceived autonomy in terms of perceived influence they had on the course differed.

Students’ qualitative feedback supports these assumptions by comprising both positive as well as negative comments on the implemented instructional approach. Many students appreciated being able to vote for elected elements in each lecture. Some of the comments also directly state that the interest in the lecture increased by choosing elected elements (45% of all comments):

“By being able to vote for elected elements, one is able to influence the content of the lectures -> increased interest.”

“The interest in the course increases when elected topics are covered.”

“I really liked deciding for the topics that I was most interested in.”

However, there was also criticism regarding how the elected elements were covered in the lectures. The main concern was that they have been too short compared to the mandatory parts of the lectures (36% of all comments):

“The idea of providing elected elements is very good. However, they often have been addressed shortly at the end of the lectures. For example, we were shown how a system from SAP looks, however, I seldom understood how it worked.”

“I like being able to vote for elected elements as well as the use of them – However, they have been covered too short in the lectures. When using elected elements, you should take enough time for them.”

“Despite the elected elements often being very interesting, they have been covered way too short in the lectures, which made the choices feel pretty pointless.”

Additional criticism addressed both the amount of information that was provided before voting for elected elements as well as the unclear relevance of these elements in the examination (18% of all comments):

“More info about the elected elements would have sometimes been useful for better forming an opinion.”

“The relevance of the elected elements for the examination has sometimes been unclear (they don’t appear in the script and there is no handout).”

In summary, the qualitative feedback emphasized that providing elected elements in IS lectures may lead to increased interest and motivation. It also shows, however, that these elected elements should have more room inside the lecture. Otherwise, they could be perceived as pointless which may reduce perceived autonomy. Finally, students have to be supplied with enough information about each alternative to be able to make a well-informed decision.

Regarding the associations between perceived autonomy and intrinsic motivation due to elected elements in IS lectures, we found a significant positive correlation between students' interest/enjoyment and perceived influence (see Table 3). In addition, we found a positive correlation between interest/enjoyment and perceived value in terms of the rated usefulness of elected elements and the desire to use ARS in other lectures as well. Finally, the latter was positively correlated with perceived influence.

Table 3: Bivariate correlations (**p < 0.01)

	Interest/ Enjoyment	Perceived Influence	Value/ Usefulness	Desirability
Interest/Enjoyment	1			
Perceived Influence	0.55**	1		
Value/Usefulness	0.58**	0.49**	1	
Desirability	0.78**	0.60**	0.62**	1

These positive correlations support our initial expectations concerning the associations between perceived autonomy and intrinsic motivation due to elected elements. We hence propose that fostering perceived autonomy by using elected elements in large-scale IS lectures may have the potential to increase students' motivation in terms of subjective value, interest and enjoyment. These correlational findings provide a basis for future research, more specifically for the intended quasi-experimental study with a comparable student population, to examine causal effects of this instructional approach on students' motivation and achievement.

2.8.5 Discussion

The results of this preliminary study indicate that providing elected elements in IS lectures might lead to perceived autonomy and increased intrinsic motivation among students. Our findings, based on qualitative and quantitative data, provide a first step towards understanding the effects of using elected elements in large-scale IS lectures. In addition, these elements are perceived well by the participants. The short-scale measures used in

this study proved to be reliable to assess “Interest/Enjoyment”, “Value/Usefulness”, “Perceived Influence”, and “Desirability”. Since most students enrolled in IS programs are equipped with mobile devices, they provide a good opportunity to let students vote for their favorite content. Once these elected elements are created by the instructor, they may be used several times and even in several different courses. Because many ARS have been improved over the years, conducting these polls is uncomplicated and arguably fewer effort than for example setting up blended learning scenarios with extensive online content. The present study extends prior research by adding a self-determination theory perspective to explain increased motivation when using ARS by increased perceived autonomy during the lectures.

There are, however, some limitations to this study. First, due to the selected ARS, individual choices of students have not been tracked. We were hence unable to investigate motivational differences between students who often voted like the majority compared to those who did not. This might have been one reason for students’ differences in perceived influence. Some students also reported technical problems either with their devices or with the network inside the lecture room. To ensure scalability, an ARS that is able to handle many connections at the same time should be used. According to the comments of students, elected elements should have more room inside each lecture. Indeed, these elements sometimes just comprised 10 minutes inside a 90-minute lecture. We will hence prolong them in future investigations. Another limitation of the study is the lack of a control group. We therefore cannot compare the achieved level of intrinsic motivation from using elected elements with a group that did not use these elements. In addition, performance data of students could not be mapped to the questionnaires due to privacy concerns. Hence, we could not investigate whether those students who reported higher levels of perceived autonomy and intrinsic motivation actually performed better than their peers with lower levels, respectively. In a next step, we will include these aspects in the subsequent study design following a quasi-experimental design.

2.8.6 Conclusion

In regard to the findings above, instructors from the IS domain may consider incorporating elected elements into their lectures. When doing so, these elements should noticeably influence the contents of the lectures and students must be supplied with sufficient information about every alternative before voting. Due to the limitations mentioned earlier, this study is only a first step towards understanding the use of elected elements in IS lectures. In the subsequent study, we will track individual choices of each participant to see whether students who have often voted like the majority are more motivated than others. Additionally, performance data of each student will be tracked to investigate effects on student learning. This may include results from examinations as well as other performance indicators, such as regularly performed quizzes. Since offering lectures is often a necessity due to increasing enrollment, our preliminary results highlight one feasible opportunity to improve this experience for both students as well as instructors.

2.9 Essay: Facilitating Student Autonomy in Large-Scale Lectures with Audience Response Systems

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2.9.1 Abstract

Lectures in higher education often address audiences that consist of over one hundred students. In this setting, it is arguably difficult to take into account individual interests of each participant. This may result in low motivation, decreased learning outcomes as well as an overall low effectiveness of lectures. Self-determination theory suggests that perceived autonomy increases intrinsic motivation, which may in turn improve learning outcomes. We therefore propose to foster perceived autonomy among students by introducing elected elements (e.g., practical examples and topics) that students can vote for with an audience response system (ARS). To investigate this instructional approach, we conducted a quasi-experimental field study with two groups of participants: One group was given the choice over some content of the lectures while the other group attended an identical course without choice. Results show that providing the choice over elected elements leads to an increase in perceived influence on the course. Students who reported more perceived influence also experienced higher intrinsic motivation. Regarding learning outcomes, intrinsically motivated students reported higher perceived learning gains, yet they did not show better test performance. Based on these findings, we derive several avenues for future research regarding the use of elected elements in large-scale lectures.

2.9.2 Introduction

Undergraduate enrollment in degree-granting postsecondary institutions has continuously grown over the past decades. For instance, in 2013, this enrollment had increased by 46 percent in the United States compared to 1990 (Kena et al., 2015). This growth results in lectures with audiences consisting of over one hundred students that passively listen to instructors (Lehmann & Söllner, 2014). In this setting, it is arguably difficult to meet the individual interests of each participant, for instance, in terms of how the knowledge is embedded in practical examples. This may result in students not being motivated, decreased learning outcomes as well as an overall low effectiveness of lectures (Beichner et al., 2000; Eison, 2010). Self-determination theory suggests that a possible way to foster students' intrinsic motivation is to increase their perceived autonomy (Deci & Ryan, 1985), i.e., their perception of being able to choose topics and to influence the course of the lectures. However, asking every student about how the lectures should unfold is practically impossible in large-scale lectures.

We therefore propose to use a variety of pre-fabricated elements (e.g., practical examples, topics, etc.) that students can choose from in every lecture by voting with an audience response system (ARS). The main idea is that every lecture contains both mandatory elements to ensure certain learning outcomes are met as well as elected elements that meet students' interests and provide a feeling of influence on the course. We therefore pose the following research question:

RQ: How does providing elected elements in large-scale lectures influence intrinsic motivation and learning outcomes of students?

In previous research, we presented the results of a preliminary study that was conducted to validate our measurement instrument (Grund & Tulis, 2017). In this current paper, we report the results of a subsequent quasi-experimental field study involving two parallel cohorts of an introductory Information Systems (IS) course at a German university. In the

treatment condition, students were given the choice over two elected elements in each lecture, whereas in the control condition, students attended identical lectures without being given any choice. During and after the course, different aspects of intrinsic motivation, perceived influence and perceived learning were assessed by questionnaire. After the course was finished, performance data was evaluated by investigating anonymized examination scores.

The remainder of this paper is organized as follows: First, we discuss related work as well as the theoretical background of this study. We then report the setup, method, and results of the study. Afterwards, these results are discussed and implications for future research are shown in the concluding section.

2.9.3 Related Work

Investigating autonomy in student learning has a long history in educational research (Holec, 1981; Little, 1990). It is often referred to as student autonomy (Yang, Tai, & Lim, 2016), learner autonomy (Ceylan, 2015; Dlaska, 2002; Jung, 2001; Smith, 2015; Snodin, 2013), or simply autonomy (Black & Deci, 2000; Xie, 2013; Xie & Ke, 2011). Due to the plethora of research on this topic, several different concepts regarding student autonomy have evolved. In its broadest meaning, student autonomy refers to the willing capacity to take control of (or take charge of or responsibility for) one's own learning (Smith, 2015). This concept refers to an attitude of the learner, rather than a mode or method of learning (Smith, 2015). Another view on student autonomy is the amount of control that is given to students. This includes control over their own learning management, control over cognitive processes as well as control over the learning content (Smith, 2015). While the broader perception of student autonomy has been thoroughly investigated in contexts such as web-based instruction (Jung, 2001), e-portfolios (Yang et al., 2016), multimedia learning (Dlaska, 2002), blended learning (Snodin, 2013), and massive open online courses (Zhou, 2016), approaches that provide students with control over course content have scarcely been reported (Hew, Huang, Chu, & Chiu, 2016). Especially in large-scale

lectures, consisting of over 100 students, it seems difficult to establish this control, since all students are attending the same lecture. For this reason, our study focuses on student autonomy in the form of control over course content in large-scale lectures. Since this control implies that students are able to influence the course, we will refer to it as “perceived influence”.

To establish this perceived influence, we aim to let students participate in votes with so-called Audience Response Systems (ARS), which are sometimes also referred to as Audience Response Technology, Personal Response Systems, Electronic Voting Systems or simply “clickers” (Moss & Crowley, 2011). Depending on the infrastructure of the institution (e.g., wireless LAN), this approach may involve many participants (Lehmann & Söllner, 2014), which makes it applicable in large-scale lectures as well as in smaller lectures. In addition, studies show that technology-savvy students appreciate ARS, which indicates its usefulness in technology-related lectures (MacGeorge et al., 2008). Several different electronic voting mechanisms have been proposed and used thus far. One popular approach is to distribute designated voting devices to students, which they sometimes also have to purchase (MacGeorge et al., 2008). However, since the advent of smart phones and tablets, ARS that allow students to use their own devices promise to lower expenses on infrastructure (Reinhardt et al., 2012). For this reason, we used such an ARS in the present study. Previous studies that investigated the use of ARS to alleviate the consequences of passive listening in large-scale lectures reported increased student engagement (Fitch, 2004; Guse & Zobitz, 2011; Lundeberg et al., 2011; Rice & Bunz, 2006), increased overall satisfaction of students (Blackman et al., 2002; Nicol & Boyle, 2003; Stuart et al., 2004) as well as increased learning outcomes (Castillo-Manzano et al., 2015; Lundeberg et al., 2011; Stratling, 2017). However, most of these studies only used ARS to test students’ knowledge (Castillo-Manzano et al., 2015; Fitch, 2004; Guse & Zobitz, 2011) or to ask for their opinions regarding the content (MacGeorge et al., 2008). To our knowledge, only one study might have facilitated perceived influence by utilizing so-called “clicker cases”, where ARS were used by students to choose several actions in a case study (Lundeberg et al., 2011). Although this approach shows how ARS

can lead to improved participation, the authors did not examine whether these choices actually had an impact on perceived influence of the students. Since this theoretical lens may increase our understanding of ways to foster student autonomy and ultimately intrinsic motivation in large-scale lectures, we focus on perceived influence and its relationship with other motivational constructs that are described below.

2.9.4 Theoretical Background and Hypotheses

Self-determination theory stems from motivational psychology and provides several explanations for human motivation (Deci & Ryan, 1985). One of its central assumptions is that intrinsic motivation (i.e., the highest level of self-determination; when individuals engage in behavior for the pleasure and satisfaction that they inherently experience with participation (Deci & Ryan, 1985)) requires the satisfaction of three basic psychological needs: Competence, relatedness, and autonomy (Deci & Ryan, 2000). Fulfilling these needs also facilitates the internalization of extrinsic regulations, for instance learning goals (Gagné & Deci, 2005). While perceived competence in large-scale lectures may be achieved by approaches that test knowledge and understanding of students (MacGeorge et al., 2008) and relatedness might be facilitated with peer-reviewing activities and group work (Schlagwein, 2015), we aim to increase student autonomy by providing elected elements in large-scale lectures. These elected elements constitute (hopefully meaningful) choices to students, which is one important aspect of autonomy-supportive learning environments (Black & Deci, 2000; Ryan & Deci, 2006).

Previous studies about autonomy-supportive environments in education have shown that shared decision making and providing choices to students indeed fosters autonomy (Assor, Kaplan, & Roth, 2002; Deci, Vallerand, Pelletier, & Ryan, 1991; Reeve, Bolt, & Cai, 1999; Skinner & Belmont, 1993; Stefanou, Perencevich, DiCintio, & Turner, 2004). For instance, Assor et al. (2002) found that elementary school students (years 8 to 14) experienced enhanced autonomy when provided with choices in the classroom. They also noted that for choices to be effective, they have to be considered relevant and interesting.

This is in line with Stefanou et al. (2004) who argue that most choices provided in classroom settings are superficial in a way that students may only choose organizational or procedural settings (i.e., instructionally irrelevant aspects). They hence propose to differentiate between different kinds of autonomy support (i.e., organizational, procedural, and cognitive). Based on the observations of several 5th and 6th-grade classrooms, they conclude that cognitive autonomy support (e.g., letting students choose course content) yields the most promising results in terms of student autonomy. While these findings suggest that offering choice over course content fosters perceived influence in elementary and middle schools, investigations in higher education remain elusive. Especially for large-scale lectures, we were not able to identify studies that investigated this approach. We hence propose our first hypothesis:

H1: Providing the opportunity to vote for elected elements in large-scale lectures has a positive impact on students' perceived influence on the lectures.

Since elected elements are relevant for students' examinations, they can be regarded as achievement tasks (i.e., tasks that pose a challenge and will result in some degree of performance). According to modern expectancy-value theory (Eccles et al., 1983), there are several aspects on which decisions about achievement tasks are based upon. Besides the personal belief to perform well in a given activity (i.e., self-efficacy and expectation of success), individuals tend to base these choices on so-called task values, which include attainment value (i.e., the importance of doing well in a specific task), intrinsic value (i.e., enjoyment and fun associated with the task), utility value (i.e., usefulness), and cost of the task (Wigfield & Eccles, 2000).

In our case, students may vote for any given elected element based on their perceived importance to score high in the examinations, their interest in the content, their belief whether this content is going to be helpful later in their field of study, as well as the possible effort that comes with learning this content.

Previous research about modern expectancy-value theory indicates that expected intrinsic value is one of the most common rationales when making choices about achievement tasks in educational contexts (Eccles & Wigfield, 1995; Guo, Parker, Marsh, & Morin, 2015). Hence, when students are provided with the opportunity to vote for the most interesting content, they are likely to experience increased intrinsic motivation due to their increased interest in the content. In addition, studies in the realm of self-determination theory conclude that perceived autonomy in educational settings precedes intrinsic motivation (Black & Deci, 2000; Deci, Schwartz, Sheinman, & Ryan, 1981; Ryan & Deci, 2006). We therefore expect students who score high on perceived influence on the course to also experience increased intrinsic motivation. Hence our second hypothesis is:

H2: Students with high perceived influence on the lectures experience increased intrinsic motivation.

While enabling intrinsic motivation among students is one objective of higher education, this should also result in improved learning outcomes. However, there is an ongoing debate in literature about how these learning outcomes manifest. For many researchers, the foremost valid criterion for measuring learning outcomes is to look at students' performance in examinations (Giannakos, 2013; Mega, Ronconi, & De Beni, 2014; Tempelaar, Niculescu, Rienties, Gijsselaers, & Giesbers, 2012). The rationale behind this view is that a high score in the test resembles a high understanding of the course content. While it appears reasonable that this score (to some extent) expresses understanding, it does not necessarily reflect learning, since learning also takes into account the individual starting point of each student. For this reason, several researchers argue that instead of

test scores, perceived learning gains of students better represent learning outcomes, since students are able to assess what they knew prior to attending the course (Alavi, Marakas, & Yoo, 2002; Buil, Catalán, & Martínez, 2016; Caspi & Blau, 2008). Criticism of this approach is mainly concerned with the possibility that students may over- or underestimate their learning outcomes, as is the problem with any self-reported measure (Gonyea, 2005).

Regardless of the conception of learning outcomes, several studies have provided evidence for a link between intrinsic motivation and both test performance (Kusurkar et al., 2013; Taylor et al., 2014) as well as perceived learning (Buil et al., 2016; Ferreira, Cardoso, & Abrantes, 2011). In a total of 3 different studies, Taylor et al. (2014) demonstrated that intrinsic motivation was consistently positively associated with academic achievement over a one-year period. These findings are consistent with a study of Kusurkar et al. (2013), who concluded that autonomous motivation (e.g., intrinsic motivation) among medical students led to higher effort, deep learning and hence increased academic performance. Being concerned with perceived learning, Buil et al. (2016) found intrinsic motivation to be a significant predictor of self-reported perceived learning in their study about clicker usage in lectures. Ferreira et al. (2011) also proposed that higher levels of intrinsic motivation lead to higher levels of perceived learning. They found support for their hypothesis in a study involving 1,986 high school students. To take both aspects of learning outcomes (i.e., perceived learning and actual test performance) into account, our third hypothesis is twofold:

H3a: Students with high intrinsic motivation report increased perceived learning.

H3b: Students with high intrinsic motivation show increased test performance.

Control variables included the perceived relevance of the course, which may impact students' motivation, and students' former grades (i.e., final high school grades) to control for performance differences between students. Figure 1 summarizes our research model and hypotheses.

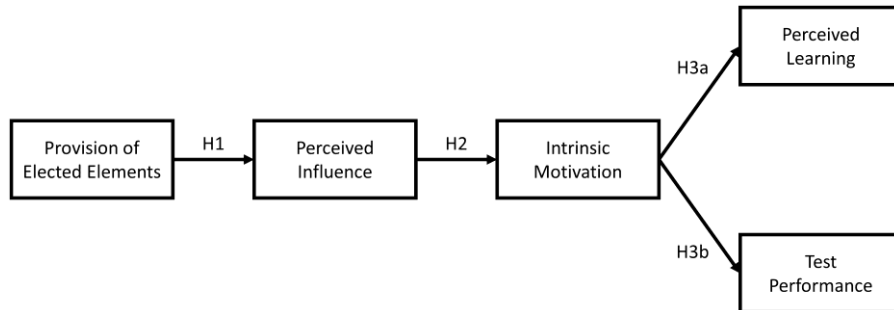


Figure 1: Research Model and Hypotheses

2.9.5 Study Setup and Results

2.9.5.1 Design, Method, and Participants

To investigate the relationships between providing elected elements in large-scale lectures and students' perceived influence, intrinsic motivation as well as learning outcomes, we implemented such elements in one of two introductory first-year IS courses at a German university, attended by students from two different techno-economical fields of study. The course with the opportunity to vote for elected elements was attended by Business and IS Engineering students. The same course (with the same instructor) was also given to Industrial Engineering students, but in this course, students were not provided with choice. Hence our field study employed a quasi-experimental design. The treatment group (Business and IS Engineering) was given the possibility to vote for elected elements at the end of each lecture in a total of 13 lectures (with 2 options in each vote). The control group (Industrial Engineering) only attended half of the semester, resulting in 7 lectures that were identical for both groups (except for the possibility to vote). To foster student voting participation in the treatment group, we used an ARS that allowed students to use their mobile devices (e.g., smart phones, tablets) for voting anonymously. At the beginning of the semester, we gathered students' demographics in a baseline questionnaire (measurement 1). In the 7th lecture, we handed out a questionnaire in both groups to compare their experiences (measurement 2). In the 13th

lecture, we did the same for the treatment group to account for differences over time (measurement 3). With this third measurement, we were able to investigate whether the duration of the treatment had an impact on perceived influence, intrinsic motivation, and learning outcomes. Finally, both groups took an exam with identical questions covering the first 7 lectures (measurement 4). The scores of these exams (i.e., test performance) could thus be compared. Figure 2 provides a visualization of the study setup. The demographics of participants in each measurement point are depicted in Table 1.

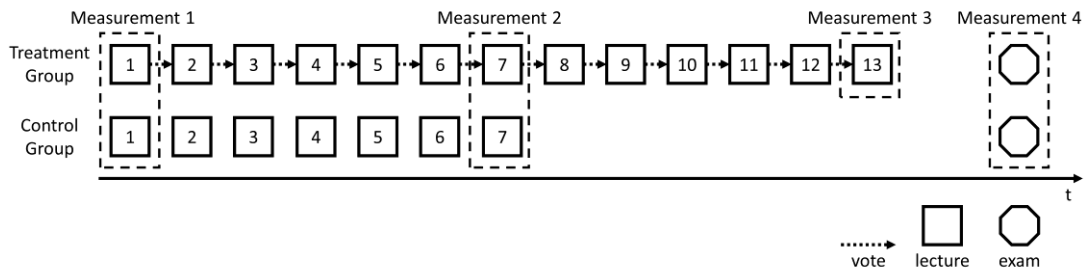


Figure 2: Study Setup and Measurement Points

The elected elements ranged from choosing between different practical examples to choosing between different software demonstrations. For instance, one week before the lecture about business process modeling took place, students in the treatment group could choose between activity diagrams and business process model and notation (BPMN) as additional modeling notations. Although these notations are quite similar regarding how they depict business processes, students were able to choose between a more universal notation (activity diagram) and a notation specifically designed for business processes (BPMN). This way, certain learning outcomes may be enforced while still providing a feeling of influence. Each elected element covered approximately 10-25% of the lecture time, depending on its complexity. After voting, students could see the distribution of votes between the elected elements. They hence received immediate feedback whether their vote belonged to the majority or not.

Since every student could participate in many votes, it was very unlikely that they always ended up in the minority, which would arguably reduce their perceived influence. Votes as well as all questionnaires were completed voluntarily and anonymously, with no incentive for students to participate.

Table 1: Demographics (Measurement Points 1-4)

		Measurement points			
		1	2	3	4
Treatment	<i>N</i>	93	57	43	70
	Gender (f/m)	21/72	12/45	9/34	19/51
	Age (M/SD)	20.83/3.01	20.25/2.75	20.44/2.4	20.49/2.71
Control	<i>N</i>	134	92		104
	Gender (f/m)	42/92	32/60		34/70
	Age (M/SD)	19.32/1.41	19.17/1.31		19.14/1.26
Total	<i>N</i>	227	149		174
	Gender (f/m)	63/164	44/105		53/121
	Age (M/SD)	19.94/2.34	19.58/2.1		19.68/2.08

2.9.5.2 Development and Validation of the Measurement Instrument

The measurement instrument was based on the questionnaire implemented in our preliminary study (Grund & Tulis, 2017). It adapts items from the intrinsic motivation inventory (IMI) that has been employed in many studies to measure intrinsic motivation of participants after an experience (McAuley et al., 1989; Plant & Ryan, 1985; Ryan, 1982). To measure perceived influence more precisely, we developed a 3-item short-scale and validated it in our preliminary study (Grund & Tulis, 2017). Finally, to account for perceived learning, we drew on the German translation of the prominent student evaluation of educational quality (SEEQ) instrument (Marsh, 1982). We used its “learning” subscale which extends the original SEEQ by one face-valid item to measure the amount of new content learned during the course (Dresel, Engelschalk, & Grassinger, 2015). For our control variable, perceived relevance of the course, we added a self-developed item that explicitly asks whether students believed the course was important

for their field of study. Every subscale except for “Perceived Learning” contained one reversely coded item that was used to identify fraudulent completions of questionnaires (i.e., there should be no contradictions). All items adapted from other instruments were modified to relate to the context and translated into German where applicable. Items were assessed using a 6-point scale, ranging from 1 = *not at all true* to 6 = *very true*, and were randomized across all subscales. In addition to the questionnaire items, students in the treatment group were provided with space for leaving any comments or suggestions regarding the opportunity to vote for elected elements.

To validate the psychometric properties of the resulting instrument and to examine the overall model fit of our measurement model, we conducted a confirmatory factor analysis (CFA). After minor modifications (e.g., correlated errors due to reversed items, for an overview see Brown, 2015), our measurement model reached a satisfactory model fit according to generally accepted thresholds (Hu & Bentler, 1999). The ratio between χ^2 and df was 1.6, which is below the desired ratio of 3. The root mean standard error of approximation (RMSEA) was .06 and therefore within the range of acceptable model fit of .08. Last, both comparative fit index (CFI) and Tucker-Lewis index (TLI) are above their common suggested minimum value of .90 (CFI=.97 TLI=.95). We may hence conclude that our measurement instrument achieved a good model fit. In addition, we accounted for reliability of the scales by computing their composite reliabilities in the form of McDonald’s ω (McDonald, 1999). In contrast to the more commonly used Cronbach’s α , McDonald’s ω does not assume Tau equivalence (i.e., equal factor loadings). It therefore provides an unbiased estimate of reliability. In our case, McDonald’s ω ranges from .77 to .85 and is hence above the desired minimum of .70 (Krippendorff, 2004). Items’ standardized factor loadings (λ) range from .63 to .90 and are thus above the recommended minimum of .45 for a fair rating (Tabachnick & Fidell, 2013). Table 2 summarizes our measurement model and shows its psychometric properties.

Table 2: Measurement Instrument

Factor	Item	M	SD	λ	ω
Perceived Influence (Grund & Tulis, 2017)	I felt that I could influence the lectures.	3.06	1.27	.79	
	I had the impression that I was able to codetermine the contents that have been taught.	3.29	1.51	.69	.77
	I believe that I was unable to influence the lectures. (R)	3.99	1.55	.68	
Intrinsic Motivation (Ryan, 1982)	The lectures until now have been fun.	4.60	1.02	.90	
	I thought the lectures until now have been boring. (R)	4.86	.96	.72	.85
	I thought the lectures until now were quite enjoyable.	4.73	.97	.63	
I enjoyed attending the lectures until now very much.	4.71	1.02	.78		
Perceived Learning (Dresel et al., 2015; Marsh, 1982)	My interest in the subject has increased as a consequence of this course.	4.53	1.17	.85	
	I have learned a lot in this course.	4.60	.93	.74	.80
	This course fosters my reflection.	4.06	1.22	.67	
Control Variables	The content of this course is important for my field of study.	4.83	1.17	-	-
	Final High School Grade	2.23	.49	-	-

2.9.5.3 Results

In terms of a manipulation check, we first examined differences in students' perceived influence between the two (quasi-)experimental conditions. As expected, students in the treatment group (course with elected elements) reported significantly higher perceived influence than students in the control group without elected elements ($M = 4.13/SD = 0.99$ vs. $M = 2.99/SD = 1.03$; $t(174) = -7.333$, $p < .001$). Both groups also differed in their initial ratings of subjective relevance of the course: Students in the treatment group (Business and IS Engineering students) reported higher subjective relevance ($M = 5.09$, $SD = 1.25$) than the Industrial Engineering students ($M = 4.66$, $SD = 1.08$) of the control group ($t(222) = -2.733$, $p = .007$). Furthermore, the initial achievement level (operationalized by final high school grades) was higher in the control group than in the treatment group ($t(222) = -8.551$, $p < .001$). Therefore, we controlled for these variables in our further group analyses.

To examine the (quasi-) experimental effects of the elected elements on the dependent variables, we compared both groups with respect to their intrinsic motivation, perceived learning gains and final test performance with an analysis of covariance (ANCOVA). There were no significant differences between the two conditions.

To see whether our hypothesized relationships between providing elected elements, students' perceived influence, intrinsic motivation, perceived learning and test performance hold true across all students (cf. Figure 1), we conducted a covariance-based structural equation modeling (SEM) analysis. SEM is commonly used as a comprehensive statistical method for investigating hypothesized relationships between latent and observed variables (Hoyle, 1995). The software utilized for this analysis was Mplus version 7 (Muthén & Muthén, 2012). After creating a structure model (i.e., adding our hypothesized paths to the measurement model described earlier), relationships between our latent and observed variables could be examined. As students differed in their initial ratings of course relevance and achievement level, we controlled for these variables in addition to the dummy coded treatment variable. The resulting model fit of the structural model turned out to be acceptable ($\chi^2/df= 1.6$ RMSEA = .06 CFI = 0.93 TLI = 0.91). Regarding our first hypothesis, we found a positive effect of the treatment (i.e., being provided elected elements) on perceived influence ($\beta = .508, p < .001$). H1 was hence supported. This perceived influence was also positively related to intrinsic motivation ($\beta = .450, p < .001$). We hence found support for H2. Regarding learning outcomes, intrinsic motivation positively predicted perceived learning ($\beta = .668, p < .001$), thus providing support for H3a. However, there was no significant relationship between intrinsic motivation and final test performance. There was hence no support for H3b. Regarding our control variables, students who perceived the course as highly relevant to their field of study perceived higher learning gains ($\beta = .097, p = .04$). Furthermore, the course (i.e., being in the treatment or control group) had a negative effect on intrinsic motivation ($\beta = -.376, p < .001$). Last, students' initial achievement level (i.e., final high school grade) positively predicted test performance ($\beta = .310, p < .001$). Figure 3 summarizes the findings of our SEM-based analysis.

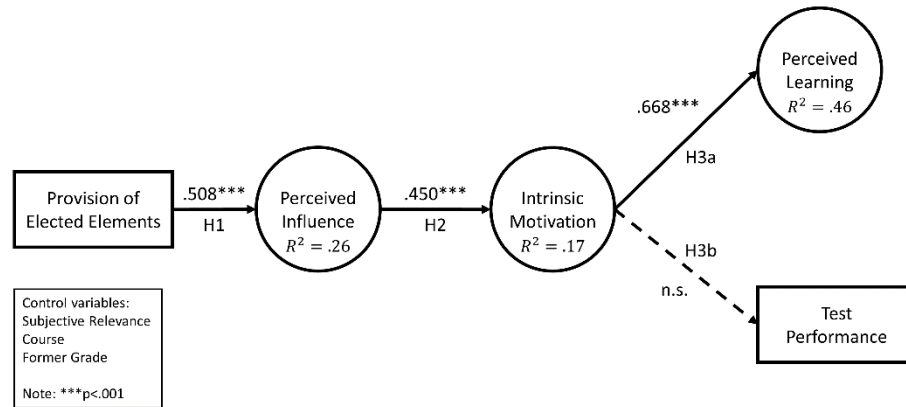


Figure 3: Results of the SEM-based analysis

Since the above analysis only considered the measurement that had been performed after half of the course (i.e., measurement point 2, cf. Figure 2), we also investigated whether the duration of being able to vote for elected elements had an effect on the motivational outcomes associated with the votes. Therefore we analyzed the longitudinal data from the treatment group to investigate any differences in students’ perceived influence, intrinsic motivation, and perceived learning over time using paired t-tests (i.e., comparing measurements 2 and 3). Cohen’s d_z (Lakens, 2013) was used to indicate effect sizes. The analysis revealed that, when compared to the first measurement point half-way through the course, students in the treatment group showed a significant increase in perceived influence ($p < .05$, $N = 42$, Cohen’s $d_z = 0.36$) at the third measurement point, which was after the course had been completed. This appears intuitive, since students had twice the amount of opportunities to vote for their favorite content at this point. Although there were also increases in intrinsic motivation (Cohen’s $d_z = 0.23$) and perceived learning (Cohen’s $d_z = 0.21$), these were not significant ($N = 42$, $p_{Motivation} = .15$, $p_{Learning} = .18$). This might be due to the small sample size of 42 students. Since there was no incentive for students to participate in the survey, it is possible that they experienced fatigue to fill out questionnaires.

In future studies, the sample size should hence be increased to further investigate these effects. Findings from our longitudinal analysis suggest that the amount of choice that is provided with elected elements may have an impact on the beneficial outcomes predicted by our SEM-based analysis.

Regarding students' comments on elected elements, we conducted a summative qualitative content analysis (Hsieh & Shannon, 2005). We investigated three different open questions: First, which improvements regarding the elected elements would students wish for? Second, what were the reasons for students not to take part in the votes? And third, what general aspects of the course would students recommend us to keep for future classes? The answers to the first two questions were manually assigned to categories by the authors in a consensual procedure. For the third question, we counted how often elected elements were mentioned. Table 3 shows the results of this analysis.

Table 3: Results of the Summative Qualitative Content Analysis

Suggested Improvements		Reasons not to Vote		Keep in Course	
More...	#	Reason	#	Aspect	#
...Detailed Description	5	Technical Difficulties	10	Elected Elements	19
...Choices	2	No Interest	2	Quiz	11
...Coverage in Lectures	2	Options Similar	2	Instructor	5
...Meaningful Choices	1	Interested in Both Options	1	Exercises	4
		Not Enough Information	1	Slides	3
		Too Much Effort	1	Other	4

As can be seen in Table 3, the most often stated wish concerning elected elements was a more detailed description before voting. Other suggested improvements address the number of choices as well as the amount of time in the lecture that is covered with elected elements. Among the reasons not no vote, technical difficulties are by far the most common. They include empty batteries (4), connection issues (4), as well as absence of suitable voting devices (2). Only few comments state a lack of interest or too similar options, which indicates that the elements have been diverse and interesting for most students.

Among all aspects students recommended us to keep in the course, elected elements have been the most common. This also indicates the popularity of their provision in large-scale lectures. These and other aspects of our results will be discussed in the following section.

2.9.6 Discussion and Contributions

In this current study, we set out to investigate the effects of providing elected elements in large-scale lectures, especially with regard to intrinsic motivation and learning outcomes of students. Our first finding was that providing these elected elements in large-scale lectures apparently leads to increased perceived influence. This could be demonstrated by significant differences between the treatment and the control group, a significant positive relationship between the treatment variable and perceived influence in our SEM-based analysis as well as a significant increase of perceived influence in the treatment group over time. Hence, using elected elements in large-scale lectures may be an appropriate way to foster student autonomy.

Regarding the effects of increased perceived influence on intrinsic motivation, our study provided mixed results. Although self-determination theory as well as modern expectancy-value theory suggest that an increase in perceived influence should result in increased intrinsic motivation (cf. H2), we found no significant differences between the treatment and the control group. However, our SEM-based analysis indicated a significant positive relationship between perceived influence and intrinsic motivation. While this may seem contradictory at first, a possible explanation might be that elected elements are unlikely to be the only source of perceived influence. Since the course comprised several interactive elements (e.g., discussions, quizzes), some students in the control group may have also felt perceived influence on the course content, even if in fact, they could not alter it. Furthermore, the group comparisons were based on the intrinsic motivation measurement after 7 lectures.

Thus, at this time point, students only had relatively few opportunities to vote. Taking into account the significant increase in perceived influence in the treatment group over time (i.e., after 14 lectures), it is likely that the effectiveness of this approach highly depends on the number of votes provided to students.

Regarding learning outcomes, we recognized a similar pattern as with intrinsic motivation: Although the quasi-experimental groups did not differ significantly regarding their perceived learning, we found a substantial association between intrinsic motivation and self-reported learning gains in our SEM-based analysis. However, intrinsic motivation did not predict students' performance in the final test at the end of the semester. A possible explanation may be the time lag between the measurement of intrinsic motivation for group comparison (i.e., measurement 2) and the actual test (i.e., measurement 4). In the meantime, motivational aspects of students may have changed.

Qualitative analyses of students' comments showed that they liked elected elements most among all features of the course. Since the votes have been performed electronically to ensure anonymity and to foster participation, instructors should take into account technical difficulties (e.g., switch to a lecture room with power outlets and sufficient Wi-Fi coverage when possible). Although we could not statistically show that providing these elements leads to increased intrinsic motivation in a group comparison, these qualitative comments at the end of the course indicate the value of these elements to students.

The contributions of this study are twofold: From a theoretical perspective, we investigated a novel instructional approach: Providing students in large-scale lectures with the opportunity to vote for their favorite content anonymously with ARS. Borrowing from motivational psychology, we sought to predict that this opportunity will lead to increased perceived influence, intrinsic motivation, and learning outcomes. Although the theoretically derived relationships could be confirmed (except for the relationship between intrinsic motivation and test performance), the immediate effect of providing elected elements in large-scale lectures in this study was mostly limited to increases in perceived influence of students. However, this in itself constitutes a valuable contribution, since it informs the discussion about how to increase student autonomy in higher

education. While providing choices to students in general is not a novel concept (see for instance Stefanou et al., 2004 for high school students), one open question from the existing SDT-literature remained: What constitutes meaningful choice for students in higher education? Ryan and Deci (2006) emphasize that many scholars confuse autonomy support with providing meaningless choices. Our findings indicate that students perceived elected elements over their course content as meaningful and thus autonomy supportive. Altogether, we hope to provide a fruitful new avenue in the theoretical debate about student autonomy in higher education, and, in particular, in large-scale lectures. Our practical contribution encompasses empirical evidence on a feasible way to use ARS in order to enhance students' autonomy. Instructors and educators may adopt this approach in their teaching. Our approach aims to achieve a balance between considering individual interests of each student and the organizational necessity of providing large-scale lectures. Since most students are equipped with mobile devices and are eager to use them in classroom settings (cf. Sung, Chang, & Liu, 2016), ARS provide a good opportunity to enhance students' personal influence on the course content. Once these elected elements are created by the instructor, they may be used several times and even in several different courses. Because many ARS have been improved over the years, conducting these polls is uncomplicated and thus feasible to incorporate in large-scale lectures.

Of course, this study also comes with some limitations. First, as mentioned above, we could only teach the control group (Industrial Engineering) for half of the semester, since in their curriculum, they only attend half of the course. Therefore, the quasi-experimental group comparisons were based on a relatively short instruction period of 7 weeks. Second, since there has been no incentive to participate, students' willingness to fill out questionnaires decreased over the course of the semester, leading to a reduced number of data points, especially at the end of the course. Future research may address both issues by conducting the same approach in two courses that can be taught over a whole semester and by implementing an incentive structure.

Third, this study has been performed in two techno-economical fields of study with technology-savvy students who probably appreciate using ARS (MacGeorge et al., 2008). Therefore, the generalizability of findings may be limited to this domain and they may not be true for all students. This study should hence also be reproduced in other fields of study.

2.9.7 Conclusion

In light of the findings above, we emphasize to support student autonomy in large-scale lectures by letting them vote for their favorite content with ARS. We would like to encourage instructors to incorporate elected elements into their lectures. When doing so, these elements should noticeably influence the contents of the lectures and students should be supplied with sufficient information about every alternative before voting. Since offering large-scale lectures is often a necessity due to increasing enrollment, our results highlight one feasible opportunity to improve this experience for both students as well as instructors.

3 Conclusion and Outlook

The essays described in this dissertation constitute novel contributions regarding how learning and motivation in IS can be supported with games and game elements.

The literature reviews examining the theoretical foundation of SG and gamification as well as the state of the art of SG for management decision support shed light on a topic not yet broadly investigated in the IS domain. They provide theory-based explanations on how games and game elements increase motivation and learning, how SG may improve the skills required in the decision process, and derive theory-informed guidelines for their design. Hence, they contribute to answering the research question of how to design SG and gamification to increase learning and motivation in IS: Their design should take into account learning and motivation theories presented in the review and may be designed to foster any specific skill in the decision process. Although there are already several recommendations for how SG and gamification should be designed from a practical perspective (e.g., Bogost, 2015; Zichermann & Cunningham, 2011), directly deriving design guidelines from different learning and motivation theories has thus far not been prominently investigated, which constitutes the novelty of this contribution. In addition, these reviews invite the field of IS and specifically the domain of business intelligence and analytics to engage in research about games and game elements to foster learning and motivation as they also show a research gap in the decision steps design and implementation. SG for skills required in these steps are scarce and should hence be developed and thoroughly evaluated.

An important limitation of these reviews is their restricted search space. Emphasis was put on examining leading journals and conferences. On the one hand, this should ensure a high quality of findings. On the other hand, a lot of valuable and even more recent facts may be found in other sources with less scientific reputation, in particular results of workshops or working papers. However, both reviews do not need to be exhaustive for their main contributions. For instance, the theories identified in the first essay are still

valid, even if future research might indicate more theories in other outlets or identifies a different weight of each theory in literature. It thus lays the foundation for other researchers to expand on in further studies. The main finding from the second essay, namely that all decision steps might be supported with SG is also still valid, even if future research might add even more SG for each decision step. The finding that there is no SG for BIV prior to the Dashboard Tournament might, however, be refuted in future research, as is the case with any literature review indicating the absence of an approach. However, by including the most prominent sources from each domain, we are confident that such a SG did not exist.

By proposing the first SG about BIV guidelines (according to our literature reviews), a new target group for game-based learning is addressed: Report designers. This may hence be a first step to change the way training is conducted in this domain. In addition, the Dashboard Tournament might also be used in higher education (e.g., accounting and management IS courses). Adding to these practical contributions, this research project also aims to inform the design of SG in general, thus contributing to answering the research question of this dissertation. In a thorough experimental evaluation, several contributions customary to DSR are provided (Briggs & Schwabe, 2011).

The first mode of inquiry employed is applied research and engineering (see Figure 5), which leads to instances of generalizable solutions, proof-of-concept prototypes, and evidence that solutions are useful and generalizable (Briggs & Schwabe, 2011). In the case of this dissertation, the first SG about BIV (according to our literature reviews) was developed and evaluated, thus contributing a novel and useful artifact to the domain of business intelligence and analytics. In a laboratory experiment, it was shown that this SG is useful for increasing knowledge about BIV guidelines and is appreciated by participants. When compared to a more conventional instructional approach (i.e., a presentation), there were no significant differences in motivation from the theoretical lens of self-determination theory.

However, providing the SG with integrated debriefing indicates higher learning outcomes than a conventional presentation. We may thus conclude that while not necessarily leading to increased motivation, SG may improve learning outcomes compared to conventional training methods.

The second mode of inquiry leading to DSR contributions used in this project is experimental research (see Figure 5). This mode of inquiry leads to hypotheses, experimental designs, and analyzed data sets (Briggs & Schwabe, 2011). With these contributions, DSR aims to measure the degree to which design objectives have been achieved. In this project, hypotheses have been derived from self-determination theory, which served as the kernel theory for artifact construction. As an important contribution, we developed a measurement instrument by adjusting the intrinsic motivation inventory (Ryan, 1982) and extending it with items from the game experience questionnaire (de Kort et al., 2007) as well as with items from modern expectancy value theory (Wigfield & Eccles, 2000). The final version of this instrument is presented in essay 6. Using this measurement instrument, it was shown that one of the most important dependent variables, namely intrinsic motivation, significantly differed between the groups with integrated and classical post-hoc debriefing. In addition, learning outcomes seem to be higher when debriefing is integrated into the SG. Being the (according to our literature reviews) first study that deliberately investigates the differences between integrated and post-hoc debriefing by implementing two different versions of a SG, it contributes to the design of effective SG. We may hence conclude that integrating debriefing into SG may yield beneficial outcomes in terms of learning and motivation compared to post-hoc debriefing, thus being a promising design principle for SG. This is especially interesting, since most SG still rely on debriefing after the game experience. This may add to theoretical works in experiential learning literature by pointing out the influence of temporal proximity of debriefing to the learning experience. As a consequence, this project informs both theory and practice about the proper design of SG. An overview of the DSR contributions of this project is depicted in Figure 5.

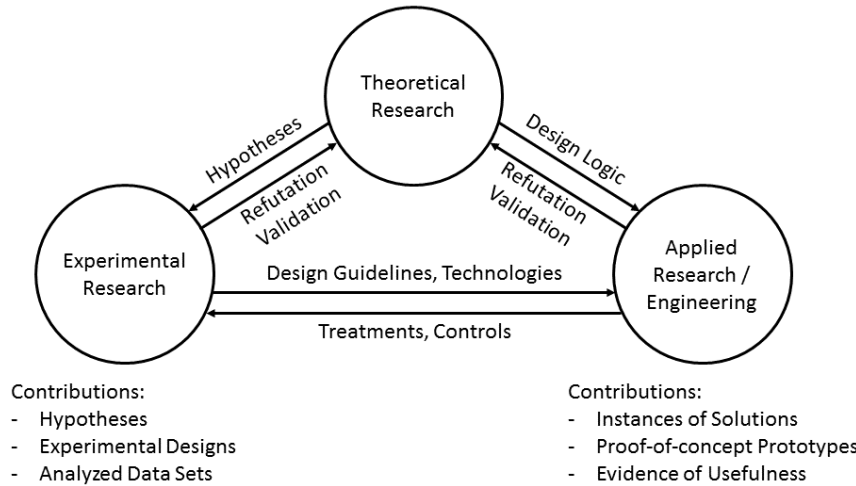


Figure 5: DSR Contributions of Essay 6 (adapted from Briggs & Schwabe, 2011)

An important limitation of this project is the scope of the minigames implemented. Although the game is designed for scalability (i.e., minigames may be added easily in future development), only four minigames could be realized. Hence, the findings above might be restricted to relatively small game experiences. However, since we argue that the differences in learning outcomes might be due to the difficulty to remember what happened during the game experience, this effect is even expected to increase when using longer game experiences. This is an important avenue for future research, to investigate whether the beneficial effects of integrating debriefing into SG also show in more complex and longer lasting game sessions, since this may fundamentally change the way SG are designed.

Beyond the game-based approach presented with the Dashboard Tournament, this dissertation also investigated a user assistance system that helps to motivate users to comply with BIV guidelines when designing business reports as a second means to improve them. In this project, it is shown that user assistance systems may impact compliance in a BIV context. Since we could not identify studies that examine whether these systems may affect the intention to comply with BIV guidelines based on our literature review, we proposed a design of such a system that aims to foster this intention

and introduced the BIV Assistant as a prototypical implementation. According to Briggs and Schwabe (2011), this is a DSR contribution of the applied science and engineering category, since we provide an instance of a generalizable solution in form of a proof-of-concept prototype. The second DSR contribution provided by this study is experimental research (Briggs & Schwabe, 2011). Based on a within-subject experiment, we provide indications that the BIV Assistant has a positive impact on complying with BIV guidelines. In addition, the findings suggest that in a BIV context, perceived ease of use of complying with BIV guidelines is especially important to foster the intention to comply with these guidelines.

As an important limitation of this project, it only draws on data from a small preliminary study. However, based on the statistically significant findings provided by it, we aim to substantiate our results in a next design cycle as proposed by Hevner (2007), using the proposed evaluation design. For this purpose, we intend to further develop the existing prototype to reflect a higher number of BIV guidelines, and seek to also evaluate it among actual decision makers in organizations in future research. Since this user assistant system aims to motivate user behavior towards compliance, we also aim to investigate whether gamification may be implemented into this system to additionally increase the motivation to comply with BIV guidelines.

By introducing missions as game elements to IS lectures, this dissertation also provides important insights into how higher education in the IS domain may be improved with gamification. This project deals with the challenge of tailoring large-scale lectures to the individual interests of students. When providing students with missions (i.e., choices about mandatory elements) in large-scale IS lectures, we give them the opportunity to vote for their favorite content, where usually they have no choice of what is taught. Since offering these lectures is often a necessity due to increasing enrollment, this approach might be one feasible opportunity to improve this experience for both students as well as instructors. Apart from this practical contribution, this research project also aims to inform the design of successful gamification of education in general. By investigating the effects of providing a sense of autonomy in IS lectures, we examined whether autonomy

facilitates intrinsic motivation and learning in the context of IS lectures, thus contributing to the research question of this dissertation. Results show that there is a significant positive relationship between perceived influence from choosing between missions and intrinsic motivation. Regarding learning outcomes, we found a substantial association between intrinsic motivation and self-reported learning gains. However, intrinsic motivation did not predict students' performance in the final test at the end of the semester. Qualitative analyses of students' comments showed that they liked elected elements most among all features of the course, thus underlining the popularity of this approach.

The contributions of this project are twofold: From a theoretical perspective, we investigated a novel instructional approach concerned with providing students with choice over the content in higher education in IS. Borrowing from motivational psychology, we sought to predict that this opportunity will lead to increased perceived influence, intrinsic motivation, and learning outcomes. While providing choices to students in general is not a novel concept (see for instance Stefanou et al., 2004 for high school students), one open question remained: What constitutes meaningful choice for students in higher education? Ryan and Deci (2006) emphasize that many scholars confuse autonomy support with providing meaningless choices. Our findings indicate that students perceived choices over their course content as meaningful and thus autonomy supportive. Altogether, we hope to provide a fruitful new avenue in the theoretical debate about student autonomy in higher education in IS. Our practical contribution encompasses empirical evidence on a feasible way to use gamification to enhance students' autonomy and to tailor learning experiences to their interests. Instructors and educators may adopt this approach in their teaching, thus potentially enhancing higher education in IS.

Of course, this project also comes with some limitations. Due to organizational constraints, we only could teach one of the courses for half a semester. Since there are indications that the number of votes has a large impact on the motivational outcomes of this approach, future research should try to compare two groups that have a longer course duration than half a semester. Another possible limitation is the so-called selection bias,

which every quasi-experimental study might be affected by. Since the two courses addressed different fields of study, future research should encompass comparing two groups of the same field of study, potentially even randomly dividing a population of students into two separate courses.

In summary, this dissertation extends prior knowledge about the motivational effects and learning outcomes of game-based learning and motivation in IS. Following the DSR paradigm, it draws on psychological research to design and analyze game-based approaches to foster learning and motivation in IS. Besides providing the theoretical foundation for these approaches alongside novel and useful artifacts for both BIV and higher education in IS, it proposes several specific design recommendations that may change the way they are implemented. Since game-based learning and motivation are not yet prominently discussed, this dissertation hence invites the field of IS to examine them rigorously in the tradition of DSR in future studies. This may not only lead to increased design knowledge about SG and gamification, but also might help to support ongoing learning processes in organizations facing the challenges of digital transformation, which will be ever more important in future information societies.

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