

Gaming for Agility: Applying Serious Games to enable Agile Project Management in Practice

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Abstract—Organizations creating new products and services are increasingly adopting agile and entrepreneurial capabilities to remain innovative. However, acquiring the necessary skills and spirit is troublesome for many organizations as they are heavily relying on a distinct mindset and experience that can only be acquired in the process. Literature indicates that serious games can help to bridge that gap.

In this paper we take the example of agile project management methods to understand how games are applied to support the acquisition of agile and entrepreneurial capabilities.

In an explorative study, we conducted qualitative interviews with game developers, business consultants, and agile coaches from 9 different companies.

Based on 475 minutes of recorded audio, 81 pages of transcripts and research on existing games, we discuss the purpose, characteristics, and success factors of serious games and their embedment in training. Further, we provide an analysis of available games and what project skills they address.

Agility needs to be exercised. The main purpose of serious games is to raise awareness, train and reflect on agile project management methods in practice.

Index Terms—Agile project management, entrepreneurship, serious games, education, training, empirical study

I. INTRODUCTION

How do we learn and improve the way we work in projects using games? The rise of entrepreneurship and agile project management methods increasingly shifts work towards self-managing project teams. Especially in knowledge intensive fields creating new products and services, agile project management methods revolutionized the way project are executed [1]. A projectification of work is a trend observed for some time now by researchers occupied with the development of modern organizations [2], [3]. However, while project work is increasing, the acquisition of mature project work capabilities, be it agile or traditional, is still troublesome for many organizations.

Serious games can help acquiring capabilities and skills [4]. Project methods heavily rely on skills embedded in routines [5], [6]. Such routines as concrete patterns of action are understood as cornerstones of capabilities, they are eventually a source of a company's competitive advantage [7]. In fact arguably one of the largest contributions of agile methods to our understanding of project-based work is their definition

of concrete routines such as standup meetings or iterative development [1]. However, the acquisition of these routines and their enactment in practice is still challenging [8], [9].

Serious games can support the adoption of agile routines in context as frequently reported by agile coaches and consultants [10], [11]. However, to this day there is little scientific evaluation on how these games are applied to do so. In this paper we for the first time present empirical insights into the application of serious games when adopting agile project management methods in practice. To academia this paper contributes a framework to understand the usage of serious games in acquiring capabilities for agile portfolio management. To project management professionals, consultants and educators this paper provides insights how games are applied.

II. RELATED WORK

In dynamic markets companies creating new products and services increasingly rely on agile methods and entrepreneurship to innovate. Reported benefits of agile project management methods include increased customer collaboration, learning, thinking ahead, estimation, and increased quality [12]. However, such approaches are based on self-managing teams, in order to operate successfully, the teams need to have adequate capabilities to execute their work.

Project management and project-based work in general is a crucial capability for entrepreneurial teams. As discussed by Stettina & Hörz [1] (compare Fig.1) in agile portfolio management there are roughly four main capabilities necessary: (1) Strategy, (2) Ideation, (3) Program and Portfolio Management, as well as (4) Execution. Independently of its size entrepreneurial company executing projects needs to have those four capabilities and the underlying skills in place.

Agile and entrepreneurial teams creating new products and services are teams of knowledge workers and are commonly self-managed. Drucker [13] emphasizes the importance of autonomy and habits of continuous learning for knowledge workers. Due to better local knowledge they should be able to find and improve their own ways of working. In order to achieve this, knowledge workers require a large degree of formal education and analytic skills.

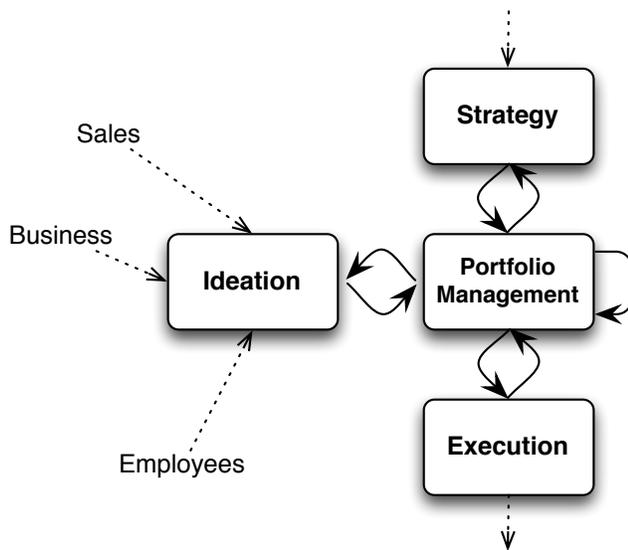


Fig. 1. Four main capabilities connecting to agile portfolio management (adapted from Stettina & Hörz (2015) [1])

A. Why is it difficult to acquire new capabilities?

Project management requires a lot of experience. Such experience is tacit and cannot be easily transferred [5]. While capabilities provide the basis for competitive advantage, research suggests that it is necessary to understand fine-grained activities, so called organizational routines [7]. In project management such crucial skills are for example planning and time management, teamwork, leadership, or decision making [14].

When acquiring routines, cognitive skills such as those involved in project work, the learner progresses through two major stages as learning theories suggests: (1) a declarative knowledge stage, and (2) a procedural knowledge stage [15], [16]. Declarative knowledge (knowing what) can be acquired from lectures and textbooks. Procedural knowledge (knowing how), however, needs to be trained on the process [15].

Organizations adopting agile methods often bridge the gap between declarative and procedural knowledge using coaches that support the adoption [5]. This is very work intensive as each team needs to be supported by a coach. Many coaches and trainers are required to support an effective acquisition of entrepreneurial and agile skills and mindset. How can we support them?

Teachers and coaches can generally support the acquisition of routines either through an inductive or an deductive approach [17]. Deductive teaching is most commonly known as the traditional classroom approach. The teacher introduces concepts and general principles, uses illustrative examples and then asks students to complete similar applications in homework. It is most suitable to teach facts and declarative knowledge. A common criticism is that little attention is paid to the rationale, the why a specific approach is taken

[17]. In inductive teaching the teacher exposes the student to the concepts by letting them experiment and reflect the concept in-use. Inductive teaching is generally better suited to acquire procedural knowledge. Such inductive approaches are commonly found in form of mentoring and coaching of agile [5] and entrepreneurial initiatives [18].

Increasingly organizations are using games where the primary objective is learning instead of entertainment. Game-based learning is an inductive teaching approach. Serious games can be physical games and/or video games (online and offline). These games can be played individual or in teams. Common terms for these games in literature are serious games, business games, simulation games, educational games and business simulations. For this research, the umbrella term serious games is used as defined by Michael and Chen [19]: “A serious game is a game in which education (in its various forms) is the primary goal, rather than entertainment”.

Serious games have been used to teach Scrum [20]. To create awareness about communication and trust in Agile software teams [21]. To practice entrepreneurship [22]. Or to teach software development in general [23]. Serious games are also used in other disciplines like military, health care and government [4], [19], [24], [25].

Based on the current state of art, we pose the following research question: *How do organizations apply serious games to support the adoption of agile project management methods in practice?*

III. METHOD

In this paper we want to create an understanding of how games are applied to support the acquisition of agile and entrepreneurial capabilities in real-world contexts. To address the research question a combination of desk research and empirical research was executed. Desk and literature research was conducted to analyse the current state and gaps in research, as well as to create an overview of serious games currently on the market. Empirical semi-structured interviews were conducted to understand the application of games in practice.

The research process can be split into three phases: (1) The first phase was the desk research in which serious games that can be found in literature and online were analysed. (2) The desk research was followed by an empirical study that consisted of gathering information from experts using semi-structured interviews. (3) In the third phase the interviews were analysed and discussed.

A. Phase 1: Desk Research on Serious Games applied in practice

In order to understand the application of games in context we conducted a desk research to identify games commonly applied by agile coaches and trainers on the web. Games reported by our interview participants were further added later. In order to allow for an appropriate analysis, we concentrated on games which materials and manuals are openly available. This allowed us to test the games and analyze which skills they addressed. The search term applied for the web search

was agile AND serious AND games. The purpose of the desk research was not to provide a complete list of games available. Rather to contribute a first classification of the games applied in in practice.

B. Phase 2: Collection of empirical data: semi-structured active interviews

The second phase, empirical study, consists of three phases: scheduling interviews, conducting interviews, and transcribing the interviews. The semi-structured interviews with experts were used to analyze the usage of serious games in practice.

After finalizing the interview guide the authors searched the internet to get into contact with organizations that are using serious games in workshops. Organizations were selected based on the following two criteria: (1) They have employees with knowledge of serious games, business simulation, and/or project management methods. (2) The organization must provide training or coaching on any of these aspects. The participants were available between the period of March 2014 and May 2014 for approximately 1 hour. The participants can be divided into two groups, game developers and trainers using serious games. Explicit roles of the participants include: consultant, agile coach, and game developer

The interviews were conducted in the period from March 2014 till May 2014. Nine experts from nine organizations were interviewed. Eight of these interviews were conducted face-to-face, within the Netherlands, and one via telephone. The face-to-face interviews were recorded after permission of the participant, the telephone interview is not recorded. The interviews were transcribed right after the interview and the interview notes were stored. A picture is made and stored in case of a participant making a drawing. All of the participating organizations are settled in the Netherlands. When the participant was from the Netherlands the interview was held in Dutch.

C. Phase 3: Interview Analysis

The research strategy for this research project is grounded theory, creating theory by analyzing patterns in empirical data [26]. When performing grounded research coding is done in three stages: open coding, axial coding and selective coding [27]. Open coding is the process of labelling the data. In this stage the data was labelled using a qualitative data analysis program. The data was placed in categories. Axial coding is the process of rearranging the codes and categories into a hierarchical form. This stage is about relationships between categories, subcategories and codes. In this stage the codes were sorted and categories were rearranged. The last stage is selective coding: In this stage the emphasis is placed on recognizing and developing the relationships between the principal categories that have emerged from this grounded approach in order to develop an explanatory theory [28]. When coding the semi-structured expert interviews, all three stages of coding were used: open coding, axial coding and selective coding [27]. At first the printed transcriptions were analyzed and important sentences were highlighted with a

written description of the finding. Then we digitized the codes using QDA Miner, creating basic categories. The second step was analyzing the codes and creating main categories and subcategories. At this step the codes were placed in categories and some codes were merged.

IV. RESULTS

In this section we provide an overview on results emerging from our desk research as well as the conducted expert interviews.

A. Desk research: Serious games analysis results

We analyzed which games contributes to the development of which skills and which domain of practice. The domains of practice were derived from [1]. The skills are derived from literature on the subject of project management and IT management, and software engineering [14], [29]–[33]. Table III presents the domains of practice per serious game.

Most of the games (17 out of 26), we identified, address the execution domain of practice. 6 games focus on project portfolio management. Strategy and governance, and ideation, respectively, were addressed by 2 games and 1 game.

Mostly addressed skills were those of (1) Communication, (2) Project management, (3) Planning and Time Management, (4) Time Management. Each of which was covered by 10 games. Following that the skills of (5) Collaboration, (6) Organization, (7) Requirements Management, (8) Decision Making, and (9) Customer-orientation. Those were addressed by at least 6 or 7 games.

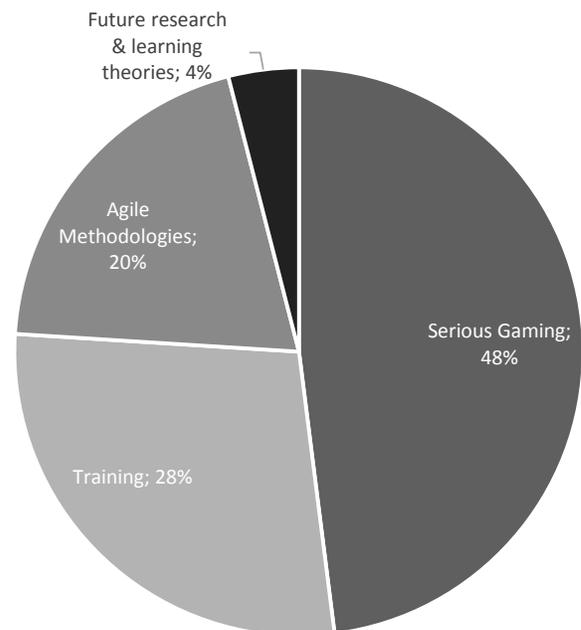


Fig. 2. results

Company code	Interview Date	Industry	Participant Role	Years exp. with Agile	Used agile Methodologies	Company size
A	11-03-2014	Business & ICT Consulting	Management Consultant	13 Years	Scrum, Kanban, Lean Six Sigma	20.000
B	27-03-2014	Business Simulation Development	Game Developer	-	-	4
C	04-04-2014	Business & ICT Consulting	User Experience Consultant	10 Years	Scrum	130.000
D	09-04-2014	Business & ICT Consulting	Consultant Advisory and Implementation	-	Scrum, Lean Six Sigma	1400
E	24-04-2014	Business & ICT Consulting	Agile Coach	6 Years	Scrum, Kanban	40
F	29-04-2014	Software Development & Training	Agile Coach	3 Years	Scrum, Lean Six Sigma	14
G	29-04-2014	Business Simulation Development	Game Developer	-	-	1
H	19-05-2014	Software Development	Consultant	4 Years	Scrum, SAFe, Kanban	440
I	13-05-2014	Business & ICT Consulting	Agile Coach	9 Years	Scrum, Lean Six Sigma, Kanban, SAFe	120

TABLE I
CASE ORGANIZATIONS

B. Semi-structured expert interviews

In total nine expert interviews with game developers, business consultants, and agile coaches were held in the period from March 2014 till May 2014 and that resulted in 475 minutes of audio, an average of 52 minutes per interview. All interviews were transcribed resulting in 81 pages of transcripts, a total of 51,700 words. Table I shows an overview of the participants and their organizations.

The pie chart of Figure 2 shows the distribution of the categories in percentages. The codes from the interviews are sorted into categories and subcategories. The total instances of codes per category are Serious Gaming (101), Training (59), Agile methodologies (27), Future Research (7) and Learning (3). The total number of used codes is 64 and the total frequency of instances is 211.

In the following subsections we will further elaborate on the three main topic code categories: (1) serious games (e.g. their characteristics and purpose), (2) training (characteristics of games specifically embedded in a training environment), and (3) agile methods (topics related to the adoption of agile methods). The last two categories are relatively small, future research is only mentioned 7 times. Future Research includes the codes that mention what participants are interested in. Mostly the participants were interested in seeing new games.

1) *Serious Games*: The Serious Gaming category comprises 48% of the total instances, as shown in Fig. 2. The following subcategories, shown in Tab. II, were identified in this category: Purpose (45 instances), Characteristics (16), Success Factors (13), Type (13), Mechanics (13), Fail Factors (1). In answering the question participants were asked what the main purpose of these games/simulation are. 51% of the answers included the codes Awareness (13 instances) and Applying Theory/Knowledge (10 instances).

A consultant from company D said with regards to awareness: Very often in reflection and evaluation I hear, that's exactly how it goes in our company. They recognize their

own organization in the game, which makes it very powerful because they recognize and experience how it works and how they can improve it. With regards to applying theory/knowledge another participant said: I think it is about 50% of all the simulation are in the area of applying knowledge in a different context.

2) *Training*: The Training category comprises 28% of the total instances, as shown in Fig. 2. The following subcategories, shown in Tab. II, were identified in this category: Success Factor (33), Measurement/methods (8), Types (7), Process (6), and Challenge (5). For an effective training to take place the trainer has to understand the real problem or goal of the organization. This was mentioned in 55% of the answers related to success factors of training.

A consultant from company D about looking into the real problem/goal: The reason for the change, the real reason for the change was another reason than the one that was communicated. The reason was actually that they eventually had to reduce costs and fire people. They said it was about improving cooperation.

3) *Agile Methodologies*: The Training category comprises 20% of the total instances, as shown in Fig. 2. The following subcategories, shown in Tab. II, were identified in this category: Frameworks (16), Success Factors (14), and Challenges (11). Scrum was mentioned in 44% of the answers as a framework that was used within the participating companies.

A consultant from company A: We often use Scrum, but we are also looking into SAFe (Scaled Agile Framework) so that we offer our clients not only advise on agile teams, but also advise on the collaboration of agile teams and the implementation of it throughout the enterprise.

4) *Future research and learning theories*: The last two categories future research and learning theories are relatively small, being mentioned, respectively, 7 times and 3 times. Future Research includes the codes that mention what participants are interested in. The participants were mostly interested

Serious Gaming	
Code	Number of instances
Purpose	45
Characteristics	16
Success factors	13
Type	13
Mechanics	13
Fail factors	1
Training	
Code	Number of instances
Success factors	33
Measurement (methods)	8
Types	7
Process	6
Measurement (challenges)	5
Fail factors	1
Agile methodologies	
Code	Number of instances
Frameworks	16
Success factors	14
Challenges	11

TABLE II
NUMBER OF INSTANCES FOR EACH CATEGORY

in seeing new games A game developer from company B was also interested in measuring the training results: It is still a nice area of interest, there is not much evidence in these kinds of simulations. Lots of evidence in small exercises and compare to teams.

The learning theories that are mentioned by the participants are Blooms taxonomy, the Active Learning Cycle and the 4-step instructional design tool. An agile coach from company E: In our training we make use of training from the back of the room. That is an approach based on a book of Sharon Bowman, based on 4C principles.

V. DISCUSSION

The goal of this research was to analyze how serious games are applied by organizations. In this section we will discuss the results of our inquiry in light of the research objectives and existing literature.

Following the perceptions of our participants, when adopting new capabilities, first the gap in knowledge and skills needs to be identified. Once the gap is identified games can be used to: (1) raise awareness amongst the participating individuals, (2) help acquiring declarative and procedural knowledge, and (3) support changing attitude of the respective individual and teams

A. Usage of games to support adoption of agile capabilities

Visualized in Fig. 3 is the authors vision, based on the perceptions of our participants, on how to use serious games to raise awareness, train and reflect on agile project management methods in practice. Included in the figure are concepts earlier discussed. The training program is divided in pre-training, training and post-training. During pre-training it is most important to get to the real goal of the organization and verify it with the participants of the training. At the training phase the emphasis is on the learning intervention, the serious game and reflecting on the lessons learned and transferring

these lessons learned from the game to a change in on-the-job behaviour. During post-training, the focus needs to be on measuring the outcome of training and effectuating the required change.

B. Success-factors the pre-training phase

Only playing the serious games does not solve the root cause of a problem that the organization is facing. According to our participants, for a trainer, agile coach or consultant it is really important to create an understanding of the problem/goal of the organization before starting the training. The case organizations were unanimous about the importance of the intake process in getting to the real problem/goal of the organization.

This corresponds to what Kirkpatrick says about clever training leaders, they use the Four-Level Evaluation Model of Kirkpatrick somewhat different [34]. They use the evaluation model backwards. Starting at the goal of the organization, then the desired on-the-job behaviour, what participants need to learn and at last they choose the type of learning intervention. They conduct an interview with the business leader and focus on the goal/opportunity this to make sure that the training supports an actual business need. Winn also addresses this when discussing the Design, Play, and Experience Framework. He argues that a game designer should come up with goals for the resulting experience first, to design a game effectively. The goals are used by the game developer to guide the design of the serious game [35].

C. Success factors the training phase

Success factors for the training are the fictional environment and the feedback loops. Most serious games contain a fictional environment in which learners can apply the lessons learned. Therefore, trainers might need to adapt the standard fictional case of game to match the organization. If this is not the case, learners tend to be more resistant to the required change, as they believe this would not work at their own company.

The intake allows the trainer to collect input for the reflection moments in the serious games. The feedback loops are crucial in transferring the lessons learned in the game to changes in on-the-job behaviour. To achieve these changes in on-the-job behaviour, it is crucial to set personal goals at the end of the training. This is where the lesson learned from the training are transferred to reality. These personal goals also provide the possibility to track the outcome and usefulness of the training.

D. Post-training

The results of the interviews showed that none of the participating companies had an effective way of measuring the outcome of training. The only way of measuring training was a form to evaluate the trainer and the training. According to Kirkpatrick this is level 1 of evaluation, to measure customer satisfaction [34]. Little attention has been given by participants to measure level 2, learning. For a trainer and organization sending employees to training this is a really interesting level.

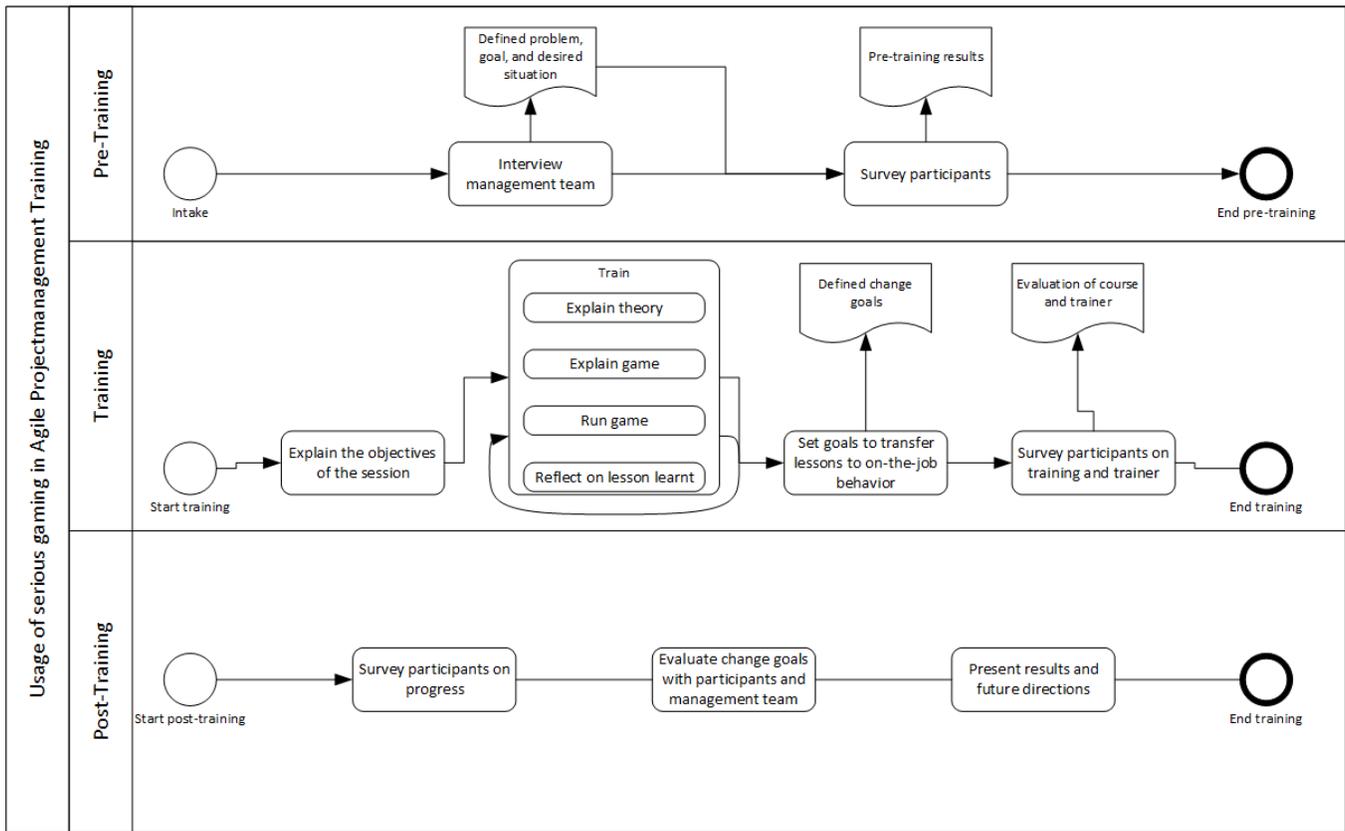


Fig. 3. Usage of serious games in training

At this level you want to measure the knowledge, attitude and behavioural changes resulting from training. Measuring on this level can include surveys, questionnaires or tests. According to the paper of Stikkolorum change in skill could be measured by using a pre-test and post-test [36].

Level 3, change in on-the-job behaviour, according to Kirkpatrick is the most difficult and most important one. When participants have learned something in training but do not apply these lessons learned then the training has been a failure. To evaluate level 3 of Kirkpatrick [34], organizations could use surveys before and after the training. The trainer needs to give participants some time to change their behaviour. For organizations themselves sending employees to training level 4 is in the end the most important one, results.

E. Threats to validity

During research design attention has to be given to two issues: validity and reliability. There are several dimensions: construct validity, internal validity, external validity and reliability [37]. With regard to construct validity, multiple sources of data were used, a total of 9 participants were interviewed for this study. The transcripts of the interviews are peer reviewed. The limited timespan of this study allowed to collect data from 9 participants from 9 organizations. The participants have different backgrounds, they can be put into two groups, serious game developers and trainers using serious games.

This relates to internal validity. The steps taken for doing the interviews, making the data sheets and the coding process were carefully documented to improve internal validity. Reliability was insured by using an interview guide during the interviews. At the start of the interview the participants were made aware that the data will be made anonymous, so they were free to speak and nobody could track their responses.

VI. CONCLUSIONS

In this paper we contribute to the understanding on how organizations apply serious games to support the adoption of agile and entrepreneurial capabilities in practice. Based on 9 in-depth interviews in 9 organizations, in total 475 minutes of recorded audio we identify: (1) how games are applied to support adoption of agile project capabilities, (2) the success factors in game-based training, and (3) a model for game-based training.

Across our cases and as backed up by literature games have been applied to: (1) create awareness, (2) apply theory, and (3) change attitude. The reported success factors identified for a game-based training were: (1) identification of the real problem, (2) realizing importance of the intake process, (3) creation of a fictional environment, and (4) the measurement of the outcome of the training.

To academia this paper provides necessary groundwork to further categorize existing games applied in project-based

organizations. To practitioners we provide concrete recommendations on how games can be applied.

We conclude that serious games (the right games in the right context) are a tool to raise awareness, train and reflect on agile project management methods in practice. However, we acknowledge that serious games alone do not provide the required change in organizational routines, such as agile project management. Much depends on the pre-training and the post-training to effectuate the change.

Throughout this research we identified the following future research. We first propose the development of a game based curriculum, which follows our proposed model for the usage of serious games in training (as shown in Fig. 3). Second, through our desk research we identified the lack of games addressing program and portfolio management. Third, we suggest to further research the domains of practice framework which allows for further classification of games.

#	Name	Subject	Description
Execution			
1	Birdie-Birdie	Basic agile principles	Understand the basic Scrum process. Why are iterations, planning and Product Owner communication important.
2	Scrum from Hell	Stand-up meeting	Practice standup meetings with a dysfunctional one
3	Battleships	Waterfall vs. Iterations	Understand the advantages of iterative planning vs. all-up-front planning using the Battleships game.
4	Play Doh Zoo	Basic agile principles	Understand the reasons behind agile, and the principles that the methodology is built on. Specifically targeted at designers and aims to highlight the benefits of agile, and illustrate how design activities can occur in an agile environment. This game is designed for a large number of people 50-150.
5	Communication Race	Communication and collaboration	Experience communication, collaboration, and leadership in a team by letting individuals collaboratively follow a circuit using a single pen by pulling strings.
6	Scrum simulation	Basic scrum principles	Learn about Scrum and its basic meeting types: Backlog grooming, Sprint planning, Daily Scrum, Sprint review, Sprint retrospective
7	The Marshmallow Challenge	Iterative PDCA cycle	Learn about how iterations help to identify the assumptions in the project, its cost and duration and the real customer needs
8	Three projects, three experiments	Multitasking	Understand high performing teams through focusing on people utilization (instead of completing projects early), continuous partial attention, effect of lack of face to face communication, limiting Work-in-progress
9	99 Test Balloons	Acceptance test	Learn about acceptance criteria, their definition and customer communication.
10	The Risk is in the Blocks	Risk assessment	Learn and conduct a risk assessment using Jenga blocks
11	52 Card Pickup	Basic agile principles	Learn about how the basic practices such as iteration planning, iteration review, and retrospective can help teams to self-organize.
12	Copycats	Requirements	Learn about communication, lack of negotiation and requirements clarity using the game of Chinese Whispers.
13	Knowledge Sharing Exercise	Requirements	Learn about Tayloristic vs. Agile knowledge sharing
14	The Herculean Doughnut	Responsibilities	Learn about roles and responsibilities across team, Product Owner and scrum Master
15	Test Driven Drawing	Requirements	Understand how the Product Owners ability of describing features leads to better results. Learn about different possible interpretations and good and bad styles of test.
16	Mission to Mars	Basic agile principles	Learn basic agile practices including he planning process in iterative software development; it brings together concepts such as: iteration (sprint), backlog, story cards and storypoints, velocity (productivity), impact of defects, technical debt, and risks
17	XP planning game	XP practices	Experience and learn: (1) negotiate an iteration plan, (2) use velocity to measure and make a predictable schedule
Portfolio Management			
18	The Big Payoff	Portfolio management	Learn about Agile projects within portfolio management, and the advantage of planning with stable teams
19	Portfolio Management Game	Portfolio management	Learn how (1) delicate the balance of projects can be, (2) to manage limited resources, and to (3) deal with conflict
20	The Business Value Game	Portfolio management	Learn how to estimate business value, and how to decide between stories, initiatives and customers.
21	The Name game	Multitasking	Learn about the inefficiency of working on working projects and tasks at the same time.
22	The Penny Game	Theory of Constraints	Learn about the inefficiency of working on working projects and tasks at the same time.
23	Lean lego simulation	Basic lean principles	Learn about the importance of continuous flow.
Identification			
24	Delight	Requirements	Learn about how product design emerges in iterative reviews with inarticulate or layman Product Owners.
Strategy and Governance			
25	Scaling Scrum	Larger scrum teams	Learn how to scale Scrum techniques across several teams
26	The scrum ball point game	Basic scrum and teamwork	Learn about why continuous improvement and flow is important.

TABLE III

SERIOUS GAMES AND THE CAPABILITIES THEY ADDRESS

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