BUSINESS PROCESS MODELLING AS SERIOUS GAME: FINDINGS FROM A FIELD STUDY

Research paper

Rosenthal, Kristina, University of Hagen, Germany, kristina.rosenthal@fernuni-hagen.de

Strecker, Stefan, University of Hagen, Germany, stefan.strecker@fernuni-hagen.de

Abstract

Serious games have received attention among researchers and practitioners as a potential means for promoting professional development. While interest in serious games has been on the rise, business process models have, to date, only rarely been studied as building block of a serious game. We present findings of a field study into the design and application of an innovative serious game based on a business process model. Applied in an in-house training involving 500 employees at a medium-sized German manufacturer, the serious game aims to familiarize the players with the intricacies of the manufacturer's complex tendering process—by challenging them to properly interpret and complement a BPMN (Business Process Model & Notation) model of the process. Following a hermeneutic research tradition, we seize the unique opportunity to study the design of the game and its application in training sessions in the field. In the paper, we report insights from studying the game design, from observations in training sessions and from interviews with participating employees, trainers and game designers.

Keywords: Business process modelling, Serious game, Field study, Interpretive research.

1 Introduction

Serious games have received attention among researchers and practitioners as a potential means for promoting professional development by stimulating an active learning process (Abt, 1970; Michael and Chen, 2006). While interest and investment in serious games have been on the rise (Seaborn and Fels, 2015), business process models have, to date, only rarely been studied as building block of a serious game (e.g. Brown et al., 2011; Ribeiro et al., 2012). To address this gap, we study a business process model-based cooperative, computer-supported serious game at a German manufacturer of large-scale filling and packaging systems. Invented and designed by the manufacturer's process management unit and applied in an in-house training, the serious game familiarizes the players with the intricacies of the manufacturer's complex tendering and order management process—by challenging them to properly interpret and complement a BPMN model of the process in a modelling software tool. Rather than presenting the players with a syntactically correct and semantically adequate process model, the game starts by a process model template, i.e., a simplified graphical representation of the process' control flow with placeholders displayed for activities, events, documents and information systems for which corresponding model elements are shown below the control flow depiction on the tool's screen. Teams of three to four employees perform the group task of understanding the meaning of the predefined model elements in the context of the tendering process, and of assigning these elements to the correct placeholder. Seemingly a task too simple to pose a challenge, this field research seizes the unique opportunity to study the serious game in situ to understand how the game's design and its application in a corporate training contribute to achieving the manufacturer's intended training objectives. The research objectives we focus on in the present work are to understand the actual game play in training sessions, particularly with regard to the players' incentives provided in the game and their motivational effects on participants' engagement, and to reason about how the game's application contributes to achieving the manufacturer's training objectives. Contrary to intuition, our findings indicate constructive and purposeful team work on the group task leading to traceable contributions to achieving set training objectives.

Following a hermeneutic research tradition (von Wright, 1971; Gadamer, 1975; Klein and Myers, 1999), we report insights from studying the game design, from observations in training sessions and from interviews with participating employees, trainers and game designers. In Strecker and Rosenthal (2016), we report on observations from early design phases in late 2014 up to an initial evaluation of the game in three pilot trainings in January and February 2015 and reconstruct the design of the game as of the end of the pilot phase in March 2016 in detail. Since then, the manufacturer's process management unit has refined the design by revising specific game elements and rules. The present work follows up and deals with the subsequent game application from the first training session starting in June 2016 to the final compulsory training sessions in December 2016 and, consequently, refers to the final game design and its application.

After reviewing related work (Sect. 2), the research design as well as the data collection process and coding are outlined (Sect. 3). Section 4 introduces the game design and game play—as prerequisite for developing an understanding of the game's application. The summary of insights into the actual game play and into how the game's application contributes to achieving set training objectives in Sect. 5 is followed by a discussion in Sect. 6.

2 Related Work

Defining and conceptualizing a 'game' is controversially discussed in literature (Wittgenstein 1953): Seaborn and Fels (2015, p. 16) suggest that games are characterised by different combinations of the following criteria common to definitions of games: rules, structure, voluntariness, uncertain outcomes, conflict, representation, resolution. Deterding et al. (2011, p. 11) emphasize rules, competition and goal-orientation as characteristics distinguishing 'games' from 'playing'. Game elements are broadly described as elements being characteristic to games as, for example, rules, groups/teams, roles, and time pressure (Abt, 1970, pp. 5, 16f; Deterding et al., 2011, p. 11f). Distinguished from the concept of (serious) games is the developing approach of 'gamification' broadly referred to as intentional, selective use of game elements for non-game tasks and contexts (Deterding et al., 2011, p. 10), for example addressed in information systems research (Thiebes et al., 2014; Schlagenhaufer and Amberg, 2015). The application of serious games, very broadly characterised as full-fledged games used for non-entertainment purposes (Michael and Chen, 2006), has been discussed in various fields and for various purposes for long, i.a., in education and industrial trainings (Abt, 1970; Zyda, 2005). The use of computer-based serious games in teaching and professional trainings rose in the past decades and emerged as an intensely studied field of research (Liu et al., 2013; Seaborn and Fels, 2015). The promise of positive effects on participants' motivation and engagement when applying serious games in educational settings have been controversially discussed in literature (Giessen, 2015; Richter et al., 2015). For example, it is indicated that the active role of participants—related to the concept of experiential learning (e.g. Kolb, 2015)—results in positive effects on acquisition and retention of knowledge (e.g. Van Eck, 2006; Boyle et al., 2016).

Business process models as foundation of serious games have only rarely been reported so far. One example is the business process management simulation game INNOV8 developed by IBM (IBM 2007). This computer-based simulation game is aimed at conveying fundamentals of business process management in a business context where participants act in the role of a consultant in a three-dimensional virtual environment. Also, aimed at conveying practical skills in business process modelling, a computer-based serious game is suggested in Brown et al. (2011). In a three-dimensional virtual world, the game fosters collaborative modelling of business processes in a BPMN variant. Another related example is ImPROVE, a business process management simulation game for a triage system in a hospital emergency unit which encourages participants to model and simulate business processes (Ribeiro et al., 2012). The game incorporates, a three-dimensional representation of business process models and emphasizes real-time feedback during the game. In Liukkonen (2009), a game-like business simulation tool called VIPROSA is outlined which primarily focusses on engaging different groups of participants involved in the simulated business processes and on collaboration between these different groups.

3 Research Design

Hermeneutics (Gadamer, 1975; Klein and Myers, 1999) is based on "understanding as a method […] a form of empathy (in German *Einfühlung*) or re-creation in the mind of the scholar of the mental atmosphere" (von Wright, 1971, p. 6). A hermeneutic research approach allows to account for the peculiarities of the research subject (e.g. contingencies of the action system and of the artefact) by way of accepting multiple, complementary perspectives on the research subject, see, for example, Morgan's thoughts on studying such settings (Morgan, 1983) and Ciborra's 'alternative views' (Ciborra, 2002). In particular, the present field research follows a hermeneutic research tradition in the light of two principle considerations: First, given that, to date, no theories or even systematic investigations on the present research subject have been established, the chosen research design aims at an exploratory understanding (following e.g. Benbasat et al., 1987). Second, hermeneutic field research on technical artefacts in social action systems allows for appreciating the peculiarities and idiosyncratic features of the specific field setting (e.g. Frank, 2006, p. 27; Ciborra, 2002), i.e., the unique aspects and characteristics of the setting under investigation. The research design enables us to approach the research objectives from multiple angles, e.g., of participating employees, trainers and game designers, to arrive at a differentiated understanding of the game's design and the game play.

Any attempt to understand implies intentionality and, thus, involves the researchers' personal experiences and perceptions, entailing the methodological challenge of providing scientific justifications for the presented interpretations which are both traceable and convincing with respect to the postulates of justifying scientific knowledge: To meet these challenges, firstly, our research process builds on the notion of a 'hermeneutic circle' (e.g. Mantzavinos, 2016) or 'hermeneutic spiral' (e.g. Gummesson, 2000, pp. 70–72). In an iterative process of reflection and interpretation, the collected data was analysed including developing, refining, and revising the researchers' understanding—resulting in the insights reported and discussed in the present work (Frank, 2006, pp. 26–28; Gummesson, 2000, p. 70). Secondly, to provide scientific justification, special attention is paid to careful reporting and marking of interpretations (Walsham, 1995, p. 78f): In order to make the intentionality in understanding traceable, a comprehensible way of reporting is pursued by adequately justifying interpretations and by reconstructing purposes and objectives of involved actors. The aim of these two approaches is to allow for the critical evaluation of the interpretations and to support a traceable, iterative justification—acknowledging that a convincing justification may not succeed in all cases (Frank 2017).

The site of this research is the German headquarters of the manufacturing company which engineers, builds and installs large-scale filling and packaging systems tailored to the needs of industrial customers. With a staff of 5,000, production facilities in Germany, the USA, Mexico, Brazil, and India, and a 2015 turnover of about 1.1 billion Euros, the manufacturer represents a medium-sized enterprise typical for the German industrial sector. The main rationale for choosing the site for this field research was the unique opportunity to study the design of the serious game and its application to a professional training.

Based on insights and preliminary findings from studying the pilot phase (Strecker and Rosenthal, 2016), we developed and refined the lines of inquiry of the field study and the data collection process. The initial understanding achieved in studying the pilot phase and deliberate reflection provided the ground for developing an in-depth understanding of the design and application of the serious game in the field (e.g. Kezar, 2000; Yin, 2014, p. 96–98). For data collection, questions of inquiry were formulated and refined based on the findings of the pilot study and the subsequently reworked research objectives of this field study (Yin, 2014, pp. 89–91). The intended lines of inquiry are represented by questions regarding the design of the serious game (including the design of game elements), the game play, intended training objectives and exceptional situations during training sessions. The questions, for example, ask in what way the rules of the game changed compared to the pilot trainings (regarding the design of the serious game), how the media, i.e., videos and documents, attached to the process model template are used by the groups and how far discussions on the respective model elements are initiated within groups (regarding the game play), if and how participants are motivated by the incentives set by game elements (also regarding the game play), how participants and trainers assess achieving the intended training objectives, i.a., regarding an understanding of the tendering and order management

process and if and how suggestions for organizational process improvement have been formulated (regarding the intended training objectives), and if exceptional situations, i.e., situations deviating from the anticipated game play, occurred and how they are handled (regarding exceptional situations).

At the research site, various, complementary data collection methods were applied: observations, artefact and document reviews as well as semi-structured and unstructured interviews. This triangulation of data collection methods and sources contributes to provide multiple perspectives on an issue and can support convincing justifications (Eisenhardt, 1989, p. 537f; Yin, 2014, p. 120). With the term data—controversially discussed with regard to its use in the context of hermeneutic approaches (e.g. Frank, 2006, p. 27)—we mean all material, in the form of words and artefacts, which forms the basis for the researchers' understanding, interpretation and reflection.

In seven trainings at the manufacturer's site between July and November 2016, one researcher attended as observer and created handwritten field notes following the outlined lines of inquiry. The design of the game and the training were explained by the process management unit and, in addition, made available to the researchers through written documentation, and material used to support participants, e.g., instructions for operating the modelling tool, including the modelling tool and the process model template as well as attached media, e.g., attached video material.

From November 2016 to January 2017, we conducted ten semi-structured interviews with participants of the trainings and four semi-structured expert interviews with trainers. Interviews are considered to provide the opportunity to achieve richer insights into interpretations of interviewees and to complement other observations to allow for an in-depth understanding (e.g. Walsham, 1995, p. 78; Yin, 2014, p. 113). All interviews were recorded (in German) and transcribed (citations from transcripts shown below have been translated to English by the authors).

For conducting semi-structured interviews with participants, a set of questions was developed based on the underlying questions of inquiry (Yin, 2014, p. 110). The set contained questions about personal experience during the training, questions concerning the intended training objectives with regard to achieving an understanding of the tendering and order management process and of the graphical notation as well as questions about specific game elements, i.a., the multiple-choice test. Moreover, the interviewees were asked to voice critique regarding the serious game. However, in addition to ensuring that the prepared questions were asked, the interviews were conducted with the opportunity to follow interesting lines of research following Myers and Newman (2007). Participants for the interviews were recruited while attending the seven training sessions. To access multiple perspectives from the heterogeneous group of participants, the selection of interviewees spans technical and non-technical staff as well as different organizational units, from line functions to middle management. As a result, six participants from functions in mechanical and construction engineering, including two interviewees from middle management, as well as four participants from non-technical functions in sales and accounting were interviewed, also including two interviewees from middle management. The ten semi-structured interviews were conducted face-to-face at the manufacturer's site during working hours lasting about ten minutes in average. Conducting interviews with participants was aimed at achieving insights into (possibly different) perceptions of participating in the training, playing the serious game and into perceptions with regard to achieving the training objectives.

For the semi-structured expert interviews, a set of themes and key questions addressing central aspects of the lines of inquiry were developed covering the game's design, the proceeding of the game play and the achievement of set training objectives. Just as the interviewed participants, trainers were asked to formulate their own critique regarding the serious game. The expert interviews proceeded in a conversational manner, open-ended and allowing flexibility and improvisation (following Myers and Newman, 2007; Yin, 2014, pp. 110–113)—in addition to bringing up the prepared themes and key questions. Trainers are considered to be (and called) experts as they have privileged knowledge on the design of the serious game and its application in trainings. The interviewees were acquired from the pool of ten instructed trainers. Again, to cover different perspectives, we selected three experts from the process management unit, including the designers of the serious game, and one expert from a technical unit as interviewees. The four interviews with experts were conducted face-to-face at the manufacturer's

site during working hours, lasting from 45 minutes to about an hour. The aim of conducting interviews with experts was to achieve insights into perceptions of the trainers regarding the game's design and, similar to the participant interviews, the actual game play as well as regarding achieving the training objectives.

We coded the interview transcripts and field notes from training observations and unstructured interviews according to Miles et al. (2014, pp. 81f.; see also, e.g., Creswell, 2014, pp. 197–199): By systematically assigning text segments to concepts, coding contributes to condensing the collected data and to (re-)assembling segments of data. Starting with codes conceptualizing the questions of inquiry (deductive coding), the code system was revised and complemented with emergent codes (inductive coding) during the iterative process of reflection and interpretation (see Tab. 1). The present work refers to the status of the training and the design of the serious game as of January 2017. The set of questions for the interviews with participants and the themes and key questions for the expert interviews as well as the complete code system including the third and ultimate level of sub codes (not shown in Tab. 1) are available from the authors (in German and translated to English).

Code	Sub codes
The game	• Game design & game elements • Group discussions during game play • (In-game) Incentives for participants • Exceptional situations
Training objectives	• (i) Understanding of the tendering and order management process • (ii) Process improvement • (iii) Comprehension of the graphical notation
Participant feedback*	/

Table 1. Code system for coding the interview transcripts and field notes up to the first level of sub codes (translated to English). Codes marked with an asterisk (*) are codes which emerged during coding.

4 Game Design and Game Play

Primary organizational context of the game design is the manufacturer's tendering and order management process comprised of more than 20 complex activities and decisions. Due to the complexity of the filling and packaging systems the manufacturer offers, instances of this process often run for several months and involve staff from mechanical and construction engineering as well as sales and accounting, among others. A resulting final tender is represented by an extensive set of documents often consisting of several hundred pages of specifications including constructional drawings, comprehensive calculations and cost estimates. Internal studies initiated by senior management suggest that employees' knowledge of the tendering process beyond immediate process involvement, i.e., across business functions, should be improved to avoid unnecessary friction and costly redundant work. Senior management, therefore, sets the primary objective for the training to achieve a consistent, company-wide comprehensive understanding of the tendering and order management process by the participants—with the subsequent, secondary objective to obtain suggestions for organizational process improvement—by incentivizing training participants to formulate and submit own ideas for such improvements.

The process management unit operationalizes these superordinate objectives during game design in terms of three training objectives: (i) familiarize the participants with the intricacies of the tendering and order management process and convey knowledge regarding important activities, events, roles, responsibilities, documents, information systems, and technical terminology; (ii) encourage the participants to recognize potential for organizational (process) improvement and to formulate suggestions for improving the tendering and order management process; (iii) enable the participants to adequately interpret a process model in the chosen modelling language, or rather, its graphical notation,

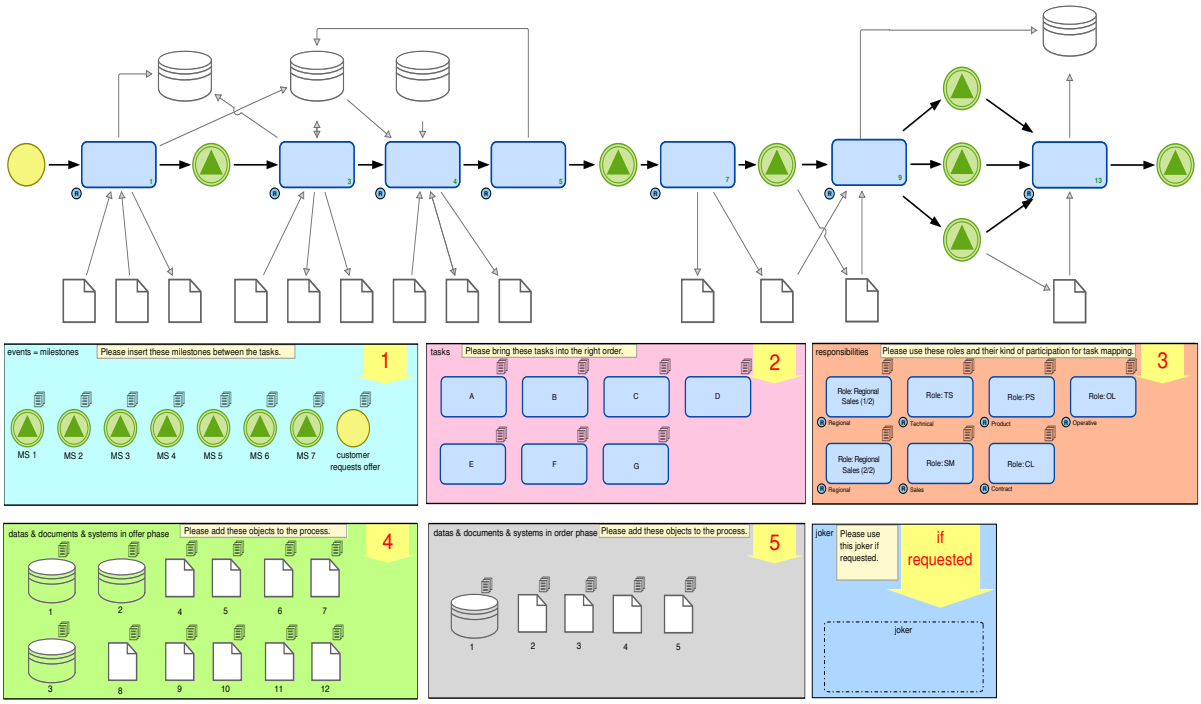

Figure 1. Process Model Template (excerpt, following Strecker and Rosenthal, 2016, p. 232)

to jointly develop a common understanding of (process-related) organizational issues based on process models and to purposefully use business process models for performing their work.

The manufacturer's process management unit based the game design on these training objectives and developed the game over a time frame of more than two years in many iterations with refinements and changes to the game's design (from March 2014 to June 2016). The final game design is characterized by an elaborate set of rules, e.g., pertaining to a game's progress over time, and by various game elements including, e.g., time pressure for teams, the process model template and video material.

Following the classification by Ratan and Ritterfeld (2009), this serious game constitutes a game with primarily occupational content and with the primary learning principle of cognitive problem solving as it aims at conveying knowledge with regard to the manufacturer's tendering and order management process. The target age group is the group of adults and the game is run computer-supported as the business process model is visualized and modified using a software tool. In the following, key game elements and fundamental changes compared to the game's design in the pilot phase are outlined.

The process model template is the key game element (see Fig.1). It shows a simplified model of the tendering and order management process including 22 activities, 14 events, 17 roles and 34 documents and information systems (note that Fig.1 shows an abridged, anonymized illustration of the template). The template depicts the process' control flow with placeholders displayed for activities, events, roles, documents and information systems (upper third of Fig. 1). Corresponding model elements are shown below the control flow. Identifiers of model elements are removed in Fig. 1 for reasons of anonymity (except for two roles given as examples)—different from the template used in the trainings where all model elements are provided with a descriptive identifier. As an essential game element, 70 short video films are attached to the respective model elements—providing participants with additional information necessary to learn about the intricacies of the tendering and order management process, and to solve the group task. The videos comprise interviews with domain experts, videos showing how to conduct a particular task using an information system as well as videos of documents used or created in the tendering process. Training participants are asked to watch 15 of the 70 videos prior to the training as a preparation to better understand organizational roles used in the game.

The game play starts by the trainer announcing prearranged teams comprised of three or four employees from different business functions, i.e., staff has to work together on the group task who is not in close

collaboration during day-to-day business. Cross-functional team composition is a game rule which aims to foster communication across business functions and to cover a wider range of prior process knowledge in each team. Each team is provided a table with chairs and one notebook computer with external monitor which runs the already started modelling software tool showing the process model template. All teams work in the same room with the trainer guiding and monitoring the game play.

The group task in the serious game is to understand the meaning of the predefined model elements in the context of the tendering and order management process and, subsequently, to assign the events, tasks, roles, documents and information systems (see areas 1–5 in Fig. 1) to the correct placeholders in the modelling tool (via drag and drop). The game play then proceeds in five time-based phases: In each phase, it is the task to assign all model elements positioned in one area to the correct predefined placeholders in the process model template, starting with the events in area 1 and proceeding in ascending order with areas 2–5 (see Fig. 1). Different from the pilot trainings, assigning information systems and documents is split into two phases, one for the offer phase and one for the order phase of the tendering process (see areas 4 and 5 in Fig. 1). Each phase concludes with a so-called 'pit stop', i.e., a discussion between all groups and the trainer with the aim to answer questions and to ensure that every group finished the respective phase of performing the group task. In addition, the participants are encouraged to discuss and submit ideas for process improvement in each pit stop. Solving the group task is supported and speeded up by the game element we denote as 'validation of the proper positioning of model elements to their placeholder': As a game rule, each group is permitted access to a software function displaying the number of already correctly assigned model elements every 5 minutes—it is not shown *which* model elements are placed incorrectly. Following a validation, the group has the task to identify incorrectly positioned model elements, to discuss other positions for these elements and to decide on alternative placements. Denoted as a 'joker', a specific kind of validation extending the regular 'validation' function is incorporated as game element which is applicable in phases 4 and 5, i.e., when assigning documents and information systems: Similar to a regular 'validation', a joker permits to validate the proper positioning of model elements. However, a joker allows for a validation in a specified region of the template (see area 'joker' in the lower right corner of Fig. 1). Thus, the result of a regular 'validation' is extended by more precise information on a specific region of the template.

Intended as an incentive to foster purposeful participation, each participant is a priori informed that it is mandatory to take a multiple-choice test after finishing the group task. The test asks detailed questions about the tendering and order management process. To answer the questions properly, it is necessary to recollect the contents of the videos available in the game. The test consists of 15 multiple-choice questions randomly drawn from a pool of 65 questions, and also requires the participant to perform a hands-on task with one of the information systems mentioned in the game as part of the test. Prior to the test, the participants are granted one hour to prepare themselves for the test by using the material provided in the game. During the test, participants are allowed to use all material in paper form handed out in the training and all notes taken by the participants. The test is not passed if more than 5 questions are answered incorrectly. In that case, a particular game rule takes effect: The superior of the participant is informed and made responsible for seeing that the participant acquires the knowledge necessary to pass the test (with access to the video material). The training closes with a group discussion gathering feedback from participants.

5 Insights

5.1 The game

Game design & game elements: A particularly striking aspect in the interviews with trainers pertains to changes to the game design after the initial pilot trainings (see Strecker and Rosenthal, 2016), e.g., splitting the phase of assigning information systems and documents into two phases and introducing the so-called pit stops. All experts evaluate the final game design as positive. The changes are assessed as primarily aimed at reducing complexity, e.g.: "*So, overall, I have to say that it was very important to change the rules of the game. [...] if most of the trainers do not understand the whole thing, that means*

having difficulties to grasp the complexity of the entire game rules [...], then for me this is a sign that it was really important to change the rules. […] After all, it was a reduction of complexity at that point."

One change in the game design aimed at reducing complexity was the removal of predefined roles as modelling tool operator, time keeper etc. assigned to each of the 3 to 4 group members. Although the original game design had complete role descriptions including task responsibilities for each role, our observations are in line with the expert perceptions that the group tasks were quickly identified and assigned to a group member—with task responsibilities partly dynamically switching among group members during game play. Those observations extend to expert opinions indicating that the removal of roles is evaluated positively, e.g.: "*Well, I thought that it had destroyed the group dynamics, if you said from the outset, everyone has a role now and must do something. In my opinion, all trainings have shown that it was unnecessary to predefine roles, because it has always fallen into place. Someone […] took the mouse, the others discussed and it was certainly the aim of the whole training that everyone would care for the content of the process model template and talk to each other, and not that someone just assumes a specific role, as operating the mouse.*"

However, regarding the complexity of the group task, our observations in attended trainings indicate that especially in the fourth phase of working on the group task, i.e., when assigning 20 information systems and documents to the template, some groups turned to a trial-and-error strategy using the game element of a joker as often as possible. From observing individual participants during game play, it appeared as if some participants in each training were overstrained, referring to this part of the group task as excessively demanding within the training. The complexity of the group task was also criticized by participants in final discussions of trainings. Feedback was provided that the group task aims to convey too much and too detailed knowledge, by stating, e.g.: "*This is too much*"; "*I cannot memorise this.*"

Similar comments were made in interviews with certain participants referring to overwhelming information and too many videos to digest properly. However, most of these participants refer to themselves as only marginally involved in the tendering and order management process, e.g.: "*Generally, of course, that was a wealth of information that you should take in within a short time. So, a difficulty for me was to identify the information—from this entire portfolio of videos, which have exceeded the entire training time by far—which I still needed, where I assumed that I still have a knowledge gap. So, that was a difficulty*"; "*But, as I said, it was very difficult to understand because it was so much content for someone who has nothing to do with it. So, you could actually understand the flow of this offer and order processing, but that was quite tough!*"

Group discussions during game play: A general observation across observed game plays is that all groups worked on the group task, and engaged in constructive in-group discussions on aspects of the tendering and order management process. Besides discussing the meaning of model elements in the context of the process, especially the process' control flow was the primary discussion topic (e.g. "A goes before B, B goes before C, …"). Based on the successively increasing understanding developed in these group discussions, placement decisions were made within the groups and most often after reaching a consensus among all group members. In most cases, discussions followed watching videos. An interesting observation is that participants discussed the content of videos within the group and that videos were stopped by participants at points considered as relevant to discuss and to develop an understanding of the addressed model elements jointly in the group. Even after solving the group task in the current phase of the game, i.e., assigning all model elements to the correct placeholder, we observed individuals in several groups who continued to watch videos and discuss their content.

Related to our observations in trainings, passages from the interviews with participants indicate that working on the group task is assessed positively by emphasizing cooperative work and fruitful discussions, also referring to the heterogeneous composition of groups: "*So, I found it quite clear. I liked it. I also found it not too dry. By working in groups and working with the computer and by having also discussed with each other about 'At which position do I have to move that now? Where does this really fit?' you got the views of the people from the other units and the knowledge that they have in some places. So, I found that just in the communication with the others good*"; "*The group compositions were*

good. That people came from different units, that was good. So, one could support the other, which I found very good."

The heterogeneous composition of groups working together on the group task is also emphasized in the interviews with trainers. The following passages indicate that the heterogeneity is assessed to foster discussions within the groups and to contribute to cover a wide range of prior process knowledge in each group as basis for solving the group task: *"[...] of course, when the groups were really heterogeneous in their composition, that was always the best and, really, always a discussion started, well, I can say that*"; "*Well, that turned out to be absolutely important that we really try to put the groups together heterogeneously. We always had difficulties if that was not the case due to the composition of participants. […] But yes, if there was a process role completely missing in the training, it was quite difficult.*"

Also regarding discussions, in the attended trainings, we could observe that in some groups individuals made placement decisions based on their prior process knowledge without discussing these decisions with the other group members. Particularly, these groups watched almost no videos and, within the groups, almost no discussions on model elements and placement decisions took place. However, this applied to only very few situations.

Besides the discussions within the groups, discussions during the so-called pit stops involving all participants of a training session are emphasized as constructive and fruitful in the interviews with trainers: "*And for example, there were always a few discussions, questions on certain process steps or roles or systems and documents. Well, that just opened a discussion between all participants. [...] that was really good with these pit stops*"; *"[…] because we also wanted that the entire group, namely the entire learning team as a whole, gets together again to interchange with each other. That is, the interchange between the participants happens not only in the individual group, but in the whole plenary. That's a very good possibility*."

(In-game) Incentives for participants: Our findings indicate that incentives incorporated into the game design including the specific game elements contribute to participants' engagement. Participants watched videos attached to model elements even after assigning all model elements to the placeholders in the current phase of the game. Participants underline the positive effect of incorporating videos as game element and asses the video explanations as an additional positive incentive referring to positive effects on information processing and retaining knowledge: "*Yes, and I just have to say, that such a video has been much better than just getting a text. [...] And the videos were just so that you could quickly replay it again and thus simply process information better*"; "*I found it very good and descriptive. Because one could of course also just write down bullet points. But I think they do not stick in your mind. So, many people work more visually or can remember things better when they see a picture. And that was based on the video much easier […]*"; "*Personally, I found the type of video to be a good idea, to do so, because I think [...] the motivation is a little higher to watch, I believe, nearly 80 videos on the subject, as if you would have the same only as text just to read.*"

Particularly, participants positively emphasize interviewing manufacturer's staff as domain experts in the videos—for several participants, that meant better understanding colleagues' tasks: "*All in all, I found the videos good, because someone from practice describes his area [...] I think it is fine, as I said, because I get a connection to the colleagues who I see here every day. And then get a description and can put this into relation*"; "*As I said, such a video helps you now, of course, to coincide the person you know, because you also run into them on the corridor or on the factory site, with the function, with the task, with the activities."* Hence, the interviewees point at a positive effect not emphasized in the game's design, but implicitly assumed by the game designers.

Besides the videos as game element, interviewees assess the multiple-choice test at the end of each training as a considerably motivating incentive contributing to the perception of the game as a serious training measure and as overall incentivizing: "*I consider the test very important to maintain the earnestness of this project. That you just keep people at it and just build up a certain pressure so that you do not just see this as an obligatory visit, but, actually, work on the matter a bit more intensively*"; *"[…] you have somehow the incentive to pay a bit more attention as if there is no test behind, where,*

probably, you look three times more on the phone than listen to the speaker. Well, that is right"; "*Well, if you know that you will be tested later, then of course you try to follow the training quite differently. So, from that point of view, I think if this subsequent test had not been announced before and would not have been done the way it has been done, then you probably would have prepared yourself in advance and tried to answer all your questions during the training with a little less motivation and ambition*."

Also, in interviews with trainers, the multiple-choice test is emphasized as game element. Again, positive effects on participants' seriousness and engagement are indicated: "*So, that the test is carried out is of great importance. [...] So, we thought we try to do it without a test and that has shown that the training is taken less seriously. So, that the participants actually during the training [...] that they do not take part with the engagement as if they know that there is a test at the end*"; "*But I think it's generally good that there was a test. [...] from the outset, there was a very different seriousness among the participants than it was the case in all other training courses. And I think that this is just because of this test situation, which only takes place there."*

Moreover, these insights are in line with our observations in trainings. Almost all participants used the time they were granted to prepare themselves for the test intensively. Besides watching numerous videos, participants took notes and, in some cases, used the time for further discussions and clarifications. These observations suggest that most participants constructively and seriously prepared for the test.

However, few participants criticize that each training is concluded with a test. In interviews, these participants primarily complain about distraction from the content of the training by focussing on the test: "*At the very most, that of course you ask yourself, if that is now relevant or if it is not, and that it even hinders concentration on the essentials, the understanding of the complex structures and the possibility of optimizing them. This distracts from the content […]*"; "*But, it made for me and the two people I sat with right there that we did not listen well or did not listen very well, but rather tried to write down information because of the test and I really wanted to take the information down somewhere. […] So it may be that the test has a little bit resulted in not always being 100 percent focused on the trainer, but more often being busy with your documents, to complete them.*"

Exceptional situations: Observations during trainings indicate that a small number of individuals appeared *not* to be motivated by the incentives in the game—some almost refusing to constructively work on the group task. We ascribe this to the observation that those individuals rarely participated in group discussions and placement decisions. These individuals include the participants criticizing the complexity of the group task and the level of detail as too high. We observed only one group in which rarely any collaborative work on the group task came about: In this particular group, a group member from the middle management operated the modelling tool and made placements decisions without discussing with the other group members. In this exceptional situation, a trainer intervened and asked all group members to work together on the group task—easing the situation but not leading to collaboration as observed in the other groups. Even though this particular group was characterized by group members coming from various hierarchical levels, this specific setup did also apply to several other groups which did not exhibit a similar situation. Hence, we attribute the breakdown of collaboration to the idiosyncratic group composition and to the individuals in this group.

5.2 Training objectives

(i) Understanding of the tendering and order management process: Passages from the interviews with participants of the training give indications related to the training objective of familiarizing the participants with the tendering and order management process. Participants especially emphasize achieving an overview over the process: "*So, I found the training itself very interesting, it was very extensive, a rough, but a very comprehensive overview was given over the whole processes*"; "*It was very varied and interesting. So, for me, […] it was once again an indication to broaden my horizon also with regard to the work that the others have to deal with. This is actually the intent and purpose of the whole story, but it has worked, yes*"; "*And even the look beyond the box, for me, was a totally good thing. […] For me, it was very worthwhile to participate in this training because always you only see*

your own small part. […] But the whole offer phase which takes place before, I know that it exists and that it faces difficulties, too, but what process steps in detail take place, I did not know before. And then, I learned a lot there." Moreover, interviewees suggest that they achieved a better understanding of the tendering and order management process and of its intricacies: "*I simply take out of this process game, which has impressed me the most, […] that one has to clarify everything in advance, so that just a smooth flow of material and order flow is ensured*"; "*So, of course, I have extremely improved my own understanding of the interrelations again.*"

These individual statements are in line with our observations in participants' feedback in group discussions and final discussions at the end of the attended trainings. Particularly, in several discussions, participants emphasized their experiences with regard to achieving an overview over the complex process and achieving new insights into specific aspects of the process, especially into the control flow. Also, results of the multiple-choice test assessing the acquisition of knowledge relate to the intended training objective of familiarizing the participants with the tendering and order management process: Only a few percent of the participants did not pass the test—indicating that the game enables the majority of participants to answer reasonably difficult questions about the process correctly (in the multiple-choice test).

(ii) Process improvement: A general observation is that in each training suggestions for process improvement had been formulated by participants. During the pit stops, aspects of improving the process emerged which in several cases led to a discussion on discrepancies participants remarked between the abstract model of the tendering process depicted in the process model template and actual process instances in which participants are involved in their daily work. We also observed intense and controversial discussions between only a few individuals, often from different organizational units on aspects of the tendering process—partially leading to suggestion for process improvement. The interviews with trainers support these observations by giving indications that opening discussions during the pit stops to obtain suggestions for process improvement is generally evaluated positively. Particularly, the overall number of suggestions is emphasized. It is indicated that the heterogeneity of the participants in each training is related to obtaining reasonable suggestions for improvement. However, suggestions are criticized for partially being at a very high level of abstraction: "*And at the pit stops, […] not at every pit stop, we also opened a little discussion on suggestions for improvement. […] There, some were more interested in discussions than others. But I believe that really good things came about, that good points were noted down, which had not been suggested in a homogeneous environment, where all employees are from the same unit*"; "*Process improvement, this has been partially achieved, but in my opinion often at a too abstract level. So, that is, what I would have promised me, it would have been that we obtain concrete hints like: Look, something is not going right here, that has to be handled. […] But many other topics were […] or many other suggestions were really too abstract. […] So it was often too unclear on the part of the participants.*"

(iii) Comprehension of the graphical notation: In interviews, it is suggested that, with only few exceptions, participants did not see problems in interpreting the business process model of the tendering and order management process in the chosen graphical notation. A surprising finding given that almost all participants were faced with a graphically represented business process model for the first time in the training. Indeed, it is emphasized by participants that the graphical representation is assessed to support understanding the tendering and order management process, especially to achieve an overview over the control flow: "*Well, in general, ordering the milestones in a timeline. […] So, this representation is good and helpful and I would like to have it like this. Because we always just have the whole thing in fragments. And to see it in such a timeline, that helps. Yes*"; "*Well, just to visualize processes. […] where is the input, what happens, where is the output and, when I look at the whole thing as a swim lane, also the question, who does what? With that, I recognize the interrelations. Well, then I recognize them*"; "*I guess, whenever you graphically represent something, it helps you to internalize what you have learned. So, whenever something is graphically represented, it helps or it helps me to remember the training content. So that is why I liked that it was graphically represented, of course.*"

This is in line with our observation that, except for very few individuals, groups performed the group task—including working with the process model template represented in the chosen graphical

notation—without facing apparent problems regarding the graphical representation. We also observed the notation to only rarely appear as subject to further enquiry by participants. In our interpretation, this implies that, in the training, participants are quickly learning and understanding the chosen graphical notation and are enabled to interpret the used graphical representation of the tendering and order management process properly.

6 Discussion

Seizing the unique opportunity to study the design and application of an innovative serious game in the field, the present work reports on findings from a field study aimed at understanding the game's design and its application in a large-scale corporate training. The present work is, to our knowledge, among the first to report on such a computer-supported serious game based on a business process model and its application. Updating an earlier intermediate research report (Strecker and Rosenthal, 2016), we present insights into the actual game play and into how the game's application contributes to achieving the training objectives.

Our findings suggest a constructive and purposeful approach to solve the group task by almost all observed teams—contrary to the initial intuition that the group task appears rather easily solved. This is in line with earlier, preliminary insights in pilot trainings. It is also in line with finding only a few individuals exhibiting renunciative behaviour during game play. Interviewed participants and trainers underline the constructive and fruitful discussions within groups and between participants of training sessions. It is indicated that participants develop a more detailed and more comprehensive understanding of the complex tendering process—particularly due to the discussions in their groups. It is also suggested that watching explanatory videos incorporated as essential game element led to and opened discussions and that the game element of working on the group task together with group members from different organizational units contributed to constructive and fruitful discussions. This relates to the incentivizing effect of the videos as suggested by our findings. Primarily, the videos aim to convey very specific domain knowledge, e.g., from mechanical and civil engineering. Our findings suggest that the videos, moreover, contribute to engage participants in the game, i.a., by showing known colleagues and by explaining their tasks not only in their technical terms but in a more accessible terminology. We identify the multiple-choice test as another game element which the participants and trainers describe as an effective incentive contributing to the participants' engagement.

Regarding the design of the serious game, present findings suggest that the game's reduced complexity due to changes and refinements relative to the design in the pilot phase has positively affected the game play. Still, a few participants seemed to be excessively demanded and assess that the game aims to convey too much knowledge—indicating that the group task is still challenging or, in isolated cases, overstraining for the participants.

Findings indicate that the game's design and its game play positively contributed to achieving the intended objectives set by the process management unit. Regarding training objective (i) our findings suggest that the game has contributed to familiarize the majority of participants with the intricacies of the tendering and order management process. This conclusion is suggested by the finding that interviewed participants emphasize having obtained an overview over the complex process and to having acquired useful insights into interrelations and other specific aspects of the process. The multiple-choice test results support our assessment. Besides, we have not observed a single case of a straightforward solution to the main game challenge, i.e., assigning model elements to placeholders. Regarding the training objective of obtaining suggestions for process improvement (ii) observations and the interviews with trainers disclose a surprisingly high amount of proposals for improvements by participants. Our observations indicate that fostering discussions within the entire group of participants in a training contributes to obtaining suggestions for process improvement. We see especially the heterogeneous composition of participants in small teams as means to initiate discussions among team members, i.e., for exchanging their ideas for improving the process. These two conclusions inform future game design: Incorporating and promoting group discussions in small groups with players from different organizational units appears to foster not only constructive game play but also thinking and reflecting

beyond game play. With regard to the graphical notation addressed with training objective (iii), our findings suggest that the game design enables participants to properly interpret the business process model and to reason about the tendering and order management process by way of the model. Considering the complexity of the process model and the inexperience of game participants with process modelling, we deem this promising for further serious game designs based on business process models. Evidently, participants achieved sufficient insights to interpret the process model, although no formal introduction to the language concepts was provided—which indicates that the participants were able to properly interpret the symbol's intended semantics during game play.

This field research follows a hermeneutic research tradition to appreciate the peculiarities of the serious game as a design artefact as well as the social action system it is embedded in. It is a principle limitation of our research approach that findings require careful reinterpretation as 'tendencies' (e.g. Walsham, 1995) if transferred to other application contexts. Studying the present serious game as a socio-technical action system in situ leads us to an exploratory understanding which adds to our knowledge on designing and applying serious games for professional trainings and contributes to further the cumulative body of knowledge on serious game design. As one of the first to study the use of business process models in serious games, subsequent studies need to further explore and refine our present understanding of serious game design, game play and contributions to achieving set objectives. We deem the tendencies outlined a useful source of inspiration for game designers of practical applications, e.g., for corporate trainings.

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