Universiteit Leiden

ICT in Business

Using Serious Games to raise awareness, train and reflect on Agile Project Management Methods in practice

Name: A.J.M (Bram) de Mooij

Student-no: S1298526

Date: 22-07-14

1st supervisor: C.J. (Christoph Johann) Stettina Msc.

2nd supervisor: Prof. Dr. B.R. (Bernhard) Katzy

MASTER'S THESIS

Leiden Institute of Advanced Computer Science (LIACS)

Leiden University

Niels Bohrweg 1

2333 CA Leiden

The Netherlands

Abstract

While companies increasingly adopt agile methods, implementing and improving these in practice is still troublesome to many organizations. Agile provides a framework of activities, practices and principles, to apply it you need to change the mind-set of the employees. This thesis addresses the research question: *How can serious games be used to raise awareness, train and reflect on Agile Project Management Methods in practice?*

To analyse how serious games can be used in practice semi-structured interviews with were held. In total 9 interviews with experts were held which resulted in 475 minutes of audio, 81 pages of transcription with a total of 51.700 words. To create an overview of the games currently on the market, the skills they train and the skills needed when using agile software development the author created several mapping sheets.

Serious games according to the participants can be used while adopting, using and improving agile methods. Most important is getting to the real problem or goal of an organization before starting the learning intervention using serious games. Participants mentioned that the main purpose of serious games is creating awareness followed by letting the learners apply lessons learned. Future research could focus on measurement since there is still no effective method to measure the organizational benefits of the training. To conclude, serious games are not the solution to the problem they are a tool to reach your goal.

Keywords

Agile software development, serious games, education, training

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1. Introduction

1.1 Problem Outline

While more and more companies are switching from traditional software development methods to agile software development methods. To adopt, use and improve agile methodologies in daily situations still troubles organizations. Agile provides a framework of activities, practices and principles. To apply such a framework requires a change in mind-set (Stettina & Hörz, 2014).

There is a great difference between traditional software development methods and agile software development methods. General characteristics of traditional software development methods include, large documentation, lots of upfront planning and the phases are subsequent. Agile methods have got a set of different characteristics, it promotes self-organizing teams and the customer's role is critical for success (Nerur, Mahapatra, & Mangalaraj, 2005). Agile software development relies more on tacit knowledge than traditional software development, this kind of knowledge is hard to transfer to other people, co-workers. Agile methods gain much of their agility from this tacit knowledge within the team (Boehm B. , 2002; Fowler & Highsmith, 2001; Boehm & Turner, 2005).Transferring tacit knowledge is expensive because it needs to be done on the job by close interaction, coaching and direct communication (Lam, 2000). It is difficult to learn using agile management methods from books because agile project management methods dependent on procedural knowledge (experience). Procedural knowledge is concerned with knowing how, and includes the ability to perform skilled actions (Eysenck & Keane, 2000). The agile transformation process is a complex organizational change and it is much more than just replacing the current tools and techniques with new ones (Nerur, Mahapatra, & Mangalaraj, 2005).

Serious games and simulations could be helpful in gaining procedural knowledge and declarative knowledge. Agile games/simulations are simulations with defined learning outcomes for training and learning (Crookall, 2010). Serious agile games are already used in training and coaching agile project management methods. Daily stand-up meetings, planning, sprints, portfolio management are just several examples of practices that can be trained using serious games.

Agile games/simulations let people practice on the process. They can be used to give people the procedural knowledge that they need to apply agile software development methods in daily situations. Serious games designed for training agile methods can be used to make agile methods more explicit and those games let participants become familiar with the practices and activities.

1.2 Research Goals

The main-question of this study is:

How can Serious Games be used to raise awareness, train and reflect on Agile Project Management Methods in practice?

The main research question is broad therefore sub-questions are used to help answer the main question. The sub-questions for the research include:

1. *What types of agile serious games are currently available?*
2. *In what way are serious games on agile methods used in practice?*

1.3 Scope

This research project is focussed on the use of serious games, a game in which education rather than entertainment is the primary goal. These serious games can be applied in various disciplines, within this thesis the focus is on serious games that can be used in organizations that adopt, use and improve agile software development methods.

1.4 Structure of the Thesis

The structure of this thesis is as followed:

Section 2: Theoretical Framework.

Section 3: Research Methodology.

Section 4: Results.

Section 5: Discussion.

Section 6: Conclusion and Future Work.

2. Theoretical Framework

This section covers the state-of-the-art in the areas related to the main question. The main areas related to this study are: agile software methodologies, serious games, coaching and learning. Section 2.1 provides a list with terms and definitions. Section 2.2 provides an overview of Software Project Management Frameworks from traditional to agile. Section 2.3 is a section about learning models and Section 2.4 is about Serious Games & Game Design.

Several libraries were used in order to find relevant articles about the main subjects of this study. Keywords used to search are: agile, agile methods, scrum, serious games, project management, business simulation, project management skills, procedural knowledge, learning models and evaluation models. Serious gaming is a fairly new concept and therefore several internet sources are used.

2.1 Terms & definitions

Serious game: A serious game is a game in which education (in its various forms) is the primary goal, rather than entertainment (Michael & Chen, 2005).

Gamification The process of game-thinking and game mechanics to engage users and solve problems (Zichermann & Cunningham, 2011).

Game-based learning: is a type of game play that has defined learning outcomes. Generally, game based learning is designed to balance subject matter with gameplay and the ability of the player to retain and apply said subject matter to the real world (Edtechreview, 2013).

2.2 Software Project Management Frameworks – Traditional to Agile

2.2.1 Traditional Software Development

In 1970 Winston Royce published a paper named: managing the development of large software systems (Royce, 1970). Royce presents 3 software development methods in his paper. The first method presented is the method that we all know under the term waterfall, a software development method using sequential steps. When using the waterfall method, the software has to be defined and described upfront and can't be changed halfway the project. Traditional software development is focussed on requirements, once a step is finished you can never go back to it. The customer isn't involved in the software development process after setting the requirements.

The article doesn't mention the term waterfall. Although Royce also presents two ways to make the "waterfall" method into an iterative software development method, the waterfall method is still the most adopted method. The next figure is a visualization of the software development process presented in the article of Royce.
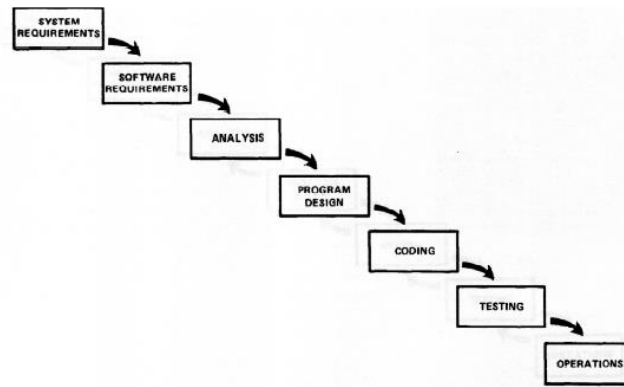
There has been lots of criticism on the waterfall method but even Royce wasn't sure about this method: *"I believe in this concept, but the implementation described above is risky and invites failure"* (Royce, 1970). According to Schwaber the use of sequential steps is the main problem of traditional software development methods (Schwaber, 1997).

Organizations have changed and are more complex than before, therefore IT projects are also more complex. The environment has changed from small local businesses to large multinationals. Using this development method gives some problems, about 30% of the expenditure on IT projects is spend on re-work, about half of the problems is found by the end user and 60% of the projects run into trouble somewhere down the road (Hass, 2007). Royce also noticed this problem: *"The required design changes are likely to be so disruptive that the software requirements upon which the design is based and which provides the rationale for everything are violated. Either the requirements must be modified, or a substantial change in the design is required. In effect the development process has returned to the origin and one can expect up to a 100-percent overrun in schedule and/or costs."*

Customer involvement is critical in agile software development methods and Royce also argues for customer involvement during the process. In his article it is one of the 5 five additional features that must be added to this basic approach to eliminate most of the development risks. Royce states "*important to involve the customer in a formal way so that he has committed himself at earlier points before final delivery. To give the contractor free rein between requirement definition and operation is inviting trouble."* Though the waterfall method was adopted from the paper of Royce, the other iterative methods and his five additional features were more agile.

2.2.2 Iterative and Incremental Software Development

In the 1980s and 1990s there was a pressure to bring products to the market faster and people had witnessed failures of the waterfall model. Organizations started to use new innovative models for software development like Boehm's Spiral model (Boehm B. , 1988), Rapid Application Development and Rational Unified Process. Similarities between those models are the movement away from heavy documentation and upfront defining of requirements (Leffingwell, 2010). Incremental and iterative

software development focusses on smaller pieces of the product instead of building the whole product. Software developers learn from developing and using the software and use that experience to build the next increments. Every increment a piece of working software is added to the product.
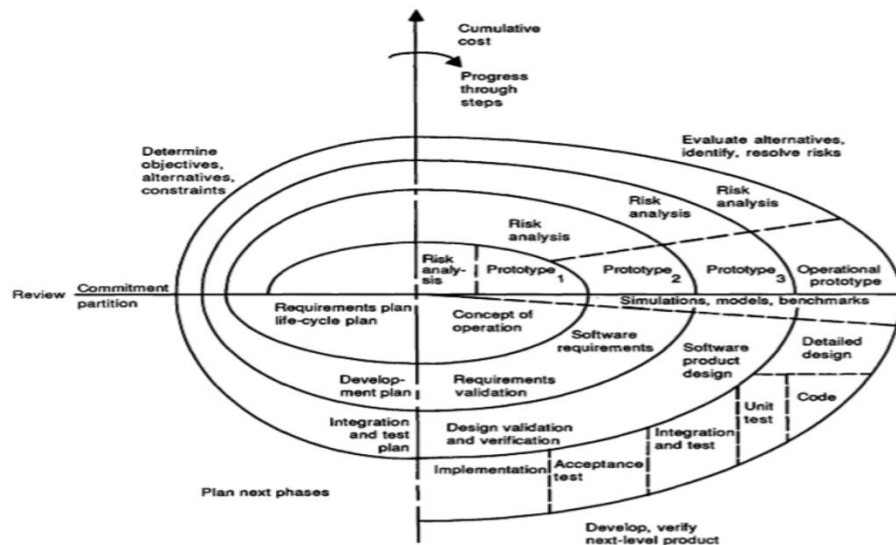
Figure 2: Boehm's Spiral model (Boehm, 1988)

The major distinguishing feature of the spiral model according to Boehm is that it creates a risk-driven approach to the software process rather than a primarily document-driven or code-driven approach. The spiral consists of four stages:

1. Determine objectives, alternatives and constraints
2. Evaluate alternatives, identify and resolve risks
3. Develop, verify next-level product
4. Plan next phases

2.2.3 Agile Software Development

In 2001 a group of software developers met to discuss the lightweight software development methods. Around that time people were already using, Rational Unified Process, Scrum, Extreme Programming, DSDM etc. The group of developers published the Manifesto for Agile software development, which included the core values and principles of the lightweight "agile" methods. Agile software development sums up the software development methodologies that support agility.

But what is agility? According to Boehm: *"agility is the counterpart of discipline. Where discipline ingrains and strengthens, agility releases and invents. Agility applies memory and history to adjust to new environments, react and adapt, take advantage of unexpected opportunities, and update the experience base for the future"* (Boehm & Turner, 2004). Applied to the domain of software development agility means the ability to react and adapt to changes in requirements. Agile software development are used to help businesses and organizations respond to the changing environment.

Agile software development is a way of thinking with concrete practices and activities. The Agile Manifesto (Fowler & Highsmith, 2001) provides 4 key values for agile software development:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

The principles behind the Agile Manifesto:

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity--the art of maximizing the amount of work not done--is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.

Several benefits of using agile methods are: flexibility/adaptability of the process, better fit with customer/business needs, speed-to-market by releasing early, quality through continuous testing, risk management because small increments help to identify problems earlier, fixed price and date instead of fixed requirements and improvement of the return on investment (ROI) for the cost of development (Begel & Nagappan, 2007; Leffingwell, 2010).

There is also some criticism on agile methods in general. When using agile software development methods the team needs to be co-located which can be a struggle for multinational companies. Another limitation is that agile is most suitable for teams not bigger than 10 people. If a team includes more than 10 people you lose the advantage of effective communication which is critical when using agile methods. Safety-critical software can't be developed using the standard testing methodologies because those methods aren't accurate enough (Turk, France, & Rumpe, 2002).

Below are two examples of agile methodologies, Scrum and Extreme Programming.

Scrum

"*Scrum is a way for teams to work together to develop a product. Product development, using Scrum, occurs in small pieces, with each piece building upon previously created pieces. Building products one small piece at a time encourages creativity and enables teams to respond to feedback and change, to build exactly and only what is needed*" (Scrum.org, 2013).

A scrum team consist of 3 basic roles, a product owner, development team and scrum master. The product owner is the business representative.
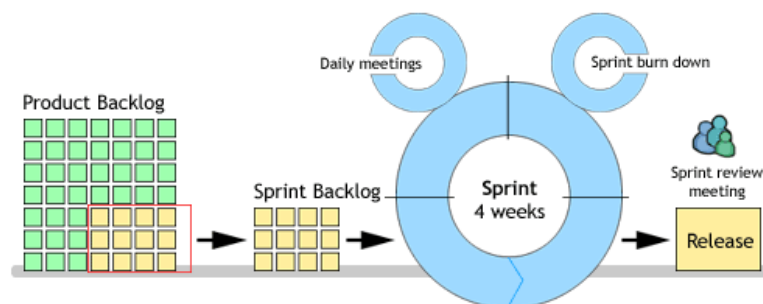
Figure 3: Scrum Process (Agile Scrum, 2013)

As shown in the picture above, scrum uses multiple practices. The practices are described below: A sprint is a development period that normally takes between two weeks up to a month. To determine what needs to be done the team create a sprint planning (sprint backlog) that includes all the work that needs to be done within the next sprint. After each sprints the team comes together and inspects the works that has been done in this sprint and they adjust the backlog. The product backlog is the list with all the features that are needed for a successful product. To constantly improve as a team and organization, the team meets after each sprint to see if something can be improved for the next sprint. A very important practice in scrum is the daily scrum (stand-up meeting), this is a short meeting of the development team to discuss the work that needs to be done in the next 24 hours.

Extreme Programming

"*XP is designed to work with projects that can be built by teams of two to ten programmers, that aren't sharply constrained by the existing computing environment, and where a reasonable job of executing tests can be done in a fraction of a day.*" (Beck, 2006)

Extreme programming is just as scrum a software development method to execute projects as a team. Extreme programming is focussed on feedback, speed and simplicity. According to Beck (Beck, 1999; Beck, 2006) these are the 12 practices used by organizations that use extreme programming (XP) to develop software: the planning game, small releases, metaphor, simple design, testing, refactoring, pair programming, collective ownership, continuous integration, 40-hour week, on-site customer and coding standards.

Just like Scrum and other agile methods extreme programming allows changing requirements. Extreme programming focusses on software quality through testing and early customer feedback. XP uses many cycles of development instead of one used in the traditional waterfall method. The roles in extreme programming include customer, developer, tracker, coach and tester.

2.2.4 Agile Transformation

While more and more companies are switching from traditional software development methods to agile software development methods this also brings some challenges for those companies. This section is about the agile transformation process that companies go through when switching to agile methods like scrum and extreme programming. Agile transformation is the process of switching from traditional methods to agile methods. The software development process change is a complex organizational change, it is more than just replacing the current tools and techniques with new ones (Nerur, Mahapatra, & Mangalaraj, 2005).

This table sums up some differences between traditional software development and agile software development:

	Traditional	Agile
Fundamental Assumptions	Systems are fully specifiable, predictable, and can be built through meticulous and extensive planning.	High-quality, adaptive software can be developed by small teams using the principles of continuous design improvement and testing based on rapid feedback and change.
Control	Process centric	People centric
Management style	Command-and-Control	Leadership-and-collaboration
Knowledge Management	Explicit	Tacit
Role Assignment	Individual-favours specialization	Self-organizing teams, encourages role interchangeability
Communication	Formal	Informal
Customer's Role	Important	Critical
Project Cycle	Guided by tasks or activities	Guided by product features
Development Model	Life cycle model(waterfall, spiral or some variation	The evolutionary-delivery model
Desired Organizational Form/Structure	Mechanistic	Organic
Technology	No restriction	Favours object-oriented technology

Table 1: Traditional versus agile software development (Nerur, 2005)

The agile adoption process typically starts with setting the business goals (speed to market, keeping projects within budget), followed by selecting a pilot project, a project to show the benefits of working according to agile methods. Ideally this pilot project is important for the business, has management visibility, can be delivered incrementally and the pilot project needs to be typical for future projects (Lindstrom & Jeffries, 2004). Then the company's current state of business is analysed and also the projects characteristics. The next step is selecting the right agile methods and practices that suit the organizational needs. This step is followed by training and then applying the chosen methods and practices (O'Connor & Duchonova, 2014).

Adopting, using and improving agile methods is still troublesome for many organizations. The annual VersionOne survey (VersionOne, 2013) among 3501 participants showed that the main cause of failed agile adoption are: company philosophy or culture at odds with core agile values (13%), external pressure to follow traditional waterfall processes (10%), a broader organizational or communications problem (10%), lack of experience with agile methods (11%), lack of cultural transition (9%), unwillingness of team to follow agile (7%), lack of management support (7%), insufficient training (3%) and new to agile (3%). The top five factors that form a barrier to further agile adoption are: inability to change organizational culture (53%), general resistance to change (42%), trying to fit agile elements into a non-agile framework (35%), availability of personnel with right skill (33%) and management support (30%).

Agile transformation requires an organizational change. The challenges can be put into four categories: Management and organizational, people, process and technology (Nerur, Mahapatra, & Mangalaraj, 2005). A summary of the challenges can be found in the following table:

Category	Issue
Management and Organizational	• Organizational Culture • Management Style • Organizational Form • Management of Software Development Knowledge • Reward Systems
People	• Working effectively in a team • High level of competence • Customer relationships—commitment, knowledge, proximity, trust, respect
Process	• Change from process-centric to a feature-driven, people-centric approach • Short, iterative, test-driven development that emphasizes adaptability • Managing large, scalable projects • Selecting an appropriate agile method
Technology (Tools and Techniques)	• Appropriateness of existing technology and tools • New skill sets—refactoring, configuration management, JUnits

Table 2: Key issues in migrating to agile (Nerur, 2005)

The culture in organizations can trouble the adoption of agile methods. *"Cultural shifts in the organization towards Agile Methods turn old ways of thinking on their end, inducing resistance"* (Coram & Bohner, 2005). Both culture and mind-set of people are difficult to change. The management style in traditional methods is one of command and control, when using agile methods leadership and collaboration is the management style. Agile project managers must act as a facilitator and coach, eliminating barriers for the team. Traditional methods rely heavy on documentation and explicit knowledge, when using agile methods most of the knowledge is tacit, in the heads of the team members. Therefore information that is critical to an organization needs to be codified (Nerur, Mahapatra, & Mangalaraj, 2005). Reward systems need to be changed to value both the individual and the team (Boehm & Turner, 2005).

Working effectively as a team is crucial when using agile methods. When using agile development methods the team members need to be co-located in a single work room. Communication and collaboration are increased by being together in one room. This may be difficult for developers who are used to work alone and have little experience with communicating with the customer (Hass, 2007). Decision making in traditional methods is done by the project manager, when using agile methods this is done by the project manager, the team and the customer representative. As said by Nerur: *"it may take an organization enormous effort, time, and patience to build a culture of trust and respect among its employees to facilitate such collaborative decision making"* (Nerur, Mahapatra, & Mangalaraj, 2005). Agile software development methods require an on-site customer representative that has the authority to make decisions.

Organizations using traditional methods have built rigid processes to support the business. Agile software development methods require flexibility and adaptability. Shifting from waterfall development to a method focussed on iterative, feature-driven development brings changes to procedures, practices and roles of people (Nerur, Mahapatra, & Mangalaraj, 2005).

2.3 Learning Theories

"Tell me and I forget, teach me and I may remember, involve me and I learn." - Benjamin Franklin

Agile software development methods place the emphasis on continuous improvement, making the team work better. This process, known as retrospective, has a fixed place in every methodology. During this retrospective the team tries to find out how they can improve their current way of working as a team. In this meeting questions are asked like, what went well, what could have gone better and what could be improved for the future. An agile team is in a continuous circle of improvement.

Learning is the process of acquiring and/or adapting knowledge, skills and behaviour. For effective learning to take place the learner needs to be actively involved and motivated, the activities need to be applicable to real life and individual differences are taken into consideration. New knowledge is best understood when it can be related to existing knowledge. Self-regulation, the process where the student is reflecting on its own learning and setting clear goals plays a critical role in learning (Vosoiadou, 2003).

2.3.1 Bloom's Taxonomy

In 1956 Benjamin Bloom developed the taxonomy of educational objectives. This taxonomy is later revised by Krathwohl and Anderson in 2001 (Krathwohl, 2002). *"Using the taxonomy to classify objectives, activities, and assessments provides a clear, concise, visual representation of a particular course or unit."* (Krathwohl, 2002)*.* Bloom identified several layers of learning, often visualised in a pyramid. The six layers in the revised taxonomy include: remembering, understanding, applying, analysing, evaluating and creating.
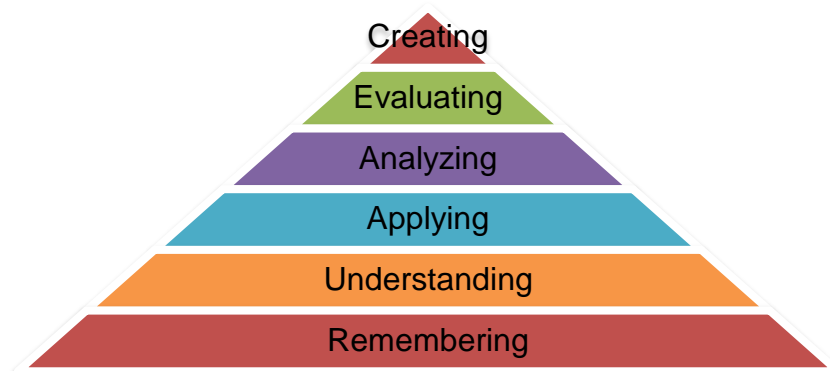
Figure 4: Blooms taxonomy revised (Krathwohl, 2002)

Essential to this model is to master a higher level, the learner needs to master the lower level. First the learner needs to acquire the basic facts/knowledge about a certain topic and create an understanding before he or she can critique or create new knowledge on that topic. The revised Bloom taxonomy identifies four knowledge domains, factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge.

When learning agile methodologies from text books and presentation slides the learner is in the bottom two layers of the model, remembering and understanding. When having learned the basic knowledge about the subject the learner needs to apply the lessons learned into daily situations. Serious games could be used to make the transition from understanding to applying easier. Serious games allow learners to apply the lessons learned in a fictional environment. In this way learners get hands-on experience with concepts like working in an iterative way, early feedback and customer involvement.

2.3.2 Declarative & Procedural knowledge

Corresponding with the revised blooms taxonomy (Krathwohl, 2002), research has shown that there are two long-term memory systems, a distinction could be made between the declarative stage and procedural stage. Declarative knowledge is concerned with knowing that something is the case, level 1 and 2 of Blooms taxonomy, understanding and remembering. Procedural knowledge is concerned with knowing how, and includes the ability to perform skilled actions, level 3 of Blooms taxonomy, applying (Eysenck & Keane, 2000). When learning a new skill the learner goes through both the declarative and the procedural stage. Declarative knowledge corresponds for example with knowing that Amsterdam is the capital of The Netherlands. Procedural knowledge corresponds with knowing how to perform a certain action, for example, how to ride a bike (Anderson, 1982; Eysenck & Keane, 2000). Serious games could be helpful for both stages of the long-term memory system. Serious games give learners a practical experience.

2.3.3 Kolb's Learning Cycle

Around 1984 David Kolb developed a model based on his Experiential Learning Theory. *"ELT is the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience"* (Kolb & Kolb, 2005). The four stages of this model include: active experimentation, concrete experience, reflective observation and abstract conceptualization. In an ideal learning situation the learner goes through all four stages. Concrete experience is when the learner goes through an experience. Reflective observation is about reflecting on that moment. Abstract conceptualization is about making improvements and adapting to the situation. Active experimentation is about testing those improvements.
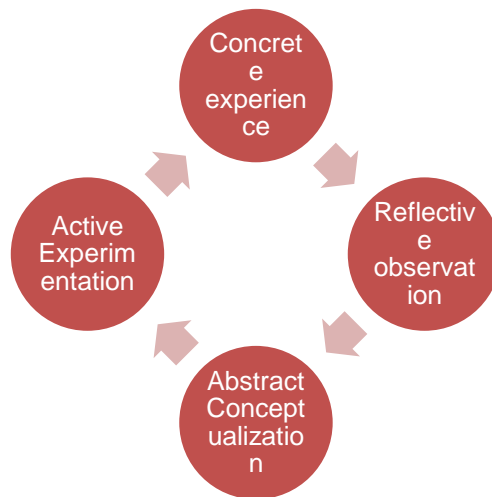
Figure 5: Kolb's learning cycle (Kolb, 2005)

The concepts can also be seen in serious games. Most serious games include several rounds of play, the concrete experience stage, each followed by a moment of reflection, reflective observation stage. The next stage is abstract conceptualization where learners make improvements to the process to make sure they do it better next round. In the following round the learners test their improvements, the active experimentation stage. Serious games typically include 4 to 6 learning cycles, after the first round of play and reflection, the cycle starts again.

2.3.4 Kirkpatrick's Four-Level Evaluation Model

In 1956 Don Kirkpatrick wrote "Evaluating a Human Relations Training Program for Supervisors" (Kirkpatrick & Kirkpatrick, 2005). In this paper Kirkpatrick describes a model to evaluate training outcomes on four levels.

The concepts, principles and techniques are now used by trainers all over the world. The four-level model of Kirkpatrick includes the following levels: reaction, learning, behaviour and results. The first level of evaluating a training program is reaction. Reaction is basically measuring the participant's satisfaction right after training. This does not measure learning outcomes but how participants liked the training in terms of topic, trainer, schedule etc. Mostly this happens in the form of an evaluation form/questionnaire. Evaluation on this level can be used to improve the training. The second level is learning, in this level you measure the knowledge, skills and attitude changes. The third level is behaviour, the behaviour level measures the behavioural change on the job, to what extend do people apply what they have learned in training in real life. The last level is results, this level is concerned with the concrete results after training for instance a productivity increase of 15%, customer satisfaction improved by 20% etc. Evaluation becomes more difficult, important and expensive at every higher level (Kirkpatrick & Kirkpatrick, 2005).

Level 1: Reaction • How do trainees react to the program, or better, what is the measure of customer satisfaction?

Level 2: Learning • To what extent has learning occurred?

Level 3: Behaviour • To what extent has on-the-job behavior changed as a result of the program?

Level 4: Results • To what extent have results occurred because of the training?
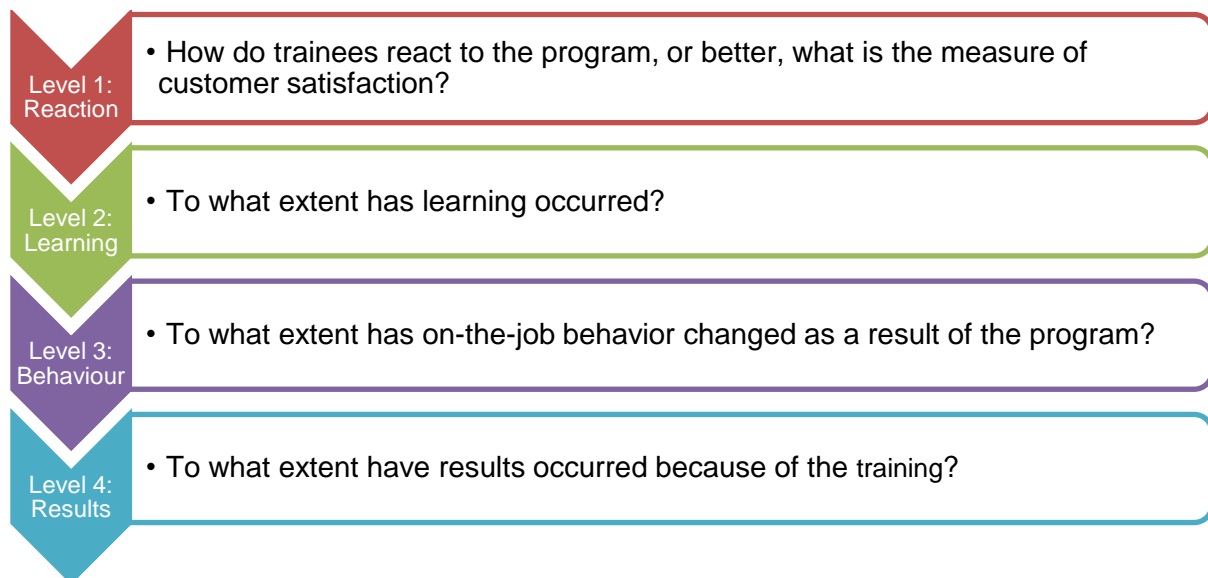
Figure 6: Kirkpatrick levels of Evaluation (Kirkpatrick & Kirkpatrick, 2005)

2.3.5 Flow

Flow is a concept developed by psychologist Csikszentmihalyi. *"Flow is the mental state of operation in which a person performing an activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity. In essence, flow is characterized by complete absorption in what one does"* (Csikszentmihalyi, 1997).

Figure 7: Flow (Csikszentmihalyi, 1975).

An educator should provide an optimal learning environment meaning balancing the challenge and skill of the learners. If the challenge is too high and the skill of the learner is too low then the learner will become frustrated. And on the other side if the challenge is low and the skill high then the learner will become bored. This concept can also be found in entertainment games and serious games. Game designers use this model to provide the player with the right amount of awards, the player receives more rewards at the steepest parts of the learning curve.

2.4 Serious Games & Game Design

Play is our brain's favourite way of learning things – Diane Ackerman

This section describes the usage, benefits and the purpose of serious games. The concept is fairly new but studies agree on the effectiveness of combining games and learning. The section includes serious games, gamification and game-based learning, three concepts that are interconnected.

2.4.1 Serious games

Increasingly organizations are using games where the primary objective is learning instead of entertainment. Serious games can be physical games and/or video games (online and offline). These games can be played individual or in teams. Literature is not clear about how to name these games. Common terms in literature are serious games, business games, simulation games, educational games and business simulations. For this study the umbrella term serious games is used as defined by Michael: *"A serious game is a game in which education (in its various forms) is the primary goal, rather than entertainment"* (Michael & Chen, 2005). The term business simulation is used for serious games that try to represent real world environments. Serious games typically take 30 minutes up to an hour, business simulations are usually played for more than 6 hours.

The first "business" simulations date from 3000 BC, the board game from Wei-Hai and the Hindu game of Chaturanga (Wolfe, 1993). The games represented real military situations. During the 1600's European chess games began using military figures such as pikemen and long bowmen. These games served several purposes from training and education to testing war operations plans. The rise of experienced-based learning around 1950 gave a new boost to the use of business simulations. *"This hands-on experience approach allows the subject to practice cognitive or intellectually abstract theories and principles while enabling a feeling of personal responsibility for the experience's outcomes"* (Wolfe, 1993).

Business simulations can be divided into top management simulations, functional simulations, and concept simulations (Faria, Hutchinson, Wellington, & Gold, 2009). In top management business simulations participants take the role of top management managing the whole company. Functional games let participants focus on a department like marketing or finance. Participants in concept simulations focus on a piece of a department like sales management.

Today in the year 2014 education uses books, television and movies to support teaching but teachers are still sceptic about using serious games. But even the Internet had to prove his effectiveness before it was widely used in education. Students are nowadays familiar with playing games almost everyone has played at least one game in its life and most of the teenagers are now playing video games on a regular basis.

Why should we use games for learning when you have teachers, according to Stapleton this is why we should use games in education: *"Games, therefore, present a learner-centred approach to learning, whereas traditional education presents a teacher-centred approach. To use a metaphor, if learning is understood as a journey, a learner-centred approach is where a learner is in charge of driving a vehicle, and a teacher-centred approach is like catching public transport, with the teacher being the driver"* (Stapleton, 2004).

Serious gaming created a whole new learning style, one that doesn't look like the traditional teacher-centred approach of education (Michael & Chen, 2005). According to Michael this new learning style aggressively ignores the structure and format of formal teaching. It is built on extensive trial and error, with a "failure is nearly free"; you just push play again" mentality. The learning style includes input and instruction from peers (other gamers), not authority figures and it emphasizes "just in time" learning, with new skills and information picked up just before they are needed.

There are a number of differences between "normal" entertainment games and serious games:

	Serious games	Entertainment games
Tasks vs. Rich experience	Problem solving focus	Rich experiences preferred
Focus	Important elements of learning	To have fun
Simulations	Assumptions necessary for workable simulations	Simplified simulation processes
Communication	Should reflect natural (i.e., non-perfect) communication	Communication is often perfect

Table 3: Games versus Serious Games (Susi, 2007)

Serious Games offer a whole range of benefits including the ability to model complex systems. It provides a learning environment that is highly motivating, creates a higher engagement with the material and allows for interactivity when learning. Repeatability is also a key strength of a game or simulation-based approach. Learners can test a particular strategy or adopt a certain approach, if they fail or don't deliver the desired outcome, then they can try again. Serious games and simulations also allow learners to experience something that is too costly, too risky or even physically impossible to achieve in the real world (Michael & Chen, 2005; Pannese & Morosini, 2013).

Serious games can be physical like board games or digital like video games in which education is the primary goal. A key aspect of serious videogame development is measurement. It is really important to develop effective measurement methods and integrate them in the serious videogame. Games can include pre-game, in-game and post-game assessments. This allows for: *"the game experience to adapt to the learners performance, to give the learner the feedback that they need in order to understand the relationship between their actions/decisions and in-game outcomes"* (Michael & Chen, 2005). Effective measurement provides both the learner and teacher with insight in the learning outcomes of the training. Serious videogames in comparison with physical games provide a better

platform for measurement. Data could be automatically analysed based on the individual decision-making in gameplay. Ideal for feedback is the possibility to replay the gameplay.

Games can be used to train a variety of skills: job-specific, people, organization, communication and strategy skills (Michael & Chen, 2005). Serious games are therefore an ideal platform for various educational goals. The purpose of the serious games can differ, possible purposes of serious games are: training, education, raising awareness and reflection.

Serious games are already used in training workshops. The serious games and business simulations used in training agile methodologies differ in time and complexity. What coaches, consultants call serious games are often games that take up to 1 hour. Those games are, compared with business simulations, less complex. They are used to make something clear. The games that are called business simulations take up a full day and are more complex than serious games. Typically in business simulations participants have a role and responsibilities.

An example of a serious games used in training agile methods is Mission to Mars: An Agile Release Planning Game developed by Philippe Kruchten (Kruchten, 2011). Mission to Mars is a physical game, the participants need to be in one room to play the game. According to Kruchten: *"Mission to Mars is an educational board game illustrating the 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."* The game is played using a fictional environment, a spaceship has crashed on the living base and this needs to be rebuild in 8 weeks. Participants have to set priorities and plan how to rebuild this base. Part of this game is a reflection moment at the end of the game. This game takes about 1 hour to play.

Serious games are also used in other disciplines like military, health care and government. An example of a serious game used in healthcare training is a major incident triage game. Participants of this videogame need to triage 8 casualties. They are assessed on accuracy, following the right procedure and speed. Participants using the serious game for training showed higher accuracy in diagnosing the casualties and in following the right procedure (Knight, et al., 2010). An example of a serious game used in by the US navy is Flight Simulator, all students get a customized version of the game at the start of their program (Macedonia, 2001). *"From a military perspective, video game playing (more generally) has a number of advantages, such as improved hand-eye coordination, improved ability to multitask, ability to work in a team using minimal communication, and willingness to take aggressive action"* (Michael & Chen, 2005).

2.4.2 Gamification

Gamification is a fairly new concept, the term originates from 2008. As described in section 2.1, Gamification is the use of game design elements in non-game contexts (Deterding, Dixon, Khaled, & Nacke, 2011). Elements in the area of gamification are for instance leaderboards, badges, levels,

feedback and 3D environments. Gamified applications use design elements used in games, not the technical possibilities. Non-game context meaning using design elements outside games, like the use of badges in Foursquare.

Techniques that are often used in gamification are:

Level	Description	Example
Game interface design patterns	Common, successful interaction design components and design solutions for a known problem in a context, including prototypical implementations	Badge, Leader board, Levels
Game design patterns and mechanics	Commonly reoccurring parts of design in a game that concern gameplay	Time constraint, limited resources, turns
Game design principles and heuristics	Evaluative guidelines to approach a design problem or analyse a given design solution	Enduring play, clear goals, variety of game styles
Game models	Conceptual models of the components of games or game experience	Challenge, fantasy, curiosity, game design atoms
Game design methods	Game design specific practices and processes	Play testing, play-centric design, value conscious game design

Table 4: Game design elements (Deterding, 2012)

Serious games are entire games, gamification is about using elements of games such as leaderboards and badges.
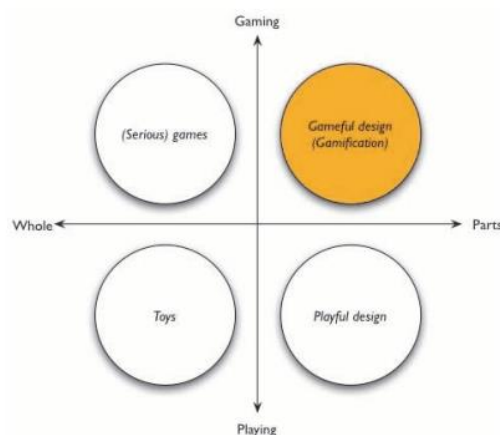
Figure 8: "Gamification" between game and play, whole and parts (Deterding, 2011)

Gamification can be used in several domains: business & marketing, health & wellness, education & training and public policy & government. An example of gamification is the status bar used at LinkedIn, this bar shows how much percentage of your profile is filled. A progress bar is typically used in video

games. Another example is foursquare which includes leader boards and badges. A progress bar, leader board and badges are used to promote competition under users.

2.4.3 Game-based learning

As defined earlier game-based learning is a type of game play that has defined learning outcomes. Generally, game based learning is designed to balance subject matter with gameplay and the ability of the player to retain and apply said subject matter to the real world (Edtechreview, 2013). Game-based learning would be useful when the material isn't motivating the learner, for instance when the subject matter is boring, technical or really difficult. It can also be used for understanding complex processes, strategy development and communication. Audiences that are hard to reach can be reached through game-based learning (Prensky, 2005). Prensky presented a list with types of learning and potential gaming styles:

Content	Examples	Learning Activities	Possible game styles
Facts	Laws, policies, product specifications	Questions Memorization Association Drill	Game show competitions Flashcard type games mnemonics Action, sport games
Judgement	Management decisions, timing, ethics, hiring	Reviewing cases Asking questions Making choices Feedback Coaching	Role play games Detective games Multiplayer interaction Adventure games Strategy games
Behaviour	Supervision, self-control setting examples	Imitation Feedback Coaching Practice	Role playing games
Process	Auditing, strategy creation	System analysis and deconstruction Practice	Strategy games Adventure games
Reasoning	Strategic and tactical thinking, quality analysis	Problems Examples	Puzzles
Skills	Interviewing, teaching, selling, running a machine, project management	Imitation Feedback Coaching Continuous practice Increasing challenge	Persistent state games Role-play games Adventure games Detective games

Table 5: Gaming Styles (Prensky, 2005).

2.4.4 The MDA and DPE Framework

The Mechanics, Dynamics, and Aesthetics framework is an approach to understand games and the way games are developed. The three key concepts, mechanics, dynamics and aesthetics can be found in any game. In this case mechanics means the data level including the algorithms, dynamics describe the run-time behaviour of the mechanics, aesthetics describes the emotional responses of the gamer (Hunicke, LeBlanc, & Zubek, 2004).

| Mechanics | ⟷ | Dynamics | ⟷ | Aesthetics |
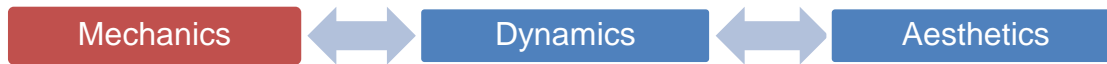
This framework shows the relationship between the game developer and the player. The game developer can only influence the mechanics of a game. The way the game is played is based on the designed mechanics. Game mechanics can include points, levels, leaderboards, badges, challenges/quests and engagement loops (Zichermann & Cunningham, 2011).

The Design, Play and Experience framework described by Winn (Winn, 2008) addresses the needs of learning in game design, this is missing in the MDA framework. Designers of games must start with the goal of the game first: "*To design a game effectively, the designer should first come up with goals for the resulting experience. These goals can be used both to guide the design and to gage the effectiveness of the design once implemented (Winn, 2008).*"

| Design | ⟷ | Play | ⟷ | Experience |

3. Research Methodology

3.1 Research Strategy & Design

This section will describe the research strategy and research design for this thesis. The choice for a strategy is an important choice in every research thesis because the choice for a research strategy has implications for the rest of the study.

The purpose of this research is to analyse how serious games can be used to raise awareness, train and reflect on agile project management methods in practice. In order to analyse how those games can be used the author defined a main research question and two sub-questions.

The main question of this study is:

How can Serious Games be used to raise awareness, train and reflect on Agile Project Management Methods in practice?

The main research question is broad therefore sub-questions are used to help answer the main question. The sub-questions for the research include:

1. *What types of agile serious games are currently available?*
2. *In what way are serious games on agile methods used in practice?*

To answer the research question the author used a combination of desk research and empirical research by doing literature research and using semi-structured expert interviews.

In order to analyse the current state and gaps in research a literature study is conducted. During the preliminary literature study the author noticed challenges when implementing Agile Project Management Methods, section 2.2.4. These challenges include less documentation and more tacit knowledge when using agile methods and the need for an appropriate culture and mind-set (Boehm & Turner, 2005; Nerur, Mahapatra, & Mangalaraj, 2005). One way to overcome those challenges could be the use of Serious Games. Those games can be used to let people practice the process and let people get familiar with certain practices.

To analyse how Serious Games can be used in practice semi-structured interviews with experts are used. The interview guide can be found in Appendix E. The interviews were held in the period from March 2014 till May 2014.

To answer the research questions several research strategies can be used. Saunders presents 7 research strategies: experiment, survey, case study, action research, grounded theory, ethnography and archival research (Saunders, Saunders, Lewis, & Thornhill, 2011). The research strategy for this research project is grounded theory, creating theory by analysing patterns in empirical data (Eisenhardt & Graebner, 2007). When performing grounded research coding is done in three stages:

open coding, axial coding and selective coding (Corbin & Strauss, 1990). Open coding is the process of labelling the data. In this stage the author labelled the data using QDA Miner, a qualitative data analysis program. The data is placed in categories. Axial coding then 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 are sorted and categories are rearranged. The last stage is selective coding: "*In this stage the emphasis is placed on recognising and developing the relationships between the principal categories that have emerged from this grounded approach in order to develop an explanatory theory.*" (Saunders, Saunders, Lewis, & Thornhill, 2011).

When coding the data from the semi-structured expert interviews, all three stages of coding are used. The data from the role descriptions and game descriptions is coded during the desk research phase using open coding. This provided the author a mapping with important skills in role descriptions and skills trained in particular games.

3.2 Research Process

The research process of this thesis can be split into three phases. The research starts with a literature study, analysing the serious games that can be found in literature and online within the scope of this research and analysing the role descriptions for necessary skills. The second phase is empirical study, getting information from experts using semi-structured interviews. The third phase is analysing the interviews, getting the results and discussion. A more detailed description follows after the following picture that visualises the research process.
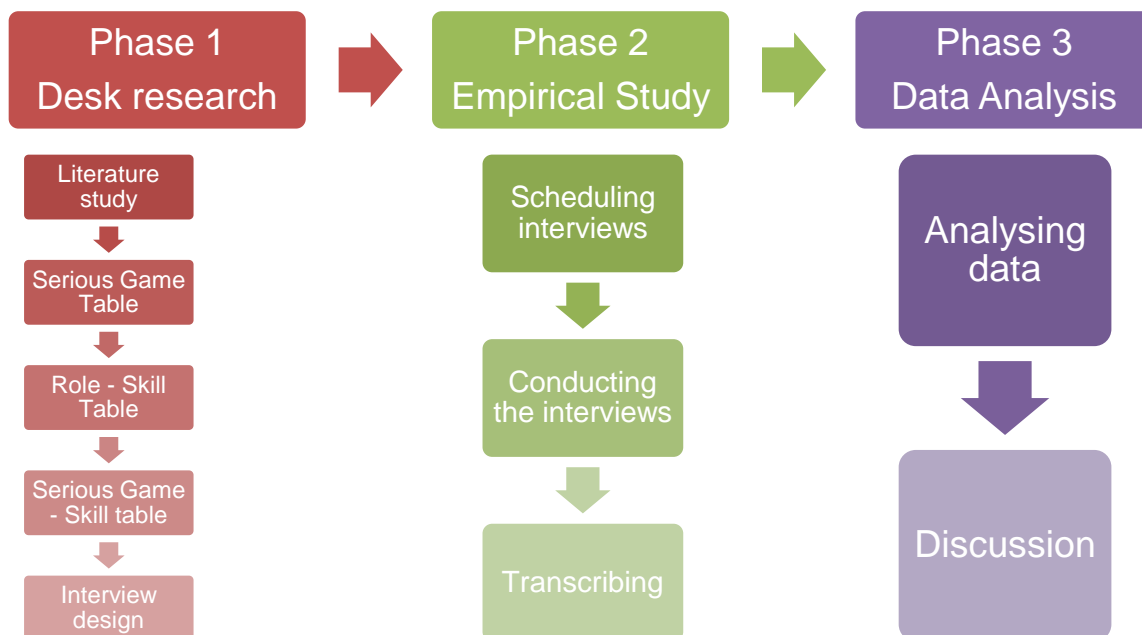
Figure 9: Research Process

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Phase 1 – Desk research

Literature Study

A literature study was conducted to give direction to this thesis. The most relevant concepts for this study were: serious games, learning theories and agile software development. At first the author collected articles using google scholar, read the abstracts and then selected useful, relevant articles for this study. The articles found present the current state of research and the gaps in research.

Serious Game Table

To create an overview of the serious games currently on the market to train agile methodologies the author created a table. This table can be found in appendix A. The table is used to analyse these serious games on: level, subject, purpose, roles included in the game. For every game there is noted what the subject is based on the description of the game. The author used the levels: team, program and portfolio to analyse for what levels those games are suitable. The same applies for the purpose of the game: to inform/awareness, training/education and reflection. The roles that are used belong to the Scaled Agile Framework. These roles are taken because the Scaled Agile Framework is the most comprehensive framework, it includes more roles than for instance Scrum or XP. The games are analysed on the following roles: developer, tester, agile master, product owner, release management, product management and portfolio management. The games that are applicable to every role in the company got the label "all". The games that are mentioned during the interviews are also added to the table. The business simulations found online are also added as a separate table, Appendix H. These business simulations are not used in the rest of this research because there was little information available.

Role – Skill Table

To analyse the necessary skills of people working in organizations that are using Agile Project Management the author analysed the role descriptions. The role descriptions of the following frameworks are analysed: Scaled Agile Framework, Scrum, Extreme Programming and Prince2. The Scaled Agile Framework is a relative new framework used to scale the agile way of working from team to portfolio level. Both Scrum and Extreme Programming are well known agile frameworks, Scrum and combinations of Scrum and Extreme Programming are according to VersionOne with 66% the most popular agile methodologies (VersionOne, 2013). Prince2 is added as a more traditional way of managing projects. This will give the author the possibility to compare the outcomes of the "agile" frameworks to the more traditional Prince2 framework. The role descriptions can be found in literature except for the role descriptions of the Scaled Agile Framework (Scaled Agile Framework, 2014; Schwaber & Sutherland, 2011; Chromatic, 2003; Grande-Bretagne, 2009). This table can be found on individual level in Appendix B and on team level in Appendix C.

The skills are derived from literature on the subject of software engineering, project management and IT management (Grande-Bretagne, 2009; Turley & Bieman, 1994; Lee & Lee, 2006; Edum-Fotwe & McCaffer, 2000; Aken & Michalisin, 2007). Teamwork, coaching, delegation, leadership and

programming are just a few examples of the skills derived from that literature. Coding is used to analyse those role descriptions on the skills that are mentioned in the text. A qualitative data analysis tool, QDA Miner, is used for coding. As an example, from the Scrum master role description this is one of the sentences: "Leading and coaching the organization in its Scrum adoption". The skills mentioned in this one sentence are: project management, leadership and coaching. This process is done for every role description. The frequency of the skills mentioned in the role description is added in the table both on team and individual level.

Serious Game – Skill Table

To create an overview of the skills trained when using various serious games the author created another table. This table includes the games mentioned in table from Appendix A. The games are analysed on the same skills as the role descriptions, Appendix B and Appendix C. This third table can be found in Appendix D.

Interview Guide Semi-Structured Interviews

As mentioned before to collect qualitative data semi-structured interviews with experts were conducted. An interview guide is created to give structure to the interview. The interview guide can be found in Appendix E. A semi-structured interview using an interview guide gives direction to the interview but is also flexible to cope with deviations of the interviewee. The structure of the interview is as follows, the first part is introduction of the interviewer, subject and purpose of the interview. Permission is being asked to record the interview. The second part includes general questions about the interviewee. The third part is about the agile training programme. The fourth part is about the usage of Serious Games. Part five is about the actual development of Serious Games. The last part is about the period after using a serious game or business simulation. The focus of the interviews shifted based on the interviewee's expertise.

Phase 2 – Empirical Study

The second phase, empirical study, consists of three phases: scheduling interviews, conducting interviews and transcribing the interviews. Semi-structured interviews with experts are used to analyse how serious games are used in practice. The interviews were scheduled to be held in the period from March 2014 till May 2014. In total 9 experts from 9 organizations were interviewed. 8 of the experts were interviewed face-to-face and 1 via telephone. The face-to-face interviews were recorded after permission of the participant, the telephone interview isn't recorded. All the expert 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. After finalising the interview guide the author searched the internet to get into contact with organizations that are using serious games in workshops. An invitation was sent via a general contact form on the website of the organization in case no personal email address was found. If the participants email address was mentioned on the website an email was sent to that address.

Case selection criteria

- Knowledge of Serious Gaming/Business Simulation and/or Project Management Methods.
- Training/coaching company
- Within the Netherlands, to have face to face interviews.
- Available for interview – between March and May for approximately 1 hour.

Participant Roles

The company selection criteria already mention that the interviewee needs to have knowledge of Serious Games and/or project management methods. 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

Phase 3 – Data Analysis

To analyse the data from the interviews the author coded the transcriptions using the earlier mentioned three stages of coding: open coding, axial coding and selective coding (Corbin & Strauss, 1990). At first the printed transcriptions were analysed and important sentences were highlighted with a written description of the finding. Then the author digitalised the codes using QDA Miner, creating basic categories. The second step was analysing the codes and creating main categories and subcategories. At this step the codes were placed in categories and some codes were merged.

3.4 Validity consideration

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 (Voss, Tsikriktsis, & Frohlich, 2002).

Construct validity, the extent to which we establish correct operational measures for the concepts being studied. The author used multiple sources of data, a total of 9 participants were interviewed for this study. The transcriptions of the interviews are peer reviewed.

External validity, is knowing whether a study's finding can be generalised beyond the immediate case study. The limited timespan of this study allowed the author 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. The participants showed interest in the results of this study.

Internal validity, the extent to which we can establish a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships. The author carefully documented the steps taken for doing the interviews, making the data sheets and the coding process. All the data sources can be found in the appendices.

Reliability, the extent to which a study's operations can be repeated, with the same results. The author used an interview guide during the interviews. The interview guide can be found in Appendix E. At the start of the interview the author mentioned that the data will be made anonymous, so participants were free to speak and nobody could track their responses.

4. Results

4.1 Data Collection

4.1.1 Case Organizations

Below is a table with information about the participants and their organization, data is made anonymous for privacy reasons. Afterwards a short description of each company and participant is given.

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 6: Case Organizations

4.1.1.1 Company A

Company A, is in the Business & ICT Consulting industry with international presence. The size of the company is 17.000. This company has 2500 employees within the Netherlands. The participant, a management consultant, is part of the consulting services division of company A. They developed a business simulation based on their vision on IT Management.

4.1.1.2 Company B

Company B is a Dutch company in the Business Simulation industry with worldwide presence through its partners. The size of the company is 4. Company B develops professional business simulations and serious games to support organizational learning and development. The Business simulations and serious games are build using industry experts and are focussed on IT departments. The participant, the director of company B, has a background in Human Research Development.

4.1.1.3 Company C

Company C is in the Business & ICT Consulting industry and is active in 44 countries. The size of the company is 130.000. This company is the world's biggest supplier of consulting, technology and outsourcing services. The participant's role is User Experience Consultant, the focus of his work shifted from usability to the transformation of people.

4.1.1.4 Company D

Company D is in the Business & ICT Consulting industry focussed on the Netherlands. The size of the company is 1400. Company D is one of the Netherlands top IT consulting organizations. The participant is part of the team advisory and implementation as a consultant, before he was a consultant in the People in Change team. Most of his projects are in the field of change management.

4.1.1.5 Company E

Company E is in the Business & ICT Consulting industry with wide international presence. The size of the company is 40 worldwide. This company is specialised in training and coaching when implementing agile. The participant of this company is the only employee within the Netherlands.

4.1.1.6 Company F

Company F is in the Software Development & Training industry. The size of the company is 14. This company is a software development company and also provides agile training, coaching and consultancy. The participant is an agile coach/consultant with 3 year experience in using agile methods.

4.1.1.7 Company G

Company G is in the Business Simulation industry. The size of the company is 1. The participant is specialised in developing business simulations both standardised and customised and has 25 years'

experience in developing business simulations. The standardised games are played by small teams/divisions, the customized games are played by 100 up to 1000 people to control the costs.

4.1.1.8 Company H

Company H is in the Software Development industry with wide international presence. The size of the company is 440. This company sells an agile lifecycle management system. The company is founded in America. The participant has been a trainer for this company for the past 4 years. As a trainer this participant trains: scrum, Kanban and Scaled Agile Framework.

4.1.1.9 Company I

Company I is in the Business & ICT Consulting industry. The size of the company is 120. This company is an international IT consulting, project and outsource organization, specialized in agile, software development, big data and architectures. The participant is an agile trainer/coach now for 9 years in total, 3 years for this organization.

4.2 Interview Results

This section provides the results from the semi-structured expert interviews. In total 9 expert interviews we're held and that resulted in 475 minutes of audio, an average of 52 minutes per interview. All the interviews were transcribed resulting in 81 pages of transcription and a total of 51.700 words.

The codes from the interviews are sorted into categories and subcategories. The main categories include: agile methodologies, training, serious games, learning and future research. The full description of the main categories, subcategories can be found in Appendix F. Below is a visualisation of the relationship between the main categories.
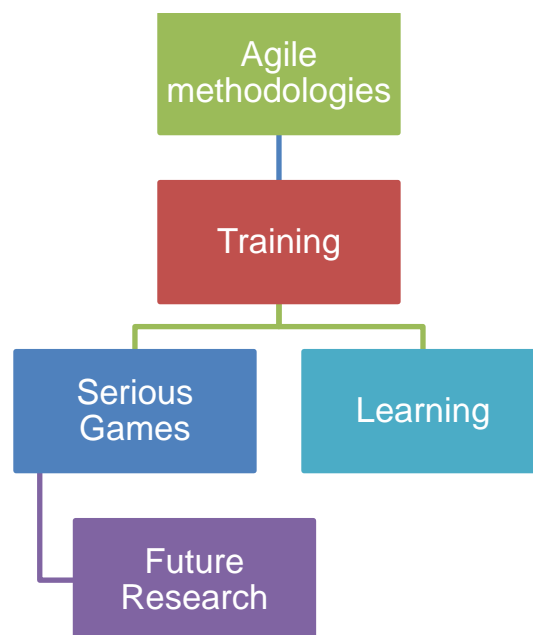
Figure 10: Relationship of Main Categories

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.
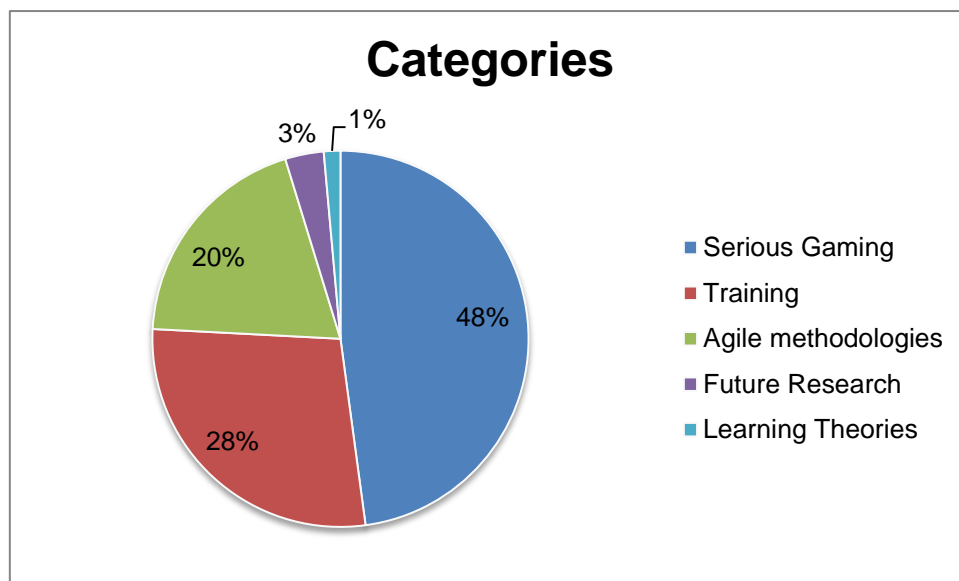
Figure 11: Percentage per Category

The 5 codes with the most instances are: Looking into the Real Problem/Goal (18), Awareness (13), Applying Theory/Knowledge (10), Fictional Environment (8), Resistance to change (8) with a total of 57 instances. All the codes and their instances can be found in Appendix G. Explanation of the results shall be given per category, with a focus on the top 3 categories, Serious Gaming, Training and Agile methodologies. These categories include 96% of the instances.

4.2.1 Serious Gaming

With 48% this is the category with highest amount of instances. The category Serious Gaming has the following subcategories: Purpose (45 instances), Characteristics (16), Success Factors (13), Type (13), Mechanics (13), Fail Factors (1) with a total of 101 instances.
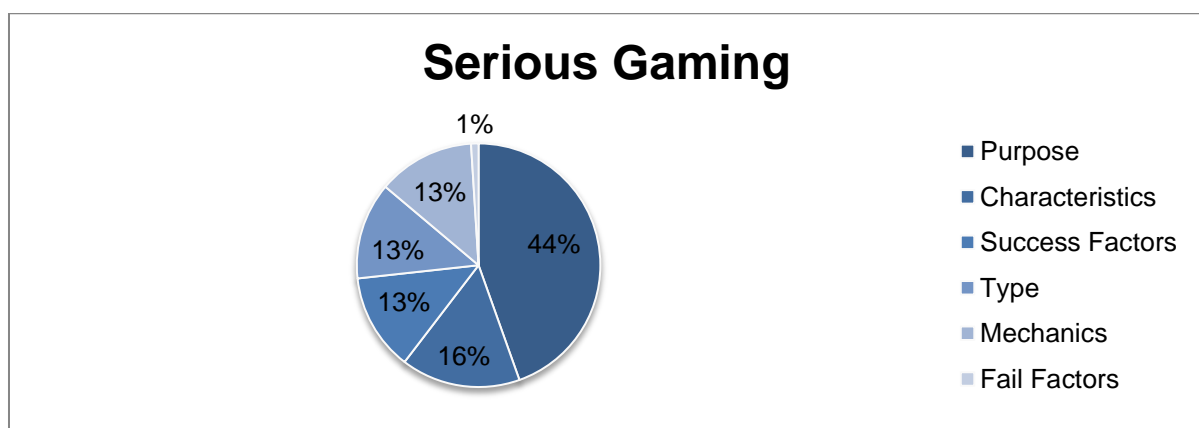
Figure 12: Percentage of instances category Serious Gaming

The subcategory purpose 44% of the instances, with a total of 45 instances is focussed on the answer given from participants on the question: *"What is the main purpose of these games/simulations?".* Awareness is mentioned 13 times by the participants, followed by applying theory/knowledge with 10 times.

Code	Nr. Instances
Awareness	13
Applying Theory/Knowledge	10
Changing attitude and behaviour	7
Teambuilding	5
Learning by Doing	4
Gaining Knowledge	2
Assessment function	2
Multidisciplinary work	1
Skill training	1

Table 7: Purpose of Serious Games

Creating awareness is the most mentioned purpose of serious games used to train agile methodologies. Participant D about 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.*"

Serious games provide an ideal platform to let learners practice the lessons learned in a safe and risk-free environment. Participant B about applying theory/knowledge: *"I think it is about 50% of all the simulation are in the area of applying knowledge in a different context."*

The participants also mentioned some characteristics of serious games (16 instances). These characteristics include a fictional environment, the games are physical with multiple persons in one room and there is no (agile) method is prescribed.

Code	Nr. Instances
Fictional Environment	8
Physical Games	7
No prescribed methods	1

Table 8: Characteristics of Serious Games

Participant B about not prescribing methods: "*it is like a pen, you can say this is a pen but the way you use it depends on yourself maybe you are a great writer or you are a great drawer or you can throw very accurate and make your money because you can throw it in the bin from 10 meters. What we are trying to teach is not the pen but we teach people on how to use the pen.*"

Participant B about fictional environments: "*A context that is not recognized at 100% similar to the real world. The risk is if it's not 100% the same people can say, no this is not how it works in our company. It is impossible to copy it.*"

A success factor for serious games is mentioned 13 times. It is really important that the learners take home the lessons learned from using the serious games and apply it into daily situations.

Code	Nr. Instances
Applying into Practice	8
Improvements after execution	5

Table 9: Success Factors of Serious Games

Participant B about not applying lessons learned into practice: "*Then it is not a great training because people are not taking it home.*"

Trainers also learn every time they use a particular serious game. They get feedback on the training and the trainer so they can use this data to improve the serious games they use.

Participants also mentioned some types of games that are used or not used as in PC games. These types include customized games, using or not using a pc game and Lego games. Trainers re-use the existing games and customize those games to best serve the organization.

Code	Nr. Instances
Customized Game	6
No PC Game	4
Lego Games	2
PC Game	1

Table 10: Types of Serious Games

Participant D about not using a PC for serious games: "*If you want to change attitude and behaviour in people, that does not work using a PC. If you're behind your computer, then you're on your own. That's very good to transfer knowledge but not to address attitude and behaviour*".

Serious games have several mechanics, one of those mechanics is a reflection moment, a moment for participants to look back and see what they can improve. In most serious games a role is appointed at the participants. Two other mechanics are flow and increasing complexity.

Code	Nr. Instances
Reflection	7
Role Playing	3
Flow	2
Increasing Complexity	1

Table 11: Mechanics in Serious Games

Participant A about reflection moments: "*We have three rounds and after each round, we have a moment reflection. A kind of retrospective. The team uses that moment to see which steps they need to change or improve to perform better in the next round.*"

One of the participants also mentioned a fail factor for games, which is making the game to complex. When a game is to complex the participants get frustrated and the game will lose its power.

4.2.2 Training

The second category, Training has the following subcategories: Success Factor (33), Measurement/methods (8), Types (7), Process (6), and Challenge (5) with a total of 59 instances

Training

- ■ Success Factor
- ■ Measurement\Methods
- ■ Types
- ■ Process
- ■ Measurement\Challenge

56%, 14%, 12%, 10%, 8%
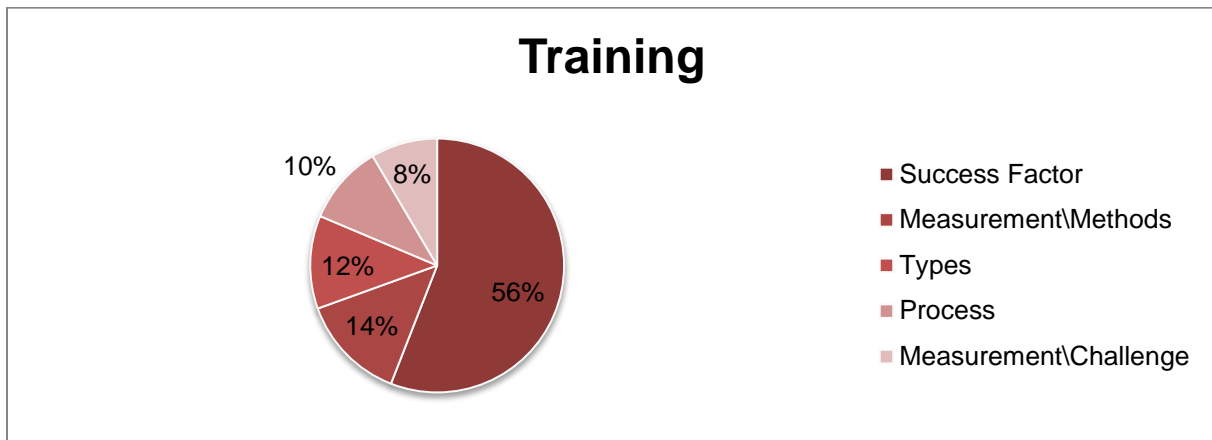
Figure 13: Percentage of instances category Training

The case organizations also mentioned several factors for a successful training. The factors mentioned for a successful training include the most mentioned code, looking into the real problem (18 instances). For an effective training to take place the trainer has to understand the real problem or goal of the organization. Two related factors are the importance of the intake and the intake provides reflection items. The items gathered during the intake are used to steer the reflection moments in the games.

Participant 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.*"

Code	Nr. Instances
Looking into the Real Problem/Goal	18
Importance of Intake	7
Intake provides Reflection Items	4
Sense of urgency	2
Responsibility for Learning Process	1
Importance of teacher	1

Table 12: Success Factors of Training

Participant H about the sense of urgency:

"*We are generally engaging with companies that have some kind of crisis or pain point. As they are willing to bring an external consultant there is something going on internally that is driving them, the sense of urgency to change something.*"

The case organizations use several methods for measuring. Methods for measuring the outcome of the training and methods for analysing the current state of business. These measurement methods include feedback on trainer/training, assessment, follow-up, agile maturity scan and a SWOT analysis.

Participant E about feedback on trainer/training: "*We let them fill in a feedback form and we ask if they liked the trainer and the training materials.*"

Participant H about feedback on trainer/training: "*I ask the teams or the people when I am training for ROI from 1 to 5 scale so 1 means they would have been better of being somewhere else and 5 means it is the best place for them to have been for their job.*"

Code	Nr. Instances
Feedback on Trainer/ Training	2
Assessment	2
Follow-up	2
Agile Maturity Scan	1
SWOT Analysis	1

Table 13: Methods for Measurement

There are several types of training other than training with the use of serious games. Participants mentioned training for training the basics (4 instances), to create a common language among

Code	Nr. Instances
Common language/ training the basics	4
Certification	3

Table 14: Types of Training

participants. Participants also mentioned training for getting a certificate (3), some of those have prescribed training material like slides and exercises.

The participants mentioned frameworks for channelling the intake, the execution of serious games and change processes. These frameworks include 8-field model (3 instances), interviews (1), V-Model (1) and the VIE approach (1).

Participant B: *"It is called the 8-field model, the essence of the model is that if you want to design a learning intervention you always should know the problem that you want to fix."*

Code	Nr. Instances
8-field model	3
Interviews	1
V-Model	1
VIE Approach	1

Table 15: Training Process

Participant B: "*In fact we use the 8-field model to have an interview first and maybe we need to take a second step and talk to some of the employees and explore the real gaps in competences or the real scenarios they want to practice.*

4.2.3 Agile Methodologies

The category Agile Methodologies has the following subcategories: Frameworks (16), Success Factors (14), and Challenges (11) with a total of 41 instances.
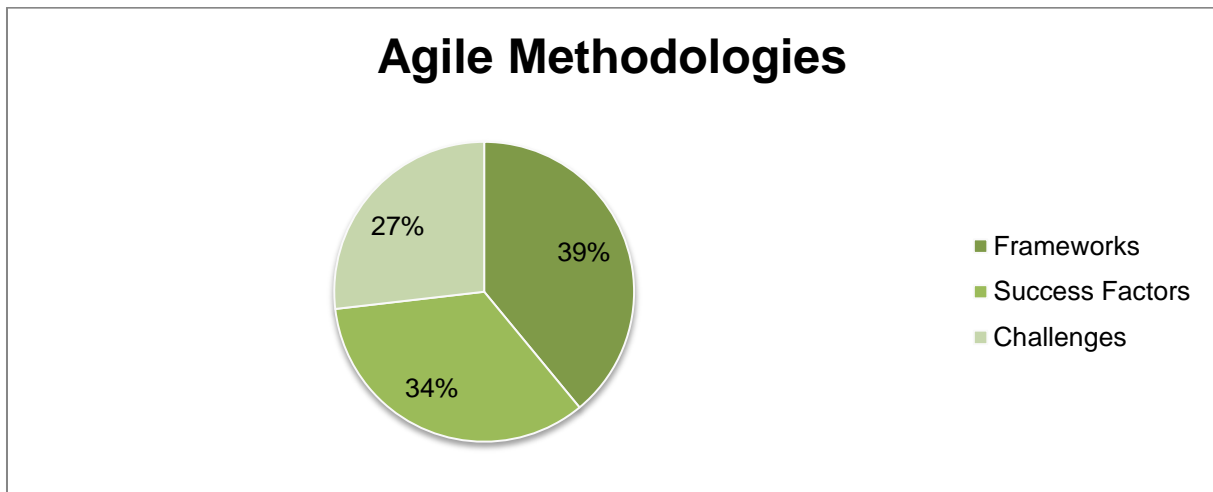
Figure 14: Percentage of instances category Agile Methodologies

The agile frameworks which are used by the participating organizations include scrum, lean six sigma, kanban and the fairly new scaled agile framework. The most used agile methodology is scrum, this method is used by companies A, C, D, E, F, H, I.

Code	Nr. Instances
Scrum	7
Lean Six Sigma	4
Kanban	3
SAFe	2

Table 16: Used Frameworks

The factors that make implementing and using agile methods a success include having an agile champion, somebody that pushes the agile adoption forward. Implementing agile also works better if it is accompanied with a change process and the organization needs a culture that supports change. Involvement of management is really important for a successful implementation and managers need to focus on team key performance indicators (KPI's) rather than individual KPI's.

Code	Nr. Instances
Agile Champion	4
Change Process	4
Culture for Change	3
Involvement of Management	2
Focus on Team	1

Table 17: Success Factors in Agile Transformation

Participant H on having an agile champion: *"I think the one thing that make the difference is to whether or not they are going to succeed is there someone in the company who has the commitment and drive to really push the agile transformation forward, do they have the vision, do they have the courage to really work hard in the company to introduce these new concepts and really live it out."*

Participant H on a culture for change: *"I feel that it is not enough to just introduce some practices. You have to be willing to fundamentally change how you think about work and be willing to really change*

yourself in that process. It is a tall order for people to move from a directive or command and control type of culture to something that is more collaborative and fluid, some organizations can make that leap and some cannot."

Implementing and using agile methodologies also brings some challenges like resistance to change, little or no involvement of management and managers focussing on individual KPI's.

Code	Nr. Instances
Resistance to change	8
Little Management Involvement	2
Focus on Individual KPI's	1

Table 18: Challenges of Agile Methodologies

Participant A about focus on KPI's: *"I once had a manager test factory and he was really stuck to his test KPI's. He was totally blind for what really matters to the business."*

4.2.4 Participants Indications on Future Research

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. Participant B however was 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."*

Participant D on new games: *"It would be nice to have a business simulation that is partly online. A hybrid form."*

4.2.5 Learning Theories

The last category, learning theories, is mentioned 3 times. This category handles the learning theories that are mentioned by the participants. The learning theories that are mentioned by the participants are Bloom's taxonomy, the Active Learning Cycle and the 4-step instructional design tool.

Participant 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".*

4.3 Serious game/skill analysis results

During the desk research phase the author analysed the role descriptions on the skills that are required to perform a certain role. Also analysed are 26 serious games, those games are analysed on the skills that can be trained when using that game. The skills required in scrum, scaled agile framework, prince 2 and extreme programming can be found in appendices B and C. The skills trained by the 26 analysed serious games can be found in appendix D.

Figure 15: Skill Training

The sheets presented in appendices B, C and D can serve as a guide to find the right serious game for training a certain skill. To perform a role certain skills are needed, serious games could be used to train these skills. For instance, a Product Owner in the Scaled Agile Framework needs to be good at collaboration, decision-making, financial management, customer-oriented, leadership, planning and time management, quality control, requirement management and teamwork. The skills are highlighted in the example below, this example shows the skills that are trained by 4 serious games.

Game	Subject	Business-Minded	Coaching	Collaboration	Communication	Decision making	Delegation	Financial Management	Customer-oriented	Project management	Leadership	Big picture view	Negotiation	Organization	Human Behavior	Planning and Time mgt	Strategic planning	Programming	Problem solving	Monitor and control	Quality Control	Requirement Management	Project Risk Mgt	Teamwork	Uses Prototypes	Writes automated tests
Birdie-Birdie	Basic agile principles					x			x	x						x						x		x	x	
Scrum from Hell	Stand-up meeting													x												
Play Doh Zoo	Basic agile principles	x		x	x				x	x						x										
Battleships	Waterfall vs. Iterations									x																

Figure 16: Example Usage of Skills Sheets

In this case Birdie-Birdie trains 5 of the 9 essential skills for a Product Owner in the Scaled Agile Framework followed by Play Doh Zoo which trains 3 of the 9 essential skills. In this way a trainer could assess which game could be used in training.

5. Discussion

This section discusses the results and findings from the previous chapter. The findings discussed in this section are: getting to the real problem, measurement of training outcomes, requirements of serious games, the purpose of serious games, the role of games in agile transformation. The section ends with a discussion of the research questions and the author presents his view on how to use serious games in training.

5.1 Training

5.1.1 Getting to the real problem

The goal of this thesis is to analyse how serious games could be used in practice. The case organizations were unanimous about the importance of the intake process in getting to the real problem/goal of the organization. Only playing the serious games does not solve the problems of the organization. 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 intake also allows the trainer to collect important items to focus on during the reflection moments in the serious games. Reflection after playing the games is crucial to transfer the lessons learned in the game to changes in on-the-job behaviour. During the intake process the trainer needs to speak with the right persons in order to get to the real goal of the training.
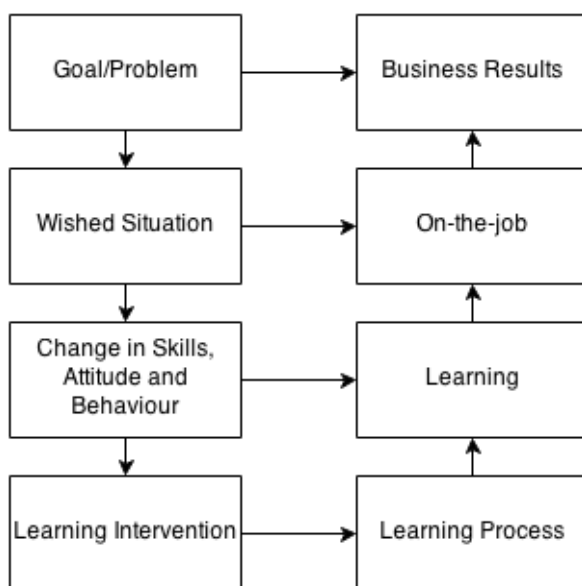
Figure 17: Intake Model

Most of the interviewees emphasized the importance of starting with the goal of the organization rather than the learning intervention. Some of the case organizations use a structured way to channel the intake process. This model is called the 8-field model or V-model. They start with the goal of the organization and work back to the learning intervention. The impact of a business simulation is much greater when it can be embedded in the strategy of the organization (Ermers, 2013). Participant D about this process: *"We always have extensive conversations with our clients. What do you want to achieve? Which changes in behaviour? Which behaviour is limiting the performance? What is the desired behaviour? Then you pick a game that fits these goals."*

This corresponds to what Kirkpatrick says about clever training leaders, they use the Four-Level Evaluation Model of Kirkpatrick somewhat different (Kirkpatrick & Kirkpatrick, 2005). 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 (Winn, 2008).

A trainer, consultant or coach can't start a learning intervention without knowing the goal of the training. The intake process is really important to get to the real problem of the organization. This intake process generally takes place with middle or top management therefore it is really important to verify this problem with people on the workplace.

5.1.2 Measurement of Training Outcomes

As mentioned earlier only using serious games isn't the solution to the problem/goal an organization might have. With the use of serious games organizations try to reach their goal. What you might expect is that trainers try to measure the effectiveness of training. The results of the interviews showed something different, none of the participating companies had an effective way of measuring the outcome of training.

The only way of evaluating that was used was a form to evaluate the trainer and the training. According to Kirkpatrick this is level 1 of evaluation, to measure customer satisfaction (Kirkpatrick & Kirkpatrick, 2005). Participants were evaluating the training using forms with questions about the trainer and the training. Some examples of evaluation questions are: Did you like the training? Did you like the trainer? Did you like the venue? How would you score the training materials? These questions evaluate level 1 of Kirkpatrick, reaction. The reactions are used to improve the training.

Little attention has been given by participants to measure level 2, learning. To what extent has learning occurred? For a trainer and organization sending employees to training this is a really interesting level. At this level you want to measure the knowledge, attitude and behavioural changes resulting from training. Skills, attitude and behaviour need to be measured before and after the training. Measuring on this level can include surveys, questionnaires or tests. According to the paper of Stikkolorum (Stikkolorum, Stevenson, & Chaudron, 2013) change in skill could be measured by using a pre-test and post-test. In this case software design skills were successfully measured with the use of an online survey. The survey consisted of a range of questions testing the design skills of students.

Measurement on the last two levels identified by Kirkpatrick might be too costly or time consuming for organizations but provide valuable information. 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. Measuring on this

level is important to measure the change in behaviour and detecting reasons why there isn't a change behaviour (Kirkpatrick & Kirkpatrick, 2005).

To evaluate level 3 of Kirkpatrick, organizations could use surveys before and after the training. The trainer needs to give participants some time to change their behaviour. For organizations sending employees to training level 4 is in the end the most important one, results. Organizations don't send employees to training to just have a nice day, they want to see some results after training. Results on this level are for instance, reduction in costs, increased sales, improved quality and return on investment (ROI) (Kirkpatrick & Kirkpatrick, 2005).

Serious videogames developers already use several tools for measurement. Developers of videogames already build-in measurement methods in their serious games. These games include pre-game, in-game and post-game assessments. Serious videogames provide an ideal platform for measurement of training outcomes but trainers using physical serious games could learn from the measurement methods used in those games. The pre-game and post-game assessment could also be a good measurement method for measuring skills, attitude and behavioural change.

Measuring the effectiveness of training is easier when the goal of training is getting a certificate, in this case effectiveness of training is measured by the number of participants getting a certificate. The trainers, coaches and consultants of the case organizations were measuring the training results in the form of a survey. This survey is used to improve the training but does not measure any change in skills, attitude or behaviour of the participants. Measuring this change in skills, attitude and behaviour provides the organization with valuable information. The author believes that using a pre-test and post-test to measure the actual results of training needs to be part of a training program. The use of a survey to measure the learning improvement seems promising (Stikkolorum, Stevenson, & Chaudron, 2013).

5.2 Application of Serious Games

5.2.1 Requirements of Serious Games

Serious games according to the results of the interviews need to have some basic characteristics and mechanics. To make the games work these basic prerequisites are required.

Serious games need to include feedback/reflection loops. The games are played in several rounds and in between there is time for reflection, improving the current way of working to do it better in the next round. In this way learners are in a continuous learning cycle when using the games. Each round the participants of the game learn and improve their performance.

One of the mechanics used in the serious games is increasing the complexity each round. The complexity of the games is increased to keep the participants in a state of flow (Csikszentmihalyi, 1997). To enter a state of flow there must be a balance between the skills required and the challenge

presented. Typically the games start easy and become harder each round. The challenge gets bigger but the skills are also increased so there is still a balance, a state of flow. When the skill of the learner increases but the challenge stays the same the learner enters a state of boredom. This is also a mechanic seen in entertainment games and serious games used in other disciplines.

According to the participants it is really important to use a fictional environment, a different context. Developers of serious games for agile training need to avoid trying to remodel the exact company environment into a serious game. Participant B about using fictional environments: "*A context that is not recognized at 100% similar to the real world. The risk is if it's not 100% the same people can say, no this is not how it works in our company.*" If you try to make the game 100% the same than you risk that people don't get the underlying principles of the game that you are using. Some fictional environments seen in serious games are space shuttles, pizza company's and a zoo. In other disciplines like military and healthcare it is really important to try and remodel the real environment. As described by Macedonia (Macedonia, 2001), the US army modified an Atari tank battle video game, Battlezone. The game was modified to have the same controls as the Bradley Infantry Fighting Vehicle.

Another characteristic as already mentioned by participant D if you want to change attitude and behaviour you need the learners physically in one room. Video games are not used at the moment in agile training. Using videogames in training is more common in other disciplines like education, healthcare and military (Stapleton, 2004; Knight, et al., 2010; Macedonia, 2001).

Serious games don't prescribe how to perform certain activities or actions. By playing the game learners need to figure out how to perform certain actions and how to improve those actions as a group. This corresponds with serious games used in other disciplines, this is one of the strengths of serious games. Players of serious games can practice and fail as much as they want.

According to our participants and literature most serious games focussed on training, creating awareness and reflecting on agile methods are team-based. This allows for discussion within the team and creating a shared understanding of the problem and how to solve this problem. Serious games are also being used in training focussed on teambuilding.

5.2.2 Purpose of Serious Games in Agile Training

According to the participants serious games can be used for several purposes including creating awareness, putting theory into practice and changing attitude and behaviour. Creating awareness and changing attitude and behaviour are closely linked together. This awareness is used to make participants of serious games realize how they are behaving and how they can improve this behaviour. When using serious games for training and changing behaviour and attitude it is important to have all the learners physically in one room. Interaction among students is crucial and therefore no PC games are used as mentioned by participant D: "*If you want to change attitude and behaviour in people, that*

does not work using a PC. If you're behind your computer, then you're on your own. That's very good to transfer knowledge but not to address attitude and behaviour".

Serious games can be used in combination with theoretical learning. Books and presentations could be used to gain declarative knowledge of agile methodologies. Serious games could then be used to get experience, procedural knowledge, with the activities used in agile (Eysenck & Keane, 2000). Serious games let participants put theory into practice and let them become familiar with the practices and activities.

5.2.3 Role of Serious Games in Agile Transformation

As described in section 2.2.4, agile transformation, adopting, using and improving agile methodologies is still troublesome for many organizations (VersionOne, 2013). Literature and the participants agree that introducing agile brings some challenges. These challenges include culture, resistance to change, lack of knowledge/no experience with agile and involvement of management (Nerur, Mahapatra, & Mangalaraj, 2005). As described by participants successful adoption of agile methods requires having (1) an agile champion, someone who is really believing in the benefits of agile and trying to fit it to their organization, (2) involvement of middle and top management and (3) creating a culture for change. Serious games could be used to overcome certain barriers and challenges when adopting, using and improving agile methodologies.

1) Having an agile champion improves the chance of having a successful agile adoption. Adopting agile methods requires time and effort from employees. Using serious games could inspire employees to really believe in agile methods as a way of working.

2) Involving top and middle management in agile transformation is crucial. Not having management support provides a barrier in 30% of the organizations adopting agile methods. Therefore it is really important to get the management team involved when implementing agile methods. Serious games could be used to make them aware of the possibilities of agile methods.

3) Having a culture for change is a crucial factor when adopting agile methods. When adopting agile two top factors forming a barrier for further adoption are the inability to change organizational culture (53%) and a general resistance to change (42%) (VersionOne, 2013). Adopting methods is more than just replacing the current tools. Using agile methods in an organization requires an organizational change (Nerur, Mahapatra, & Mangalaraj, 2005). By using serious games in training awareness is created. Employees are more open to change when they are aware of the benefits of this change. These games are also used as kick-off material to show participants how the current way of working can be improved when adopting agile methodologies.

Lack of knowledge or experience with agile methods can be solved when using serious games in training. Serious games like Birdie Birdie show learners the basics of agile development but there are

also more specific games to train for instance, agile portfolio management. Serious games let participants practice on the process and apply the lessons learned. This gives participants the procedural knowledge, the knowledge of how to perform a certain action (Eysenck & Keane, 2000).

5.3 Discussion of Research Questions/ Executive Summary

How can Serious Games be used to raise awareness, train and reflect on Agile Project Management Methods in practice?

The goal of this thesis is to analyse how serious games can be used in practice. According to literature and the case organizations serious games could be used in practice if at least the following requirements are met. (1) A trainer, coach or consultant needs to get to the real problem/goal of the organization during the intake process and verify this problem. (2) The game includes reflection moments, to improve the in-game performance and to transfer the lessons learned in the game to on-the-job behaviour goals. (3) The game does not replicate the real life environment, game developers don't need to remodel the existing company. Using a fictional environment prevents participants to oppose the game because it is not 100% the same. (4) The complexity of the game needs to increase each round. Participants learn when playing the game and improve their performance therefore the complexity of the game needs to increase each round to keep participants involved. (5) The participants, a team needs to be physically together. A PC can be used to transfer knowledge but if you want to change attitude and behaviour the team needs to be physically together. (6) The changes in skills, attitude and behaviour need to be measured using a pre-game and post-game survey to measure the effectiveness of training. An interview is held with some of the participants and the management team to assess whether the goal has been reached or the problem has been solved. The results need to be communicated to the participants.

Serious games could be used create awareness and to get procedural knowledge before using agile methodologies in real life situations. This is a cost effective, risk-free way of learning how to apply the practices and principles of agile software development methodologies.

Visualised below is the authors vision 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. Post-training the focus need to be on measuring the outcome of training by using a post-training survey and an interview with participants and the management team.
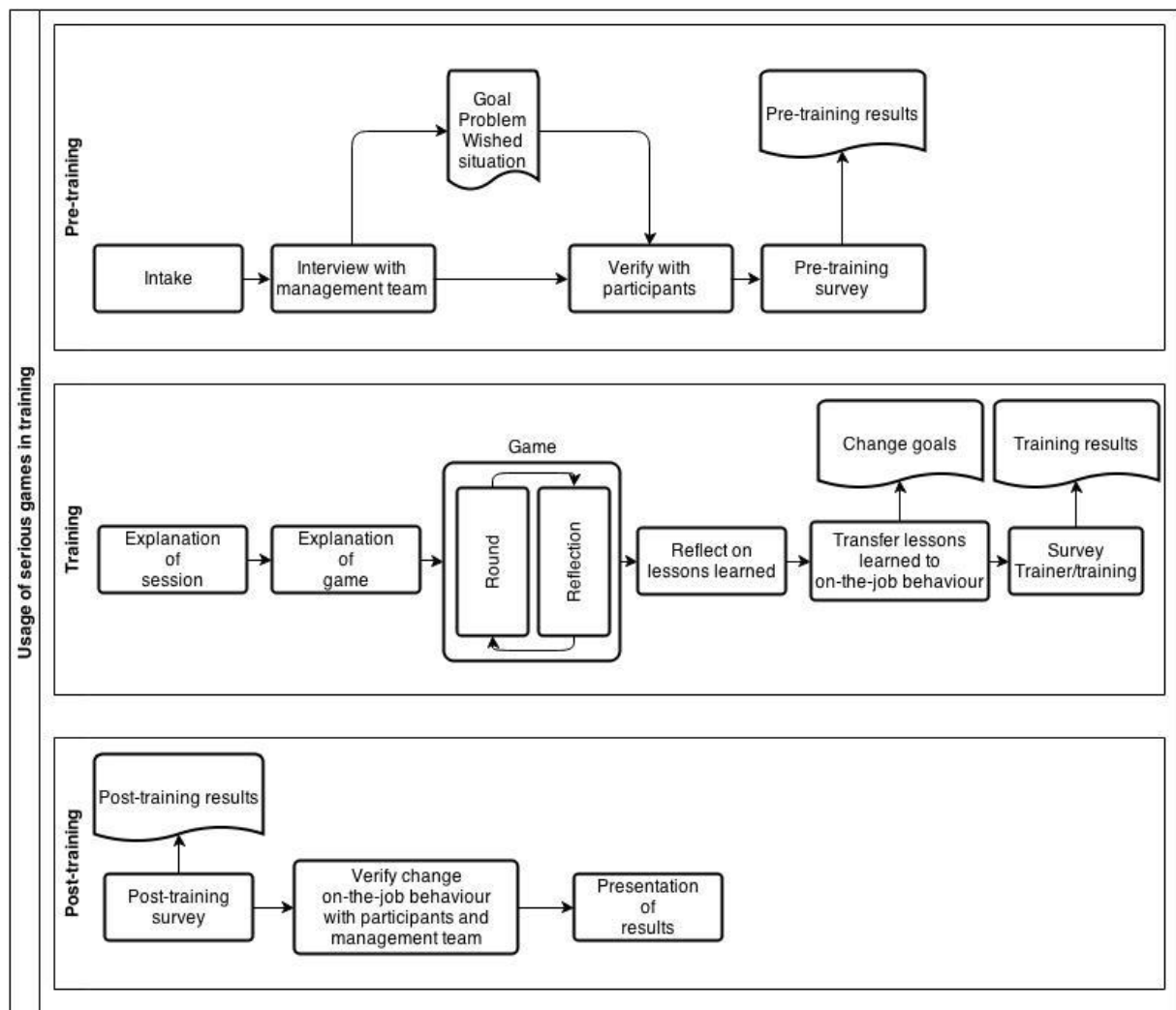
Figure 18: Usage of serious games in training

What types of agile serious games are currently available?

There are two types of games currently on the market serious games and business simulations. The author of this thesis makes a distinction between the two based on the time they take in training. Serious games typically take 30 minutes up to an hour, business simulations usually are played for more than 6 hours. Both serious games and business simulations are played in teams. For business simulations this is even a requirement, these games cannot be played by individuals. Serious games however could be played by individuals, the games found by the author focussed on agile methods are all team based.

Serious games could be divided into two types, pc games and physical games. None of the participants used a pc game in training, the games the participants were using were all physical games. Some of the participants showed interest in a pc game for training the basics of agile, the pc game should then substitute the presentations or learning from books.

Appendix D shows 26 games that are focussed on agile methodologies including the skills that those games train.

In what way are serious games on agile methods used in practice?

The case organizations use serious games and business simulations in change processes. According to the participants the serious games are mostly used to create awareness. Second was applying theory/knowledge, letting people practice on the process. Serious games are used as a tool to reach the goal and should not be considered as a solution. Reflection after using a serious game is crucial, during this reflection the experiences of playing the serious game must be translated into on-the-job behaviour.

6. Conclusion & Future Work

6.1 Conclusion

The goal of this thesis is to address the following research question: *How can Serious Games be used to raise awareness, train and reflect on Agile Project Management Methods in practice?* To answer this research question the author conducted 9 semi-structured interviews with experts. The interviews resulted in 475 minutes of audio, an average of 52 minutes per interview and 81 pages of transcription, a total of 51.700 words. In total 64 codes are used with a total frequency of instances of 211. The category with the highest amount of instances is serious gaming (101 instances) followed by training (59), agile methodologies (27), future research (7) and learning (3). The code with the highest amount of instances is, looking into the real problem/goal (18). The experts showed interest in the results of this study.

Serious games are an excellent tool to make agile more explicit and to become familiar with the practices and activities. These games let people experience the benefits and possibilities of agile methodologies but can also be used to train a set of skills like collaboration, teamwork and time management.

As discussed earlier it is really important to look and focus on the real goal or problem that an organization has. Interviewing people and observing the team should provide the trainer with enough information and focus points to choose an appropriate learning intervention. For an effective learning intervention to take place this is critical.

The results of the interviews show that it is difficult to measure the outcomes of training for an external consulting or training company using physical, board and/or role playing games. That is because of two main reasons. The first one is that most serious games are conducted by external consultants or experts. When the change process/training is finished they leave the organization so it is difficult to see the results in terms of return on investment. Second, they find it really hard to measure the behavioural change and business results as an outcome of training. Literature shows how to measure the outcomes of training when using serious video games with pre-game, in-game and post-game measurement methods.

This thesis shows how organizations could use serious games for training, creating awareness and reflecting on agile methodologies. Serious games could really help trainers, agile coaches and consultants in the process of adopting, using and improving agile software development methods.

6.2 Limitations

Since this study has a limited timeframe (8 months) the author only had time for conducting 9 interviews and collecting/analysing 26 serious games. The use of Serious Games is quite new therefore it was difficult to find the right experts to interview within the scope of the research. Further research could be done to assess whether the results also apply for organizations outside the Netherlands.

Conducting the interviews and performing the coding process relies on the authors competences and can be biased. The first two interviews were held with two interviewers to limit the possibility of missing critical information. The transcriptions of the interviews were peer reviewed to limit the possibility that the results are biased.

6.3 Future work

Future research could be done on the subject of measuring training outcomes when using serious games. Currently none of the participating organizations had a tool for measuring the business results and behavioural changes after using a serious game or business simulation. Measuring the actual business results resulting from training might be too costly for organizations. Measuring to what extend learning has occurred gives organization insight in the benefits of training. Does training have the desired effects and does the training change participant's skills, attitude and behaviour. Future research could be done on the appropriate method of evaluating to what extend learning has occurred.

Overall most experts were pleased with the games currently on the marked but they are still looking for more games. A few of the participants showed interest in a serious videogame for training the basics of agile methodologies.

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Appendix A

Subject	Team	Program	Portfolio	Developer	Tester	Agile master	Product owner	Release management	Product management	Portfolio management	All	To inform/awareness	Training and education	Reflection	Link
Basic agile principles	✗			✗	✗		✗					✗	✗	✗	http://www.cyment.com/blog/2011/10/birdie-birdie-a-product-building-simulation/
Stand-up meeting	✗			✗		✗	✗					✗	✗	✗	http://xp123.com/articles/scrum-from-hell/
Waterfall vs. Iterations	✗			✗	✗	✗	✗					✗	✗	✗	http://tastycupcakes.org/2012/02/you-sunk-my-methodology/
Basic agile principles	✗			✗	✗	✗	✗					✗	✗		http://tastycupcakes.org/2013/03/play-doh-zoo-agile-ux-unleashed/
Communication and collaboration	✗											✗	✗	✗	http://tastycupcakes.org/2013/04/communication-race/
XP practices	✗			✗	✗		✗					✗	✗	✗	http://www.xp.be/xpgame/
Portfolio management			✗								✗		✗	✗		http://tastycupcakes.org/2011/07/the-big-payoff/
Portfolio management			✗								✗		✗	✗	✗	http://integrumtech.com/2011/12/agile-portfolio-management-game/
Larger scrum teams		✗		✗	✗	✗	✗						✗	✗	✗	http://scrumcoaching.wordpress.com/2011/04/05/training-exercise-scaling-scrum/
Basic scrum principles	✗			✗	✗	✗	✗						✗	✗	✗	http://scrumcoaching.wordpress.com/2011/05/20/training-exercise-scrum-simulation/
Portfolio management		✗	✗								✗		✗		✗	http://www.agilebelgium.be/businessvaluegame/
Multitasking												✗	✗	✗	✗	http://www.leansimulations.org/2013/01/the-name-game-aka-hldittwan.html
PDCA cycle												✗	✗	✗	✗	http://www.leansimulations.org/2012/12/the-marshmallow-challenge-and-pdca-cycle.html
Basic scrum and teamwork												✗	✗	✗	✗	http://www.leansimulations.org/2012/08/scrum-ball-point-game-tennis-anyone.html
Basic lean principles												✗	✗	✗	✗	http://www.leansimulations.org/2011/04/lean-lego-simulation-its-back.html
Multitasking												✗	✗	✗	✗	http://tastycupcakes.org/2013/11/three-projects-three-experiments/
Acceptance test				✗	✗	✗							✗	✗	✗	http://tastycupcakes.org/2009/06/99-test-balloons/
Theory of Constraints	✗											✗	✗	✗	✗	http://tastycupcakes.org/2013/05/the-penny-game/
Risk assessment	✗			✗	✗		✗						✗	✗	✗	http://tastycupcakes.org/2013/04/the-risk-is-in-the-blocks/
Basic agile principles	✗			✗	✗								✗	✗		http://tastycupcakes.org/2013/02/52-card-pickup/
Requirements	✗			✗	✗		✗						✗	✗	✗	http://tastycupcakes.org/2013/02/copycats-2/
Responsibilities	✗			✗	✗		✗						✗	✗	✗	http://tastycupcakes.org/2013/02/the-herculean-doughnut/
Requirements	✗			✗	✗		✗						✗	✗	✗	http://tastycupcakes.org/2012/11/tdd-test-driven-drawing/
Requirements	✗			✗	✗		✗						✗	✗	✗	http://tastycupcakes.org/2012/11/delight/
Basic agile principles	✗			✗	✗		✗						✗	✗	✗	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=5876148

Appendix B

Role - Skills		Skills																								
		Business-Minded	Coaching	Collaboration	Communication [1,2]	Decision making [1,4]	Delegation [7]	Financial Management [4,5]	Customer-oriented [2,3,5]	Project management [3,5]	Leadership [3,4]	Big picture view [2]	Negotiation [1,4,5]	Organization [3,4,5]	Human Behavior [4]	Planning and Time mgt [1,2,3,4,5]	Strategic planning [4,5]	Programming [3]	Problem solving [2,3,5]	Monitor and control [2,3,4]	Quality Control [2,3,4]	Requirement Management	Project Risk Mgt [5]	Teamwork [2,4]	Uses Prototypes [2]	Writes automated tests [2]
Roles		9	10	20	17	20	8	10	15	9	15	1	2	4	0	24	5	4	2	18	10	19	19	11	1	4
Scaled Agile Framework [6]	83																									
Product Owner	14			2		1		1	1		1					2					1	4		1		
Scrum Master	16		2	1						3	1					3				2			4			
Developer & Testers	11			2														2						2	1	4
Release Management	16			3	2								1			4				2	2			2		
Product Management	15	1		1	1	3						1				3	1					4				
Portfolio Management	11					2	2	2									4			1						
Scrum [7]	34																									
Product Owner	8			1	2	1			1		1					1						1				
Scrum Master	22		5	5	1					5	2			1		1		1					1			
Developer	4													1		1				1				1		
XP [8]	46																									
Customer	28	2				4	1	3	2		3					5				1		2	2	3		
Developer	11				1	1			1							3		1			1		1	2		
Tracker	2				1															1						
Coach	5		1							1	1								1				1			
Prince2 [1]	94																									
Executive	21	3		2		3	2	2	2		3			1					1	1			1			
Senior User	19				2	3	1		4											3	1	5				
Senior Supplier	8		1			1	1														2	2	1			
Project Manager	11		1		2		1				3			1						2			1			
Team Manager	9			3	1															2	1		2			
Project Assurance	21	2			4	1		1	3							1				2	2		5			
Change Authority	4	1						1	1													1				
Project Support	1												1													

References:

1. (Grande-Bretagne, 2009)
2. (Turley & Bieman, 1994)
3. (Lee & Lee, 2006)
4. (Edum-Fotwe & McCaffer, 2000)
5 (Aken & Michalisin, 2007)
6. (Scaled Agile Framework, 2014).
7. (Schwaber, K., & Sutherland, J. 2011)
8. (Chromatic, 2003)

Appendix C

Role - Skills

Skill	Prince2 [1]	XP [8]	Scrum [7]	Scaled Agile Framework [6]	Skills
(Totals)	93	46	34	83	
Business-Minded	6	2		1	9
Coaching	2	1	5	2	10
Collaboration	5		6	9	20
Communication [1,2]	9	2	3	3	17
Decision making [1,4]	8	5	1	6	20
Delegation [7]	5	1		2	8
Financial Management [4,5]	4	3		3	10
Customer-oriented [2,3,5]	10	3	1	1	15
Project management [3,5]		1	5	3	9
Leadership [3,4]	6	4	3	2	15
Big picture view [2]				1	1
Negotiation [1,4,5]				1	1
Organization [3,4,5]	1		2	3	3
Human Behavior [4]	1			1	1
Planning and Time mgt [1,2,3,4,5]	1	8	3	12	24
Strategic planning [4,5]			5		5
Programming [3]		1	1	2	4
Problem solving [2,3,5]	1	1	1		2
Monitor and control [2,3,4]	10	2	1	5	18
Quality Control [2,3,4]	6	1	1	3	10
Requirement Management	6	2	1	8	17
Project Risk Mgt [5]	12	4	1	4	21
Teamwork [2,4]		5	1	5	11
Uses Prototypes [2]				1	1
Writes automated tests [2]				4	4

References:

1. (Grande-Bretagne, 2009)
2. (Turley & Bieman, 1994)
3. (Lee & Lee, 2006)
4. (Edum-Fotwe & McCaffer, 2000)
5 (Aken & Michalisin, 2007)
6. (Scaled Agile Framework, 2014).
7. (Schwaber, K., & Sutherland, J. 2011)
8. (Chromatic, 2003)

Nr.	Game	Subject	Skills																									Link
			Business-Minded	Coaching	Collaboration	Communication [1,2]	Decision making [1,4]	Delegation [7]	Financial Management [4,5]	Customer-oriented [2,3,5]	Project management [3,5]	Leadership [3,4]	Big picture view [2]	Negotiation [1,4,5]	Organization [3,4,5]	Human Behavior [4]	Planning and Time mgt [1,2,3,4,5]	Strategic planning [4,5]	Programming [3]	Problem solving [2,3,5]	Monitor and control [2,3,4]	Quality Control [2,3,4]	Requirement Management	Project Risk Mgt [5]	Teamwork [2,4]	Uses Prototypes [2]	Writes automated tests [2]	
1	Birdie-Birdie	Basic agile principles					×					×					×								×			http://www.cvment.com/blog/2011/10/birdie-birdie-a-product-building-simulation/
2	Scrum from Hell	Stand-up meeting				×	×			×	×			×			×			×			×	×	×	×		http://xp123.com/articles/scrum-from-hell/
3	Battleships	Waterfall vs. Iterations			×	×	×			×	×			×			×	×		×			×	×	×			http://tastycupcakes.org/2012/02/you-sunk-my-methodology/
4	Play Doh Zoo	Basic agile principles				×	×						×				×								×			http://tastycupcakes.org/2013/03/play-doh-zoo-agile-ux-unleashed/
5	Communication Race	Communication and collaboration	×			×																						http://tastycupcakes.org/2013/04/communication-race/
6	XP planing game	XP practices						×																				http://www.xp.be/xpgame/
7	The Big Payoff	Portfolio management							×																			http://tastycupcakes.org/2011/07/the-big-payoff/
8	Portfolio Management Game	Portfolio management				×	×			×			×		×		×	×							×			http://intergamtech.com/2011/12/agile-portfolio-management-game/
9	Scaling Scrum	Larger scrum teams				×	×			×	×		×	×			×	×		×	×		×	×	×	×		http://scrumcoaching.wordpress.com/2011/04/05/training-exercise-scaling-scrum/
10	Scrum simulation	Basic scrum principles			×	×	×			×	×						×			×			×		×			http://scrumcoaching.wordpress.com/2011/05/20/training-exercise-scrum-simulation/
11	The Business Value Game	Portfolio management	×																									http://www.agilebelgium.be/businessvaluegame/
12	The Name game	Multitasking				×	×			×			×		×		×	×					×		×			http://www.leansimulations.org/2013/01/the-name-game-aka-hidittvan.html
13	The Marshmallow Challenge	PDCA cycle				×																					×	http://www.leansimulations.org/2012/12/the-marshmallow-challenge-and-pdca-cycle.html
14	The scrum ball point game	Basic scrum and teamwork				×						×													×			http://www.leansimulations.org/2011/08/scrum-ball-point-game-tennis-anyone.html
15	Lean lego simulation	Basic lean principles														×	×											http://www.leansimulations.org/2011/04/lean-lego-simulation-its-back.html
16	Three projects, three experiments	Multitasking															×											http://tastycupcakes.org/2013/11/three-projects-three-experiments/
18	99 Test Balloons	Acceptance test															×					×	×		×		×	http://tastycupcakes.org/2009/06/99-test-balloons/
19	The Penny Game	Theory of Constraints													×		×											http://tastycupcakes.org/2013/05/the-penny-game/
20	Jenga Game	Risk assessment					×																	×				http://tastycupcakes.org/2013/04/the-risk-is-in-the-blocks/
21	52 Card Pickup	Basic agile principles				×	×																		×			http://tastycupcakes.org/2013/02/52-card-pickup/
22	Copycats	Requirements						×																				http://tastycupcakes.org/2013/02/copycats-2/
23	The Herculean Doughnut	Responsibilities			×	×									×													http://tastycupcakes.org/2013/02/the-herculean-doughnut/
24	Test Driven Drawing	Requirements			×	×					×				×		×			×			×				×	http://tastycupcakes.org/2012/11/tdd-test-driven-drawing/
25	Delight	Requirements																					×	×				http://tastycupcakes.org/2012/11/delight/
26	Mission to Mark	Basic agile principles					×			×	×				×		×						×		×	×		http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=5876148

References:
1. (Grande-Bretagne, 2009)
2. (Turley & Bleman, 1994)
3. (Lee & Lee, 2006)
4. (Edun-Fotwe & McCaffer, 2000)
5. (Aken & Michalisin, 2007)

Appendix E

Interview guide v1.1

Part 1 - Introduction

1) Introduction of research topic and goals of the interview
    a) <u>Research topic</u>: The research topic is the application of serious games raising awareness, training and reflecting on agile project management methods.
    b) <u>The purpose of this interview</u>: The purpose of this interview is to get an understanding of how agile is coached/applied today by organizations that provide agile training, how agile games/simulations are being used/developed to raise awareness, train and reflect and what happens after training.
    c) <u>Reason why</u>: It is difficult to learn using agile management methods from books because of their dependence on procedural knowledge (experience), the knowledge of knowing how to perform a certain action. Agile games/simulations let people practice on the process.
    d) <u>Explain data will be made anonymous</u>: Data will be made anonymous so that you are free to speak and nobody will be able to track your responses.
    e) <u>Explain recording the interview</u>: I want to record this interview to transcribe and analyse it afterwards. Do I have your permission to record this interview?
    f) <u>Explain structure of the interview</u>: The structure of this interview is as follows, part 2 is part of the introduction, part 3 is about the training programme, part 4 specifically handles the usage of games/simulations in agile training, part 5 is about the development of games/simulations and part 6 is about the period after training.
2) Do you have any questions?

Part 2 - Overview

3) Participant
    a) What is the participant's role/job?
    b) What is the participant's field of expertise?
    c) How long have you been training/coaching agile? (years)
4) Company context
    a) What type of company/organization is this? (Consultancy, software development, testing?)
    b) What is the size of the company in numbers of employees?
    c) Does your organization coach/apply a specific agile method? If yes, which agile methodologies/frameworks do you apply?
    d) What is the Nr. of agile coaches within this company/organization?
    e) How long does this organization use agile methods? (nr. of years)
    f) How did your organization began with using agile, why?
    g) How did your organization began with agile training, why?

Part 3 – Agile training – programme, workshops

This part is about the program/workshops that your organization uses to coach agile project management methods.

5) How does your organization train/coach agile methods?
6) How does your training programme look like? (Is it possible to get an example?)
7) Do your employees get training on agile methods? How often do they get training?
8) What are concrete steps when sending coaches into an organization?
9) Can you tell me the concrete steps of the training at your last customer?
10) Do you encounter problems coaching agile? If yes, what kind of problems?

Part 4 – Usage of Agile games/simulations

This part is about the usage of games and simulations for the purpose of agile project management.

11) Do you use games/simulations to train agile methods? If yes, what types of games/simulations do you use? (Board games, pc games, card games etc.)
12) What are the games/simulations that you use to train agile? (Could you give an example, provide a list with the games that your organization uses)?
13) What is the main purpose of these games/simulations? (Awareness, Training, Reflection)?
14) Do you measure the learning/training outcomes, if yes, how?
15) Are you satisfied with the current games/simulations to support agile training and coaching? What works well? What could be improved? What games would you like to see?
16) Are you satisfied with the current agile training and coaching programme in general? What works well? What could be improved?

Part 5 – Development of Agile games/simulations

The next part is about the actual creation/development of agile games and simulations.

17) Do you develop games yourself? If yes, how? If no, how do you get the games that you use in coaching?
18) How do you choose learning goals?
19) How do you structure your games/simulations to ensure that specific learning goals are met?
20) How do you match the specific competences/skills of your customers and the game/simulation that you are using?
21) Which activities you think are still missing to complete the necessary competences of that role?

Part 6 – After training

This part is about the period after training

22) What happens after training agile in an organization?

23) Does it happen that training is not successful?

24) Do you encounter organizations that fail to introduce agile methods?

25) Do you observe development of internal coaching capabilities in organizations (e.g. agile expert, certification etc.)? How? Can you name concrete examples?

Part 7 – Closing

26) Would you like to add something?

Thank you for your time and answers

Appendix F

Category	Description	Quote	Example of code
Agile methodologies\Frameworks	Methods/Frameworks that are applied	Participant A: "We gebruiken een heleboel Scrum"	Scrum
Agile methodologies\Challenges	Challenges when implementing and using agile	Participant D: "Er zitten allerlei vormen van weerstand bij, dat heeft heel erg met houding en gedrag te maken."	Resistance to change
Agile methodologies\SuccesFactors	Factors to make agile (implementation) successful	Participant D: "Dat lag aan dat top management te weinig betrokken was"	Involvement of Management
Training\Type	Types of training	Participant H: "Then we did some SAFe training, lean agiliest training."	Common language/training the basics
Training\Process	Procedural aspects of training/change process	Participant B: "It is called the 8-field model, the essence of the model is that if you want to design a learning intenvention you always should know the problem that you want to fix."	8-field model
Training\SuccesFactors	What is important according to our participants for a training to be successful	Participant B: "The problem must be very serious, if there is no real problem then one of the other questions what happens after the simulation will be not successful because there is no sense of urgency."	Sence of Urgency
Training\Measurement\Methods	Methods for measuring outcomes of training	Participant E: "We proberen dan een soort feedback formulier in te laten vullen en dan vragen we of ze de trainingsmaterialen duidelijk vonden"	Feedback on trainer/training
Training\Measurement\Challenges	Challenges when measuring outcomes of training	Participant B: "But behaviour is very hard to measure."	Hard to measure
Serious Gaming\Types	What types of games are applied	Participant F: "Lego serious play, ook dat is wel weer leuk."	Lego Game
Serious Gaming\Purpose	Main purpose mentioned by participants	Participant C: "Als je het over agile zou doen welk element uit agile wil je dan juist een bepaalde bewustwording van krijgen."	Awareness
Serious Gaming\Mechanics	Main mechanics used in games	Participant B: "You have two elements, the complexity will increase in each round"	Increasing Complexity
Serious Gaming\Characteristics	What characteristics do games have?	Participant H: "So for me I want people to moving in the game, moving physically, I like them to move around the room. So they are moving their legs and bodies."	Physical games
Serious Gaming\Succes Factors	Key succes factors for games	Participant B: "But then it is not a great training because people are not taking it home."	Applying into Practice
Serious Gaming\Fail Factors	Key fail factors for games	Participant G: "In 1 geval vond ik dat het spel te complex was. Er ging veel te veel aandacht uit naar van hoe je dat spel moest runnen en doen."	Game to Complex
Learning Theories	Learning theories mentioned by participants	Participant B: "You can say according to maybe you know Bloom, taxonomy of Bloom. Maybe if I explain it you can recognize is. Bloom has a few levels."	Bloom's taxonomy
Future research	What participants are interested in	Participant B: "develop scientific evidence to really measure the value of simulations."	Measuring

Appendix G

Category	Concept	Code	Nr of Codes
Training	Success Factor	Looking into the Real Problem/Goal	18
Serious Gaming	Purpose	Awareness	13
Serious Gaming	Purpose	Applying Theory/Knowledge	10
Serious Gaming	Characteristics	Fictional Environment	8
Agile methodologies	Challenges	Resistance to change	8
Serious Gaming	Success Factors	Applying into Practice	8
Serious Gaming	Characteristics	Physical Games	7
Serious Gaming	Mechanics	Reflection	7
Serious Gaming	Purpose	Changing attitude and behaviour	7
Training	Success Factor	Importance of Intake	7
Serious Gaming	Type	Customized Game	6
Serious Gaming	Purpose	Teambuilding	5
Serious Gaming	Success Factors	Improvements after execution	5
Training	Challenge	Hard to Measure	5
Agile methodologies	Success Factors	Agile Champion	4
Agile methodologies	Success Factors	Change Process	4
Serious Gaming	Purpose	Learning by Doing	4
Serious Gaming	Type	No PC Game	4
Training	Success Factor	Intake provides Reflection Items	4
Training	Types	Common language/training the basics	4
Agile methodologies	Success Factors	Culture for Change	3
Serious Gaming	Mechanics	Role Playing	3
Training	Process	8-field model	3
Training	Types	Certification	3
Agile methodologies	Challenges	Little Management Involvement	2
Agile methodologies	Success Factors	Involvement of Management	2
Serious Gaming	Mechanics	Flow	2
Serious Gaming	Purpose	Gaining Knowledge	2
Serious Gaming	Purpose	Assessment function	2
Serious Gaming	Type	Lego Games	2
Training	Measurement\Methods	Feedback on Trainer/Training	2
Training	Measurement\Methods	Assessment	2
Training	Measurement\Methods	Follow-up	2
Training	Success Factor	Sense of urgency	2
Agile methodologies	Challenges	Focus on KPI's	1
Agile methodologies	Frameworks	SAFe	1
Agile methodologies	Frameworks	Scrum	1
Agile methodologies	Success Factors	Focus on Team	1
Future Research		Less Teacher Dependent	1
Future Research		Hybrid Game	1
Future Research		Measuring	1
Future Research		Governance Game	1
Future Research		Digital Information	1
Future Research		Strategy Game	1
Future Research		Leadership Game	1
Learning	Theories	Active Learning Cycle	1
Learning	Theories	Blooms taxonomy	1
Learning	Theories	4-C Map	1
Serious Gaming	Characteristics	No prescribed methods	1

Serious Gaming	Fail Factors	Game to Complex	1
Serious Gaming	Mechanics	Increasing Complexity	1
Serious Gaming	Purpose	Multidisciplinary work	1
Serious Gaming	Purpose	Skill training	1
Serious Gaming	Type	PC Game	1
Training	Measurement\Methods	Agile Maturity Scan	1
Training	Measurement\Methods	SWOT Analysis	1
Training	Process	Interviews	1
Training	Process	V-Model	1
Training	Process	VIE Approach	1
Training	Success Factor	Responsibility for Learning Process	1
Training	Success Factor	Importance of teacher	1