Serious Games production:

State-of-the-art, State-of-the-practice and potential Requirements Engineering benefits

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Chapter 1 Introduction

During the last quarter of the century interest has peaked on the potential of using games for purposes other than pure entertainment (Connoly et al., 2012). Possible benefits such as increased visual abilities and the motivating features of digital games captured the interest of various researchers (Connoly et al., 2012). Such efforts have led to the emergence of serious games (SG), a relatively new form of games that combines the entertainment aspect of games with educational aspects and/or knowledge acquisition. This can be identified by the definition of a serious game as: "*[any] computerized game whose chief mission is not entertainment [including] entertainment games which can be reapplied to a different mission other than entertainment*" (Sawyer, 2004) and/or "*a mental contest, [played with a computer] in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives* "(Zyda, 2005). In addition, recent studies have shown that digital games have tangible effects on the users, with knowledge acquisition being one of the most important identified influences (Connoly et al., 2012).

Despite the expected wealth of benefits, serious games have yet to deliver on their promise and be widely adopted (Azadegan et al., 2012; Riedel et al., 2013). Many experts challenge their educational capabilities (Blunt, 2009) in spite of the serious gaming industry being worth close to 10 billion dollars according to studies by the Ambient Insight Research and the Interpret, presented at the Serious Play Conference 2012 (Hypergrid Business, 2012). Other interesting findings include the growing recognition that while traditional education methods underperform and positive findings regarding the learning outcomes of game-based learning and the evolution of technology come to light, the Serious Gaming industry is still held back (Hypergrid Business, 2012). Reasons for this include industry specific factors like the lack of serious game benefits awareness, problematic economy, hesitance to try new educational methods or the lack of proved assessment tools (Hypergrid Business, 2012).

Besides the industry-specific factors, Serious Games also fail due to a lack of strong design principles in the genre (Terdiman, 2006). Game Studios devote a big proportion of their resources onto the experience aspects of a serious game (e.g., graphics, sound, etc.) and not in its essence: knowledge acquisition (Terdiman, 2006). This happens due to various reasons, for example lack of an understanding of the game educational objectives, a lack of systematic practices considering the combination of pedagogy with the entertainment part of the game, miscommunication between relevant stakeholders and more. An interesting example about serious game adoption was presented at the 2013 Games4Change Conference by Dr. Alicia Sanchez, where she presented the results of a study showing that adult students don't approve being seen playing games, despite them aiming to educate, resulting in serious games failure (Chen, 2014).

As it is apparent, cases like the previous one are not simple to analyze since they require an understanding of both the environment in which the games are aimed for, the current technological capabilities present at the time of the project and of course the specific wishes of all the relevant stakeholders (e.g. game producing company, target audience preferences, client targets, etc.). This research project aims at researching those problems by studying SG production processes, with the goal of better understanding why some serious games fail, the serious game production process, identify specific problems of this production process, study the state of the art of possible solutions from the literature and the industry and propose reference methods that try and solve (some of) these problems while increasing the potential value of future serious games for all stakeholders.

In addition, the secondary objective of this thesis is to research Requirements Engineering (RE) best practices and identify whether they can benefit the SG production process. In software engineering, RE has emerged as a discipline for specifying the "right" system that meets the stakeholders' expectations (Nuseibeh & Easterbrook, 2000). Effective RE can also provide benefits for the development process, since good requirements management process ensures effective information exchange between all relevant stakeholders, improved decision-making and finally domain knowledge transfer (Hull et al., 2005; Vlandeeren & Brinkkemper, 2013). For all the above reasons, RE has been selected as a candidate discipline for providing real value to the SG production process, through the potential adaptation of RE best practices.

1.1 Research questions and approach

The main focus of this research is on how serious game production processes are perceived and designed in the literature, the industry and whether Requirements Engineering could have an impact on those processes. Digital serious games are games that have more goals beyond entertainment and this fact leads us to assume that since software engineering and computer game software engineering, despite having a lot in common, are quite different, especially regarding RE, this might be the case for serious games as well.

The main research objective of this thesis project therefore is: ***Understanding how the balance is aimed between the educational and entertainment aspects of serious games in serious games production processes.***

This objective is challenging as these two aspects of serious games can often be conflicting: on the one side, the game should achieve the purpose it was designed for, e.g., for a organizational management training game the players should be trained on organizational processes, potential process improvements, individual role responsibilities, etc.; on the other side, it has to entertain its players so that they keep using the game. How do experts find that balance in their work and ensure that their product fulfills both types of requirements, and does not give primacy to one of them by overlooking the other? How can RE practices help (if they can) achieve better results in that search for balance?

In order to study this subject, various research methods were used. A literature review from various sources covered the research objective of identifying the state-of-the-art and the state-of-the-practice in serious game development and established in a structured manner what has been happening in this field. Unfortunately, no clear and direct answer to the search for the balance between the educational and entertainment aspects was identified in the literature, so another road was selected for the identification of the research question answer: Which are the best practices for designing SG in the literature and in the industry and potential combination of those best practices. This was done because a wealth of different approaches in the SG design processes were identified during the literature review, and through those different approaches different aspects of a SG were covered. Specifically, since most SG design processed identified in the literature are created by members of the academia, these approaches are mostly targeted towards the educational aspects of a SG and how can those be more effectively designed.

A number of expert interviews conducted in Dutch (serious) game development companies also took place with a research objective of understanding how the (serious) gaming industry works in practice. This research phase is important, since researchers agree that there is a lack of insights, experiments and case-studies in the field of game software engineering which leads to unexplored areas of the field (Ampatzoglou and Stamelos, 2010). In addition, similarly to the literature SG design processes, the approach followed by the members of the industry aims at different aspects of the SG, e.g. entertainment capabilities of the game, since for most commercial games, success in this aspect is frequently associated with market success or more cost-efficient production processes, since many SG production studios are not large but mostly small and medium enterprises.

The literature review and expert interviews research phases led to the identification of current practices and the modeling of methods currently employed in serious game production. These methods were modeled using various techniques (Process Deliverable Diagrams (PDD), van de Weerd & Brinkkemper, (2008) being a prominent technique in this family) resulting in clear and compact models. From these models, method fragments were then identified, leading to the development of a new reference method, specifically designed for serious game development, based on both the literature and industrial insights and practice. This serious game situational nature of the method is a very important feature, since there can be no one-size-fits-all solution for both regular games and serious games, as each of them targets a specific purpose (i.e., entertainment vs. education), specific audience and balance between their needs, usually different from game to game. Finally, all individual methods from the interviews and the new method were validated by game production experts from Dutch game studios, via answering a specifically designed for that purpose questionnaire.

In order to answer the main research topic, the following research sub-questions (RSQ) are formed and through their answers a clear understanding of the topic will be gained with an ultimate goal of answering the main research question.

- RSQ1: How do serious games differ from regular entertainment digital games, especially development wise?

The differences between serious and regular entertainment games, especially development wise should be identified and studied, since this could lead to a deeper understanding of the development processes, their differences and potential improvements.

- RSQ2: What is the process of creating serious games proposed by the scientific literature and what is the process followed by the gaming industry?

The identification and modeling of current serious game production processes from both the literature and industry is one the main targets of this thesis project.

- RSQ3: How can the differences between regular and serious game development processes be used for the creation of situational methods?

In case specific and clearly defined differences are identified between serious and regular game processes, these could lead to the identification of specific situational factors and the consequent creation of situational production processes, adaptable to specific project characteristics and not one plain solution for all problems.

- RSQ4: How do the literature and the industry propose finding a balance between the educational and entertaining aspects of a serious game?

We assume that literature and industry models take somehow a different perspective considering serious game development processes. This comes from the assumption that literature models are focused more on the theoretical aspects of the production process, while the industry models are more practice oriented. How both these approaches manage to achieve a balance between the educational and entertaining aspects of a serious game is quite important, especially for the combined SG reference production method assembly.

- RSQ5: Which steps in the serious game creation process influence the success of the game?

The identification of the success critical steps will enhance the improvement capabilities of the combined final method, indicating to practitioners and academics in which steps they should pay extra attention.

- RSQ6: How can requirements engineering (as a whole or parts of it) be applied to the production processes in order to improve them?

The last question aims to provide answers to the secondary objective of this thesis project, specifically the identification and proposal of improvements on SG production processes based on best RE techniques.

1.2 Main thesis stages and deliverables

The research project includes five distinct research phases: the literature review, the expert interviews, the data analysis and modeling of the state-of-the-art in literature and industry, the evaluation and the final method creation. During those phases the PDD modeling technique will be used for the representation of the models and their updates. An overview figure of the research method steps and RSQ answered during each of the steps, can be seen in Figure 1.
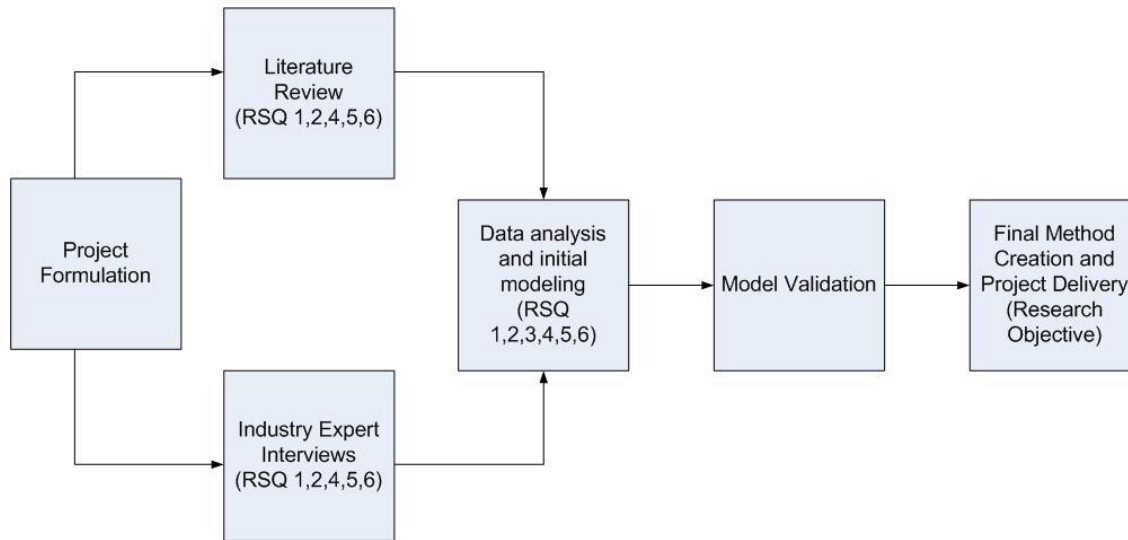
Figure 1: Research method

During the literature review, a set of relevant literature on the topics of (serious) game production, requirements engineering and their combination was identified and studied in order to try an answer (some parts of) the research sub-questions. The main techniques used during this phase were the appropriate keywords search in various research engines and the "snowball" literature elicitation technique (Greenhalgh & Peacock, 2005). A first set of relevant scientific literature was identified with the use of various key words and then from this set of papers further relevant literature was identified through their included references. This phase resulted in a serious game production reference process model, which aims to represent the prominent theories on those topics. In addition, the first part (i.e. theoretical part) of the research sub-questions RSQ: 1,2,4,5 and 6 was identified during that stage. For a more elaborate view refer to Chapters 2 and 3.

The next phase was the interviews phase. It included semi-structured interviews with experts from the Dutch and German gaming industry. The aim was further answering the research sub-questions 1,2,4,5 and 6 (i.e. the practitioners part) and the identification and creation of a serious game production process reference method which represents the current practices in the serious gaming industry. The semi-structured interviews included four basic question sections, specifically: preliminary questions about the company, questions about the game production process they follow, questions specific to serious games (i.e. questions about the educational and entertaining parts of the game and how they are balanced within the game design) and finally questions about requirements engineering and how those practices are applied within the game production process. For a more elaborate description refer to Chapter 4.

The data analysis and modeling of the methods begun in parallel with the literature review and continued in parallel with the interviews until all the data were collected and analyzed. With the successful conduction of the interviews the data were analyzed and a similar state-of-the-art gaming production model from the industry was designed. This deliverable was next used in comparison with the literature model to provide the final answers to the RSQ 1,2,4,5 and 6 and the combination of those methods led to an answer to RSQ 3 a new method, including best practices from both literature and industry. For the complete process refer to Chapter 5.

Finally, the validation and final method creation followed. The proposed method was used for the creation of a questionnaire representing the most important findings up to that point. This questionnaire was answered by the experts who provided the interviews during the industry model creation phase and another set of SG experts. This phase led to very useful feedback from an industry perspective and most importantly an expert validation of the research findings. For a complete description refer to Chapter 6.

Chapter 2 Literature Review

During the literature review, a set of relevant literature on the topics of (serious) game production processes was identified and studied in order to try and answer the research sub-questions, identified during the earlier research phases. The main techniques used during this phase were the appropriate keywords search in various research engines and the "snowball" literature elicitation technique (Greenhalgh & Peacock, 2005). A first set of relevant scientific literature was identified with the use of various key words and then from this set of papers further relevant literature was identified through their included references. This phase resulted in a serious game production reference process model, which aims to represent the prominent theories on those topics.

However, besides the literature SG production reference process model creation, a secondary objective of the thesis project is to identify and study RE and propose potential improvements from this scientific field to the identified SG production processes. In order to do so, an extensive literature review on RE and its main activities took place and led to the identification of potentially useful techniques for the SG production methods. The rest of this chapter focuses specifically on this RE side of the literature review stage, while Chapter 3 focuses on the identified SG production methods and the consequent creation of the SG reference production method.

2.1 Requirements Engineering

While digital games can be considered software products, their development process differs significantly from that of traditional software systems (van de Weerd et al., 2007; Ampatzoglou and Stamelos, 2010). They require the creation of an appealing digital world for the player. The success of a game does not only depend on the technical features of the software; several well-engineered games turn out to be failures as the players do not enjoy them. Digital serious games, despite being digital games, require a different production process than entertainment digital games, for their success requires equilibrium between their expected fun part (since they still are a video game) and their expected efficacy in transferring knowledge. This is one of the major challenges that serious game developers face, one for which an effective game design plays a decisive role for creating the "right" system (Kelly et al., 2007).

In software engineering, requirements engineering (RE) has emerged as a discipline for specifying the "right" system that meets the stakeholders' expectations (Nuseibeh & Easterbrook, 2000). Identifying software requirements, clearly understanding and defining them and choosing the right ones under the specific conditions of the software project at hand can prove to be a decisive factor between software success and failure, since they allow for better market needs understanding and project adaptation (Damian et al., 2004). Naturally, a well designed software product can end up being a commercial failure if (some of) the wishes of the targeted market are not implemented in its design. Effective RE can also provide benefits for the development process, since good requirements management process ensures effective information exchange between all relevant stakeholders, improved decision-making and finally domain knowledge transfer (Hull et al., 2005; Vlandeeren & Brinkkemper, 2013). However, despite these obvious benefits of RE application there are still a lot of software engineers and developers that choose to ignore this aspect of software engineering (van Lamsweerde, 2008).

Requirements engineering is a broad field and can be applied in a variety of contexts, for example market-based software products or client-based software products and different types of software products such as financial software, gaming software, operating systems, etc. (Nuseibeh & Easterbrook, 2000). These different contexts naturally influence the types of RE methods applied per project; RE for market-based financial software will be different from RE for client-based networking systems. Despite those different contexts and RE applications, some essential RE activities can be identified depending on their general goals and these basic activities are (Sommerville & Kotonya, 1998):

- Requirements elicitation,
- Requirements modeling and analysis,
- Requirements validation, and
- Requirements management.

An important note about RE is that a lot of researchers present requirements engineering activities as sequential, starting with elicitation as the first step and moving towards the next steps until they reach management (Sommerville, 2005). This however is not correct, as RE is actually an iterative process, as requirements are constantly elicited, analyzed and modeled, documented, prioritized, validated and updated, with the iterations continuing until the final system is delivered (Sommerville, 2005). The following paragraphs focus on the individual RE core activities while trying to give a basic idea of the whole process.

2.1.1 Requirements elicitation

Requirements elicitation is the process of collecting the requirements for the system from all the relevant stakeholders. Since RE aims at satisfying the stakeholders' needs and delivers the "right" system for the project at hand, requirements elicitation is considered to be quite important for the overall success of the project (Nuseibeh & Easterbrook, 2000; Dieste et al., 2008). Especially since requirements elicitation is the first process in RE mistakes during that step will be spread and multiplied in the later stages, resulting in a problematic end system (Rakagopal et al., 2005; Zowghi & Coulin, 2005). The whole process is very complex, includes many sub-activities with a high degree of error (Zowghi & Coulin, 2005).

The main goal requirements elicitation aims to achieve is identify the actual problem that needs a system-solution while taking under consideration the specific context within which the system will be employed (Dieste et al., 2008). Understanding the problem in relation with the specific environment drives requirements elicitation, since it includes identifying and analyzing all relevant stakeholders, deciding the goals the final system must achieve, understanding the tasks users will need the system for, etc. (Zowghi & Coulin, 2005). Naturally, especially since RE is applied in multiple contexts, multiple requirements elicitation techniques are available and many of those techniques are more effective and efficient in specific contexts than others (Zowghi & Coulin, 2005). These techniques can be broadly assigned in the following categories (Nuseibeh & Easterbrook, 2000):

Traditional requirements elicitation techniques include techniques that aim at crude information gathering, for example questionnaires, surveys, interviews and documentation analysis, etc..

Group elicitation techniques focus on stakeholder collaboration and team meetings to get a better understanding of the context and the resulting requirements. Examples include brainstorming sessions, RAD/JAD workshops, etc..

Prototyping includes techniques that focus on artifact creation, usage and analysis in order to elicit requirements.

Model-driven techniques focus on the information models which will be created with the elicited requirements and include goal-based methods like KAOS and I* and scenario-based methods like CREWS, etc..

Cognitive techniques are essentially the application of methods designed for method acquisition in the context of requirements elicitation. Some examples of such techniques are laddering, protocol analysis, card sorting, etc..

Contextual techniques aim for the middle ground between traditional and cognitive techniques and include ethnographic techniques, conversation analysis, etc..

Various studies have been conducted considering the most effective elicitation techniques but the evidence is not yet conclusive. For example, Dieste et al. (2008) identified interviews as the most effective requirements elicitation technique, with structured interviews performing even better than non-structured ones. They also identified laddering as another effective elicitation technique and in contrast sorting and protocol analysis as techniques that achieve low efficiency (Dieste et al., 2008).

Many of the requirements elicitation techniques can be combined for better results and are not mutually exclusive, for example the use of a prototyping in brainstorming sessions for gaining some better understanding (Nuseibeh & Easterbrook, 2000). Unfortunately, there is no agreement among specialists as to how these techniques can be best combined or how to select the most appropriate ones depending on the specific project context (Dieste et al., 2008). The high number of requirements elicitation techniques available, the different levels of efficiency achieved depending on the context and the techniques combination possibilities present have led to the proposal of requirements pre-elicitation. This step in requirements engineering focuses on which approach for requirements elicitation should be chosen based on the specific project characteristics and context (Carrizo et al., 2014; Anwar & Razali, 2012; Pacheco & Garcia, 2012; Hickey et al., 2004; Dieste et al., 2008; Tsumaki & Tamai, 2006).

Despite the relative high number of research on the requirements pre-elicitation process, most of the literature includes general guidelines and no specific steps for a systematic process, which makes difficult the modeling of the techniques. This can be attributable to the high number of techniques available, the complementary nature of many of these techniques and of course the high dependence on specific project characteristics and general context (Zowghi & Coulin, 2005).

An interesting research regarding potential systematization and modeling of requirements pre-elicitation can be found at Carizzo et al. (2014) as it includes specific steps and pre-defined set of attributes with clear instructions. This framework in essence uses a set of attributes to determine the contextual situation of the problem. The current values of these attributes are applied in an "adequacy matrix" from which the most applicable techniques for the current situation are identified. The framework results in either a set of proposed techniques or in modification suggestions so that proposed techniques can be elicited. The

framework works in sessions, so different situations apply at different stages of the project. At the initial stages the set of attributes have certain values but as the project progresses so do those values change as well. Depending on those changes, new sessions take place and potentially new techniques are identified as most fitting for the current stage of the project. This requirements pre-elicitation process can be applied throughout the duration of the project development life cycle to yield best results (Carizzo et al., 2014).

Due to the high importance requirements elicitation has on the final success of RE on a project, a lot of research is conducted on the field (Zowghi & Coulin, 2005). This has led to a high number of proposed techniques and consequently various approaches as to decide which of these techniques are most appropriate per project (Zowghi & Coulin, 2005). In addition, despite not being a universally accepted step in software production, requirements elicitation is increasingly being adopted as an essential part of software development either by being formally included in the production process or even informally (Zowghi & Coulin, 2005). This takes place mostly by applying generic and more traditional techniques such as interviews and brainstorming sessions but the growing understanding that software companies need better and more effective and efficient requirements elicitation processes leads to the creation and adoption of many new approaches (Zowghi & Coulin, 2005).

2.1.2 Requirements modeling and analysis

Modeling and analyzing elicited requirements is another step in requirements engineering and it includes a lot of sub-processes like requirements analysis, modeling, documentation and prioritization. It involves translating the requirements to usable models which capture the purpose of the final system, the system's behavior and the behavior of the organization in which the system will be deployed, understanding and documenting those requirements, identifying overlaps and conflicts and resolving them (Nuseibeh & Easterbrook, 2000; Sommervile, 2005). Some general categories for requirements modeling are the following (Nuseibeh & Easterbrook, 2000):

Enterprise modeling and analysis involves understanding an organization's structure, operation systems in place, goals, tasks, input and output data types etc.. It allows better understanding of the environment the final system will be implemented for, which leads to more effective and efficient requirements.

Data modeling is mostly focused on computer-based systems which require large amount of information, which needs to be handled in a systematized style. Due to this nature of information systems these types of data should be studied and the final system should be built around them.

Behavioral modeling aims at understanding current and planned systems and stakeholder behavior and translating that to usable models. Especially the difference between current and planned systems is quite important and should be carefully studied.

Domain modeling includes translating the field in which the system will be used into a closed description. It allows for better understanding and validating various assumptions about the system domain which can lead to better re-use opportunities and better automated tools creation.

Non-functional requirements modeling handles the non-functional requirements, a subset of requirements which focuses on "softer" properties of the final system. This nature of non-functional requirements makes them difficult to understand and therefore systematize which makes their modeling in measurable and testable manner even more important for the success of the final system.

Modeling the requirements benefits the whole process since it allows for easier requirements analysis. During this process requirements are studied to understand whether they actually describe what they should, identify inconsistencies or conflicts between them, etc. (Jitnah et al., 1995). Requirements should be clear, complete, consistent and unambiguous while any conflicts should be resolved (Verma & Kass, 2008). In order to ensure those properties, requirements should be checked whether they describe a system with functions that best serve the stakeholder's needs, that all potential conflicts have been identified and resolved, that all the stakeholders needs and wishes are described by the set of requirements at hand, that all requirements are feasible in terms of time, budget and technology and all requirements should be formatted in such a way that they can be checked (Sommerville, 2004).

When requirements are modeled and analyzed efficiently, it allows for better requirements documentation and communication among stakeholders (Nuseibeh & Easterbrook, 2000). Documented requirements can be classified and organized into coherent clusters which also allows for better requirements prioritization (Sommoerville & Kotonya, 1998).

2.1.3 Requirements validation

Requirements validation is focused on validating that they describe what they should and ensuring that the elicited requirements are what the stakeholders and the final system need (Sommerville, 2005). This can be a quite difficult process, especially since stakeholders have to agree about the requirements the system is based on and often they have conflicting wishes (Nuseibeh & Easterbrook, 2000). The validation process is essentially concerned with demonstrating that the requirements describe a system that all stakeholders want, need and agree to (Sommerville, 2004). This step is quite important, since identifying and fixing mistakes in requirements after the system has been built and delivered may incur costs up to 100 times higher than fixing those mistakes earlier in the production process (Sommerville, 2004).

Various techniques exist for requirements validation and can be broadly divided as either focusing on the consistency of the requirements or focusing on validating the requirement compatibility with an actual problem (Nuseibeh & Easterbrook, 2000). Some examples of the former are inspection and requirements reviews which focus on systematic manual analysis of the requirements while examples of the latter are scenarios and prototyping, i.e. the use of a crude version of the system to check the requirements in practice (Sommerville, 2004). Another example of a requirements validation technique is test-case generation, which includes the creation of specific tests for the requirements through which those requirements are validated (Sommerville, 2004).

Another aspect of requirements validation is stakeholder negotiation (Nuseibeh & Easterbrook, 2000; Sommerville, 2005). A natural phenomenon in software projects with multiple stakeholders is that not always all stakeholders agree to the proposed system model and requirements and consequently negotiation is needed to resolve those conflicts without lowering individual stakeholder satisfaction (Nuseibeh & Easterbrook, 2000; Sommerville, 2005). In order to do so, the most important goals of each

stakeholder should be elicited and during the development process it should be ensured through negotiation that at least these goals are satisfied by the system (Nuseibeh & Easterbrook, 2000).

Requirements prioritization can be considered as being positioned somewhere between requirements modeling and analysis and requirements validation (Sommerville, 2004). This is the case because prioritization focuses on placing the requirements in a prioritized list which can be used for analyzing them and for resolving stakeholder conflicts (Berander & Andrews, 2005). Other important benefits of effective requirements prioritization include better project planning, core requirements identification, customer satisfaction estimation, rework minimization, optimal set of requirements for implementation planning and selection and many more (Berander & Andrews, 2005). Prioritization techniques can be divided into two categories: methods and negotiation approaches. The first focuses on quantitatively assigning values to requirements while negotiation approaches try to give priorities based on stakeholder negotiations and subjective measures (Berander & Andrews, 2005).

Interesting work on requirements prioritization is the one from Bakalova et al. (2011) focusing on Agile requirements prioritization. It is considered interesting in the context of this thesis project because a lot of gaming companies employ agile methodologies for producing games and a requirements prioritization framework specifically focused on such methods seems fitting. This framework aims at informing the stakeholders of all the important concepts required in requirements prioritization and allows them to understand the process better from the production side (Bakalova et al., 2011). The model consists of 8 aspects of the project that stakeholders consider important when prioritizing requirements, on which various prioritization techniques from the literature are mapped resulting in a complete matrix which allows for a better overview of each of these techniques in relation with the 8 aspects of the framework (Bakalova et al., 2011).

2.1.4 Requirements management

Requirements management focuses on handling documented requirements and managing their evolution over the course of the whole project (Nuseibeh & Easterbrook, 2000; Sommerville, 2004). A proposal to achieve this management over time was to develop documentation standards which allow for the production of requirements documents with predicted attributes, especially considering readability and traceability (Nuseibeh & Easterbrook, 2000). However, some researchers believe that no highly systematic templates can be created since the requirements and the whole RE process depend on the specific project context, therefore one-size-fits-all solutions are not possible to be identified (Nuseibeh & Easterbrook, 2000). Instead of a complete template, more general guidelines and standards can be defined which can then be coupled with the project contextual details (Nuseibeh & Easterbrook, 2000).

Requirements traceability is important for requirements management, since it allows to study the whole lifecycle of a requirement from its initial conception to its development and finally to its implementation, after some potential rounds of updates throughout its lifecycle (Nuseibeh & Easterbrook, 2000; Sommerville, 2004). Efficient traceability helps enhance understanding about choices made during the development process, since through traceability a rationale for all requirements can be identified, analyzed and the impact of changes can be studied (Nuseibeh & Easterbrook, 2000; Sommerville, 2004).

Including requirements traceability in documenting requirements also helps with managing requirements evolution and change (Nuseibeh & Easterbrook, 2000).

Change management has a direct relationship with software system success since systems change along with their environment and stakeholders needs, so naturally effectively managing these changes leads to better information systems (Nuseibeh & Easterbrook, 2000). Adding, updating or deleting requirements should be documented along with version control and updated traceability links so that the impact of those changes can be analyzed (Nuseibeh & Easterbrook, 2000; Sommerville, 2004). All proposed changes should be subject to change management and more specifically problem analysis, change analysis and costing and change implementation (Sommerville, 2004). Most changes usually follow stakeholders' needs change, budget and schedule restrictions or discovered inconsistencies- typical project problems that require some form of action and solution (Nuseibeh & Easterbrook, 2000; Sommerville, 2004).

Due to the iterative nature of RE, managing change in requirements is not only limited in documentation but also focuses on identifying and handling changes on new requirements elicitation, modeling and analysis and validation iterations and risk re-evaluation (Nuseibeh & Easterbrook, 2000). Research has shown that trying to manage change on the software code level can lead to problematic software structure and maintainability, so evaluating proposed changes on a higher –the requirements- level is a more effective and efficient way in studying their effects on the final system (Nuseibeh & Easterbrook, 2000).

2.2 Requirements Engineering and Game Development

Recent studies in game software engineering have shown that software production is quite different from game production (Kasurinen et al., 2011; Murphy-Hill et al., 2014). This can be attributed to many different factors, such as game developers having less clear requirements than non-game developers due to the "special" nature of games. Since creativity is an important value driving game production, game development teams are required to be more diverse than traditional non-game development teams and this creates the necessity of the ability for engineers to communicate with non-engineers (Kasurinen et al., 2011; Murphy-Hill et al., 2014).

RE is not formally applied in the gaming industry because of this creative side of games and the industry resistance in systemizing the game development process (Kasurinen et al., 2011). This process includes many changes in the initial ideas for the game, since game developers need to manage plans and product requirements continually as the product may vary between the first design and final release. These changes are created based on the feedback from the initial prototype testing, the first playable version of the game testing, marketing research, etc.. Game developers try to minimize the amount of functional requirements that should be implemented so that they can focus on the non-functional requirements of the game. Requirements analysis is conducted mostly with user tests and usability testing which also leads to requirements changes and frequent updates (Kasurinen et al., 2011).

Currently, there are two main development approaches in the gaming industry: Development pipelines and the Iterative model (Kasurinen et al., 2011). In the first approach, the product matures sequentially from one production phase to the next with minimal iterations. This approach is chosen because it delivers a functional prototype before the game contract is signed, testing does not influence heavily the

productions or that the production company follows a strict plan with distinct phases and deadlines. In the Iterative model, the development returns to design and requirements management elicitation as the production process includes rounds of iterations between the multiple phases of game design and testing. Production starts with a draft plan and during various iterations features are tested and updated with the game being open to a lot of changes (Kasurinen et al., 2011).

Recently, RE has emerged as one of the most popular research topics in game software engineering research (Ampatzoglou and Stamelos, 2010). This can be attributed to the additional importance proper requirements management has on a successful game. User enjoyment requirements or attractive user interface requirements, while play a smaller role in traditional software products, are essential traits of games. This consequently leads to an increase in research on RE for game software engineering (Ampatzoglou and Stamelos, 2010).

Despite no formal RE stages present in the industry, informal requirements elicitation and analysis are present in many cases (Kasurinen et al., 2011). Due to the nature of the games however, RE practices should be applied after the game idea has been elicited and agreed onto since it is difficult to apply effectively RE during the early conception phases of the game production process. Experience requirements have a big impact on deciding whether a game should be created or not. This focus on the "softer" requirements in games leads some gaming studios to treat functional requirements as not so important and try to outsource their development (Kasurinen et al., 2011).

Some steps in the direction of educational software have already been done, with the identification of educational requirements and their further categorization in Hadjerrouit, (2007). According to this research requirements relevant to the educational aspects of a software product can be categorized in:

- Teacher requirements: Educational requirements that constitute the target knowledge and are mostly contributed by teachers. These include the intended learning objectives of the game, the teaching content required to be included in the game, the targeted skills that players should acquire through the game, the assessment procedures embedded in the game, etc. (Hadjerrouit, 2007)

- Pedagogical requirements: Educationalists (i.e. educational researchers and practitioners) are the main source for this type of requirements. They specify the most appropriate learning strategies and methods present in current learning theories (e.g., constructivism, behaviorsm, collaborativism, etc.) according to various factors relevant to the game (Hadjerrouit, 2007).

- Learner requirements: This type of requirements comes from the target audience of the game, the learners and includes the target audience characteristics, their prior knowledge and expertise, their age, etc. (Hadjerrouit, 2007).

These educational requirements can be modeled and presented as storyboards or diagrams so the educational experts can validate them even before any kind of game implementation, prototype or artifact creation. Some other important properties regarding educational requirements are the kind of reflection

the game allows, the amount of information the game provides its players (too much information can hinder the learning experience), the exploration allowed in the game world, possible incremental learning process capabilities present in the game which could allow adaptation capabilities depending on the player skills and also assessment capabilities of the game (Harteveld et al., 2007; Moreno-Ger et al., 2008).

The fun aspects of a game have also been researched and a set of experience requirements have been identified (Callele et al., 2006; Callele et al., 2010a). These experience requirements capture the intended player emotional response and the means for the induction of this response. A summary of the experience requirements identified by Callele et al. (2006; 2010a; 2011) can be seen in Table 1.

Category of requirements	Sub-category of requirements	Explanation
Emotional requirements		Requirements about the emotional response
Gameplay requirements		Requirements about the complete intellectual response
	Cognitive requirements	Requirements about the brain response
	Mechanical requirements	Requirements about the potential stimulation and movements response of the body
Sensory requirements		Requirements about the body senses stimulation and response
	Visual requirements	Requirements about the optical stimulation and responses
	Auditory requirements	Requirements about the audio stimulation and responses
	Haptic requirements (if available)	Requirements about the potential touch stimulation and responses

Table 1: Experience requirements

Current research suggests that close communication between the gaming industry and the gaming community could benefit the effort to understand and identify those types of requirements more effectively in order to model and successfully apply them to (serious) game production (Callele et al., 2011). Unfortunately, no further scientific research has been published on such requirements types, despite the potential benefit such research can have for the (serious) gaming industry scientific literature.

Chapter 3 (Serious) Games Production Methods in the literature

The most important goal of the literature review stage of this research project is to identify the current state-of-the-art in (Serious) Games production methods. This identification should lead in the design of one (super/reference) serious game production method which represents the prominent theories present in the literature. Unfortunately there are very few methods for Serious Game production processes documented in the literature so during the initial steps of the literature analysis more general methods about game production were studied. The first methods studied for the creation of this serious game production method was the one presented in van de Weerd et al. (2007) and an extension to this method by Amanatiadou and van de Weerd., (2009). These methods were chosen as a starting point because they are reference methods that give a complete overview of the gaming production process and in addition the extension to this reference method includes a serious game route.

The first method was constructed after four game production methods were analyzed, compared and finally used to construct initially a super method from which the most suitable method fragments were chosen for the creation of a reference method. Three of these methods are documented in game production books and they were chosen because of their focus on the management perspective rather than the technical side of the game production process (van de Weerd et al., 2007). The fourth method was created after a case study was conducted in a Dutch game production company which allows for the industry perspective to be included in the research.

After these methods were selected they were analyzed using the Process – Deliverable diagrams (PDDs) technique which results in a set of diagrams presenting the development process on the left side of the diagrams and the deliverables (or concepts) of each step on the right side of the diagrams accompanied by activities and concept tables which elaborate on the process steps and the deliverables (van de Weerd & Brinkkemper, 2008).

These models are further analyzed in process steps and concepts from which a comparison table is created. All process steps and concepts from all the methods are included in the table as a super method (i.e. a method that included everything from the previous methods) and compared with each of the smaller methods. All steps and deliverables can be the same (or quite similar) in both super and smaller method, one can result in more or less than another, one can overlap another or finally an activity or concept present in the super method can be absent from the smaller method. This whole step results in the identification of the most prominent (or "best") steps and concepts from all the methods. These are then selected, analyzed and finally combined to the reference method (van de Weerd et al., 2007).

The resulting reference method gives a complete overview of all activities and deliverables present in a game production process and an overview of the process side of the method can be seen in Figure 2.
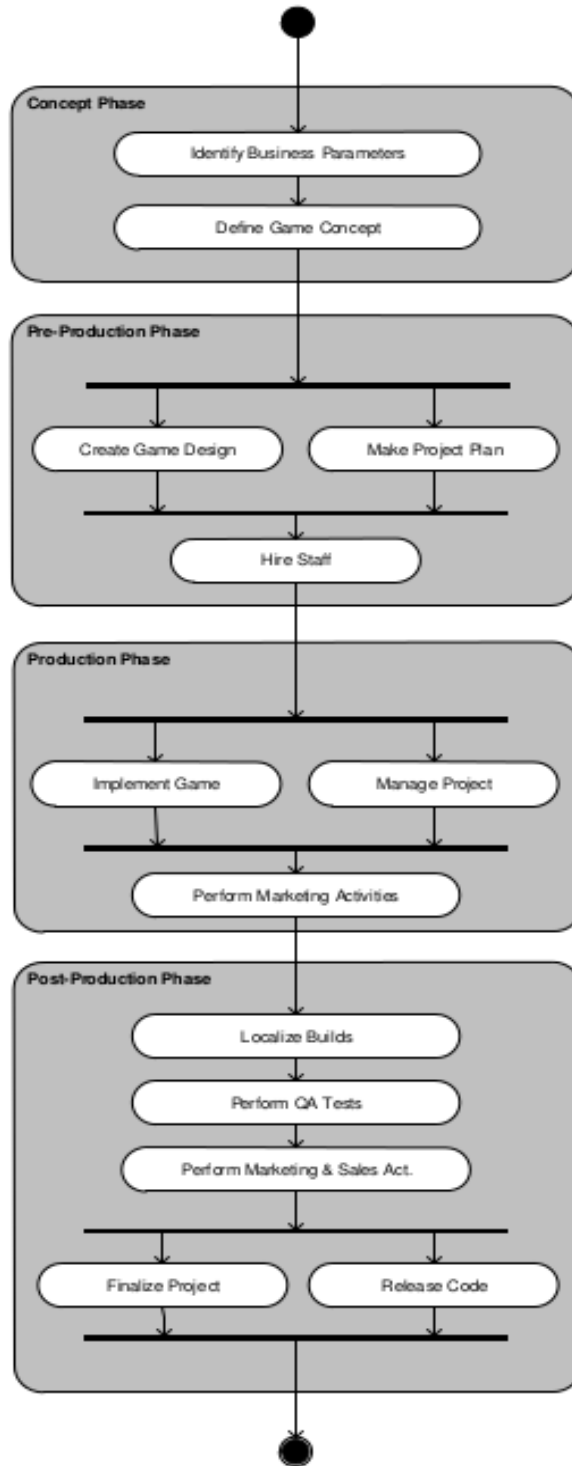
Figure 2: Process Diagram of the Reference Method (van de Weerd et al., 2007)

3.1 Extended game production method

The reference method consists of 4 phases (concept, pre-production, production and post-production phases), 13 activities and 69 sub-activities which result in 93 deliverables. The first phase focuses on identifying and defining the business parameters of the project (e.g. budget, time-to-market, market analysis, etc.). These parameters with some first details of the game are combined to create a game concept, usually in the form of a prototype of the game. This prototype should give a first idea of the direction the game production is taking and how the game would look after the final implementation. This is important because stakeholders have to be able to approve the game concept early in the production process and try to ensure as little changes later as possible.

During the pre-production phase, the game design document is created and it includes the story, gameplay, art and requirements for the game. Besides the game design document, a project and hiring plan are developed to ensure the successful completion of the game. Both are based on the game concept created and approved during the previous phase. Both the game concept and game design creation processes are highly creative and rely in the evaluation and approval steps from the client.

The production phase includes the final game implementation and project management. The game is developed through prototyping and tested until it is ready for the alpha and beta versions and art assets. After the game is finished the marketing activities are initiated which include demo releases, game screenshots, etc.. The final game production phase is post-production which includes game localization so it can be released in various countries, Q&A tests, further marketing activities and the final shipping of the game.

An extension to this reference method was proposed in Amanatiadou and van de Weerd, (2009). They attempted to add a situational nature to the reference method, i.e., allow the method to be tuned according the specific characteristics of the project at hand (Amanatiadou & van de Weerd, 2009). The four specific routes identified in the extended version include a serious games route, an online games route, a prototype route and a localization route.

The serious games route introduces changes on the game concept phase, especially due to the educational nature of serious games. The educational and/or training nature of the serious game mostly influences the game concept phase, as it has to be embedded in the gameplay for effective results. The educational aspects of the game and the learning objectives should be clearly understood by the production team and then be embedded in the game goal, mechanics, context and gameplay. This should take place early in the production process, as the client has to be able to see what the game would look like and approve it.

The online route mostly focuses on the post-production phase of the game production process. This happens because gaming companies have to update their game code and provide extensive after sales support to the game players. Besides the game type, other factors are identified as influencing the game production process and one of them is the prototype route, which is heavily influenced by the introduction of agile methodologies for game development. Most changes in this route take place after the pre-

production phase and before the implementation step. The final route is the localization one that focuses on the differences between companies that localize their games for various countries and companies that don't. Most changes occur in the production and post-production phases and have to do with quality assurance testing and debugging. An overview of the extended model can be seen in Figure 3.
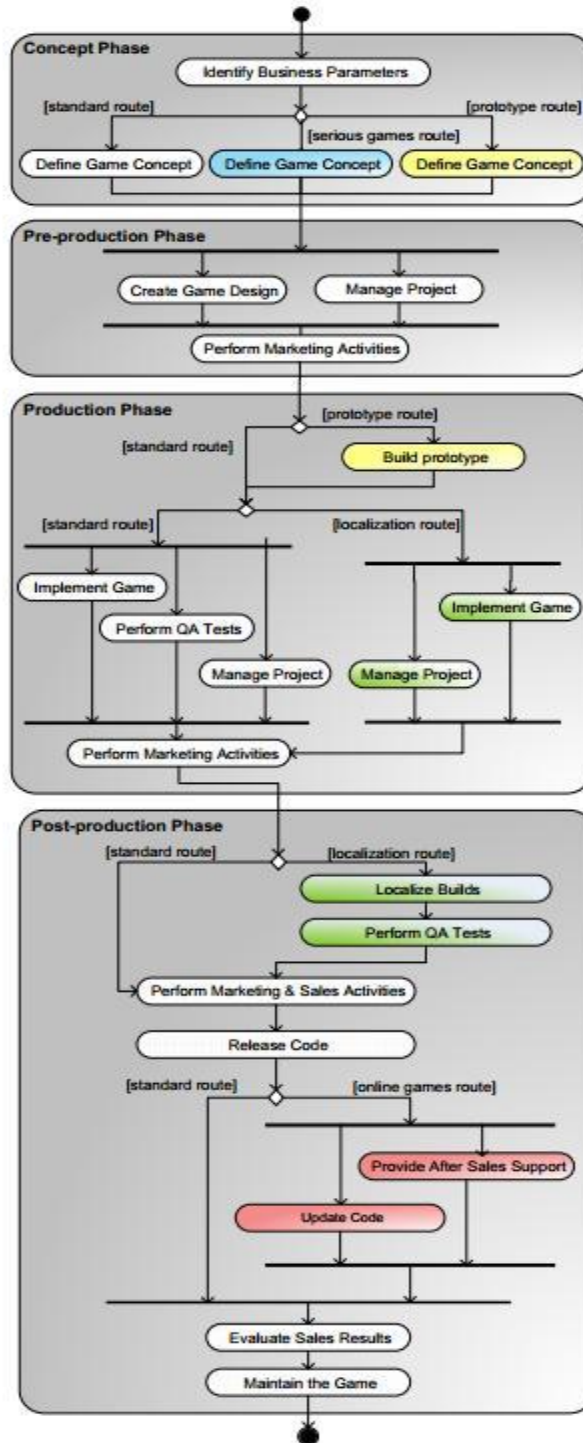
Figure 3: Extended method by Amanatiadou and van de Weerd, (2009).

3.2 Serious Game production chain model

Another research focusing on serious games production is the work of Marfisi-Schottman et al. (2009). In this paper a production chain model for serious games is proposed with the goal of helping gaming companies efficiently produce serious games while ensuring their educational and fun qualities. The production chain model is based on the 5M classification used in industrial engineering (Method, Milieu, Manpower, Machine and Material) and includes most aspects of the production process, from the method steps, to the stakeholders and members of the production team, the tools used during the production process and the deliverables of each step.

Creating a serious game according to the production chain starts with a request for a game from a client to the production team. This request is then analyzed by the production team to identify the business parameters of the game (e.g. budget, time-to-market, etc.), extract the domain knowledge required for and from the serious game, design the specific game scenarios and activities and combine all those into a mock-up model, i.e., a storyboard which demonstrates the virtual world, the characters and the general nature of the game.

In order to extract the domain specific knowledge for the project at hand, a cognitive expert along with domain experts, usually provided by the client, work closely with the production team to formalize the specific domain knowledge required for the game. This step allows for the definition of the pedagogical objectives of the game, the creation of the game scenario, target audience profiles, gameplay and ensure that these let the players learn through the use of the game. In parallel, entertaining scenarios are designed to ensure the game is also fun to play and the final serious game scenario is a combination of the entertaining and educational scenarios. The researchers propose the use of learning activities sequences (modules) through which the learning process takes place. After these modules have been designed they have to be structured into the game scenes (the entertaining scenarios) in a natural way resulting in a complete game storyboard. This storyboard is used by the art designers to add the audiovisual elements of the game resulting in a complete mock-up model of the game.

An approval step follows for the mock-up model before it is forwarded for implementation. It includes a set of tests on the storyboard to eliminate potential dead ends and ensure that all modules allow the players to learn. These tests result in a complete educational evaluation of the mock-up model and prevent costly updates later in the production process. After the feedback from the tests is analyzed and included in the mock-up model an approval session takes place.

After the mock-up model has been approved it is handed to the implementation team, which consists of developers, art designers, etc.. These members collaborate to turn the mock-up model into a playable prototype ready for user testing. The prototype is validated and debugged and then forwarded to a representative user test group for testing. The prototype is extensively used and feedback is provided by the test group. This feedback is analyzed and implemented in the game in another production round. After the game has been developed, a pedagogical quality control phase follows to ensure the game is

educationally sound (i.e., actually educates its users). Based on the pedagogical evaluation the game is either updated to include the proposed pedagogical changes or is certified and finished.

3.3 Seven-step process for designing Serious Games

A follow-up to the previous research is the one from Marfisi-Schottman et al. (2010), which proposes a seven step process for designing serious games. These seven steps are:

Specification of the pedagogical objectives: During this step the domain specific knowledge is extracted and formalized from the domain and cognitive experts. These specifications are used by the pedagogical expert for the identification and organization of the skills to be learned by the players and consequently the pedagogical objectives.

Choice of the serious game model: The researchers propose the use of predefined models for the serious game, specifically types of games: board game, investigation game, puzzle and adventure game. This step is added under the assumption that these models are well defined from an educational point of view and the pedagogical expert can adapt them when designing the fun scenario.

General description of the scenario and virtual environment: This step is focused on the draft pedagogical and fun scenarios creation and matching. These include the storyline, game characters, game world, etc..

Search for reusable software components: Software components created for previous games that can be reused in the current project are researched. This step is based on the existence of a component database where software components are stored, since re-use is usually more efficient than starting from the beginning.

Detailed description of the scenario: After the software components have been identified and included in the design, a complete game scenario can be created. This includes both fun and educational scenarios, complete gameplay and any type of interaction offered by the game to the players.

Pedagogical quality control: This step includes a pre-evaluation of the educational and entertaining nature of the serious game before any form of implementation is initiated. Tests are conducted on the game scenario to eliminate dead-ends and ensure that the game actually educates its users and promotes the game learning objectives.

Precise specifications for subcontractors: The results from all previous steps are included in a specifications document with detailed instructions for each developer and art designer, to guide the production process.

3.4 Educational software design methodology

The last research used in this project for the creation of the literature serious game production model is the work of Lage et al. (2001). This paper is focused on a methodology for educational software design and specifically the integration of pedagogical aspects to the conventional software production process.

This is done through the presentation and elaboration of a life cycle model, specifically the evolutional prototype with successive refinements model. This approach includes the following stages:

Feasibility: The software product details are researched and its feasibility is determined, in relation to business parameters (e.g. budget, time-to-market, competitor analysis, etc.). During this stage also the educational needs are identified.

System requirements definition: An initial list of functionalities, interfaces and design development types of the system are defined during this step. The requirements can be categorized as system (software and hardware) and educational requirements.

Specification of prototype requirements: The sub-set of requirements for the prototype is defined in this step. These include the specification of the prototype functions, its interfaces and input/outputs required for a workable prototype.

Prototype design: After the requirements list for the prototype has been created an analysis is performed to align them with the implementable modules and functions, how the work is going to be performed, etc..

Detailed design of the prototype: The control and data structure, the interface relations, basic algorithms and assumptions of each prototype component are defined in this stage. During this step, the requirements are translated into the final software representation to ensure the required software quality before the actual implementation begins.

Prototype development (codification): The prototype design is translated into code.

Prototype implementation and testing and iterative refinement of prototype specifications: The creation and testing of a workable prototype is the main focus of this step. All required functionality must be implemented and tested to ensure everything works as planned, that specific input produces a specific output and all functions are working as expected. These tests usually produce feedback that initiates a prototype specifications refinement and update.

Design of the final system: In this stage, all modules are included in the final system design along with various updates and refinements which are results of the previous stages.

Implementation of the final system: The final system design is implemented along with its documentation and staff training (if needed) and finally is installed in the client location.

Operation and maintenance: The system is turned on and monitored for any maintenance required.

Withdrawal: This step is described as "a transition between the functions carried out for the product and their successors".

3.5 Method assembly

In order to further analyze and compare the serious game production methods presented in the previous paragraphs, the method engineering (ME) approach first proposed by Hong et al. (1993) and further used in van de Weerd et al. (2007) will be used. According to this ME approach the various methods selected are modeled using a meta-modeling technique -in this case process-deliverable diagrams (PDDs, van de Weerd & Brinkkemper, 2008). These methods are then broken up in method fragments and combined in a super method. A super method is a collection of all the relevant method fragments from all the selected methods. These are all included in a comparison matrix and relationships between all method fragments and methods are defined. From this matrix it is possible to compare all method fragments and select the best ones resulting in a complete reference method, without having duplicate processes or deliverables (Hong et al., 1993).

The following steps are taken in this research project for the creation of the literature review serious game reference method:

Method selection: For the creation of the literature serious game production reference method the serious game route with the reference production method, the production chain model and the seven step process for designing serious games and finally the evolutional prototype with successive refinements model are collected (Amanatiadou & van de Weerd, 2009; Marfisi-Schottman et al., 2009; Marfisi-Schottman et al., 2010; Lage et al., 2001). The collected methods are analyzed and the scope of each method is defined.

Method modeling: The selected methods are translated in meta-models using the process-deliverable-diagrams technique. The process and deliverable diagrams are accompanied by activity and concept tables which elaborate on both concepts and activities.

Development of super method: The modeled methods are decomposed in activities and deliverables/concepts and are included in a comparison table. The super method includes all activities and concepts from all methods.

Comparison of methods: The methods are compared by filling all rows and columns in the comparison table with comparison symbols. An '=' symbol indicates that the activity/concept are the same, the '<' and '>' symbols indicate that the activity/concept in the super method includes more than the activity/concept in the comparing method, the '><' symbol indicates that the activity/concept in the super method overlaps the activity/concept in the comparing method and finally in case a field is left blank indicates that the activity/concept is not present in the comparing method.

Reference method creation: Based on the results from the comparison of all methods the most appropriate method fragments are selected. These method fragments are combined into a complete reference method for serious game production.

After the methods were collected their scopes were defined. This step is necessary as some of these methods focus on the whole design and production process, specifically Amanatiadou & van de Weerd, (2009) and Marfisi-Schottman et al. (2009) while the rest focus on specific phases and steps of the

production process, specifically design and prototyping: Lage et al. (2001) and Marfisi-Schottman et al. (2010). Due to the nature and specific goals of this thesis project (i.e., research on how the balance between the educational and entertainment natures of a serious game are achieved and whether requirements engineering can have an impact on this balance) the later stages in the complete production methods are considered out of scope. Specifically, the post-production and final steps of the production methods are not elaborated neither considered in full for the creation of the literature serious game reference method. After the scope of the methods was defined they were analyzed and modeled into PDDs and accompanying tables. These PDDs and tables can be found in Appendix A.

All method fragments from all the methods were then included into a super method and this super method was in turn compared with each individual method in the comparison table. The activities were compared into an activity comparison table and the deliverables/concepts into a concept comparison table. This comparison resulted into the identification of the "best" method fragments and the creation of the literature reference serious game production method. The comparison tables can be found in Appendix A.

The literature reference serious game production method consists of 4 Phases, 12 main activities, 75 sub-activities and 90 concepts. The whole process is dependent a lot on the Serious Game route from the extended game production method by Amanatiadou and van de Weerd, (2009), since this method was the most complete and elaborate one. The main changes are the addition of the Mock-up model and pedagogical quality evaluation method fragments because they were not present in the main method. Both Mock-up model creation and pedagogical quality evaluation activities should take place before any implementation takes place because through those activities the pedagogical quality of the serious game is evaluated early in the process, mistakes are identified and fixed before any costly implementation takes place and the clients get a more clear idea of what the game would look like later on (Marfisi-Schottman et al., 2009; Marfisi-Schottman et al., 2010). In addition, the prototyping phase was enriched with method fragments from Lage et al. (2001), since in the original serious game route production method this activity was not elaborated enough and more specific steps were required.

A literature reference serious game production method overview can be seen in Figure 4. For a more elaborate version of each production phase within the method all figures can be found in Appendix A.
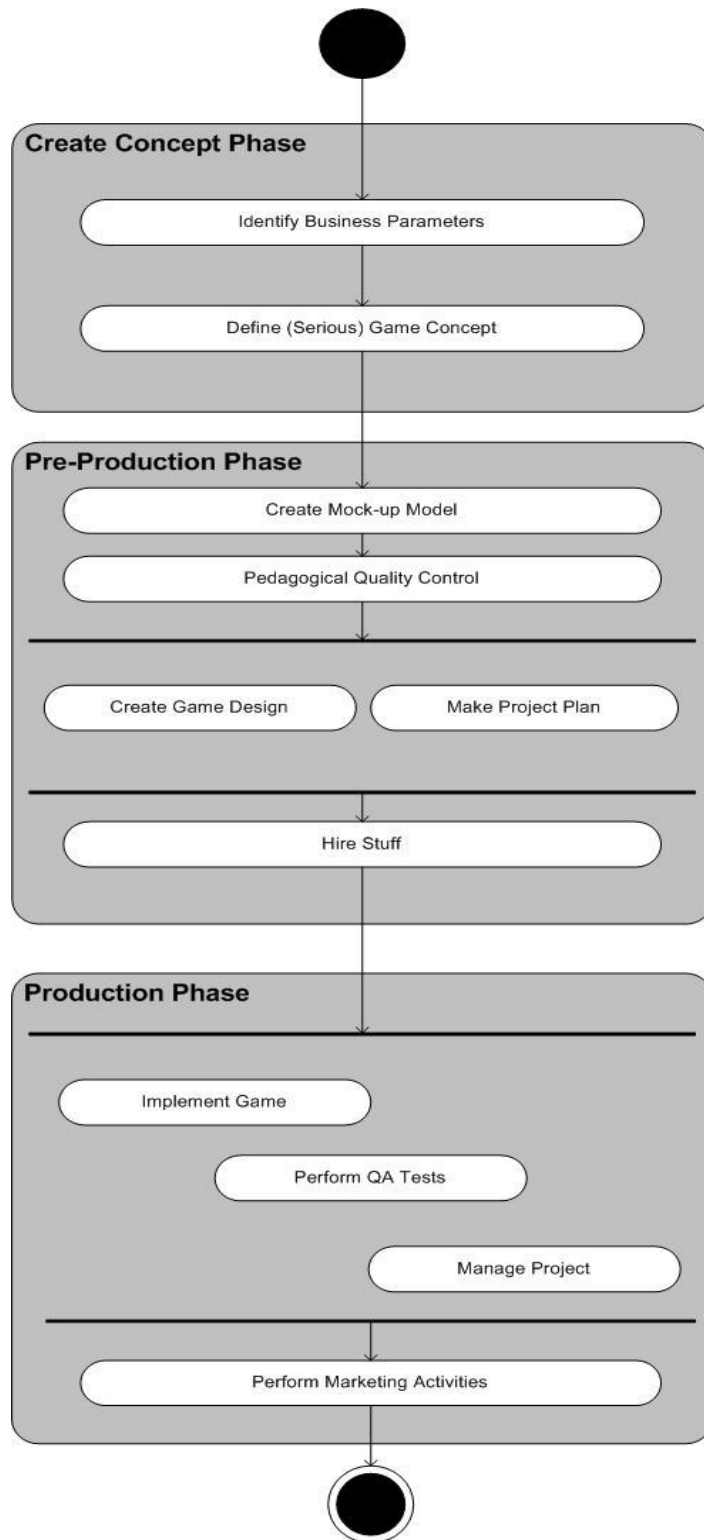
Figure 4: Literature reference serious game production method

Chapter 4 (Serious) Games Production Methods in the industry

The next step in the research project was the conduction of the expert-interviews and the consequent analysis of the collected data. In total, out of 18 Gaming studios, four Dutch (Serious) Game production companies agreed to participate in the project and experts from those companies were interviewed. The type of the interviews was semi-structured with open questions based on four main sections: preliminary questions about the company, questions about the game production process they follow, questions specific to serious games (i.e. questions about the educational and entertaining parts of the game and how they are balanced within the game design) and finally questions about requirements engineering and how those practices are applied within the game production process. The complete questionnaire can be found in Appendix B.

The interviews were conducted within a two-month period and the analysis of each of those interviews started almost immediately after. With the successful conduction of the interviews the data were analyzed and a state-of-the-art gaming production model from the industry, similar to the literature reference serious game production model, was designed. The process followed was the same as in the literature model, based on the process described by Hong et al. (1993).

The most important aspects of each interview can be seen in table 2, while summaries from all the interviews are presented in the following paragraphs to provide an overview of the collected data during the interview conduction phase. The related PDDs and tables created after the data analysis for each case are included in Appendix B.

4.1 Interviews summaries

	Company 1	Company 2	Company 3	Company 4
Contact Person Role within the company	Game Developer	Principal Technologist	Game Designer	CEO
General Comments	Uses AGILE/SCRUM methodology.	Uses AGILE modified methodology with playtesting really integrated in the process.	Uses AGILE/SCRUM methodology.	Uses AGILE/SCRUM methodology.
Game Concept phase	Researches idea feasibility before game concept. Produces the pen and paper prototype as early as possible	Researches idea feasibility before game concept. Produces the simple prototype as early as possible	Includes a question articulation phase in their design process to better define the game concepts. Pen and paper prototype is created as soon as	Game feasibility is researched in parallel with the design of the game concept, as both are considered to be closely related. The pen and paper

			possible and evaluated with rounds of playtesting by all parties involved.	prototype is created as soon as possible.
Pre-Production	Game design is based on pen-and paper prototype. Through SCRUM sprints the prototype is updated with pedagogical quality assessment integrated in SCRUM sprints. Game art is created last.	Based on the simple prototype feedback and the game design the Game prototype is constantly updated. Playtesting is completely integrated in the production process, since it takes place even after the earliest versions of the prototype have been created. Game art is created last.	Game design is based on pen-and paper prototype. Through SCRUM sprints the prototype is updated with playtesting rounds integrated in the SCRUM sprints. Game art is created last.	Game design is based on pen-and paper prototype. Through SCRUM sprints the prototype is updated with playtesting rounds integrated in the SCRUM sprints. In addition, they include pedagogical quality assessment in their process, which impacts directly the product backlog. Game art is created last.
Production	Follows SCRUM, implement game and create final documentation	After the final game has been implemented constant rounds of playtesting take place until the game is deemed ready by all parties participating in the process. Game documentation is created after the successful implementation of the game.	Follows SCRUM, implement game and create final documentation. No playtesting is involved after the final game has been implemented.	Follows SCRUM, implement game and create final documentation. No playtesting or pedagogical quality assessment are involved after the final game has been decided to be implemented.

Table 2: Interviews imporant aspects

4.1.1 Interview Company 1

The first interviewer is a principal game developer and the discussion started with a brief company introduction. Currently, there are five permanent employees and two audio specialists. The company started around a year ago with an educational game about the banking system. So far they have developed both client and market based games and they also handle work as sub-contractors to bigger companies but this form of project undertaking depends on the available time and running projects.

The idea inception phase in the company is done in two main styles. Either a client brings a game idea to the team (the most common case) or a member of the team has a more general idea that he/she is passionate about and through various discussions with the other members a specific game idea is formed. After the proposal of a project, various parameters are researched to develop the feasibility of the idea. Research on the idea topics and on the market take place for market-based games to see initially whether the project is feasible and after project initiation to define the most important details of the project. When a client comes to the team with a proposal, the team tries to figure out the time the project would take, which leads to a budget level definition. Those parameters are discussed with the client and after some form of negotiating the team and the client agree to the project details (i.e. time to market, budget, etc.).

After the negotiations with the client, the game idea is ready and the team has several meetings and brainstorming sessions to create the game concept. For client based games, most features and general ideas come from the client where for market based games all the ideas and features come from the team after various brainstorming sessions and research. The company follows the SCRUM production process. They work in regular sprints, during which a functional prototype is created. This prototype is then evaluated by the team and possibly the client (if it is about a client-based game). After the evaluation, the feedback is used in the next sprint for the update of the prototype. After a number of sprints the prototype is ready (this is also decided based on initial budget and time constraints) and accepted by the client or the team (for market based games). It was also mentioned that the art of the game is implemented in the later production stages and not early in the production process. When the prototype is relatively complete, the alpha version of the game is produced which includes all the features for testing and after that the beta version of the game is made available to the public (i.e. test gamers for evaluating the game, etc.).

During the interview, it was mentioned that two of the factors that differentiate the game production process are 1) whether the game is market or client based and 2) the company size. So, for a young and small company it is not possible to have the same systems and processes in place as an older bigger company. Especially when the number of team members is sufficiently small enough, it is possible to keep the specifics of a project or the general production process in the minds of the team members, without having to document everything. This also contributes to the re-use capabilities present in the company. Every member has in their personal files pieces of previous projects and the knowledge to understand if, what and how can be modified and re-used per project. The size of the company also leads to other choices, like the production of game design documents per project. Since the team is relatively small there is no need for a well defined formal GDD but a smaller, less formal one is created at the beginning of the project. This document is used at the early stages and is updated based on the project specifics, but it is mostly used as a reference document, since the details of the project are known to each team member sufficiently without the need of central documentation. The essence of the game is included and demonstrated by the prototypes produced per production sprint, complemented by all the source codes, which are stored in Git.

Regarding the educational aspects of the game, they are mostly handled in the following steps: A pen and paper prototype or board game, are created for testing and evaluation of the nature of the game. Based on feedback from the team members, the client and test users the game design containing the educational

aspects is created. The educational details of the game are mostly provided by the clients, since they have a clear understanding of what the game should teach and how. When creating market based games though, the entertainment aspects of the game are considered more important than the educational aspects, since the game should entertain its users. Nevertheless, when designing educational market-based games, research on the specific topics is conducted and the results are combined with already acquired knowledge from previous projects. The educational approach of the team is that the game should first provide the specific knowledge to the user and then offer the user "missions" to test what the user has actually learned. In addition, for market based games, there is no clear targeting to a specific audience (e.g. students under 18) but the games are designed so that they can educate and entertain any type of user, with no prerequisite knowledge requirements. The pedagogical quality of the game (i.e. that the game indeed educates its users) is assessed with test groups. The users are asked questions before the use of a prototype of the game and then after the use to determine the effect the game had on their knowledge.

When considering requirements management, some forms of requirements elicitation and management are present but not formally defined. The word features is used to describe the requirements for the game, especially since they are typical software requirements but are mostly fluid features that change and evolve a lot during the production process. In client-based games, most of the requirements elicitation is performed on the client side (i.e. the client provides most -if not all- the features during the initial stages of the design process). The identified requirements/features set is then used during the next stages of the production process as guidance. Most of the times, not all features within the initial set are actually implemented in the game due to a lot of reasons, mostly time and budget constraints. So, a form of requirements/features prioritization takes place during production, through communication and negotiations with the client.

The company creates web-based games for Apple based products and recently they decided to move on the Windows platform. They chose these technology platforms initially since they feel that they provide most opportunities for game developers, since these markets are sufficiently big. The Android platform was considered, but since most of its users prefer free products the actual market is relatively small, it was not chosen as a starting point. Nevertheless, the team has plans for releasing their games also for the Android platform in the future. The general development process followed by the company can be seen in Figure 5 while figures for each individual phase can be found in Appendix B.

4.1.2 Interview Company 2

The company started in 2009 and has so far developed both client and self commissioned (or market-based) games. Currently, there are 2 principal designers (the interview was conducted with one of those principal designers or "technologist") and they often hire associates and experts on a per-project basis. The company mostly focuses on the conceptualization and design phases of a game (i.e. early stages) but they also offer research and development services.

The idea inception phase in the company is done in two main styles. Usually a client brings a game idea to the team (the most common case) or the team has a more general idea that they believe would work
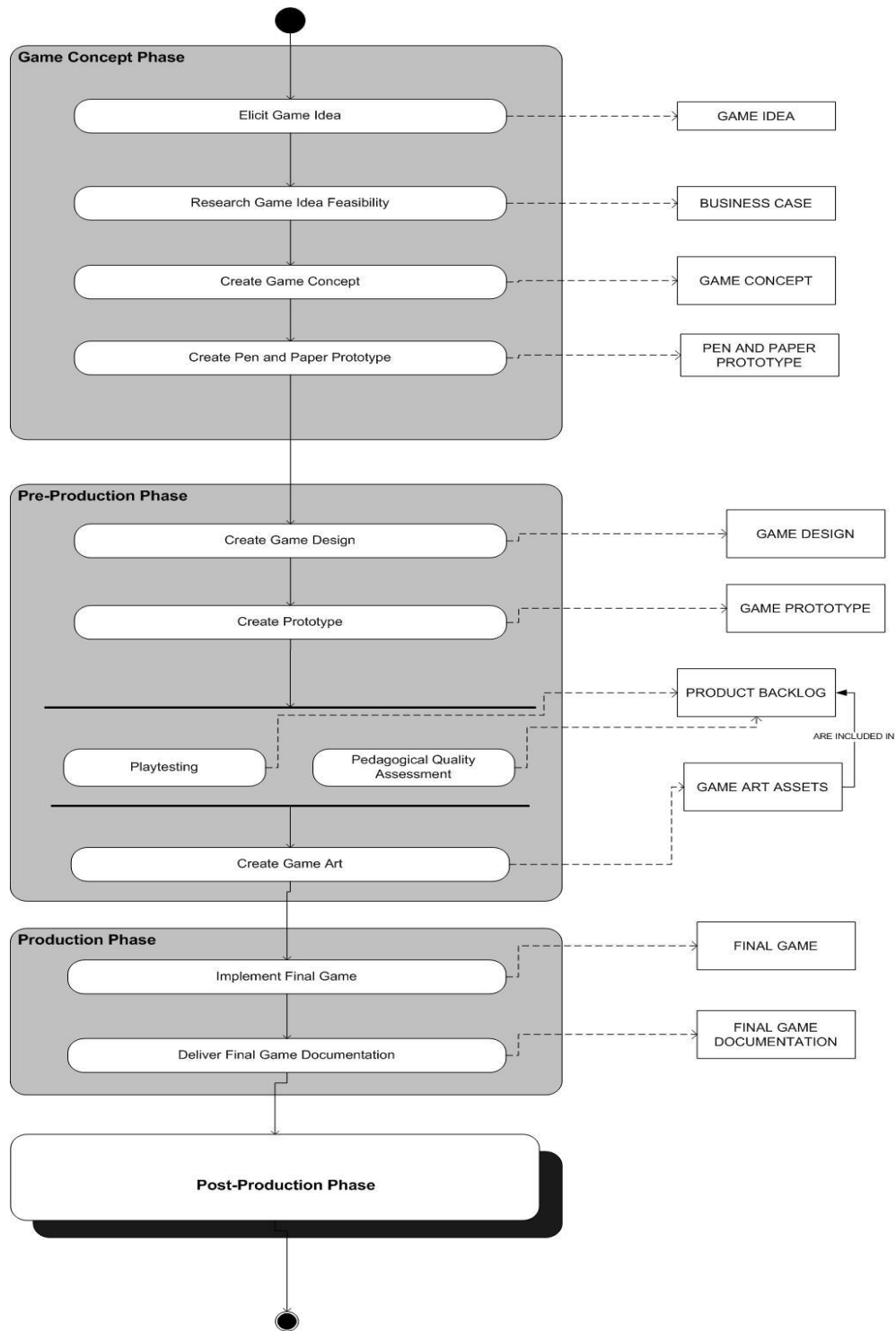
Figure 5: Company 1 General development process

well right now, especially based on the cultural and social landscape that exists on the Internet nowadays. After the initial proposal the team usually takes either a workshop or performs a case study with the client because they feel that being with the client on their site and understand the environment is really important for the design of the game. After the initial client details have been identified the team conducts research on the literature and does a round of internal brainstorming to come up with a dozen of game concepts to cover the whole game territory. This means that most of the game possibilities like physical or non physical games, multiplayer or solo, etc. are covered and presented in a unique concept. These concepts are all documented (i.e. the visual description of the game concept, the general direction the game concept is in, etc.) and then presented to the client to decide which of these concepts is what they actually want. The problem with that approach is that most clients expect to see all the game goals be satisfied by simply looking at a game, ignoring the fact that most of the educational capabilities of the game are emergent through playing the game. This "forces" the team to create game ideas that sell based on those client requirements and then see that the implementation does not fall far from the initial idea.

After the client approves the idea, the main game design phase follows. This phase begins with simple game concept prototyping with tools like playing cards, dice and poker chips. These initially simple prototypes are studied and consequently lead to more elaborate pen and paper prototypes which in turn are evaluated and used and ultimately leading to software prototypes. The main game design phase is conducted in the game studio with the occasional help of external experts like game designers, artists, etc. who are hired per project. When the first playable prototypes are created the Playtesting technique is employed, initially with the team members and then with the client and the actual target audience on the actual site the game will be deployed. Playtesting is a really good fit for a game design studio, since it allows the target audience and the design team to evaluate the game experience in a "tangible" style. Players can experience the game; see firsthand whether it is entertaining, aesthetically pleasing, comprehensible, etc.. This technique gathers direct feedback from the target audience and allows for a lot of early improvements on the game.

On the same time, the design team conducts research and studies the results of the Playtesting technique which also allows for the identification of other important design characteristics of the game like various architectural decisions, e.g. an app-style program. These tests lead to constant feedback on the game which in turn leads to various game prototype improvements. In addition, early requirements are constantly evaluated and updated during each of the iterations. The validation of the prototypes stage is done through the client requirements satisfaction. This means that from the initial requirements list the game should satisfy the essential (the "must have") requirements and also as many as possible from the "nice-to-have" requirements. Also, the specific project characteristics may impose limitations to the number of satisfiable requirements. In that case, there is a round of requirements prioritization between the client and the design team. In any case, the clients decide when the game is ready and is a good result. This form of iterative development is followed until the final game delivery. Usually this phase lasts anywhere from 2 to 4 weeks.

The next step in the process is the principal development stage. During that stage many development roles (e.g. front and back end engineers, graphic designers, game producers, game and interaction designers) can be covered by expert hires depending on the needs of the project. The process follows a similar iterative approach, as the team keeps developing the software prototype until it is accepted by the client. Then it is deployed and tested in its aimed environment by a set of target audience members and a team of

technical support and a "puppet master" who manage and ensure the player experience. This step leads to additional feedback and improvements on the game until it is complete, accepted by and delivered to the customer.

During the interview, it was mentioned that literature and previous case studies support that two of the factors that differentiate the game production process are 1) whether the game is market or client based and 2) the company size. So, for a young and small company it is not possible to have the same systems and processes in place as an older bigger company. Especially when the number of team members is sufficiently small enough, it is possible to keep the specifics of a project or the general production process in the minds of the team members, without having to document everything. This also contributes to the re-use capabilities present in a smaller game studio. In the Specific company case, this is not entirely true but the main principles also apply there. The team maintains a set of formal documentation from their previous cases accompanied of course by software already created in previous projects. These can be used in future projects, since this re-use capabilities allow for faster game concept design and development. A type of Game Design Document (GDD) is produced during the early stages of game design and it mostly includes the client requirements and general game characteristics in the form of a proposal. Most of the game concept essence is captured in the previously mentioned game concepts documentation.

Regarding the educational aspects of the game, the team does not feel they should be more important than the fun aspects of the game, since every game allows its players to learn through playing but the game should be interesting and entertaining enough. So the educational approach of the team is to embed the educational goals of the game in the Gameplay but not in a forced style. The game should offer its users a fun environment and the educational objectives will be covered through playing. The clients are providing the educational goals of the game and through the design process they can re-evaluate their goals and what the game provides. Specifically, after the creation of the pen and paper prototypes, when the clients can actually see the various game concepts, and especially after the creation of the first software prototypes they have the ability to see representations of the game idea and decide which one is better for what they want and need and in later stages evaluate if indeed their previous choices where what they actually wanted. The team's experience is that the clients tend to usually choose the most conservative options, which do not prove to be the most helpful. These are what most clients believe they need and they are usually very one-to-one (i.e. translate the problem domain to the game domain in a simple way) or simulations, since those allow the clients to cover their bases of what should be demonstrated by the game. This creates the problem that clients expect to see everything the game should teach appear on the screen by simply looking at it ignoring the fact that most of the gaming experience is emergent.

When considering requirements management, various forms of requirements elicitation and management are present. An initial crude requirements list is provided by the client, which is constantly updated during the early stages of the design process. After the game concept has been approved a clear list of requirements and their importance to the project (i.e. must have, could have, should have, won't have requirements, etc.) is created, which leads the next steps of the project. The Playtesting technique allows for target audience requirements elicitation in the form of feedback for the prototype at hand and the game in later development stages. It also allows for forms of prioritization, since the actual target

audience uses the game and identifies what is important or not. In cases where the project characteristics lead to requirements re-evaluation, a prioritization round takes place between the team and the client, where the client decides which requirements are more important for the project. The client has the biggest impact on the requirements of the game, since they provide the initial list and through the iterative design process the team follows they can give constant feedback and validation. A game won't be released if the client doesn't approve it and the client won't approve it unless their requirements are satisfied. This is also true for the educational requirements of the game, despite them not being formally defined and introduced in the design process. The client uses the game and determines whether the educational goals are satisfied or not, which indirectly can be characterized as educational requirements validation.

To summarize, the company represents a new approach to game design and development. They do not believe that a game can be designed in a restraining systematic way or be designed in a strictly objective based process. Players cannot simply be put in a game environment and follow instructions to fulfill the educational game goals. Playing is an experience, so game design should be freer than simply following the client instructions. The stakeholder goals for the game should be included in the design but this is achieved through the Playtesting format and not in a systematic way. A game should primary be entertaining and through that it should serve its educational goals. The team also firmly believes that most -if not all- stakeholders should be included in the design process as early as possible and all their requirements should be identified and recognized. Playtesting as a design technique is really important for this goal, since it allows stakeholders to be involved in the game design process in a practical manner. For all these reasons, the company team has created and follows their own game design approach, which on one hand allows them to create games following a reproducible process while allowing creativity and stakeholder opinions to emerge and influence positively the game development process. The general development process followed by the company can be seen in Figure 6 while figures for each individual phase can be found in Appendix B.

4.1.3 Interview Company 3

The interviewee of the third company works in the team as a game designer. Currently, there are 35-40 permanent employees at the company. So far they have been working on "playful interventions". They have three main divisions; one working on interactive installations, a department that focuses on educational software for kids and youngsters producing apps, websites and digital educational content and finally there is the serious games division, which focuses on producing serious games for adults. Their main target audiences include working professionals from healthcare, finance, logistics, etc.. Besides client based serious games they don't really produce pure entertainment games or market based games with some rare exceptions of some projects in those areas.

The idea inception phase in the company includes the client presenting a draft request for a product, mostly a question about a problem without too many details. Then a "question articulation" step follows, that includes an investigation whether the initial question the client presented the team corresponds with the actual problem the client faces. Usually the problem/solution is not really what the client had in mind initially, that makes this first step quite crucial. This research phase also includes literature reviews and/or expert interviews and is conducted before everything else, even before a proposal to the client is presented, so that the problem/solution domain will be clearly identified.
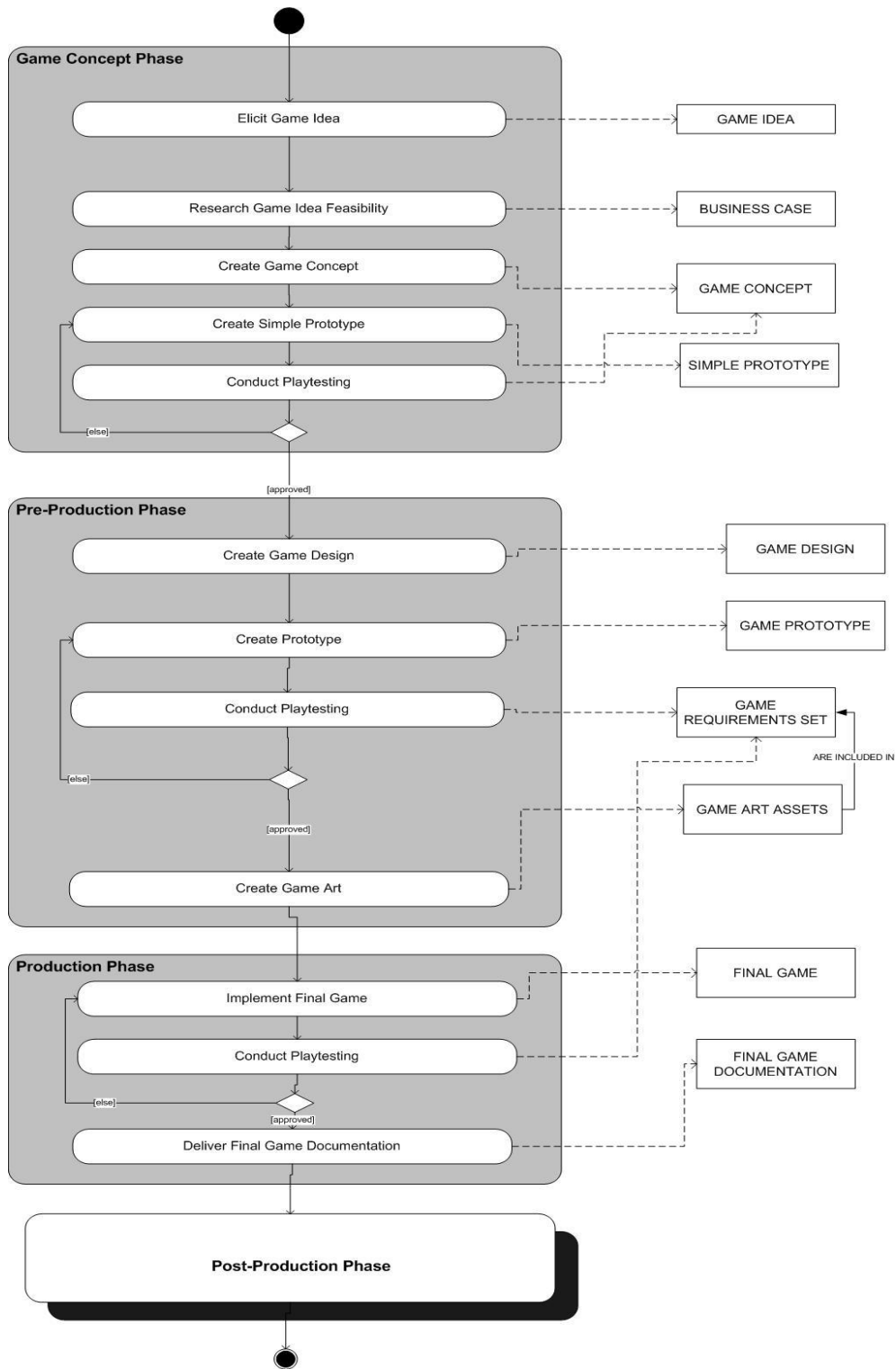
Figure 6: Company 2 general development process

The second phase is identifying the initial design requirements for the game. Design requirements is a crude list of draft features/project parameters that have to be taken under consideration like budget, deadlines, target audience characteristics (e.g. age, gender, preferences), client company wishes (e.g. a wish for a browser game, or an app, etc.). The development team formation can also influence some design choices at that point, so for example, if the team ready for the project has a lot of experience with a specific technology (e.g. html) naturally the first project proposal aims to utilize this experience instead of looking at other similar technologies (e.g. flash or unity VS html).

The next step is coming up with concepts and in order to do that they employ various techniques. One of them is to use the "strategists". They are members from the team who are assigned to learn as many things as they can about the client's area of expertise and have a broader perspective than simply the project or project portfolio. They look at complete market (e.g. healthcare, education, etc.) from a broader perspective and identify the position of the client company within it and within future developments. These "strategists" go to the client in order to identify the project stakeholders, investigate the problem within the client environment and they come up with what the concepts can look like. The "strategists" work with a small group (usually two people) from the client side and they create first draft game concepts and problem descriptions. These are used by the producing team to create a complete game concept (it is preferred to make one initially because the team feels that allowing many concepts be available so early confuse the client rather than allow for constructive feedback) while working really close with the client, since they know their target audience characteristics and the knowledge domain better. This also helps develop a form of trust which is really important because in later stages the client won't be able to understand everything the team does and they need to be able to trust them. This stage does not produce a document with strict details because it is too early in the production process and it is not desired to "lock" the team in certain choices that maybe won't be feasible later on.

What is created for approval at that early point are "user stories". These are a draft description of basic capabilities the game will have, but it is really important that these remain as high level as possible. For example, "I (the player) want be able to save my score" is an example of such a feature description, while "there is a button on the upper left screen where the player pushes and the score is saved in a list" is not. This form of describing features allows for greater adaptability later in the production process. The game concept phase is long because the team feels that the production should be pushed back as much as possible, so that most of the design choices are as well defined as possible. If this does not happen, then the production will face a lot of changes which are more expensive at that later point than at the beginning.

After the game concept phase a first playable pen-and-paper prototype is created in order for playtesting to begin. This first playable prototype is ready usually sometime between 2-3 days and two weeks from the beginning of the game concept phase. This first prototype is not anything complete, it usually includes some basic mechanics of the game but it is important for testing purposes but also because it is the first deliverable presented to the client and it is used to train them to the game approach and what the team is actually making. A lot of clients have a problem accepting the fact that the game will resemble a virtual world that the player can explore, make mistakes and learn from them without being protected/deterred from doing things that don't make sense. This phase allows for feedback and improvements on the first game concept by the client but also from the team.

The next step depends on the project characteristics. When the team was making a game about pensions and other financial packages it "required" a digital prototype quite early since it involved too much calculus. Generally, after a number of early iterations, a software prototype is produced and they keep working on improving it and adding the features needed. For visuals they create a number of alternatives for the client to choose from, because this approach allows the client to choose specifics they like from the various proposals. They keep working on the prototype in an AGILE/SCRUM type methodology always in close communication and negotiation with the client.

As mentioned earlier, when a first playable (game concept) is ready playtesting begins always with the client. At that point the team asks the client to form a group of "experts" from within the client organization, people the team can call when they have questions or need things cleared. After some early iterations on the first playable a more clear and well defined form of the game has been created and then target audience playtesting occurs. People from the target group form initially small teams (5-6 people) and are invited at the company to have an hourly session to play and test the game. The client is also invited to watch these sessions in order to provide and/or receive feedback through discussions with the game designer, which allows for further improvements on the game prototype. These sessions ideally take place after each production sprint as early in the design process as possible.

The game production process can be differentiated by a lot of things. One of them is the environment needs (i.e. whether they need an app or a desktop computer program), target audience characteristics, whether the game will be a simulation or a game (i.e. level of reality in the game that also depends on the target audience characteristics-prior knowledge -different for doctors different for high school students etc.). These properties should be decided early in the design process and this happens through extensive discussions with the client. This is another reason that makes the first pen and paper prototypes really important, because this format allows for those choices to be made in an easier way than the alternatives.

They don't re-use previously produced code pieces to their games. They try to make games from the start and set them up in a way to make sequels but straight re-use does not really work really. Instead of direct code re-use they apply re-use principles and architectures.

The team does not employ pedagogy specialists or other people with similar specific degrees. They prefer using experts in the teaching field and many members of the producing team have diplomas and years of experience to teach. They used to employ pedagogy experts but they discovered that e-learning specialists tend to be bound in a specific educational approach/philosophy and this creates friction between different schools. The team has their own vision and they try to explain it to the clients but this approach does not compete with specific pedagogy philosophies because it comes from producing educational games (game design angle) and not from any traditional pedagogical style.

Considering the balance between education and entertainment they feel that both should be at a 100% of what they can be within the project at hand. Clients tend to provide their educational parameters at the beginning during the design requirements elicitation phase. The learning activities present in the game depend on the project details (the audience and the way they want to implement the game). They prefer making games that work during the downtime of a person and not during their working or leisure time.

For example, a game that can be played for about 5-10 minutes per session allows for use while waiting the bus or during lunch with colleges. This results in not forcing the player to see the game as a mandatory activity to learn something, but as something they want to use when they have some downtime. In order for this to happen, the game needs to be game like and include social features so that it can be discussed with co-workers or family, etc.. In some cases, so if the game is aimed at being played at work, then it should not look like a game, it should look serious or else players don't like playing it in the workplace, where anyone can look at what they are doing and possibly draw the wrong conclusions.

The main idea behind the game design is "not the best game ever, but the best situation to learn. The aim is not to win game design prices but to make people bigger". In order for this to happen, gameplay plays an important role. The starting point for designing the gameplay is the design requirements list and the game concept. The team used to have brainstorming sessions but this didn't really work, because a good brainstorm session is really hard to organize. Instead they found out that one to one discussions allow much more diverse ideas and resulted in better results.

Considering RE they don't employ any formal RE techniques, despite many of them being present in the production process. They have started to work with embedded researchers and they get to be a little more formal considering requirements but usually it is pretty informal and constantly changing since clients tend to propose different things constantly. Besides the client and the team, requirements for the game also come from the target audience and expert groups. Actually, the expert group ends up provides a lot of the requirements because it consists of people as diverse as possible (not only doctors but also medical specialist and education specialists) but the team also asks the target audience for what they think. When it comes to prioritization, the features/wishes/requirements are divided in two lists. The team starts by identifying what they feel is important on one side and what the client feels is important on the other side but usually these two lists are huge and not really complementary besides a small number of things. But this small common set is what is important about the game so the production starts by building these requirements first. Then this small set is being expanded by items from both the client and team lists. This last step does not aim at adding as many requirements as possible to the final product but adding features in a way that makes the game complete and not just add a feature for the sake of simply adding it. The prioritization of what goes in the game or not is done with the client and usually the client focuses on the details/features and the team focuses on the system.

Choice for platforms always follows the initial game concept. This is important because this choice influences various properties and it is best that it is taken early in the design process. The team does not create the typical GDD because they find it very hard to keep it current. If they create it, it happens mostly for the client's approval, but this approach is risky, as mentioned earlier. They do make a lot of documentation about what they do (e.g. excel) but mostly they talk to each other in order to know what is being done and who is doing it. The general development process followed by the company can be seen in Figure 7 while figures for each individual phase can be found in Appendix B.

4.1.4 Interview Company 4

The fourth interview was conducted with the CEO of the company and active game producer. The company is a game development studio which focuses on Serious Games (SG). They have been building games for the last 11 years and currently they have 14 employees. The team produces both client and market based games, by having a client coming to them with an idea or through collaboration projects
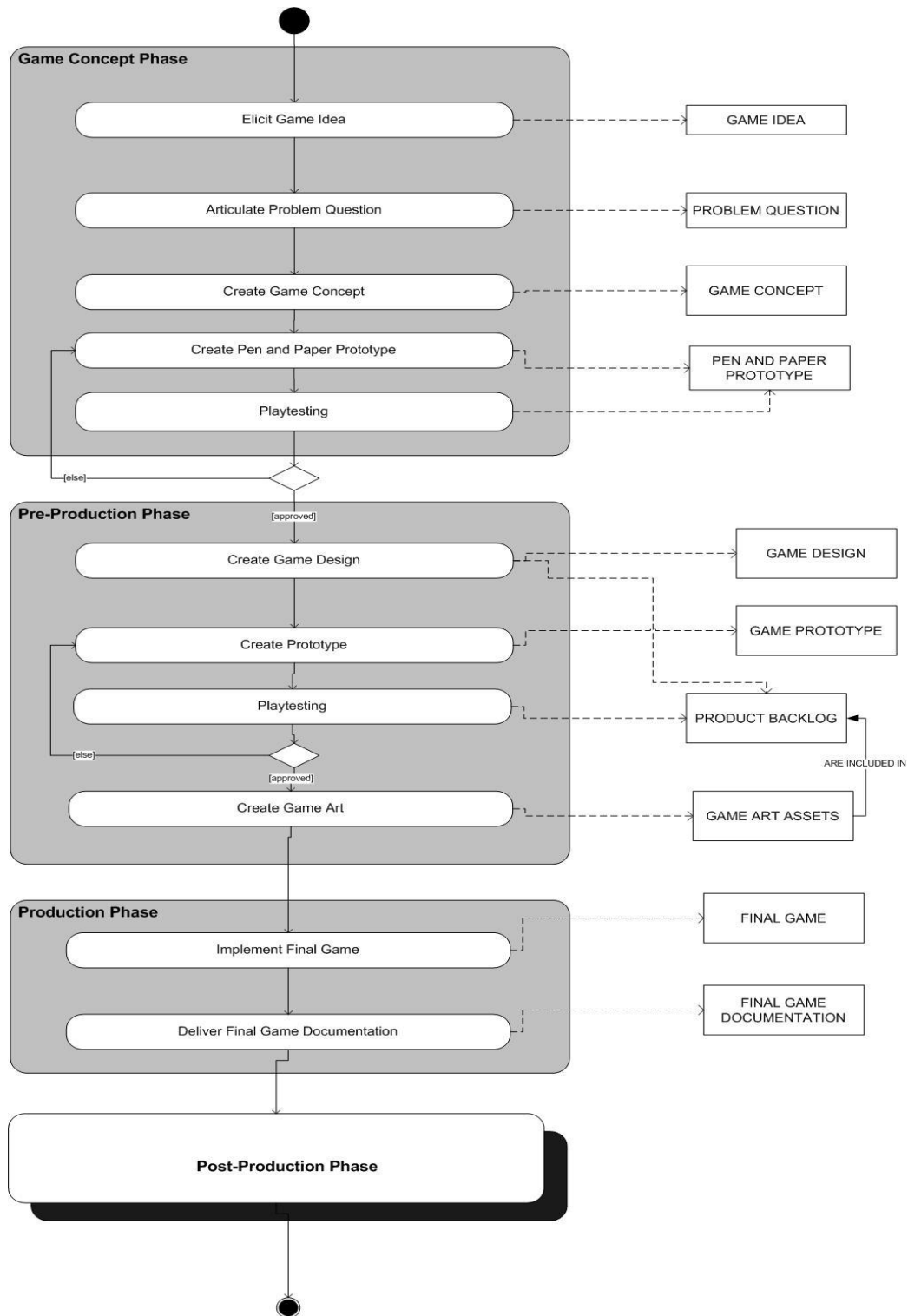
Figure 7: Company 3 general development process

with other companies or by investing in themselves (in cash or in "kind") and they get a share of the ownership of the product and then try to promote it to the market. Sometimes, they start projects as client projects but these can evolve in market targeted games, since the team feels that if a game is fun enough to play, then it can outgrow its initial target group and be targeted to a bigger market audience. They used to make pure entertainment games but they don't anymore since they decided to focus on serious games.

After the game idea has been identified (either by having a client propose one or by themselves identifying it) they conduct a business case for the idea. This whole phase revolves around the question: "How do you get as many people to use the game?" During this phase they start considering attributes that influence heavily the game and the team looks at target audience characteristics (age, previous knowledge, financial capabilities, etc.), budget constraints, target environment and market promotion (e.g. different for serious games aiming at surgeons and different for serious games aiming at a general market of uneducated users) and these things should be taken into account from the get go. For this reason they start by performing the business case at the beginning and research the game feasibility. In case they are not satisfied with the results of the study they inform the client that they won't be investing in the game. The client can either drop the project or keep the team working on as work for hire while taking full responsibility for doing his/her own business case studies. The division between work for hire projects and projects where the team participate in the subsidy (invest in kind, so take some cash for their time upfront but invest most in the game which gives them part ownership of the final product) is now close to 50-50.

Almost at the same time they conduct the business case they also work on the game concepts since the basic set of features the game will support will heavily influence the business case. The team tries to create and present the client a very small number of game concepts, usually one or two. This happens because the more game concepts are presented to the client the more confusing it usually is. This happens because they want to have the total control about the game side, because this is where the team's expertise lies while the client's expertise lies in the serious side (i.e. specific domain knowledge for the game). After these have been identified they move to the functional requirements elicitation phase on the serious side and then they move to the game side functional requirements. There are not any real differences between client and market based games during those stages, so for both types of serious games roughly the same process is followed.

Eliciting the functional requirements for the serious side is pretty important since without them the team is not able to design gameplay elements around this set of wishes. The elicitation process includes brainstorming, client interviews, stakeholder interviews, end users interviews, literature research and by tracking the game origins. This means that they will visit the client/target environment for the game and study what takes place there, how these activities can be included in the game, interview clients, etc.. For example a game origin might be physical rehabilitation, so they have to visit physical therapists in their natural environment, try to see what the doctors do and try to understand what the specific physical exercises include and what the goals for each exercise are and finally interview patients to understand their side.

After they have elicited the initial list of functional requirements for the serious side, they move onto the game side functional requirements, things like gameplay elements that would fit the functional requirements set by the stakeholders (client and end-users). These requirements are then used for the

creation of small playable software prototypes in cooperation with the client. This happens in an AGILE/SCRUM type methodology in two week sprints. After the conclusion of every sprint, they send the new version of the prototype to the client for playtesting and for them to provide feedback which is in turn analyzed and included in the next sprint(s) to the prototype. Usually the clients provide more useful feedback on the educational side while the team focuses on the entertainment and game parts.

After a number of iterations and work on the small prototypes the team (in close collaboration with the client) decide what is important and should be included in the final game and after these elements have been identified the game production phase starts, following again an AGILE/SCRUM type methodology in two week iterations. This phase is quite lengthy and includes a high number of iterations despite the previous work in the prototype phase. This happens mostly because the clients keep changing their wishes and the team has to be able to follow on that. The exact order and time per stage depend on the project at hand and its specific characteristics. Often the decision to move from the prototype phase to the final implementation phase is heavily influenced by project characteristics like budget and scheduling. The deliverable of each production sprint is in turn forwarded to the client and to some end-user groups for further playtesting and for the stakeholders to provide their feedback. For every stakeholder group they have identified one or two representative persons who are invited to discuss and analyze the feedback with the producing team in order to prioritize what the specific stakeholder group considers more important. Everybody has their say and the team argues what is feasible and what is not, how each decision impacts the gameplay, the graphics, etc.. After these sessions with the stakeholder representatives feedback from the end of the previous sprint has been put in order and the instruction for the next sprint have been identified. The team uses the prototypes for the documentation rather than doing it in an explicit style. Every project has a lead designer and that person is responsible for gathering all the information and for the documentation. They use a Game Design Document (GDD) but they find it quite difficult to keep it up to date.

The team does not employ pedagogical experts or follow explicitly any specific pedagogical approach and they mostly rely on their experience and the people from the stakeholder groups since they are experts in their fields when the producing team members are not. For that reason they ask for an expert from every stakeholder group to assist the team in designing the game. The team has a lot of experience in communicating all the ideas to the player and embedding them in the gameplay. For the producing team both entertainment and educational aspects of the serious game are equally important for the game to succeed. Another interesting fact raised during the interview was that the differences between pure entertainment games and serious games lie mostly on the educational part. Both types of games should be entertaining because if they are not then no one would use them resulting in bad products. This makes the entertainment part of the game quite important, so the work needed to achieve a high level of "fun" is similar in both types of games. The big differences lie in communicating with the expert stakeholders to get their knowledge and translate that into an interesting gameplay, which of course lies to the serious side of the game.

The educational activities present in the game are designed as parts of the gameplay and always depend on the game origin, as already mentioned. These origins should be coupled with the team's game design

method and they try to design a game environment with factors that are disconnected from the initial client environment, so that the game can be used virtually anywhere. They do that by designing a fantasy world within which the game characters, learning activities, rest of the gameplay are all embedded harmonically. This whole process is quite creative and based heavily on the producing team's experience and therefore is not able to be really systematized.

In order to assess the pedagogical quality of the game (i.e. that the game actually educates its users) they try to assign someone, usually a PhD student relevant to the serious game scientific field. This person is responsible for testing the game and validating that the game is scientifically sound. This assessment stage depends on the project budget, because not all game projects allow for scientific assessment budget allocation. The team does not use storyboards so much but during the game concept phase they use concept art, mockup videos, prototypes and animations to give an impression of what the game might become. The game art comes from individual artists employed by the company and everyone is responsible and dedicated for their own field. The gameplay is the responsibility of the game designer and usually it involves the combination of all the different aspects of the game (the story from the story designers, the art from the art team etc.). The biggest problems when trying to combine all the aspects for the game come from combining the educational parts with the entertainment. The difficulty comes from understanding the specific project domain knowledge (e.g. a clinical expert knows exactly what should be going on but it is really hard to explain to the game designer how everything works in order to include the exercises or domain knowledge in the game correctly). This process is quite time consuming since it has to be made right and all stakeholders have to understand what is going on.

The team does not employ explicitly any formal requirements engineering techniques but most of them are present informally within the production process. They keep a list of the functional requirements elicited from the stakeholders and the game producer maintains a master list of all the requirements and keeps it up to date. These lists allow for better prioritization especially since no formal prioritization techniques are present during production.

The game platforms are decided during the business case and this choice is influenced by many different factors like the environment the game will be played, client requirements, the target group etc.. During the business case analysis all the factors are weighted and the team chooses the most suited platforms for the projects at hand. The general development process followed by the company can be seen in Figure 8 while figures for each individual phase can be found in Appendix B.

4.2 Reference Method

All interviews were analyzed and modeled using the PDDs technique. This resulted into diagrams and accompanying tables that included the modeled method steps, their deliverables and explanations of the activities and deliverables (or concepts) of each of these methods. These figures and tables can be found in Appendix B.

After the methods were analyzed they were combined into one super-method. This method includes all the activities and concepts from all the analyzed methods. It consists of 204 activities and 148 concepts which were in turn included into comparison tables. These tables resulted in the "best" method fragments (i.e., activities and concepts) from all methods which in turn were used for the creation of the Serious
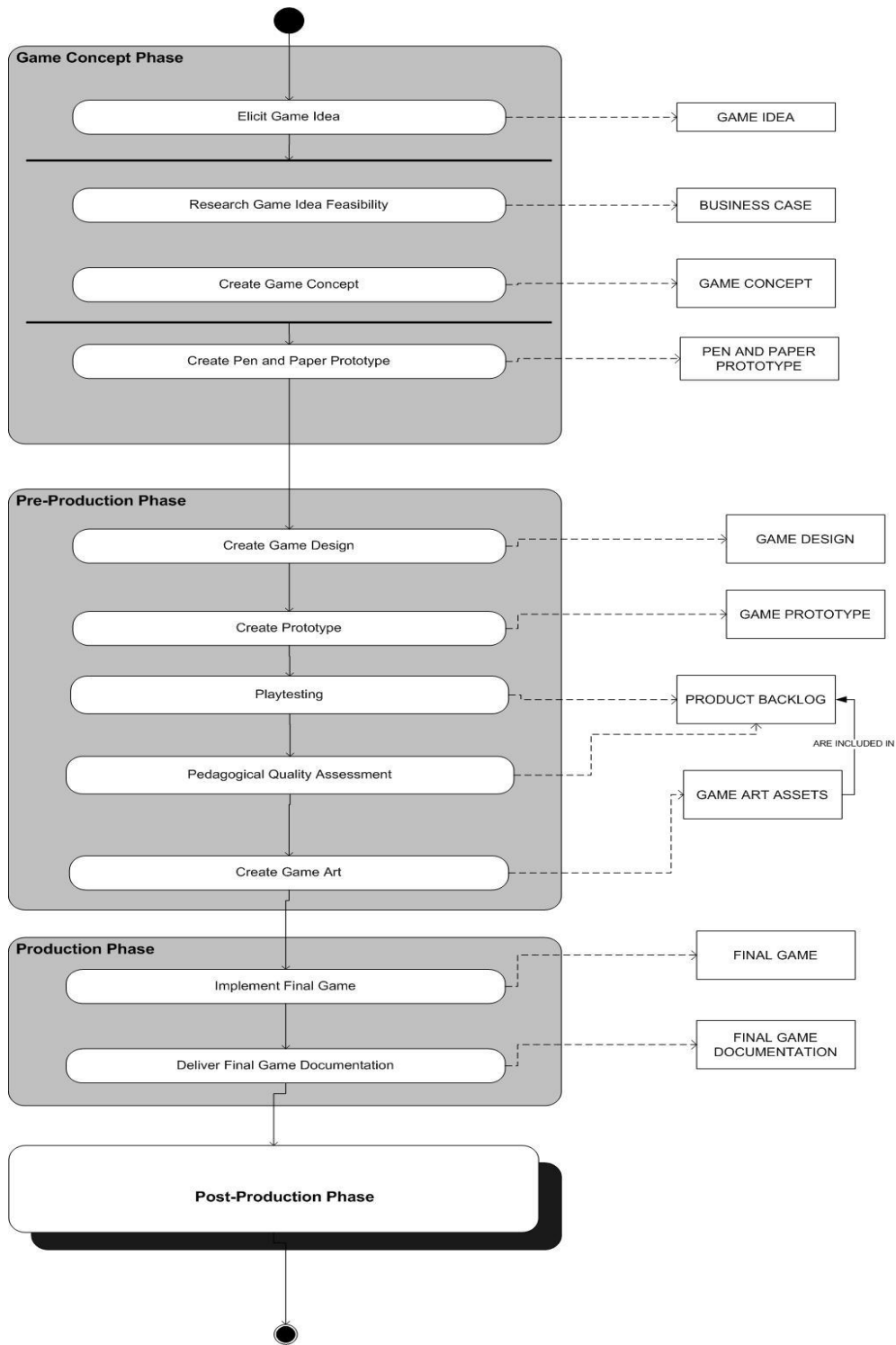
Figure 8: Company 4 general development process

Game Reference Method from the Industry. The comparison tables and the reference method can be found in Appendix B.

An overview of the Serious Game Reference Method from the Industry can be seen in Figure 9. The method consists of 4 distinct phases out of which the last phase is considered out of scope for the purposes of this thesis research project (Post-Production Phase). In total, 12 main activities, 58 sub-activities and 40 concepts are included in the final method. There are four main phases, specifically Game Concept phase, Pre-Production Phase, Production Phase and Post-Production phase (which as was already mentioned is considered to be out of the scope of the thesis project). Besides the general process which can be seen in Figure 9, elaboration figures on each of the first 3 phases are included in Appendix B.

The Game Concept phase begins with the game elicitation idea, either from a client or from a member of the production team. This idea is then analyzed by the production team and an initial game proposal is created. Depending on whether the game is client or market based, some different steps are introduced in the production process. For market based a games a Business Case feasibility study is conducted to determine whether the game idea should be turned into a complete product. The project parameters are researched and the complete business case is evaluated. If the idea is deemed non-profitable this leads to the project cancellation.

For client-based games, a case study is conducted at the client environment so that the initial details of the project can be identified. This step is important, so that the team can get a good idea of what the client needs and compare it with the client proposal, or what the client "thinks" he needs. The project parameters are researched and a round of internal brainstorming takes place for the formulation of a game proposal for the client. If this proposal is approved by the client the next phase begins.

During the next phase, the game concept is created. A round of brainstorming, client interviews (for client based games), literature research and target audience characteristics research take place for the identification of the basic Game concept requirements. These are used for the creation of a small number of draft game concepts (one or two- this is important because if there are a lot of draft game concepts the client gets confused). These draft game concepts are evaluated with the client and this step leads to the creation of the final game concept for the game.

After the game concept has been created, the functional requirements elicitation phase for the game side takes place. There are not any real differences between client and market based games during those stages, so for both types of serious games roughly the same process is followed. Eliciting the functional requirements for the serious side includes team brainstorming, client interviews, stakeholder interviews, end users interviews, literature research and tracking the game origins.

After the game concept and functional requirements elicitation steps a first playable simple prototype is created in order for playtesting to begin. This step was present in all interviews and for the creation of this prototype SCRUM is followed. This first prototype is not anything complete, it usually includes some basic mechanics of the game but it is important for testing purposes but also because it is the first deliverable presented to the client and it is used to train them to the game approach and what the team is actually making. This phase allows for feedback and improvements on the first game concept by the client but also from the team.
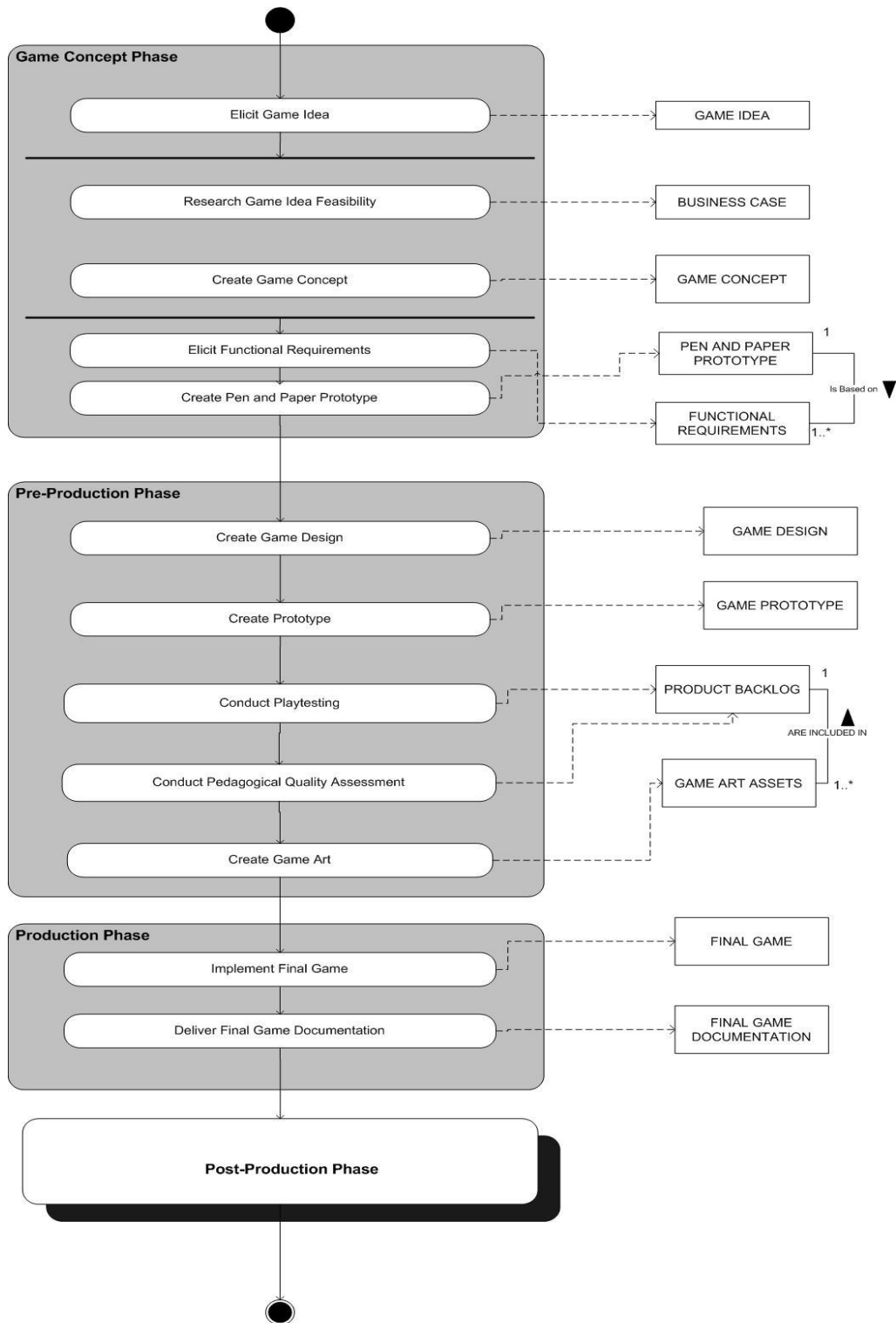
Figure 9: Serious Game Reference Production Method General Process- Industry

Playtesting is quite important for the design of serious games, as through this process, updates and quality feedback for the prototype can be elicited. A set of Playtesting groups is identified so that no overlaps occur between the testing groups. A round of internal playtesting by the team members, a user group playtesting and a client playtesting sessions take place at the same time, which lead to updates and improvements to the game prototype.

Pre-Production phase follows in the production process. During this step, the main game elements are created, specifically the game play, the game elements, the game storyline, draft visualizations and the combination of the educational and entertainment aspects of the game. These are documented in the Game Design document, which is validated with the client. After the successful validation of the Game Design, extensive prototyping takes place following the SCRUM principles again, so that a complete playable prototype is created based on the Game Design Document.

After a complete prototype has been created, extensive Playtesting takes place following similar groups as the ones identified in the Game Concept phase for the evaluation of the complete prototype. This phase leads to improvements to both entertaining and educational aspects of the game and takes place until the prototype is deemed ready by the client and the production team.

Pedagogical Quality for the game is finally assessed during these stages of the production process. A person, usually a PhD student relevant to the serious game scientific field, is assigned the task of evaluating the game. This person is responsible for testing the game and validating that it is scientifically sound. This pedagogical quality assessment phase aims at validating that the game is indeed educational and that this aspect is neither overshadowing the entertainment aspect of the game or be overshadowed by it. A round of playtesting takes place along with a literature review and scientific evaluation of the pedagogical aspects of the game and these steps result in a complete pedagogical evaluation of the game and proposed changes and updates. After this phase, the game art is created and included into the game backlog.

Finally, the final game implementation is created again based on SCRUM principles. The final game is also evaluated through a round of playtesting which leads to the final updated and improvements. After the final game version has been approved, it is delivered to the client along with the final game documentation.

Chapter 5 Assembling a unified serious game production process model

During the previous stages of the thesis project a literature serious game reference production method and an industry serious game reference production method were constructed from the results of an extensive literature review on serious games production processes and a set of expert interviews with members of the Dutch and German serious games industries.

The combination of the resulting models from the literature review and expert interviews was one of the goals of this research project. In the previous paragraphs, both models were presented and analyzed. For the creation of the final model, a similar approach for method comparison and assembly, based on Hong et al. (1993) was followed. All figures and tables from this process can be found in Appendix C.

Based on the results from the comparison of all methods the most appropriate (or "best") method fragments were selected. In the current case some specific choices were made during this step due to the nature of the compared methods. Both the industry and the literature methods are describing essentially the same process but their main differences were approach-based. In the literature model, the "waterfall" or sequential development approach was followed, with every activity following the previous until the game is delivered. Due to the popularity growth of AGILE/SCRUM development methodologies however, the more recent industry model follows a different, iterative approach. Since this is the case, it was decided to follow mostly the more current industry model and enrich it with activities from the older literature model. This resulted in a method following an AGILE/SCRUM type methodology, with many iterations present. However, in the literature method, the pedagogical and educational quality and aspects of the serious game were much more emphasized, so most of the relevant educational/pedagogical method fragments come from the literature method. All the selected method fragments were combined into a complete reference method for serious game production.

A graphical representation of the method assembly process, as depicted in Brinkkemper, (1996), can be seen in Figure 10 and an overview of the final SG production method can be seen in Figure 11. The final method consists of four main phases:

Game-Concept phase: The initial game idea is elicited and translated into a set of game concepts out of which a first simple playable pen-and-paper prototype is created.

Pre-production phase: During which the game design is created based on the results of Playtesting with the simple pen-and-paper prototype. The game design is consequently implemented into the game prototype.

The game prototype is produced following an AGILE/SCRUM type methodology, with small increments creation and update during iterative production sprints (as can be noted in the figure by the feedback loops during production sub-steps) until it is deemed ready. Every production sprint ends up with a

playable prototype which is then used for Playtesting. During Playtesting, members from all important stakeholder groups test the prototype and provide their feedback which results in constant game updates and refinements.
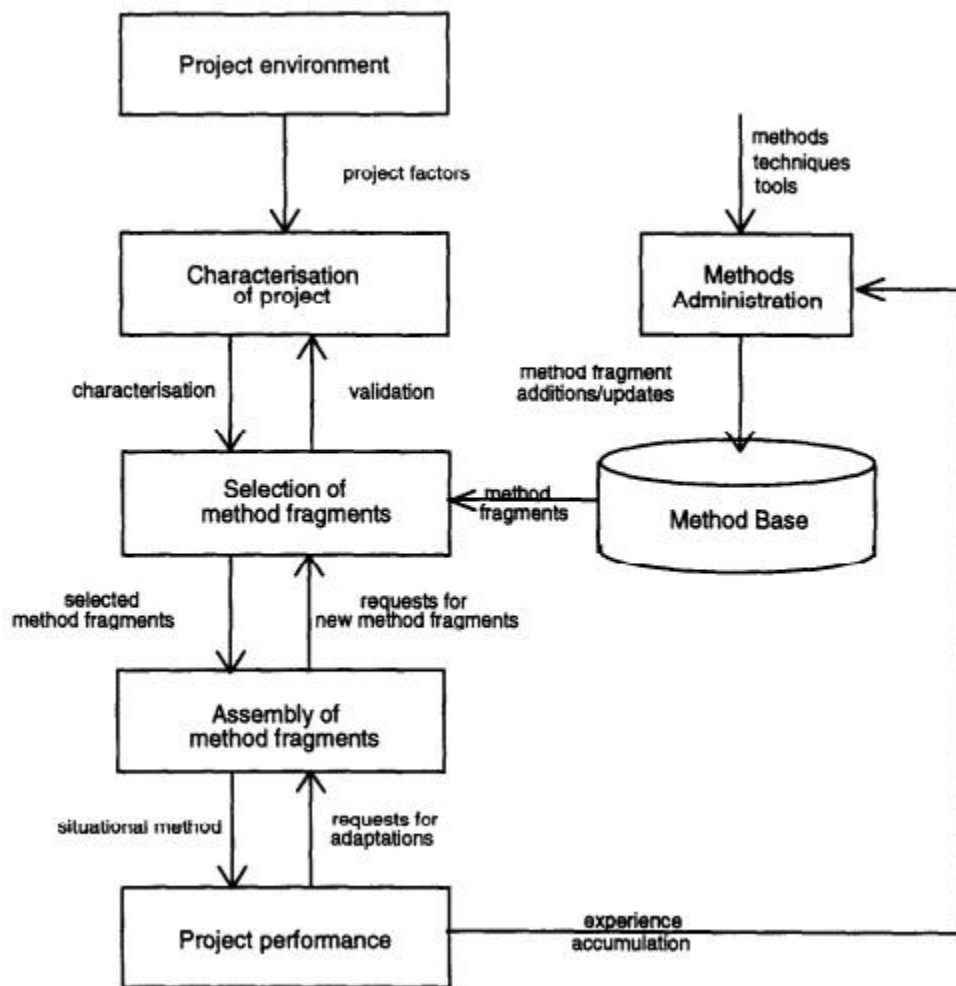
Figure 10: Method Assembly (Brinkkemper, 1996)

Production phase: When the prototype is deemed ready then the production phase for the game starts. During that phase the final game is created following again the AGILE/SCRUM type methodology with constant iterations and updates.

Post-production phase: After the final version of the game has been created and delivered, the post-production phase starts, with the production team providing support for the game. During that phase the game is released to the market with marketing activities and also limited support. Due to the nature of the thesis and its focus on the intersection between serious game production processes and requirements

engineering, the post-production phase, characterized mostly by marketing activities, is characterized as out of scope, and it won't be elaborated.

During the next paragraphs, the first three phases will be elaborated as to give an overview of the whole method. In addition, the results of the investigation on whether RE best practices can be applied within the production process are presented at the second half of the chapter.

5.1 Final Method Phases

5.1.1 Concept phase

The Game-Concept phase can be seen in Figure 12. During this phase, the initial game idea is elicited either through a client or through the production team. When a client brings the idea, then after an initial case study at the client environment, research on the project parameters and brainstorming rounds a game proposal is created and presented to the client, who in turn either accepts or rejects the game project. When it is an internal idea, the team conducts a business case and researches the project parameters in order to evaluate the business case and decide whether the game will be created or cancelled.

After the game proposal has been approved, the team begins eliciting the game concept requirements, through brainstorming, client interviews and literature and target audience research. In addition, the game synopsis, the global project plan, the knowledge model for the game and a first draft set of visualizations are created and combined into a set of draft game concepts for the client. After an evaluation round with the client the final game concept is created.

The next step in the process is eliciting the functional requirements for the game. This is done through brainstorming sessions, expert interviews with the client and the most important stakeholder groups, further literature and target audience research and finally by tracking the serious game origins. The last step means that members from the production team will visit the client/target environment for the game and study what takes place there, how these activities can be included in the game, interview clients, etc.. This step allows the producing team to get a complete understanding of the game idea roots and the client and targeted environment.

With the completion of the functional requirements list, the simple prototype is created. This is done following an AGILE/SCRUM – type methodology. The prototype backlog is created based on the functional requirements list, brainstorming sessions within the team, client interviews and further literature research (if needed). From this, the sprint backlog is created, as a sub-set of the prototype backlog. Before starting the various production sprints, the team designs the prototype Gameplay and storyline. Then, the sprints take place until the game prototype is approved. Per every sprint, the prototype Gameplay and storyline are also reviewed and updated.
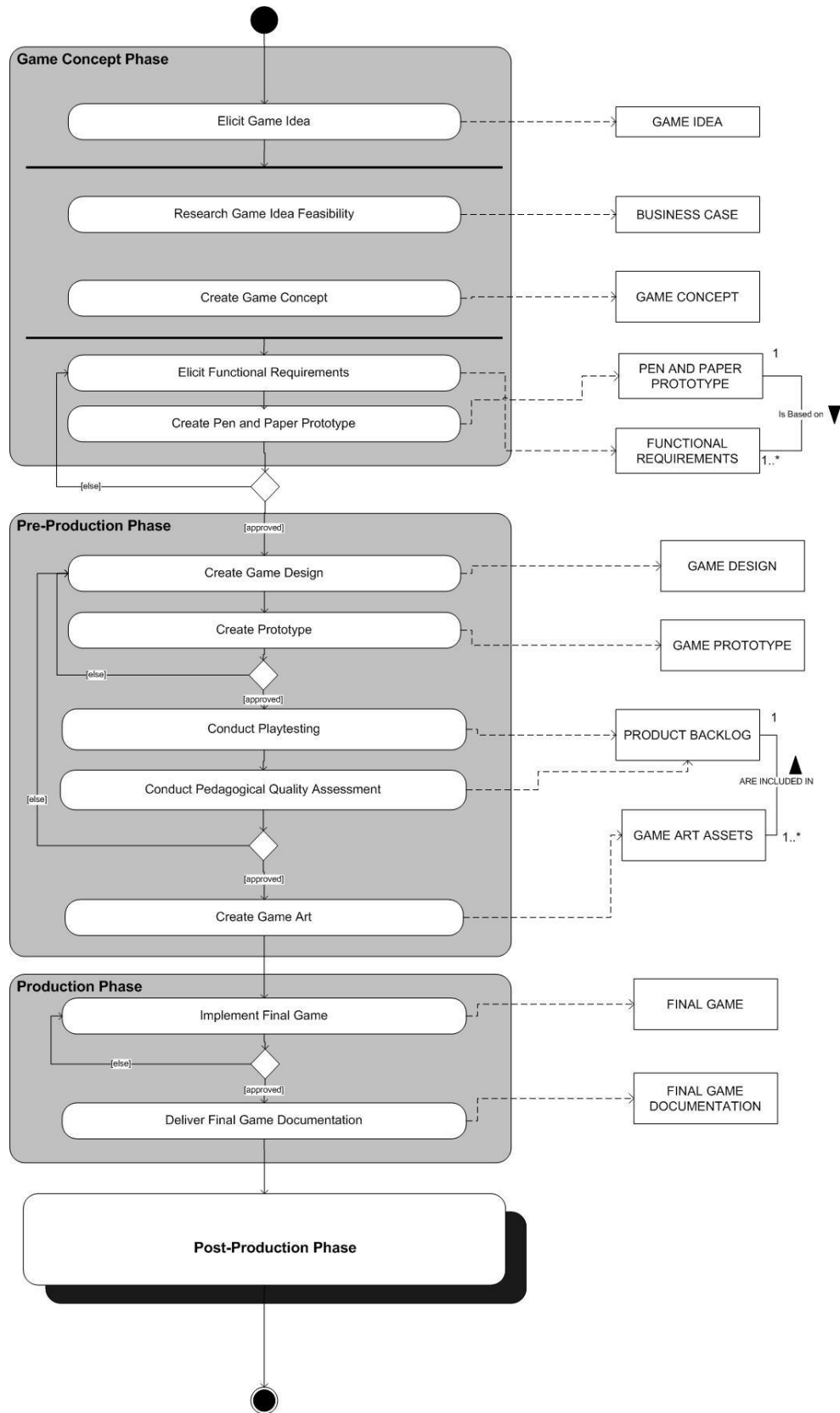
Figure 11: Combined Method for Serious Games Production

After the prototype has been approved, the Playtesting phase follows. First, the Playtesting groups from all important stakeholder groups have to be identified. Playtesting by the team members, user groups and the client follow and result in various updates for the game prototype.

The final step in the Game Concept phase is the pedagogical quality control phase. An educational expert evaluates the educational nature of the game with the client and the team and the feedback from this phase is also included in the game prototype design.

This first phase of the combined method is quite interesting, since it demonstrates the nature of the research project and the combined results. The method consists mostly of steps from the industry method, since they represent the current state of practice in the industry. Especially since the literature does not elaborate enough on these early steps in the production method, the inclusion of the industry perspective and practices provides a good understanding of what is actually happening in the real world. AGILE practices appear to be the standard in the gaming industry and this can be seen throughout the combined final method. Especially in the Game Concept stage, the first draft game concepts and simple game prototype are created base on a SCRUM-type approach, which guarantees functional and faster results and customization capabilities.

However, the state-of-the-practice method lacks the theoretical educational approach required by the "double" nature of serious games. For this reason, several theoretical steps from the literature have been included in the final method. A literature review stage in most research steps within the project and more importantly, the knowledge model creation and the pedagogical quality control activities are added to provide the theoretical cover required in Serious Games, to ensure both the fun and educational aspects of the game.

In addition Playtesting is added and elaborated from the very early stages of game design and development, as it was discovered during the literature and -mostly- the industry research phases that it is a very effective technique for the evaluation of a functional game increment and the discovery of further requirements from the most important stakeholder groups.

Finally, the separation between Market and Client based games, allows for more effective game design based on the specific situation at hand. Market based games require a very different approach, as many information usually provided by the client side (e.g. the educational aspects of the game) need to be elicited by the production team itself. In addition, the success of the game influences directly the production company, as market based games have to be successful enough to compensate for their production costs.
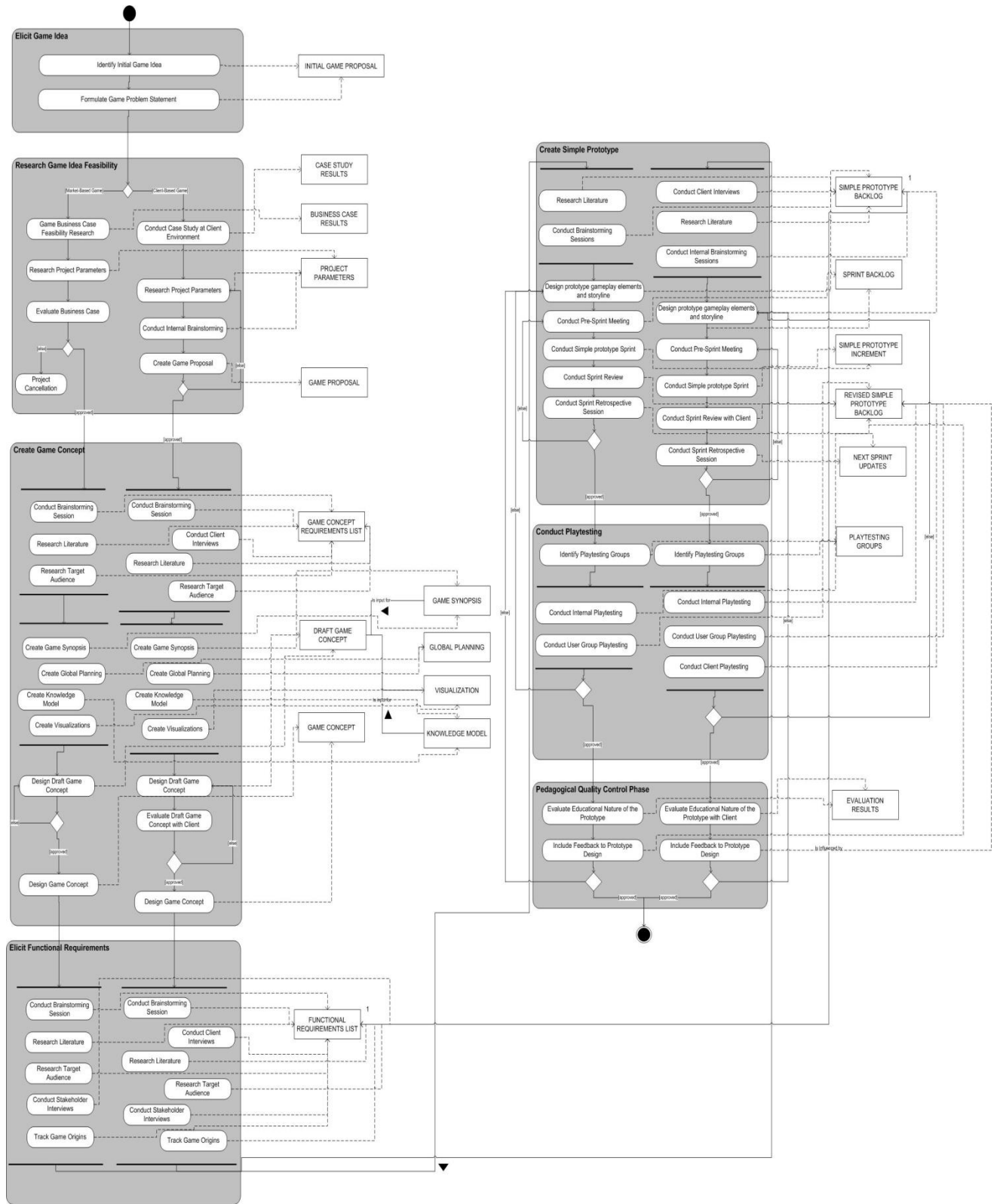
Figure 12: Combined Method Game Concept phase

5.1.2 Pre-production phase

The pre-production phase starts with the creation of the game design. The extensive Gameplay and storyline for the game are identified; the educational mechanics of the game, the educational game-missions and the serious game components and behaviors are designed first and evaluated with the client. After their approval, a visualization prototype is created for the game and all the results of the previous steps are included into the game design, which is validated with the client.

After the game design is approved, the prototyping process begins. A complete playable prototype is incrementally created until it reaches the acceptable level of quality. AGILE/SCRUM – type methodology is followed again, with regular sprints taking place until the prototype is deemed ready. Then it is used for Playtesting and a complete pedagogical quality assessment. Feedback from both Playtesting with the client, within the team and with important stakeholder groups is included in the game prototype along with the educational assessment feedback provided by the pedagogical assessment expert. After both phases have been conducted and the game prototype approved, the game art is created by design experts and evaluated by the client. After it has been approved, it is included in the final product backlog for implementation.

The pre-production phase is heavily based on the industry method, since theoretical method fragments from the literature were included in the game concept stage of the final method. This was done because the pre-production approach in the industry is quite straightforward and prototype based, which means that the practitioners design and build the games heavily based on the results from the game concept stage.

The pre-production phase can be seen in Figure 13.

5.1.3 Production phase

The production phase follows a similar AGILE/SCRUM –type methodology for the creation of the final game. A final round of Playtesting takes place which results in the final updates for the game. After the final version has been created, the game is released along with the relevant documentation.

Again the production phase is mostly influenced by the industry, since during this step the actual production of the game takes place and very few-if any- research activities take place. The production phase of the combined method represents the AGILE/SCRUM type approach followed by the industry and provides an update to the current literature and useful references for future researchers aiming to identify recent serious game production practices.

The production phase can be seen in Figure 14.
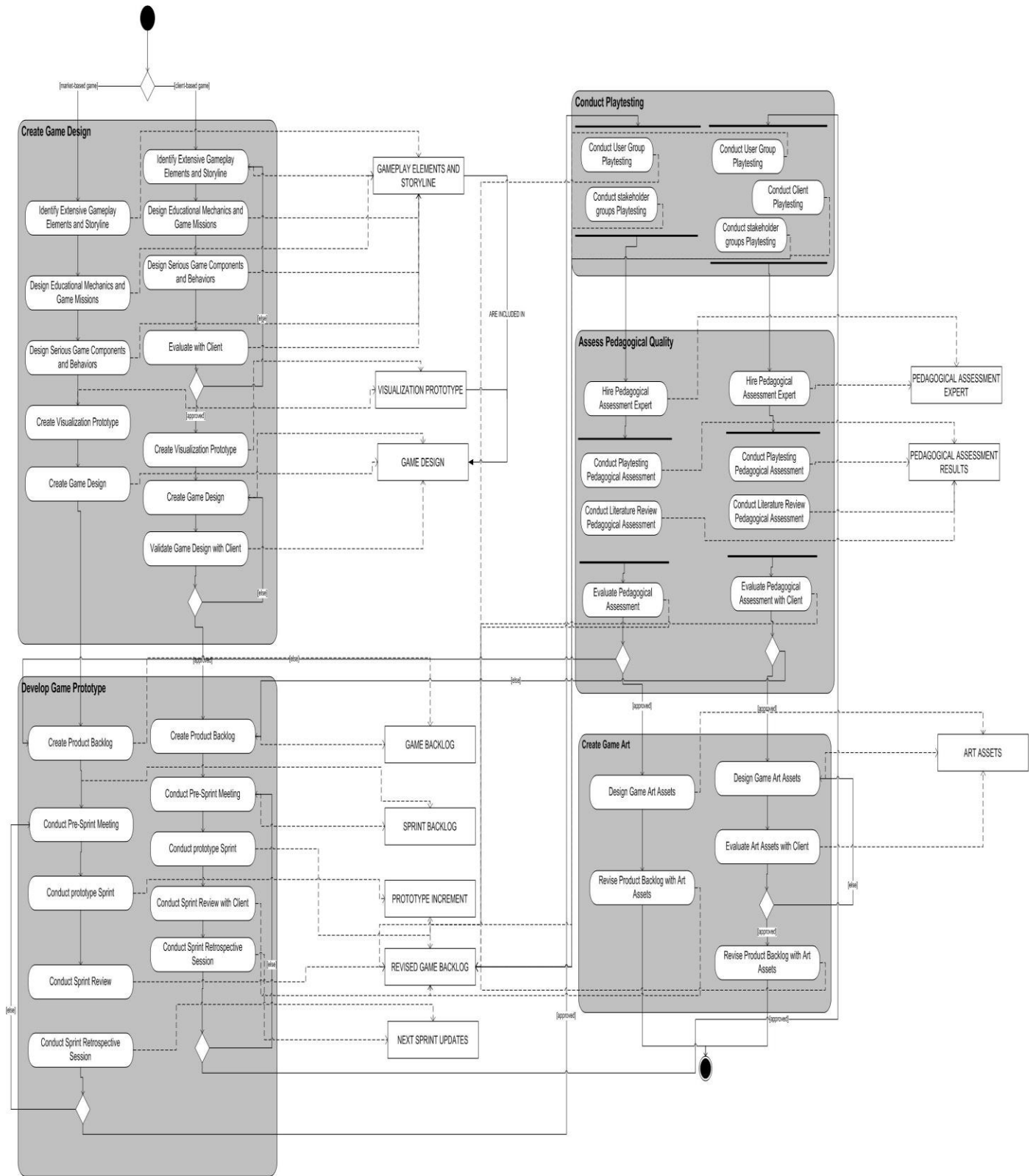
Figure 13: Combined method pre-production phase
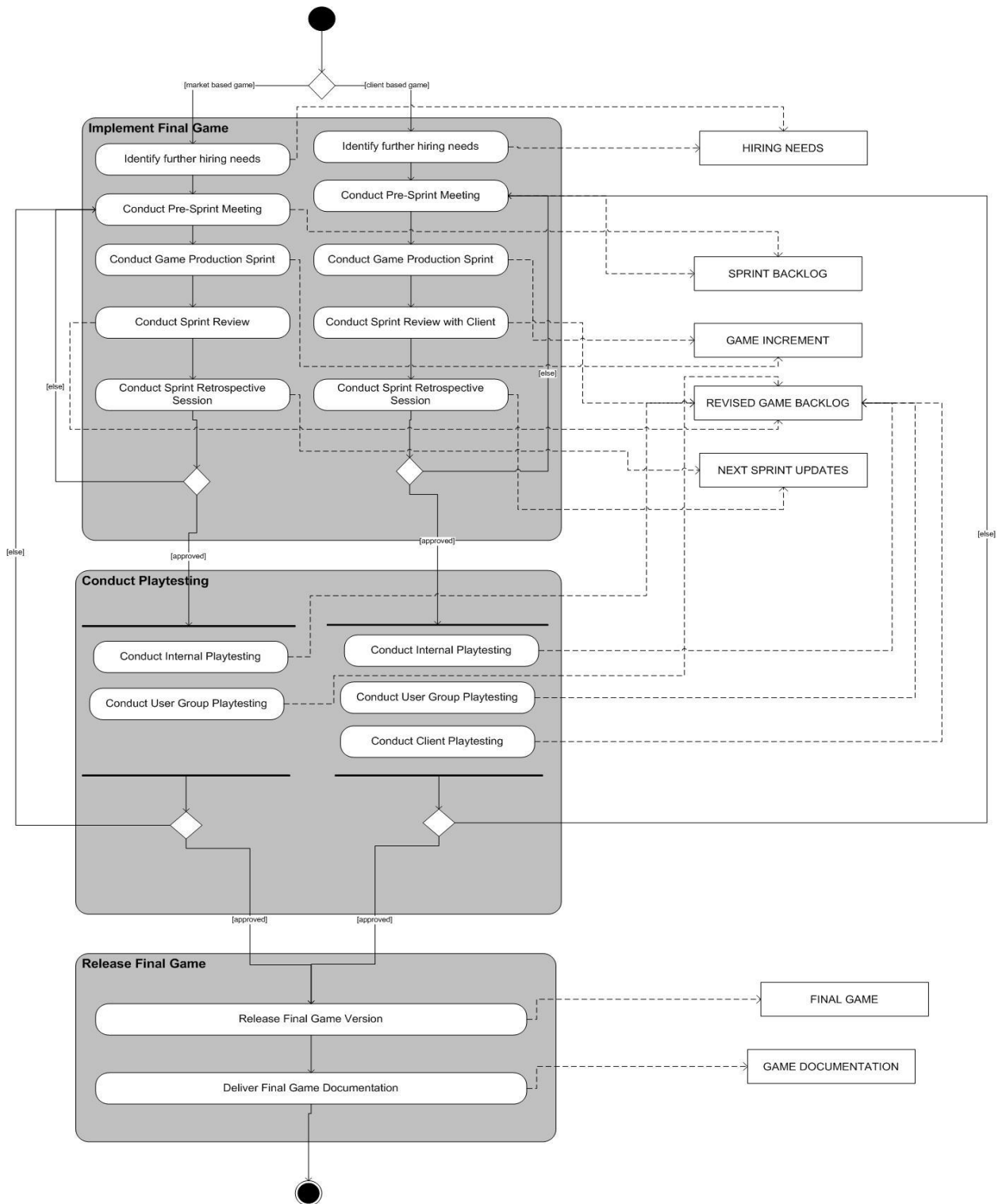
Figure 14: Combined method production phase

5.2 Requirements Engineering best practices

As mentioned in the previous chapters, the secondary contribution of this research thesis project is an investigation on whether requirements engineering (RE) best practices can be applied into the serious game production process in order to improve the overall process. During the literature review stage, RE was researched with current best practices identified. Besides best practices some further interesting information about RE and game development have been discovered during the literature review.

Despite no formal RE stages being present in the industry, informal requirements elicitation and analysis are present in many cases (Kasurinen et al., 2011). Due to the nature of the games however, RE practices should be applied after the game idea has been elicited and agreed upon since it is difficult to apply effectively systematic RE during the early conception phases of the game production process (Kasurinen et al., 2011).

As already mentioned, RE consists of the requirements elicitation, modeling and analysis, validation and management activities. Requirements elicitation and analysis are already present informally in many production environments due to their partial fit with the game production processes. Before describing the best practices for these two activities which could enrich the serious game production reference method, another RE step is described as a potential benefactor for the reference method, specifically the requirements pre-elicitation step.

5.2.1 Requirements elicitation

Due to the high number of requirements elicitation techniques available, the different levels of efficiency achieved depending on the context and the techniques combination possibilities present have led some researchers to the proposal of requirements pre-elicitation. This step in requirements engineering focuses on which approach for requirements elicitation should be chosen based on the specific project characteristics and context (Carrizo et al., 2014; Anwar & Razali, 2012; Pacheco & Garcia, 2012; Hickey et al., 2004; Dieste et al., 2008; Tsumaki & Tamai, 2006). The most interesting and current work on requirements pre-elicitation is Carizzo et al. (2014). This research proposes a systematic framework for requirements pre-elicitation which includes specific steps and pre-defined set of attributes with clear instructions. This framework in essence uses a set of attributes to determine the contextual situation of the problem. The current values of these attributes are applied in an "adequacy matrix" from which the most applicable techniques for the current situation are identified. The framework results in either a set of proposed techniques or in modification suggestions so that proposed techniques can be elicited. The framework works in sessions, so different situations apply at different stages of the project. At the initial stages the set of attributes have certain values but as the project progresses so do those values change as well. Depending on those changes, new sessions take place and potentially new techniques are identified as most fitting for the current stage of the project. This requirements pre-elicitation process can be applied throughout the duration of the project development life cycle to yield best results (Carizzo et al., 2014).The requirements pre-elicitation framework has been modeled using the PDDs technique and can be seen in Figure 15. This can allow practitioners to include the requirements pre-elicitation step into the

reference serious game production method as they see fit, depending on the context of their serious game projects.

The first step of the process, "Identify contextual situation" refers to the identification of the framework attributes values based on the project context. The main results of this step is the contextual situation matrix, which includes a complete matrix with all the values for the pre-defined attributes of the framework, which results into a complete contextual description of the project.
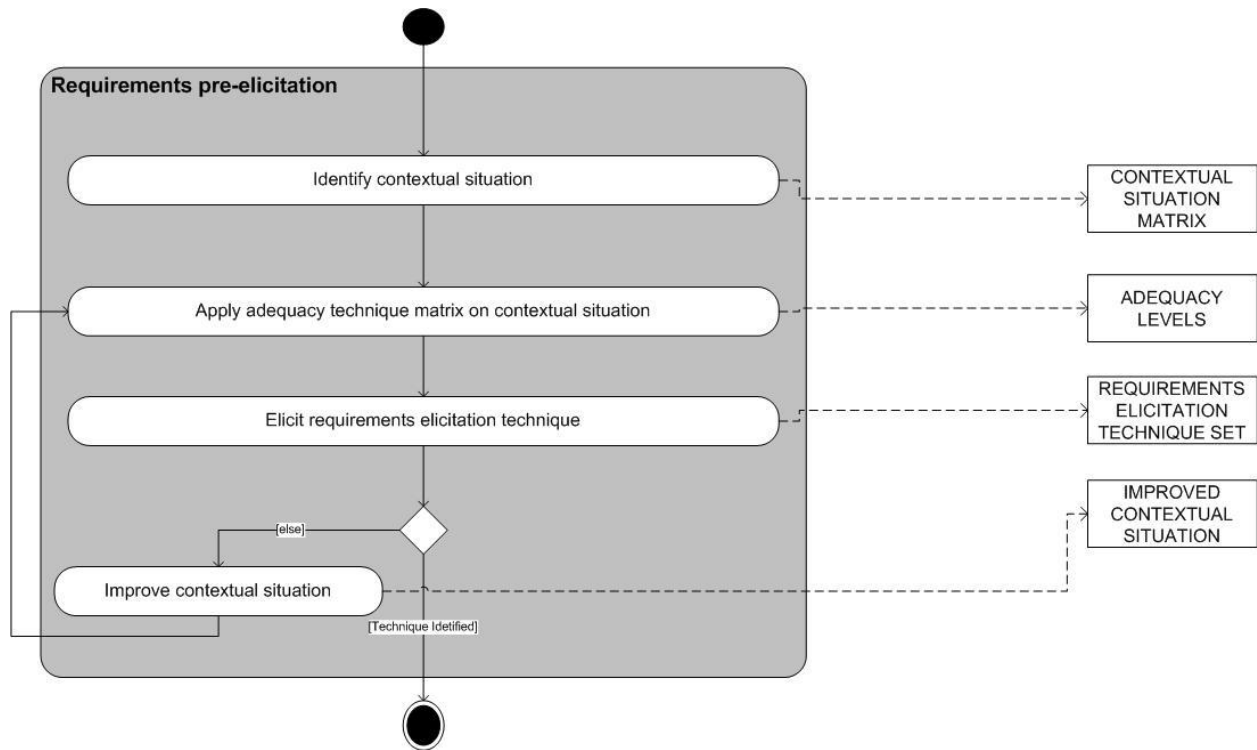
Figure 15: Requirements pre-elicitation

The next step involves the application of a pre-defined adequacy technique matrix on the current contextual situation identified in the previous step. The adequacy technique matrix includes 16 elicitation techniques with pre-defined values for each available attribute and value. The current contextual situation matrix is applied onto the adequacy matrix and results into the adequacy levels of each elicitation technique for the specific project.

The next step starts with a prioritization step based on the application of a mathematical formula on the adequacy levels, which results in a complete prioritized list of all elicitation techniques. Out of this list the most adequate techniques for the current situation are identified and selected. In some cases, this step won't produce any clear preferred technique due to the specific context present in the project. Then, an improvement on the contextual situation has to take place, by updating the values of the contextual situation attributes. This results in an updated contextual situation matrix and more clear results in the identification of the best elicitation technique for the project. For more details on the requirements pre-

elicitation technique refer to the activities and concepts tables present in Appendix C and in the work of Carizzo et al. (2014).

Besides requirements pre-elicitation, researchers have also identified cases where some requirements elicitation techniques are better than others, despite not being conclusive yet. According to Dieste et al. (2008), interviews are the most effective requirements elicitation technique, with structured interviews performing better than non-structured interviews. In addition, laddering was identified as another really effective elicitation technique while sorting and protocol analysis were identified as low efficiency techniques.

So far, in the combined serious game production reference method various requirements elicitation techniques are informally present. Prototyping, interviews, brainstorming, literature reviews and target audience research during the early phases are also used for requirements elicitation. But due to the high number of elicitation techniques available, our suggestion is the introduction of requirements pre-elicitation step in serious game production processes as early as possible. It requires at least a person responsible for the process, which means being acquainted with the contextual situation and adequacy matrixes, the process of calculating the values and prioritizing the techniques and if needed re-evaluate the contextual situation. However, in cases where the existence of such an expert is not possible, we suggest the application of structured and/or unstructured interviews, at least during the Game concept and Pre-production phases for the elicitation of the early serious game requirements. In addition, for the prototyping and production phases laddering can be used for the prototype and game requirements elicitation, as an effective elicitation technique.

5.2.2 Requirements modeling and analysis

Considering requirements modeling and analysis, informal version of such techniques are also present in the combined serious game reference production method but more steps could be updated or even inserted for better results. Requirements documentation is an important part of RE, since it allows traceability for each requirement. This should take place during the SCRUM-type sprints, where each requirement present in the product and sprint backlog should be adequately documented. In order to achieve this level, a requirements evaluation step should be added during the "Elicit Functional Requirements" step, in Game Concept phase. During the evaluation, the requirements should be evaluated whether they are clear, complete, consistent and unambiguous while any conflicts should be resolved (Verma & Kass, 2008). In order to ensure those properties, requirements should also be checked whether they describe a system with functions that best serve the stakeholder's needs, that all potential conflicts have been identified and resolved, that all the stakeholders needs and wishes are described by the set of requirements at hand, that all requirements are feasible in terms of time, budget and technology and all requirements should be formatted in such a way that they can be checked (Sommerville, 2004). When requirements are modeled and analyzed efficiently, it allows for better requirements documentation and communication among stakeholders (Nuseibeh & Easterbrook, 2000). Documented requirements can be classified and organized into coherent clusters which also allows for better requirements prioritization (Sommoerville & Kotonya, 1998).

Requirements prioritization is also an important aspect of RE focuses on placing the requirements in a prioritized list which can be used for analyzing them and for resolving stakeholder conflicts (Berander & Andrews, 2005). Other important benefits of effective requirements prioritization include better project

planning, core requirements identification, customer satisfaction estimation, rework minimization, optimal set of requirements for implementation planning and selection and many more (Berander & Andrews, 2005).

Interesting work on requirements prioritization was conducted by Bakalova et al. (2011). It resulted into a refined conceptual model describing on a generic level the concepts that impact agile requirements prioritization and a table with relations between the model concepts and prioritization methods from the literature. The general process described can be applied into the combined serious game production method as a guide for more effective requirements prioritization. The process was modeled using PDDs to allow members of the industry to include it into the combined serious game reference production method and can be seen in Figure 16.
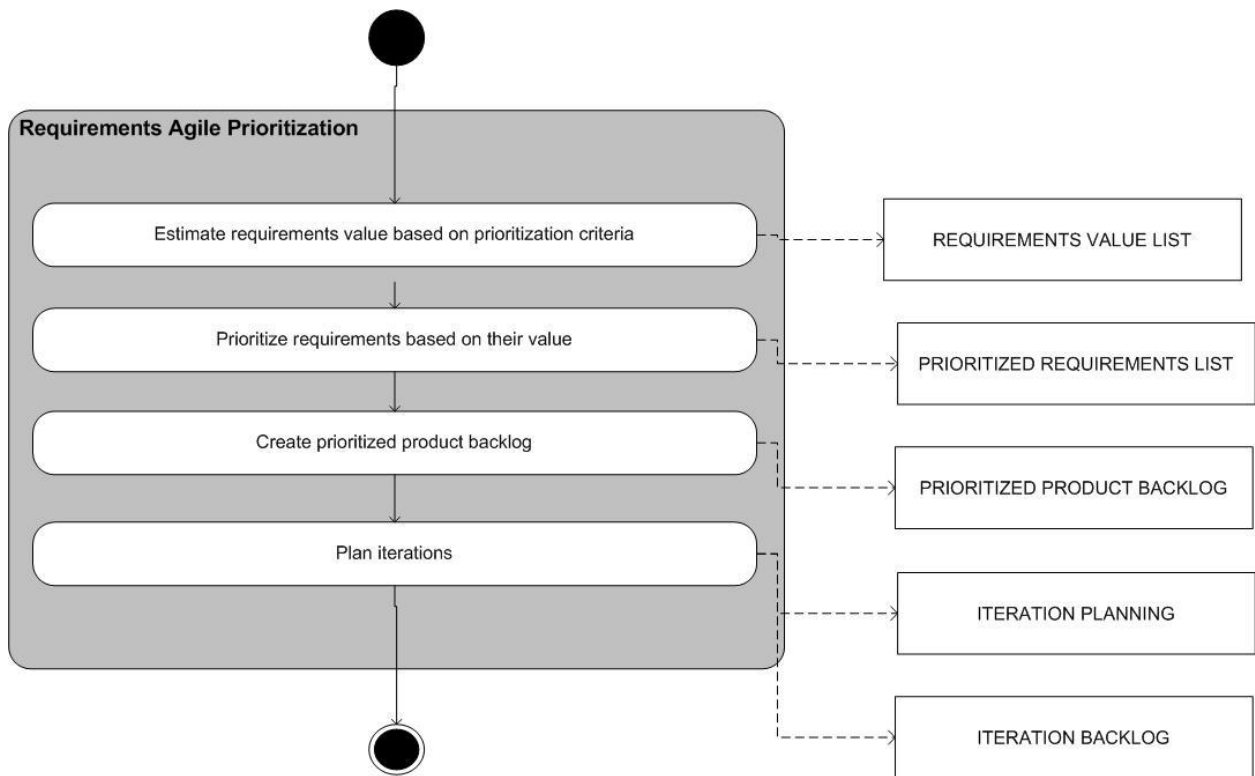
Figure 16: AGILE Requirements prioritization

During the first step of the process, the each requirement value is calculated based on prioritization criteria such as business value, negative value (i.e., how necessary to support the main user scenario the requirement is) and risk. This step leads to a list of all the requirements with their calculated value. Then, based on the results of the previous stage, the experience gathered from the project up to that point, any external changes and the project constraints the list is prioritized. Then, the prioritized list is applied on the product backlog to create a prioritized product backlog. This backlog is used to plan the next iterations of the project and divide the requirements to be developed based on their specific priority and details. Such a technique can provide real value for SG development teams, since requirements for each

development sprint can be efficiently prioritized resulting in less mismatches between what the market or client expect and what the team actually develops. For more details, refer to the AGILE requirements prioritization activities and concept tables present in Appendix C.

5.2.3 Requirements validation

Next, requirements validation techniques are already informally present in the combined serious game reference production method. Prototyping is also used as a validation technique, to ensure that the game prototype up to that point of development represents what the system should do and what it needs should meet. This of course is quite important, since identifying and fixing mistakes in requirements after the system has been built and delivered may incur costs up to 100 times higher than fixing those mistakes earlier in the production process (Sommerville, 2004).

5.2.4 Requirements management

Finally, requirements management focuses on handling documented requirements and managing their evolution over the course of the whole project (Nuseibeh & Easterbrook, 2000; Sommerville, 2004). In the combined serious game production reference method no formal requirements management techniques are available due to the nature of serious game production. Serious gaming companies rarely focus on such a level of detail concerning the game requirements. This can be attributed to the high creativity level present in the gaming industry, to the lack of resources for such detailed requirements monitoring or in a combination of both. In case a practitioner would like to include requirements management into the combined serious game production method, requirements traceability and change management are the most important factors to take under consideration. For effective requirements traceability, all requirements should be formally documented along with their creation rationale and conditions. Change management, on the other hand, has a direct relationship with software system success since systems change along with their environment and stakeholders needs, so naturally effectively managing these changes leads to better information systems (Nuseibeh & Easterbrook, 2000). Adding, updating or deleting requirements should be documented along with version control and updated traceability links so that the impact of those changes can be analyzed (Nuseibeh & Easterbrook, 2000; Sommerville, 2004). All proposed changes should be subject to change management and more specifically problem analysis, change analysis and costing and change implementation (Sommerville, 2004).

Chapter 6 Method Validation

In the previous chapters the main deliverables of the research project were presented and analyzed. In this chapter, the proposed methods are evaluated by experts in the Game Development and Serious Games Development field, to identify if and to what extent they could benefit the serious game development professionals. The proposed validation methods were expert interviews and deliverable reviews by an expert panel but this was not possible due to geographical and time limitations. In addition, in order to get a broader validation it was decided that the best method for this research project is a questionnaire.

To succeed in using effectively a questionnaire for validation purposes a translation of the most crucial parts of the final method into representative questions had to be done. For example, during the model creation phase it was identified that serious game practitioners could benefit from introducing clear requirements pre-elicitation selection, since this would improve the early design phases greatly. Such a finding was translated into a small set of questions, so that the respondents could get a clear idea of what the research suggests and how such an intervention could benefit their own processes. Also, the questionnaire should offer an overview of who the respondents are, their level of experience and of course they had to be given the ability not only evaluate the proposed method but also provide their own insights.

The final questionnaire consists of 21 questions divided into five thematic sections, specifically:

- Questions about the respondent.
- General game production process questions.
- Game development techniques.
- Game educational quality evaluation.
- Requirements in game production process.

At the end of each section an option is provided for the respondent to provide his/her feedback on the section questions or any other feedback he needs to provide. The complete questionnaire can be seen in Appendix D.

These sets of questions were created based on the main findings of the research up to this point. The models described in the previous chapters focus on general game production processes with various interventions in certain design and development steps. These interventions target some traditional game development techniques and propose changes. They suggest an additional focus on the educational quality of the serious games being produced, since during the expert interviews and literature reviews it was identified that the practitioners rarely have the capability to really ensure that educational quality. Finally, requirements engineering techniques were investigated during the earlier stages of the research and the individual findings were further investigated through the last two question sets of the questionnaire from a practitioner perspective.

6.1 Results

The questionnaire was distributed to the experts interviewed during the earlier stages of the research project and also (Serious) games development professionals participating in the Games network e-mail list , LinkedIn serious game development groups and Facebook groups, specifically : Game development, Serious games society and Semaphore (a game research group at University of Toronto. In total 14 SG professionals responded. These respondents cover various roles in SG development, as it can be seen in Figure 17.

What is your principal current role in (serious) game development?

Game developer (coding)	3	21%
Game designer	5	36%
Game producer	0	0%
Game art designer	0	0%
Educational specialist	1	7%
Researcher	3	21%
Other	2	14%
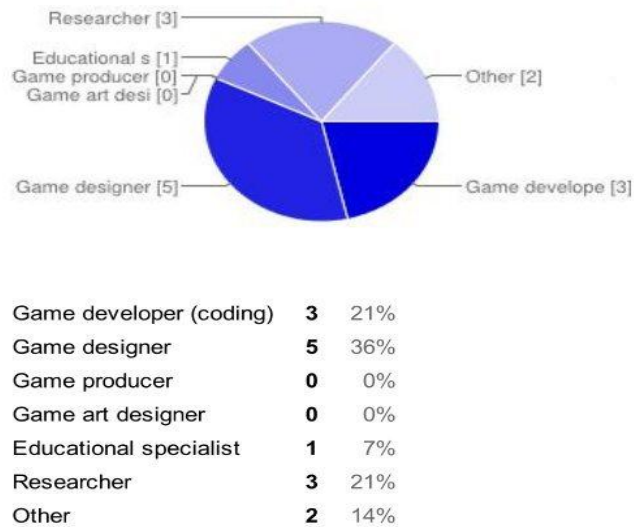
Figure 17: Questionnaire respondent roles

In addition, they have varying experience, with some being employed in the SG development field for only a year while others have 15 years of experience. Also, the ages of the participants vary from 23 years old up to 58. They are based and working on various countries, with most of the participants based in Europe (one participant from each of: Portugal, UK, Germany, Norway, Italy, Denmark, the Netherlands) and the rest coming from various places around the globe (2 participants from the USA and the rest from Canada, Georgia, Brazil and Australia). Although the low number of respondents suggests that there is one subject per country (with the exception of USA, where there are two respondents), the variety of role age and countries of the participants provides a lot of value to the validation process, since the resulted feedback and validation are not one-sided or focused only on a small group and geographical location and/or established practices.

The next section in the questionnaire, "General game production process questions" focuses on the current practices applied by the participants in their everyday development processes and gain some useful insights. The first question looked to understand whether the SG professionals consider games designed for market-wide releases different than the ones created based on specific client wishes. As it

can be seen in Figure 18, half of the respondents (50%) believe that the development process should be different depending of the type of the game, while 21% are neutral and the rest (28%) believe that the development process should be standard and irrelevant to the type of the game. The average number of the answers is 2.43 and the standard deviation 1.45, indicating that most respondents agree with the differentiation depending on the type of the game. This is in agreement with the current findings of the research, that the actual development process steps are project-relevant and are influenced by whether the game is client or market based.

1	6	43%
2	1	7%
3	3	21%
4	3	21%
5	1	7%

Figure 18: Game-type (i.e. market or client based) importance for differentiating development process

The next four questions are focused on specific techniques applied during the game development process. Specifically, the respondents were asked whether they conduct thorough research on the specific target audience for the game and their learning capabilities, whether they conduct research on the client environment (for client-based games) and whether they conduct literature reviews during the game development process. An overview of the results can be seen in Figures 19-22.

I conduct thorough research on the specific target audience for the game.

1	1	7%
2	1	7%
3	1	7%
4	2	14%
5	9	64%

Figure 19: Target audience research importance

The vast majority of the participants (78%) conducts some form of thorough research on the specific target audience of the game, with only 21% being neutral or ignores this type of research. The average of 4.21 and standard deviation of 1.311 agree with the previous findings so far, since target audience research was considered a quite important step in the game design process and present in most of the identified production processes.

I research the specific learning capabilities of the game target audience

1	2	14%
2	0	0%
3	2	14%
4	8	57%
5	2	14%

Figure 20: Target audience learning capabilities importance

This is also true for researching the specific learning capabilities of the target audience, with 71% conducting such research and 28% being either neutral or negative towards such activities. The average value of responses is 3.57 and the standard deviation is 1.22. Research on the client environment is also considered important, since 79% consider it really important, 14% being neutral and only 7% find it not really important. The average is 4.14 indicating a strong preference and the standard deviation is 0.95. However, it should be noted here that during the literature review stages, client environment research was not suggested as a critical development step and was first identified during the industry research phase. However, this finding demonstrates the importance of researching both the literature and the actual industry practices in order to get a complete perspective of the field.

The situation is also similar when considering literature reviews, with the average of the answers being 3.93, the standard deviation 1.14 and 72% of the respondents considering them really important, 21% being neutral and only 7% finding them not important at all.

When developing client-based games, I conduct research on the client environment for gaining an understanding of the game background.

1	0	0%
2	1	7%
3	2	14%
4	5	36%
5	6	43%

Figure 21: Client-environment research importance

Some of the participants also provided comments on the previous questions and the general topic these questions touch. One of the participants commented on the learning capabilities of the target audience that it is quite difficult to research them in many cases, especially when the target audience for the game is virtually the entire world. In such cases references to "popular culture" are a good aid. Another participant suggested that recreational games can be used for inspiration and especially how their mechanisms work on helping players interact with specific concepts. An overview of all the comments the participants made can be found in Appendix D.

1	1	7%
2	0	0%
3	3	21%
4	5	36%
5	5	36%

Figure 22: Literature review importance

The next section, "Game development techniques", includes questions used to identify certain techniques used by SG professionals, specifically prototyping, Playtesting and knowledge maps.

As it can be seen from Figure23, prototyping is considered as very important by the majority of the participants (93%) and included in their production processes from the very early stages. The strong average of 4.35 and very low standard deviation of 0.63 indicate that the responses tend to agree much, confirming the research findings up to that point.

Figure 23: (Early) Prototype development importance

The situation is similar with Playtesting, with the average of the answers being 4.57 and standard deviation just 0.755, translating in 85% of the participants applying the technique during the game development process and only 14% being neutral about its use. In addition, after being asked how often the participants use Playtesting, all of the participants responded that they try to use it as often as possible, with only two participants stating that they use it depending on the funding of the project and the environment. The importance of playtesting was highlighted during the expert interviews and the answers to these questions confirm the research findings.

Figure 24: Playtesting importance

Answers about the knowledge map/model were more distributed (1.28 standard deviation and 3.42 the answers average), with 57% of the participants using the knowledge map somehow in their development processes, 14% being neutral to its use and 28% not using it. In addition, most of the participants commented on this question that while a knowledge map is a very useful guide and while it should not

restrict development, it should be used during prototype development to connect the target knowledge objects with the prototype game experience design.

Knowledge maps were identified as important in serious game development from the literature review phase but their importance was downsized by the expert interviews, as knowledge maps were identified as rarely being used by the industry practitioners. The questionnaire results confirm their rare use and provide additional insight as to why that is the actual case.

Figure 25: Knowledge map/model importance

The next section focuses on the educational quality evaluation of a game by the development team. The questions aim to understand whether practitioners apply educational quality evaluation on their games and if they do what their preferred methods are. This is considered important since during the earlier research stages the literature findings somehow disagreed with the industry practices. While the literature suggests that educational quality of the game is very important for the overall product quality, very few practitioners actually apply educational quality testing during development.

I would conduct an educational evaluation session starting early in the production, and continuing in all the game increments

1	0	0%
2	6	43%
3	2	14%
4	3	21%
5	3	21%

Figure 26: Educational evaluation session importance

Many of the participants (43%) disagree with the conduction of an educational evaluation early in the development process with 14% being neutral and 42% agree with early conduction of educational evaluation in the development process. The average of the answers is 3.21 and the standard deviation is 1.25. This is an interesting finding, demonstrating that SG professionals are divided when considering educational evaluation sessions.

Similar results are produced when asking about permanent educational specialist, with half the participants agreeing with their employment and the other half disagreeing. The average of the answers is 3.28 and the standard deviation 1.68, indicating again that the participants are divided. This is an interesting finding, since literature suggests that an educational specialist should be part of the team, even if only to provide feedback on whether the game actually educates or not.

I would employ a permanent educational specialist who would evaluate all the game increments for their educational quality

1	2	14%
2	5	36%
3	0	0%
4	1	7%
5	6	43%

Figure 27: Permanent educational specialist importance

Finally in this section, most of the participants (71%) responded that they feel the educational activities present in the game should not be separate from the game scenario and should be created together while

7% is neutral and 21% feel that the educational activities should be created separately. The average is 3.85 however the standard deviation is 1.66, indicating diverse answers. The answers to this question seem to be contradicting the findings of the research project about the design of educational activities and game scenario, since the literature and practitioners interviewed suggest that they should be separate.

The educational activities present in the game should not be created separately from the game scenario and later merged together

1	3	21%
2	0	0%
3	1	7%
4	2	14%
5	8	57%

Figure 28: Separate educational activities and game scenario creation importance

Finally, the respondents left many comments for this section about all the above questions. A participant noted that while educational activities and game scenario should be created separately, the difficulty in merging them together later on makes this task much harder than designing them as merged together. Another participant comments that educational evaluation sessions depend on the project at hand and the kind of intended knowledge. Also, two of the participants would like to hire a permanent educational specialist in their development teams but cannot afford it. For all the comments provided by the participants refer to Appendix D.

The last section of the questionnaire includes questions about requirements and various proposed techniques identified during the research project. Requirements elicitation is the focus of the first question and as it can be seen in Figure 29, most participants (65%) agree that requirements elicitation should be project-specific while 36% is neutral. The average of the answers is 4 and the standard deviation 0.88, both showing a clear preference. This question aims to understand the importance practitioners assign to requirements elicitation techniques as the research suggested that the right choice of requirements elicitation technique could greatly improve the overall quality of the final product. The answers to this question demonstrate that practitioners agree that this choice is important based on the specific characteristics of the project at hand.

I believe the choice of a requirements elicitation technique is project specific and heavily influences the final outcome

1	0	0%
2	0	0%
3	5	36%
4	4	29%
5	5	36%

Figure 29: Requirements elicitation technique importance

However, when asked whether they would employ a systematic method for the identification of the "best" requirements elicitation technique(s) for the project at hand, most participants seem unsure, with the average of the answers being 3.21 and the standard deviation 1.05. 14% of the answers is negative towards the idea, 28% is positive and 57% is neutral, as it can be seen in Figure 30.

1	1	7%
2	1	7%
3	8	57%
4	2	14%
5	2	14%

Figure 30: Requirements elicitation technique selection importance

The next question touches upon the subject of documentation. The results suggest that the participants are either neutral (36%) or positive (50%) with applying requirements documentation during the game development process with only 14% being negative towards such activities. The average of 3.64 and standard deviation of 1.08 come in agreement with the research results up to that point, which suggested that correct requirements documentation should be present during development, as it increases requirements quality and results to effective overall requirements management.

I would use requirements documentation in the game development process (e.g., during SCRUM sprints, when the backlog items are evaluated and implemented)

1	0	0%
2	2	14%
3	5	36%
4	3	21%
5	4	29%

Figure 31: Requirements documentation importance

Educational evaluation was the subject of the next question and most participants (57%) conduct a session early in the production process on the first prototypes while 21% are neutral and don't apply it every time and the rest (21%) don't apply it at all. The negative formulation of this question explains the average of 2.64 while the standard deviation of 0.84 indicates strong preferences among the participants. These results confirm the previous findings on the importance of educational evaluation of even the early prototype versions.

I never conduct an educational evaluation session early in the production process on the first simple prototype or even earlier game concepts

1	0	0%
2	8	57%
3	3	21%
4	3	21%
5	0	0%

Figure 32: Early educational evaluation importance

Regarding requirements prioritization, the responses were spread (standard deviation of 1.34 and average of 2.57), with 57% disagreeing with no application of a systematic method for requirements prioritization, 21% being neutral about its use or not and 21% positive to not applying such a method. The question aims to verify earlier results that systematic requirements prioritization results in more effective game design through better requirements management.

I would never apply a systematic method to prioritize the game requirements.

1	3	21%
2	5	36%
3	3	21%
4	1	7%
5	2	14%
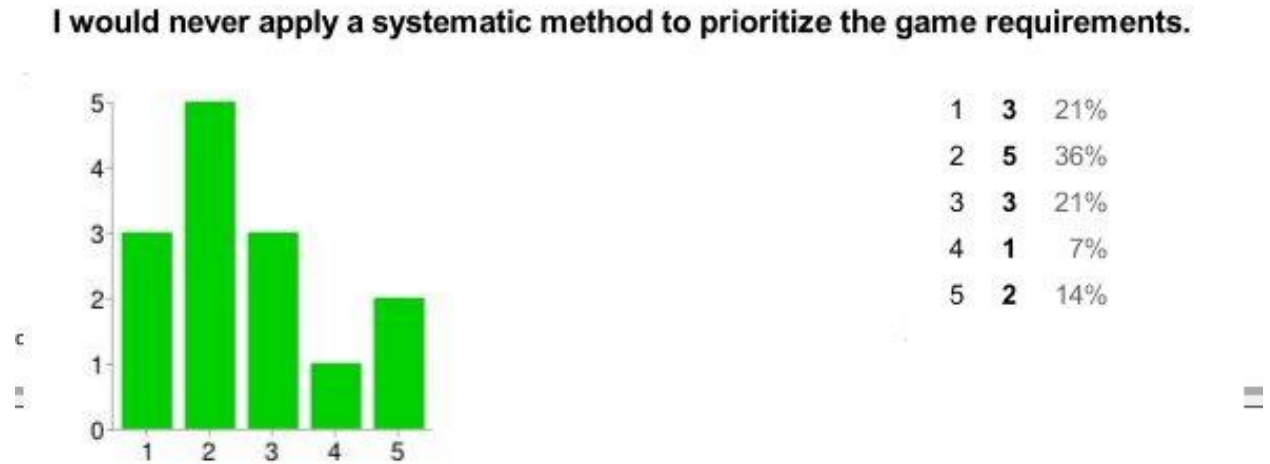
Figure 33: Requirements prioritization importance

6.2 Validity

Online surveys are used more and more frequently nowadays as they are cheaper, faster and more convenient for certain types of research projects (Wiersma, 2010). However, they include many validity threats, both for internal and external validity (Wiersma, 2010). In Wiersma, (2010), the notions of an online and an offline survey have been separated across various types of solicitation and delivery and based on that separation, the threats to validity have been categorized and clarified. Based on that work, this survey suffers from the most frequent treats to validity every online survey faces nowadays.

6.2.1 External Validity

External validity refers to the actual generalizability of the study results to the general population across contexts (Wiersma, 2010). Limited coverage of the population is not considered as a big problem in this case, since the intended audience of the survey includes mostly IT professionals and academics, people who have constant access to the means through which we distributed the survey. One other important threat is lack of sampling frame (Wiersma, 2010). To handle this threat, we decided to share the questionnaire only to email lists, Facebook and LinkedIn groups consisting of (Serious) game development professionals and academics, as they are the intended target group. In addition, a section in the questionnaire includes questions about the general characteristics of the respondent so that the irrelevant responses can be eliminated. Another threat of online web surveys to external validity is the very low response-rate (Wiersma, 2010). Unfortunately, despite our best efforts (i.e. share the questionnaire only in relevant lists and sending frequent reminders) the response rate in our questionnaire was really low.

6.2.2 Internal Validity

Internal validity refers to the extent to which the measures made actually measure the concepts they intend to (Wiersma, 2010).

Access control is an important threat of online surveys to internal validity (Wiersma, 2010). As already mentioned, we included a section in the questionnaire that aims to identify the characteristics of the respondents and eliminate double or irrelevant entries. However, we recognize that someone could simply lie in his responses but we cannot do anything about such cases.

Extraneous events on the participants were not able to be tackled, since the questionnaire was completed on-line and there is no way to understand the history of the participants and whether something influences their answers. Finally, display effects were minimized through the use of a standardized service – Google Docs platform and more specifically Google Forms. This service is delivered in the same manner to all users regardless of the operating system or device they use, while employing minimum design elements that could confuse the participants.

6.2.3 Construct Validity

As construct validity we refer to the amount of which the conclusion drawn by the measurements of the survey accurately reflects its original construct. Essentially it demonstrates the level of generalizations from the measurements to the original constructs. In our case, a threat to construct validity is the lack of reliability of the independent variable and lack of representativeness of the independent variable. That is mostly due to the nature of the online survey and the channels through which it reached its audience. By not being sure of who answered the survey we lack the information to be sure of the variations between respondents and whether they actually are an adequate representation of the intended audience.

In addition, we tried to design the questionnaire to be as straightforward as possible, so as to limit cues to the participants as to what kinds of results are expected to minimize experimenter expectancy effects. However, due to the online nature of the questionnaire we can't be sure that this threat was adequately tackled. Strategic responding by the research participants is another threat to construct validity of this survey and we tried to tackle it by not revealing through the questions the expected outcomes of this survey. However we can't be sure that the participants didn't answer the questions with the intend to "help" or "challenge" their perceived goals of the survey. Finally, linguistic or cultural bias threat is another threat to construct validity and we tried to handle it by adding explanatory text to questions open to this kind of threat.

Chapter 7 Discussion and Conclusion

As explained in the previous chapters, this research project aim is researching SG and look for a balance between education and entertainment through the preferred SG production processes in both literature and industry, with the goal of better understanding what is the serious game production process, identify specific problems of this production process, study the state of the art of possible solutions from the literature and the industry and propose reference methods that try and solve (some of) these problems while increasing the potential value of future serious games for all stakeholders.

Naturally due to the aim, the main focus of this research is on serious game production processes and whether RE could have an impact on them. Digital serious games are games that have more goals beyond entertainment and this fact leads us to assume that since software engineering and computer game software engineering, despite having a lot in common, are quite different, especially regarding RE, this might be the case for serious games as well.

The main research objective of this thesis project was defined as: ***Understanding how the balance can be aimed between the educational and entertainment aspects of serious games in serious games production processes.***

In order to study this subject, various research methods were used. A literature review from various sources covered the research objective of identifying the state-of-the-art and the state-of-the-practice in serious game development and established in a structured manner what has been happening in this field. A number of expert interviews conducted in Dutch and German (serious) game development studios also took place with a research objective of understanding how the (serious) gaming industry works in practice. This research phase is important, since researchers agree that there is a lack of insights, experiments and case-studies in the field of game software engineering which leads to unexplored areas of the field (Ampatzoglou and Stamelos, 2010).

The literature review and expert interviews research phases led to the identification of current practices and the modeling of methods currently employed in serious game production. These methods were modeled using various techniques resulting in clear and compact models. From these models, method fragments were then identified, leading to the development of a new reference method, specifically designed for serious game development, based on both the literature and industrial insights and practice, combining different approaches with different individual aims. This serious game situational nature of the method is a very important feature, since there can be no one-size-fits-all solution for both regular games and serious games, as each of them targets a specific purpose (i.e., entertainment vs. education), specific audience and balance between their needs, usually different from game to game. Finally, all individual methods from the interviews and the new method were validated by game production experts (i.e. both from industry and academia) via answering a -specifically designed for that purpose- questionnaire.

Since the main research objective of this thesis is complex, a set of research sub-questions (RSQ) were formed and through their answers a clear understanding of the topic will be gained with an ultimate goal of answering the main research question.

7.1 Discussion

For each of those research sub-questions, the answer was identified during the various stages of the thesis research project. In the next paragraphs, those answers are explained and elaborated.

7.1.1 RSQ1: Serious vs regular entertainment digital games:
<u>"How do serious games differ from regular entertainment digital games, especially development wise?"</u>

The first sub-question aims not to understand the fundamental differences between entertainment digital games and serious games but mostly tries to see this question answered from a SG professional developer point of view. As most of the experts interviewed during the industry model phase suggested (and the previous literature findings agree with), the differences between those two types of games are not great, development-wise. The entertainment aspects of the game are designed similarly in both cases, however in the case of SG, there is an educational element that needs to be combined with the entertainment element into a fully integrated product. This final step was considered by all the participants as very important one for the overall success of the SG. In addition, there are some cases of SG that turn out to be fun enough to outgrow their initial target group and consequently be marketed as an entertainment game, as an expert described during the interviews phase. Despite this case being rare, its occurrence indicates that SG and pure entertainment games might have more in common than originally believed.

7.1.2 RSQ2: Serious Games production process in the literature and industry:
<u>"What is the process of creating serious games proposed by the scientific literature and what is the process followed by the gaming industry?"</u>

The second question was answered through the research and consequent creation of the literature and industry models, extensively described in previous chapters.

The literature reference serious game production method consists of 4 Phases, 12 main activities, 75 subactivities and 90 concepts. The whole process is dependent a lot on the Serious Game route from the extended game production method by Amanatiadou and van de Weerd, (2009), since this method was the most complete and elaborate one. Some of the most interesting parts in the literature model, are the addition of the Mock-up model and pedagogical quality evaluation method fragments because they were not present in the main method the literature model was based on. Both Mock-up model creation and pedagogical quality evaluation activities should take place before any implementation takes place because through those activities the pedagogical quality of the serious game is evaluated early in the process, mistakes are identified and fixed before any costly implementation takes place and the clients get a more clear idea of what the game would look like later on (Marfisi-Schottman et al., 2009; Marfisi-Schottman et al., 2010). In addition, the prototyping phase was enriched with method fragments from Lage et al.

(2001), since in the original serious game route production method this activity was not elaborated enough and more specific steps were required.

The Serious Game Reference Method from the Industry consists of 4 distinct phases out of which the last phase is considered out of scope for the purposes of this thesis research project (Post-Production Phase). In total, 12 main activities, 58 subactivities and 40 concepts are included in the final method. There are four main phases, specifically Game Concept phase, Pre-Production Phase, Production Phase and Post-Production phase (which as was already mentioned is considered to be out of the scope of the thesis project).

The production process begins with the game elicitation idea, either from a client or from a member of the production team. Depending on whether the game is client or market based, some different steps are introduced in the production process. For example, for market based a games a Business Case feasibility study is conducted to determine whether the game idea should be turned into a complete product. The project parameters are researched and the complete business case is evaluated. If the idea is deemed non-profitable this leads to the project cancellation. On the other hand, for client-based games, a case study is conducted at the client environment so that the initial details of the project can be identified. This step is important, so that the team can get a good idea of what the client needs and compare it with the client proposal, or what the client "thinks" he needs. The project parameters are researched and a round of internal brainstorming takes place for the formulation of a game proposal for the client. If this proposal is approved by the client the next phase begins.

During the next phases, the game concept is created through a round of brainstorming, client interviews (for client based games), literature research and target audience characteristics research take place for the identification of the basic Game concept requirements. These are used for the creation of a small number of draft game concepts which are evaluated with the client and this step leads to the creation of the final game concept for the game.

After the game concept has been created, the functional requirements elicitation phase for the game side takes place. There are not any real differences between client and market based games during those stages, so for both types of serious games roughly the same process is followed. Eliciting the functional requirements for the serious side includes team brainstorming, client interviews, stakeholder interviews, end users interviews, literature research and tracking the game origins.

After the game concept and functional requirements elicitation steps a first playable simple prototype is created to be used for playtesting. This phase allows for feedback and improvements on the first game concept by the client but also from the team. Playtesting is quite important for the design of serious games, as through this process, updates and quality feedback for the prototype can be elicited.

Pre-Production phase follows and during this step, the main game elements are created, specifically the game play, the game elements, the game storyline, draft visualizations and the combination of the educational and entertainment aspects of the game into a complete prototype.

After a complete prototype has been created, extensive Playtesting takes place with similar groups as the ones identified in the Game Concept phase for the evaluation of the complete prototype. This phase

leads to improvements to both entertaining and educational aspects of the game and takes place until the prototype is deemed ready by the client and the production team.

Pedagogical Quality for the game is finally assessed by a person, usually a PhD student relevant to the serious game scientific field, is assigned the task of evaluating the game. A round of playtesting takes place along with a literature review and scientific evaluation of the pedagogical aspects of the game and these steps result in a complete pedagogical evaluation of the game and proposed changes and updates.

Finally, the final game implementation is created again based on SCRUM principles. The final game is also evaluated through a round of playtesting which leads to the final updated and improvements. After the final game version has been approved, it is delivered to the client along with the final game documentation.

7.1.3 RSQ3: Serious VS regular games situational methods

"How can those differences between regular and serious game development process be used for the creation of situational methods?"

The differences between the two types of games can be represented in the design of game development methods by creating two situational routes, one for each type. However, as already mentioned, most of the differences would show in the SG situational route since there are new steps added. These steps include the research analysis and design of the educational aspects of the game from knowledge sets into game activities, gameplay and scenarios and finally be integrated with the entertainment aspects of the game.

Besides differences between regular and serious games there are also differences within SG that influence the development process. The two most frequently mentioned ones are the size of the company (Small and Medium Enterprises or Large) and the type of SG (client-based or market-based). These factors were identified during the literature review stage and confirmed during the expert interviews, since almost all the experts recognized those factors as really important. However, since we couldn't interview any experts from large companies and all the interviews come from SME, we identified the company size factor but couldn't get more data so that we could include it in the final models. Therefore, the situational routes present in the SG development process are influenced on the type of SG (i.e. client or market based) factor.

7.1.4 RSQ4: Educational VS entertainment balance in literature and industry:

"How do the literature and the industry propose finding a balance between the educational and entertaining aspects of a serious game?"

The so called "balance" between the educational and entertaining aspects of a serious game comes into place after each individual aspect has been designed. In addition, as the majority of the interviewed experts stated, in reality there is no "balance". Both aspects of the game need to be at 100% of what they

can be or the best they can be for the final game to work. The models analyzed from both the literature and the industry agree that game design and educational specialists should participate in the design of the entertainment and educational aspects of the game and then together with the development team should help in combining those into one fully integrated game. The balance is achieved by an equal quality of each side of the game and an effective combination of both sides into a final product. However it should be noted that most of the industry experts suggested that the educational specialist responsible for the educational aspects of the game comes from the client side (for client-based games), therefore this "balance" search in the case of client-based games, mostly lies in the client side.

7.1.5 RSQ5: Success critical production steps:

"Which steps in the serious game creation process influence the success of the game?"

Based on both literature and industry findings, the most important steps for the success of a SG are the early design phase of the game prototype, the playtesting phases and the combination of entertainment and educational aspects step. These steps combined result in the most important features of the game, as the prototype includes the initial design (which in turn includes the initial requirements elicitation and game concepts), playtesting tests that design and suggests improvements on it and finally the combination of entertainment and educational aspects should lead to a fully integrated game, where rather than fun or education overcoming one another, both are utilized for the desired knowledge transfer effects.

7.1.6 RSQ6: Requirements engineering potential applications:

"How can requirements engineering (as a whole or parts of it) be applied to the production processes in order to improve them?"

This sub-question aims at investigating whether RE best practices can be applied into the serious game production process. During the literature review stage, RE was researched with current best practices identified. Despite no formal RE stages being present in the industry, informal requirements elicitation and analysis are present in many cases (Kasurinen et al., 2011). Due to the nature of the games however, RE practices should be applied after the game idea has been elicited and agreed upon since it is difficult to apply effectively systematic RE during the early conception phases of the game production process (Kasurinen et al., 2011).

After researching all RE activities, it was identified that within the current design of the combined SG development process and the beliefs of the experts interviewed, there is room for proposing improvements. Specifically, two techniques were identified as candidates for being included in the final method and during the validation phase those techniques were evaluated by the expert participants via answering the relevant questions in the questionnaire.

The first technique is requirements pre-elicitation, focusing on the selection of the most suitable approach for requirements elicitation based on the specific project characteristics. This systematic technique for requirements pre-elicitation includes specific steps and pre-defined set of attributes with clear instructions. The technique in essence uses a set of attributes to determine the contextual situation of the problem. The current values of these attributes are applied in an "adequacy matrix" from which the most applicable techniques for the current situation are identified. This step results in either a set of proposed

techniques or in modification suggestions so that proposed techniques can be elicited. The technique works in sessions, so different situations apply at different stages of the project. At the initial stages the set of attributes have certain values but as the project progresses so do those values change as well. Depending on those changes, new sessions take place and potentially new techniques are identified as most fitting for the current stage of the project. This requirements pre-elicitation process can be applied throughout the duration of the project development life cycle to yield best results (Carizzo et al., 2014). When the experts were asked about the subject, the vast majority answered that while understanding the importance of the step, they are unsure about applying such a step within their processes without testing its efficiency first.

The second technique focuses on AGILE requirements prioritization, an important aspect of RE that focuses on placing the requirements in a prioritized list which can be used for analyzing them and for resolving stakeholder conflicts (Berander & Andrews, 2005). Other important benefits of effective requirements prioritization include better project planning, core requirements identification, customer satisfaction estimation, rework minimization, optimal set of requirements for implementation planning and selection and many more (Berander & Andrews, 2005).

The proposed technique comes from the work of Bakalova et al. (2011), which resulted into a refined conceptual model describing on a generic level the concepts that impact agile requirements prioritization and a table with relations between the model concepts and prioritization methods from the literature. The general process described can be applied into the combined serious game production method as a guide for more effective requirements prioritization.

During the first step of the process, the each requirement value is calculated based on prioritization criteria such as business value, negative value (i.e., how necessary to support the main user scenario the requirement is) and risk. This step leads to a list of all the requirements with their calculated value. Then, based on the results of the previous stage, the experience gathered from the project up to that point, any external changes and the project constraints the list is prioritized. Then, the prioritized list is applied on the product backlog to create a prioritized product backlog. This backlog is used to plan the next iterations of the project and divide the requirements to be developed based on their specific priority and details. Such a technique can provide real value for SG development teams, since requirements for each development sprint can be efficiently prioritized resulting in less mismatches between what the market or client expect and what the team actually develops. Both proposed techniques have been modeled using PDDs so that they can be easily applicable in the previously modeled and analyzed methods. All relevant PDDs and accompanying tables are described in the previous chapters.

7.2 Validation

The questionnaire analyzed in the previous chapter was created so that SG professionals could provide feedback and evaluate the main findings of the research project. The results mostly confirm the thesis findings. Most professionals agree that a differentiated development process should be followed

depending of the game type (i.e. client or market based). Research during the very early design stages of the game is believed to benefit the final product, especially when considering target audience research and client-environment. Prototyping and Playtesting have been identified as very important development techniques, as identified during the research project as well, with the use of the knowledge map/model however not being universally agreed upon by the industry professionals.

Regarding educational evaluation of the serious game under development, participants are divided between employing such techniques, in contrast with the findings of the research project so far. Most of the participants don't believe that an educational evaluation session should be conducted early during the production process and despite most of them agreeing on the value of a permanent educational specialist employed by their company, very few actually have the financial capability to do so. In addition, most of the participants believe that the educational activities present in the game should not be created separately of the game scenario, something completely different from the research project findings so far.

Finally, regarding requirements engineering practices, survey participants are mostly positive towards such interventions, however they remain a bit skeptical about them. Despite most of them agreeing that requirements elicitation techniques are project-specific, they remain highly skeptical about introducing a systematic method for identifying such techniques based on the specific project characteristics. In addition, most of them agree on including requirements documentation techniques in their development processes and applying a systematic method for requirements prioritization.

To conclude, the most important findings of the research project so far have been partly validated by this survey. Most of the participants agree with the current conclusions, with the exception of educational evaluation of the game development process. However, there have been many limitations to the validation process (e.g. the threats to validity of this survey already analyzed) that allow for further research. The type of validation (i.e. survey) was selected as the most suitable medium for gaining useful insight from various experts on the results of the thesis on a limited time frame. However, a set of exploratory sessions with SG professionals would probably yield a more complete set of feedback, since the expert would have the time to study and analyze the proposed process, adapt it for his process and possibly apply it and be able to comment on the results.

7.3 Future Work

Due to the scope of this research thesis project, several limitations arose, mostly due to the time factor. Given more time for further conduction of research, various aspects of the proposed results should be further tested and researched. The suggested combined final method should be applied in the industry and tested in real life environments. The proposed production steps should be followed by an actual SG production studio while the practitioners in close communication with the researcher observe and measure the differences (if any) between the results of applying the method and not applying it. The proposed benefits of the method can be identified in the potential success of the serious game, both in commercial success and educational success, i.e. the amount of knowledge the game users obtain after using the game and the amount of time this knowledge stays with them after finishing the game. In order to identify such benefits, the measurements need to cover a long life span, from the initial application of the method within the production studio to the effects the game has on its users, long after its been designed, implemented and released to its intended market or clients.

In addition, the proposed RE techniques should be individually included in the production method either in combination or separately. Their application success should be measured in various situations (e.g.

research the production method without both RE techniques, research the benefits of applying only one of two techniques and research the benefits of applying both techniques). This research will add more data on whether those proposed techniques actually benefit the production process and the commercial and educational success of the game and possibly point to further research opportunities on the application of RE in the SG production processes.

7.4 Conclusion

During the last quarter of the century interest has peaked on potential of using games for purposes other than pure entertainment. Possible benefits such as increased visual abilities and the motivating features of digital games captured the interest of various researchers and such efforts have led to the emergence of serious games (SG), a relatively new form of games that combines the entertainment aspect of games with educational aspects and/or knowledge acquisition.

Despite the expected wealth of benefits, serious games have yet to deliver on their promise and be widely adopted. Research findings indicate that despite traditional education methods underperformance, positive findings regarding the learning outcomes of game-based learning and the evolution of technology, the Serious Gaming industry is still held back. Reasons for this include industry specific factors like the lack of serious game benefits awareness, problematic economy, hesitance to try new educational methods or the lack of proved assessment tools. Besides the industry specific factors, Serious Games also fail due to a lack of strong design principles in the genre. This happens due to various reasons, for example lack of an understanding of the game educational objectives, a lack of systematic practices considering the combination of pedagogy with the entertainment part of the game, miscommunication between relevant stakeholders and more.

This research project aims at researching those problems with the goal of better understanding why serious games fail, the serious game production process, identify specific problems of this production process, study the state of the art of possible solutions from the literature and the industry and propose reference methods that try and solve (some of) these problems while increasing the potential value of future serious games for all stakeholders. These objectives have been fulfilled with the research and creation of both the literature and industry SG production processes. Their combination resulted in a complete model with best practices from both literature and industry experts.

In addition, a set of useful RE techniques have been identified and proposed as useful addition to the final method. However, due to the AGILE way of working and informal application of RE within the current production processes, these interventions were described separately from the final method with suggestions as to where and how this could be included in the production process. This allows SG professionals to evaluate separately the RE techniques and decide if and where they would apply them.

Chapter 7 Discussion and Conclusion

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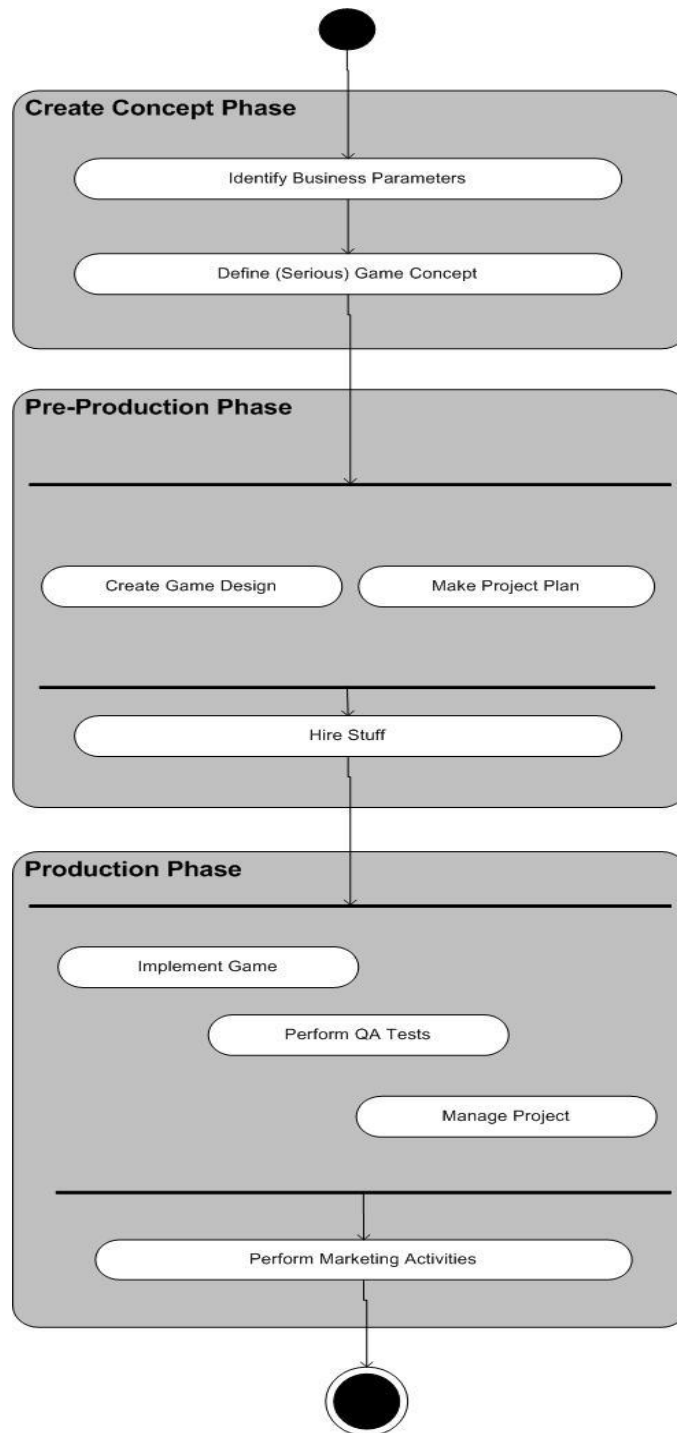
Appendix A

Figure 34: Serious Game production route-method (Amanatiadou & van de Weerd, 2009)

Appendix A

Figure 35: Create Concept phase (Amanatiadou & van de Weerd, 2009)

Figure 36: Pre-production phase (Amanatiadou & van de Weerd, 2009)

Appendix A

Figure 37: Production phase (Amanatiadou & van de Weerd, 2009)

Activity	Subactivity	Activity Explanation
Identify Business parameters	Set Goals and Analyze them	The goals for the project are set and analyzed
	Set Timeframe	The timeframe for the project is set
	Identify Available Money	The budget for the project is set
	Identify Resources	The resources for the project are identified
	Perform Risk Analysis	A risk analysis is conducted for the project
Define Game Concept	Have brainstorm session	The first meeting of the team where the GAME GOAL, GAME MECHANICS and GAME CONTEXT are defined
	Define Game Ideas	The main game ideas are defined
	Evaluate Ideas with Client	The ideas are evaluated with the client and updated
	Create Game Synopsis (parallel)	A short description of the game that is used as input for the GAME CONCEPT
	Create Game Concept (parallel)	The game concept is created
	Create Global Planning (parallel)	Planning the project and finalizing the budget. Defining possible problems
	Consult Domain Experts (parallel)	The domain experts for the serious game are consulted for the extraction and formalization of the domain knowledge
	Create Visualizations (parallel)	The preliminary visualizations for the game are created
	Create Knowledge Model (parallel)	The knowledge model for the serious game is created
	Present Concept to Client	The concept is presented to the client
	Have Final Decision Meeting	A decision meeting takes place to evaluate and approve the game concept
	Sign Contract	The contract for the game is signed between the client and the production company
Create Game Design	Brainstorm	The first meeting of the team where the next steps of the process are defined
	Delegate Design	The design process steps are delegated to the team
	Create Game Design Document	The Game Design Document is created by combining all sub-pieces
	Create Visualizations	The visualizations for the prototype are created
	Create Technical Design Document	The TDD is created

	Create Functional Design Document	The FDD is created
	Present Game Design	The game design is presented to the complete team and the client
Make Project Plan	Perform Risk Analysis	A risk analysis is conducted for the project
	Define Milestones	The milestones for the project are defined
	Define Project Management Charts	Various project management charts are created for the monitoring of the project
	Create Budget	The budget for the project is re-evaluated at this point
	Define and Prioritize Game Features	The game features are analyzed an prioritized based on the project details
	Conduct Profit and Loss Analysis	A profit and loss analysis is conducted
Hire People	Create Workload Document	Defining Tasks
	Create Staffing Plan	A staffing plan for the project needs is created
	Contact and Select External Developers	External developers are hired in case the team needs them based on project needs
	Sign Development Agreements	Agreements are signed with external and internal developers
Build Prototype	Program the Prototype	The prototype is programmed
	Create Prototype Graphics	Graphic files of the prototype are created
	Test Prototype	The prototype is tested for bugs and also the gameplay is evaluated
	Create Test Report	The test report is created based on the results of the testing
	Present Prototype	The prototype is presented to the complete team in order to register comments. The gameplay and the concept are also presented
	Update Game Requirements	The game requirements are updated according to the results of the presentation
Implement Game	Create Visual Assets	The visual assets of the game are created
	Create Audio Assets	The audio asets of the game are created
	Develop Game Code	The final game code is developed
	Create Text Artwork	The text artwork for the game is created
	Update GDD	Update the GDD based on the changes that occurred during the production phase
	Update TDD	Update the TDD based on the changes that occurred during the

		production phase
	Implement and Test Alpha Version	Implement the alpha version of the game
	Implement and Test Beta Version	Implement the beta version of the game
	Implement Test Group Version	Implement the version to be tested by the target group
Perform QA Tests	Define Testing Schedule and Testing Plan	Define the details, schedule and plan of the testing process
	Identify and Report Bugs	Bugs are identified and reported for fixing
	Fix Bugs	The bugs are fixed
Manage Project	Track Tasks	The tasks needed for the successful completion of the project are tracked
	Measure Progress	The measured of the project is compared to what is needed for the completion of the project
	Control Feature Creep	The feature creep is controled
	Manage Teams	The production teams are managed
	Manage Problems/Changes	Problems/changes that emerged during the production are managed
Perform Marketing Activities	Replace Working Title with Final Title	The final title of the game is created
	Release Screenshots	Game screenshots are released
	Release Demo Versions	The demo version of the game are released

Table 3: Activity Table for Amanatiadou & van de Weerd, (2009) - Serious Games route

Concept	Concept explanation
PROJECT TRIANGLE	A complete set of project goals
GOAL	The game goals
PROJECT DEADLINE	The proect deadline
BUDGET	The budget for the project
RESOURCE SHEET	The resources are included in this document
RISK	The project risks
RISK CLASSIFICATION	A classification of the project risks

Appendix A

GRID	
GAME GOAL	The game goals
GAME CONTEXT	The objective and the target group of the game
GAME MECHANISM	The game mechanics based on elements that exists in all the genres. For example a game can contain elements from puzzle, action, strategy, simulation or more genres
IDEA	A game idea
IDEA	A game idea
GAME SYNOPSIS	Short description of the game
GAME CONCEPT	Game concept is defined together with the client at this early stage
GLOBAL PLANNING	First project planning including milestones and development risks
DOMAIN EXPERT	When developing serious games domain experts need to provide their opinion regarding the GAME CONTENT, the GAME CONCEPT, and the PROJECT DEFINITION
VISUALIZATION	Preliminary graphics of the game
KNOWLEDGE MODEL	The model that represents the knowledge that is included in the game. The company develops training games and therefore this deliverable is crucial
PRESENTATION	During this presentation the decision is made whether to proceed to the next phase. All deliverables of this phase are evaluated (risks,competitors, game ideas, etc.)
CONTRACT	The customer and the company sign the contract with the details of the game development and the business case
PROJECT DEFINITION	The game as a product including the game scope and game concept. It is based on the opinion of experts
TASK	The document that includes all the tasks and assigns them to employees
GAME DESIGN DOCUMENT	The document that includes all the elements of the game design
ART DOCUMENTATION	A document that provides details about the art of the game
CONTEXTUAL GAMEPLAY	A contextual description of the gameplay for the game
STORY	A document that provides the story of the game
REQUIREMENT	Development specifications
CORE GAMEPLAY	The core gameplay is included in this document
VISUALIZATION	A document that provides details about the graphics of the game
TECHNICAL DESIGN DOCUMENT	The document with all the technical design details
SOFTWARE ARCHITECTURE	The structure of the game, for example middleware, game engines and 3rd party software to be used
FUNCTIONAL DESIGN DOCUMENT	User cases, user experience, music and sound design and interaction design are elements of this document that are tested with the target group
PRESENTATION	A presentation of the game design
RISK CLASSIFICATION GRID	A classification of the project risks
RISK	The project risks

TASK LIST	A list of all required tasks for the project
TASK	A task required for the completion of the project
GANT CHART	The gant chart illustrates the project schedule
PERT CHART	This chart analyzes and demostrates the tasks needed for completing the project
BUDGET	The budget for the project is reevaluated at this point
DELIVERABLE	A complete set of features as a game deliverable
PROFIT AND LOSS ACCOUNT	A complete account of profits and losses
WORKLOAD DOCUMENT	The document that includes all the tasks and assigns them to employees
EMPLOYEE	A person working at the project
STAFFING PLAN	A complete plan of all the employees needed for the project
EXTERNAL DEVELOPER	An external developer that is working with the company for various projects depending on the project needs.
DEVELOPMENT AGREEMENT	An agreement which includes the responsibilities of each developer
JOB DESCRIPTION	The description of each specific job
PROTOTYPE	The prototype of the game, it contains the essense of the game for intestive testing
GRAPHIC FILE	Graphic files of the prototype.
BUG	An error in the game code
REQUIREMENT	Development specifications
TEST REPORT	The report with the results of the prototype testing
COMMENTS	Comments made by the development team
VISUAL ASSET	The graphics of the game
AUDIO ASSET	The audio of the game
GAME CODE	The game code
TEXT ARTWORK	The texts of the game
FINAL VERSION	The final version of the game
GDD	During game implementation the GDD document is frequently updated
TDD	The TDD is updated
ALPHA VERSION	The alpha version of the game
BETA VERSION	The beta version of the game
TEST GROUP VERSION	The game version that is going to be tested by the users
TESTING SCHEDULE	The schedule for the tests
TESTING PLAN	The planning process for the game tests
BUG REPORT	A report of a game bug
BUG	An error in the game code
SCREENSHOT	A screenshot of the game
DEMO	A playable demo
VISUAL DEMO	A non-playable demo

Table 4: Concept Table for Amanatiadou & van de Weerd, (2009) - Serious Games route

Appendix A

Figure 38: Serious Game Production Method (Marfisi-Schottman et al., 2009)

Activity	Sub-activity	Explanation
Project request	Client's request	The client requests a SG for his specific needs
	Request analysis	The production team analyzes the business parameters of the game
Game Mock-up model phase	Domain knowledge formalization	The production team along with domain experts and cognitive experts formalizes the required domain knowledge for the game
	Define pedagogical objectives	The domain knowledge is translated into specific pedagogical objectives
	Identify Target audience profiles	The specific details and attributes of the target audience that drive the game design are identified
	Create educational scenario	The pedagogical objectives are translated into educational game modules to be completed by the players
	Create entertainment scenario	The fun factor is embedded into the gameplay through game scenes consisting into the entertainment game scenario
	Create a game storyboard	The entertainment and educational scenarios are combined to a game storyboard
	Create mock-up model art	Based on the storyboard the art designers enrich the game with various audiovisual characteristics
	Create mock-up model	All results from the previous steps are combined into the complete game Mock-up model
Pedagogical quality control phase	Evaluate educational nature of the game	It includes a set of tests on the storyboard to eliminate potential dead ends and ensure that all modules allow the players to learn.
	Include feedback to mock-up model design	The game evaluation is translated into mock-up model updates and refinements
Production phase	Game implementation (parallel)	The final game is implemented in the form of a functional prototype
	Final game art creation (parallel)	The final game art will be designed and included in the final prototype

	User group testing	The prototype is tested by a user group which results in feedback and proposed updates
	Prototype validation	The prototype is validated and debugged
Pedagogical quality certification and Game delivery	Evaluate educational nature of the game	It includes a set of tests on the prototype by educational specialists to ensure the game is educationally sound and provide certification
	Final game implementation	The game prototype is completed and turned into the final shippable game

Table 5: Activity table for Marfisi-Schottman et al. (2009)

Concept	Concept explanation
CLIENT REQUEST	A request in the form of a problem statement
BUSINESS PARAMETERS	The business parameters for the game project (e.g. budget, time-to-market,etc.)
DOMAIN SPECIFIC KNOWLEDGE	The formalized domain specific knowledge for the game
PEDAGOGICAL OBJECTIVES	The pedagogical goals of the game
TARGET AUDIENCE PROFILES	Specific target audience attributes like previous knowledge, age, etc..
EDUCATIONAL GAME MODULES AND EDUCATIONAL SCENARIO	The educational goals are translated into game modules (i.e., sequential educational activities within the game) which are in turn combined to an educational scenario
ENTERTAINMENT SCENARIO AND GAME SCENES	A set of game scenes describing the entertainment aspects of the game which are in turn combined into an entertainment scenario
GAME STORYBOARD	A combination of the educational and entertainment scenarios
MOCK-UP MODEL ART	The audiovisual details of the game
MOCK-UP MODEL	All previous results are combined into the mock-up model
TEST RESULTS	The results from the pedagogical quality tests into the form of a game evaluation
MOCK-UP UPDATES	A list of the updates on the mock-up model based on the feedback from the evaluation
EVALUATION RESULTS	The results from the evaluation which could lead to mock-up model refinements
GAME PROTOTYPE	The mock-up model is turned into a complete playable game prototype which includes everything the final game should include

GAME PROTOTYPE ART	The final game art (visual, audio, etc.) is included in the game prototype
USER GROUP TEST RESULTS	The user group test results in the form of game feedback
GAME VALIDATION	Based on the feedback from the test groups and the client the game is validated and debugged
TEST RESULTS	The results from the pedagogical quality tests into the form of a game evaluation
FINAL GAME	The final serious game

Table 6: Concept table for Marfisi-Schottman et al. (2009)
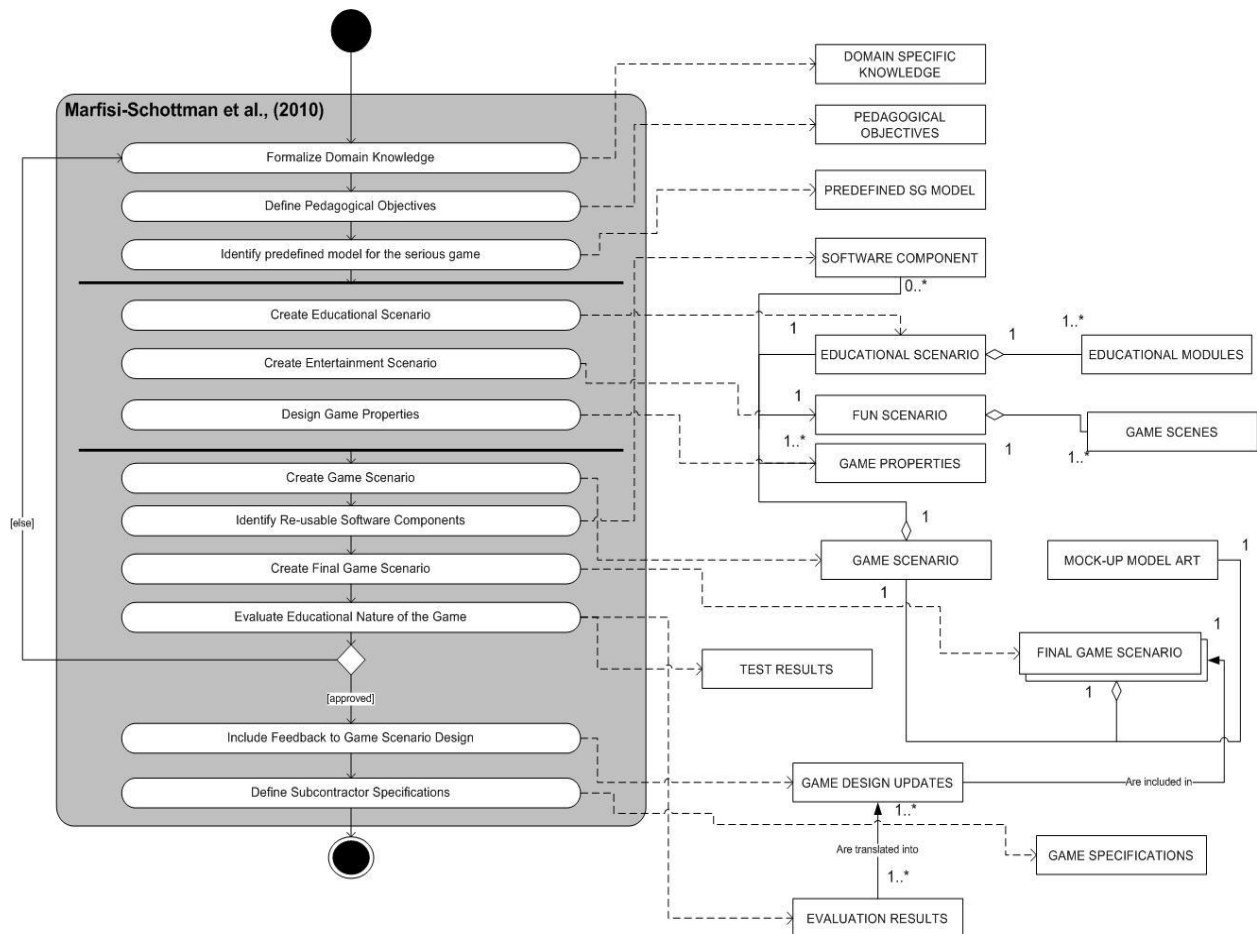
Figure 39: Serious Game Design Phase (Marfisi-Schottman et al., 2010)

Activity	Sub-activity	Explanation
Specification of the pedagogical objectives	Extract and formalize domain specific knowledge	The production team along with domain experts and cognitive experts formalizes the required domain knowledge for the game

	Define pedagogical objectives	The domain knowledge is translated into specific pedagogical objectives
Choice of Serious Game model	Identify predefined model for the serious game	The pedagogical expert can choose a predefined model for the Serious Game
General description of the scenario and virtual environment	Create educational scenario (parallel)	The pedagogical objectives are translated into educational game modules to be completed by the players
	Create fun scenario (parallel)	The fun factor is embedded into the gameplay through game scenes consisting into the entertainment game scenario
	Design game properties (parallel)	The rest of the game properties are designed
	Create game scenario	The entertainment and educational scenarios are combined with the rest of the game properties to a game scenario
Search for reusable software components	Identify software components	The production team searches a software component database for potential reusable software components fitting for the project at hand
Detailed description of the scenario	Create final game scenario	After any potential software components have been identified for reuse the complete game scenario is created by the artistic director and storyboard writer
Pedagogical quality control	Evaluate educational nature of the game	It includes a set of tests on the storyboard to eliminate potential dead ends and ensure that all modules allow the players to learn.
	Include feedback to game design	The game evaluation is translated into updates and refinements
Precise specifications for subcontractors	Define subcontractor specifications	The specifications for all subcontractors (graphic designers, sound managers, developers, etc.) are defined

Table 7: Activity table for Marfisi-Schottman et al. (2010)

Concept	Concept explanation
DOMAIN SPECIFIC KNOWLEDGE	The formalized domain specific knowledge for the game
PEDAGOGICAL OBJECTIVES	The pedagogical goals of the game
PREDEFINED SERIOUS GAME MODEL	A predefined serious game model which includes the game genre and embedded pedagogical tools and modules
EDUCATIONAL GAME MODULES AND EDUCATIONAL SCENARIO	The educational goals are translated into game modules (i.e., sequential educational activities within the game) which are in turn combined to an educational scenario
ENTERTAINMENT SCENARIO AND GAME SCENES	A set of game scenes describing the entertainment aspects of the game which are in turn combined into an entertainment scenario

GAME PROPERTIES	The game properties consist of the rest of the game details outside the educational and entertainment scenarios (e.g., game world details, game characters, etc.)
GAME SCENARIO	A combination of the educational and entertainment scenarios with the rest of the game properties
SOFTWARE COMPONENTS	Any software components from previous projects deemed fitting for reuse in the project at hand
FINAL GAME SCENARIO	The final game scenario includes all potential game scenes, interactions and details that are going to be implemented in the final game
TEST RESULTS	The results from the pedagogical quality tests into the form of a game evaluation
GAME DESIGN UPDATES	A list of the updates on the game design based on the feedback from the evaluation
GAME SPECIFICATIONS	A set of specifications for all subcontractors who will build the final game

Table 8: Concept table for Marfisi-Schottman et al. (2010)
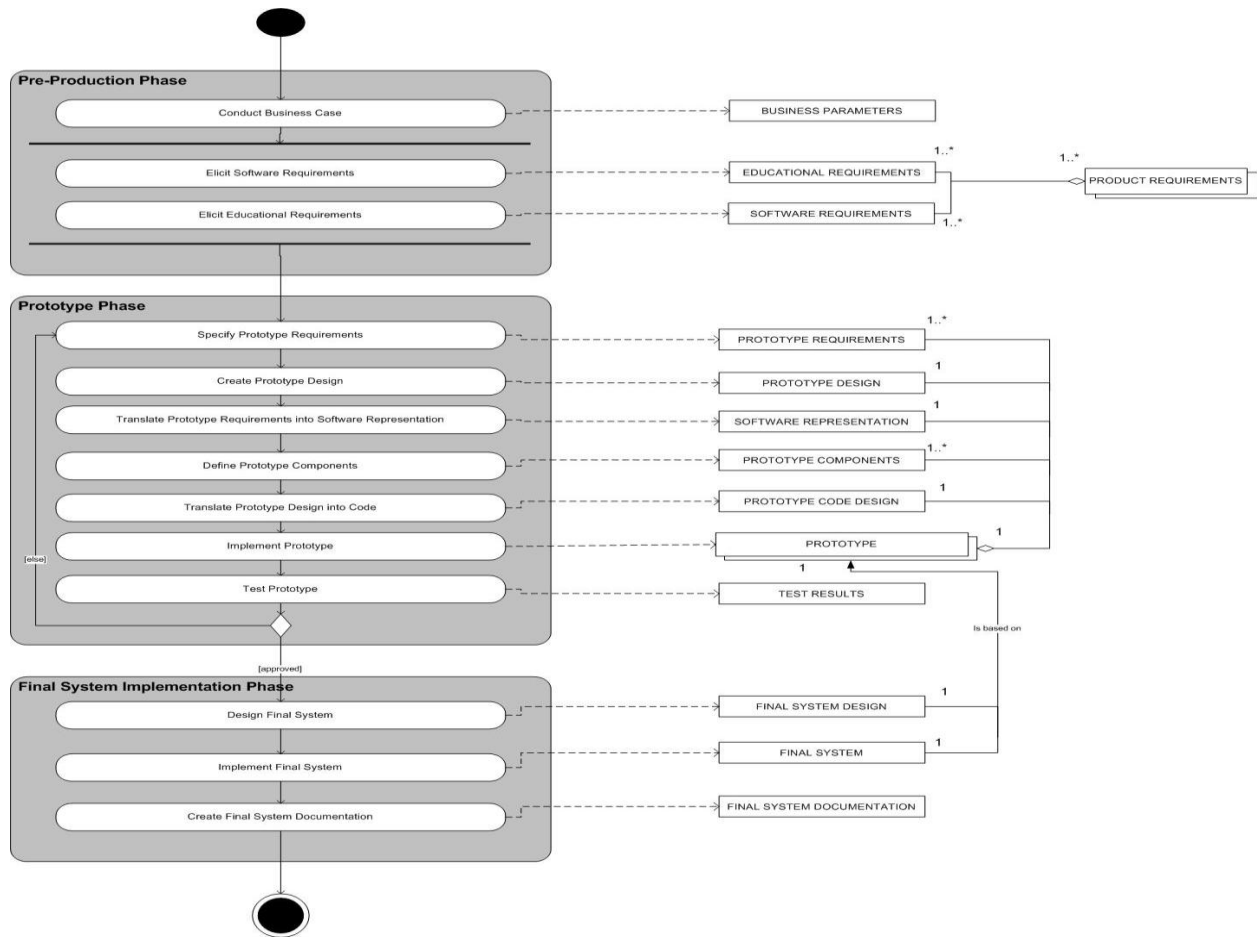
Figure 40: Educational Software Production Method (Lage et al., 2001)

Activity	Sub-activity	Explanation
Feasibility research	Business Case conduction	The production team analyzes the business parameters of the educational software
System requirements definition	Software requirements definition	An initial list of functionalities, interfaces and design development types of the system are defined during this step.
	Educational requirements definition	The educational requirements of the educational software are defined during this step
Specification of prototype requirements	Specify prototype requirements	The sub-set of requirements for the prototype is defined in this step. These include the specification of the prototype functions, its interfaces and input/outputs required for a workable prototype.
Prototype design	Create prototype design	After the requirements list for the prototype has been created an analysis is performed to align them with the implementable modules and functions, how the work is going to be performed, etc..
Detailed design of the prototype	Translate requirements into software representation	During this step, the requirements are translated into the final software representation to ensure the required software quality before the actual implementation begins.

	Define prototype components	The control and data structure, the interface relations, basic algorithms and assumptions of each prototype component are defined in this stage.
Prototype development	Prototype development	The prototype design is translated into code.
Prototype implementation and testing	Prototype implementation	A workable prototype is created during this step
	Prototype testing	The workable prototype is tested to ensure everything works as planned
Design of the final system	Design final system	In this stage, all modules are included in the final system design along with various updates and refinements which are results of the previous stages.
Implementation of the final system	Implement final system	The final system is implemented and installed in the client location
	Create system documentation	The final system documentation is created and delivered to the client
Operation and maintenance (Out of scope)		The system is turned on and monitored for any maintenance required.
Withdrawal (Out of scope)		This step is described as "a transition between the functions carried out for the product and their successors".

Table 9: Activity table for Lage et al. (2001)

Concept	Concept explanation
BUSINESS PARAMETERS	The business parameters for the game project (e.g. budget, time-to-market,etc.)
SOFTWARE REQUIREMENTS	The system requirements are included in this document
EDUCATIONAL REQUIREMENTS	The educational requirements for the system are defined in this step
PROTOTYPE REQUIREMENTS	The prototype requirements, a sub-set of system requirements
PROTOTYPE DESIGN	An analysis including the alignment of prototype requirements with the implementable modules and functions
SOFTWARE REPRESENTATION	A document included the translation from requirements to software representation
PROTOTYPE COMPONENTS	The set of prototype components: data and control structure, interface relations, algorithms, assumptions etc.

PROTOTYPE CODE DESIGN	The prototype design is translated into code
PROTOTYPE	A workable prototype
TEST RESULTS	The results and analysis of the tests conducted on the prototype
FINAL SYSTEM DESIGN	A document which includes all system modules and updates from previous stages
FINAL SYSTEM	The final system implementation
FINAL SYSTEM DOCUMENTATION	The final system documentation

Table 10: Concept table for Lage et al. (2001)

Subactivity	Amanatiadou & van de Weerd, (2009)	Marfisi-Schottman et al. (2009)	Marfisi-Schottman et al. (2010)	Lage et al. (2001)
Set Goals and Analyze them	=			
Set Timeframe	=	><		><
Identify Available Money	=	><		><
Identify Resources	=	><		><
Perform Risk Analysis	=			
Have brainstorm session	=			
Define Game Ideas	=			><
Evaluate Ideas with Client	=			
Create Game Synopsis (parallel)	=			
Create Game Concept (parallel)	=			
Create Global Planning (parallel)	=			
Consult Domain Experts (parallel)	=	><	><	
Create Visualizations (parallel)	=			
Create Knowledge Model (parallel)	=	><	><	
Present Concept to Client	=			
Have Final Decision Meeting	=			
Sign Contract	=			
Brainstorm	=			

Delegate Design	=			
Create Game Design Document	=			
Create Visualizations	=			
Create Technical Design Document	=			
Create Functional Design Document	=			
Present Game Design	=			
Perform Risk Analysis	=			
Define Milestones	=			
Define Project Management Charts	=			
Create Budget	=			
Define and Prioritize Game Features	=	><		><
Conduct Profit and Loss Analysis	=			
Create Workload Document	=			
Create Staffing Plan	=			
Contact and Select External Developers	=			
Sign Development Agreements	=			
Program the Prototype	=	><		><
Create Prototype Graphics	=	><		><
Test Prototype	=	><		><
Create Test Report	=	><		><
Present Prototype	=			
Update Game Requirements	=	><		><
Create Visual Assets	=			

Appendix A

Task	Col2	Col3	Col4	Col5
Create Audio Assets	=			
Develop Game Code	=	><		><
Create Text Artwork	=	><		
Update GDD	=			
Update TDD	=			
Implement and Test Alpha Version	=			
Implement and Test Beta Version	=			
Implement Test Group Version	=	><		><
Define Testing Schedule and Testing Plan	=			
Identify and Report Bugs	=	><		><
Fix Bugs	=	><		><
Track Tasks	=			
Measure Progress	=			
Control Feature Creep	=			
Manage Teams	=			
Manage Problems/Changes	=			
Replace Working Title with Final Title	=			
Release Screenshots	=			
Release Demo Versions	=			
Client's request		=		
Request analysis		=		
Domain knowledge formalization	><	=	=	
Define pedagogical objectives		=	=	><
Identify Target audience profiles		=		
Create educational scenario	><	=	=	><

Create entertainment scenario	><	=	=	
Create a game storyboard		=	><	
Create mock-up model art		=		
Create mock-up model		=		
Evaluate educational nature of the game		=	=	
Include feedback to mock-up model design		=	><	
Evaluate mock-up model		=	><	
Game implementation (parallel)	=	=		><
Final game art creation (parallel)	><	=		
User group testing	><	=		><
Prototype validation	><	=		><
Evaluate educational nature of the game	><	=	=	><
Final game implementation	><	=		><
Extract and formalize domain specific knowledge	><	=	=	
Define pedagogical objectives	><	=	=	><
Identify predefined model for the serious game			=	
Create	><	=	=	

Appendix A

educational scenario (parallel)				
Create fun scenario (parallel)	><	=	=	
Design game properties (parallel)	><		=	
Create game scenario	><	=	=	
Identify software components			=	
Create final game scenario	><		=	
Evaluate educational nature of the game	><	=	=	><
Include feedback to game design	><	=	=	><
Define subcontractor specifications			=	
Business Case conduction	><	=		=
Software requirements definition	><			=
Educational requirements definition	><	><	><	=
Specify prototype requirements	><			=
Create prototype design	><			=
Translate requirements into software representation				=
Define prototype components	><	><		=
Prototype development	><	><		=
Prototype implementation	><	><		=
Prototype testing	=	><		=
Design final system	><	><		=

Implement final system	><	=		=
Create system documentation				=

Table 11: Activity Comparison Table

Supermethod Concept	Amanatiadou & van de Weerd, (2009)	Marfisi-Schottman et al. (2009)	Marfisi-Schottman et al. (2010)	Lage et al. (2001)
PROJECT TRIANGLE	=			
GOAL	=			
PROJECT DEADLINE	=	><		><
BUDGET	=	><		><
RESOURCE SHEET	=	><		><
RISK	=	><		><
RISK CLASSIFICATION GRID	=			
GAME GOAL	=	><	><	
GAME CONTEXT	=	><	><	
GAME MECHANISM	=	><	><	
IDEA	=			
IDEA	=			
GAME SYNOPSIS	=	><	><	
GAME CONCEPT	=	><	><	
GLOBAL PLANNING	=			
DOMAIN EXPERT	=			
VISUALIZATION	=	><		
KNOWLEDGE MODEL	=	><	><	
PRESENTATION	=			
CONTRACT	=			
PROJECT DEFINITION	=			
TASK	=			
GAME DESIGN DOCUMENT	=			
ART DOCUMENTATION	=			
CONTEXTUAL GAMEPLAY	=	><	><	
STORY	=	><	><	
REQUIREMENT	=	><	><	><
CORE GAMEPLAY	=	><	><	
VISUALIZATION	=	><		

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TECHNICAL DESIGN DOCUMENT	=			
SOFTWARE ARCHITECTURE	=			
FUNCTIONAL DESIGN DOCUMENT	=			
PRESENTATION	=			
RISK CLASSIFICATION GRID	=			
RISK	=			
TASK LIST	=			
TASK	=			
GANT CHART	=			
PERT CHART	=			
BUDGET	=			><
DELIVERABLE	=			
PROFIT AND LOSS ACCOUNT	=			
WORKLOAD DOCUMENT	=			
EMPLOYEE	=			
STAFFING PLAN	=			
EXTERNAL DEVELOPER	=			
DEVELOPMENT AGREEMENT	=			
JOB DESCRIPTION	=			
PROTOTYPE	=	=		=
GRAPHIC FILE	=	><		
BUG	=	><		><
REQUIREMENT	=	><		><
TEST REPORT	=	><		><
COMMENTS	=			
VISUAL ASSET	=	><		
AUDIO ASSET	=	><		
GAME CODE	=	><		
TEXT ARTWORK	=	><		
FINAL VERSION	=	=		
GDD	=			
TDD	=			
ALPHA VERSION	=			
BETA VERSION	=			
TEST GROUP VERSION	=	><		><
TESTING SCHEDULE	=			
TESTING PLAN	=			
BUG REPORT	=			
BUG	=	><		><

SCREENSHOT	=			
DEMO	=			
VISUAL DEMO	=			
CLIENT REQUEST		=		
BUSINESS PARAMETERS	><	=		
DOMAIN SPECIFIC KNOWLEDGE	><	=	=	><
PEDAGOGICAL OBJECTIVES	><	=	=	><
TARGET AUDIENCE PROFILES		=		><
EDUCATIONAL GAME MODULES AND EDUCATIONAL SCENARIO	><	=	=	><
ENTERTAINMENT SCENARIO AND GAME SCENES	><	=	=	
GAME STORYBOARD		=	><	
MOCK-UP MODEL ART		=		
MOCK-UP MODEL		=		
TEST RESULTS	><	=	><	
MOCK-UP UPDATES		=		
EVALUATION RESULTS	><	=	><	><
GAME PROTOTYPE	=	=		=
GAME PROTOTYPE ART	=	=		
USER GROUP TEST RESULTS	><	=		
GAME VALIDATION	><	=		><
TEST RESULTS	><	=	><	><
FINAL GAME	=	=		><
DOMAIN SPECIFIC KNOWLEDGE	><	=	=	><
PEDAGOGICAL OBJECTIVES	><	=	=	><
PREDEFINED SERIOUS GAME MODEL			=	
EDUCATIONAL GAME MODULES AND EDUCATIONAL SCENARIO	><	=	=	><
ENTERTAINMENT	><	=	=	

Appendix A

SCENARIO AND GAME SCENES				
GAME PROPERTIES	><		=	
GAME SCENARIO	><	><	=	
SOFTWARE COMPONENTS			=	><
FINAL GAME SCENARIO	><	><	=	
TEST RESULTS	><		=	><
GAME DESIGN UPDATES	><		=	
GAME SPECIFICATIONS	><		=	
BUSINESS PARAMETERS	><	=		=
SOFTWARE REQUIREMENTS	><			=
EDUCATIONAL REQUIREMENTS	><	><	><	=
PROTOTYPE REQUIREMENTS	><	><		=
PROTOTYPE DESIGN	><	><		=
SOFTWARE REPRESENTATION				=
PROTOTYPE COMPONENTS	><	><		=
PROTOTYPE CODE DESIGN	><	><		=
PROTOTYPE	=	=		=
TEST RESULTS	=	><	><	=
FINAL SYSTEM DESIGN	><	><	><	=
FINAL SYSTEM	=	=		=
FINAL SYSTEM DOCUMENTATION				=

Table 12: Concepts Comparions Table

Activity	Subactivity	Activity Explanation
Identify Business parameters	Set Goals and Analyze them	The goals for the project are set and analyzed
	Set Timeframe	The timeframe for the project is set
	Identify Available Money	The budget for the project is set
	Identify Resources	The resources for the project are identified
	Perform Risk Analysis	A risk analysis is conducted for the project
Define Game Concept	Have brainstorm session	The first meeting of the team where the GAME GOAL, GAME MECHANICS and GAME CONTEXT are defined
	Define Game Ideas	The main game ideas are defined

	Evaluate Ideas with Client	The ideas are evaluated with the client and updated
	Create Game Synopsis (parallel)	A short description of the game that is used as input for the GAME CONCEPT
	Create Game Concept (parallel)	The game concept is created
	Create Global Planning (parallel)	Planning the project and finalizing the budget. Defining possible problems
	Consult Domain Experts (parallel)	The domain experts for the serious game are consulted for the extraction and formalization of the domain knowledge
	Create Visualizations (parallel)	The preliminary visualizations for the game are created
	Create Knowledge Model (parallel)	The knowledge model for the serious game is created
	Present Concept to Client	The concept is presented to the client
	Have Final Decision Meeting	A decision meeting takes place to evaluate and approve the game concept
	Sign Contract	The contract for the game is signed between the client and the production company
Game Mock-up model phase	Domain knowledge formalization	The production team along with domain experts and cognitive experts formalizes the required domain knowledge for the game
	Define pedagogical objectives	The domain knowledge is translated into specific pedagogical objectives
	Identify Target audience profiles	The specific details and attributes of the target audience that drive the game design are identified
	Create educational scenario	The pedagogical objectives are translated into educational game modules to be completed by the players
	Create entertainment scenario	The fun factor is embedded into the gameplay through game scenes consisting into the entertainment game scenario
	Create a game storyboard	The entertainment and educational scenarios are combined to a game storyboard
	Create mock-up model art	Based on the storyboard the art designers enrich the game with various audiovisual characteristics
	Create mock-up model	All results from the previous steps are combined into the complete game Mock-up model
Pedagogical quality control phase	Evaluate educational nature of the game	It includes a set of tests on the storyboard to eliminate potential dead ends and ensure that all modules allow the players to learn.
	Include feedback to mock-up model design	The game evaluation is translated into mock-up model updates and refinements

Appendix A

Create Game Design	Brainstorm	The first meeting of the team where the next steps of the process are defined
	Delegate Design	The design process steps are delegated to the team
	Create Game Design Document	The Game Design Document is created by combining all sub-pieces
	Create Visualizations	The visualizations for the prototype are created
	Create Technical Design Document	The TDD is created
	Create Functional Design Document	The FDD is created
	Present Game Design	The game design is presented to the complete team and the client
Make Project Plan	Perform Risk Analysis	A risk analysis is conducted for the project
	Define Milestones	The milestones for the project are defined
	Define Project Management Charts	Various project management charts are created for the monitoring of the project
	Create Budget	The budget for the project is re-evaluated at this point
	Define and Prioritize Game Features	The game features are analyzed an prioritized based on the project details
	Conduct Profit and Loss Analysis	A profit and loss analysis is conducted
Hire People	Create Workload Document	Defining Tasks
	Create Staffing Plan	A staffing plan for the project needs is created
	Contact and Select External Developers	External developers are hired in case the team needs them based on project needs
	Sign Development Agreements	Agreements are signed with external and internal developers
Build Prototype	Specify prototype requirements	The sub-set of requirements for the prototype is defined in this step. These include the specification of the prototype functions, its interfaces and input/outputs required for a workable prototype.
	Create prototype design	After the requirements list for the prototype has been created an analysis is performed to align them with the implementable modules and functions, how the work is going to be performed, etc..
	Translate requirements into software representation	During this step, the requirements are translated into the final software representation to ensure the required software quality before the actual implementation begins.
	Define prototype components	The control and data structure, the interface relations, basic algorithms and assumptions of each prototype component are defined in this stage.
	Prototype development	The prototype design is translated into code.

	Create Prototype Graphics	Graphic files of the prototype are created
	Test Prototype	The prototype is tested for bugs and also the gameplay is evaluated
	Create Test Report	The test report is created based on the results of the testing
	Present Prototype	The prototype is presented to the complete team in order to register comments. The gameplay and the concept are also presented
	Update Game Requirements	The game requirements are updated according to the results of the presentation
Implement Game	Create Visual Assets	The visual assets of the game are created
	Create Audio Assets	The audio asets of the game are created
	Develop Game Code	The final game code is developed
	Create Text Artwork	The text artwork for the game is created
	Update GDD	Update the GDD based on the changes that occurred during the production phase
	Update TDD	Update the TDD based on the changes that occurred during the production phase
	Implement and Test Alpha Version	Implement the alpha version of the game
	Implement and Test Beta Version	Implement the beta version of the game
	Implement Test Group Version	Implement the version to be tested by the target group
Perform QA Tests	Define Testing Schedule and Testing Plan	Define the details, schedule and plan of the testing process
	Identify and Report Bugs	Bugs are identified and reported for fixing
	Fix Bugs	The bugs are fixed
Manage Project	Track Tasks	The tasks needed for the successful completion of the project are tracked
	Measure Progress	The measured of the project is compared to what is needed for the completion of the project
	Control Feature Creep	The feature creep is controled
	Manage Teams	The production teams are managed
	Manage Problems/Changes	Problems/changes that emerged during the production are managed

Perform Marketing Activities	Replace Working Title with Final Title	The final title of the game is created
	Release Screenshots	Game screenshots are released
	Release Demo Versions	The demo version of the game are released

Table 13: Activities table for literature reference serious game production method

Concept	Concept explanation
PROJECT TRIANGLE	A complete set of project goals
GOAL	The game goals
PROJECT DEADLINE	The proect deadline
BUDGET	The budget for the project
RESOURCE SHEET	The resources are included in this document
RISK	The project risks
RISK CLASSIFICATION GRID	A classification of the project risks
GAME GOAL	The game goals
GAME CONTEXT	The objective and the target group of the game
GAME MECHANISM	The game mechanics based on elements that exists in all the genres. For example a game can contain elements from puzzle, action, strategy, simulation or more genres
IDEA	A game idea
IDEA	A game idea
GAME SYNOPSIS	Short description of the game
GAME CONCEPT	Game concept is defined together with the client at this early stage
GLOBAL PLANNING	First project planning including milestones and development risks
DOMAIN EXPERT	When developing serious games domain experts need to provide their opinion regarding the GAME CONTENT, the GAME CONCEPT, and the PROJECT DEFINITION
VISUALIZATION	Preliminary graphics of the game
KNOWLEDGE MODEL	The model that represents the knowledge that is included in the game. The company develops training games and therefore this deliverable is crucial
PRESENTATION	During this presentation the decision is made whether to proceed to the next phase. All deliverables of this phase are evaluated (risks, competitors, game ideas, etc.)
CONTRACT	The customer and the company sign the contract with the details of the game development and the business case
DOMAIN SPECIFIC KNOWLEDGE	The formalized domain specific knowledge for the game
PEDAGOGICAL OBJECTIVES	The pedagogical goals of the game
TARGET AUDIENCE	Specific target audience attributes like previous knowledge, age, etc..

PROFILES	
EDUCATIONAL GAME MODULES AND EDUCATIONAL SCENARIO	The educational goals are translated into game modules (i.e., sequential educational activities within the game) which are in turn combined to an educational scenario
ENTERTAINMENT SCENARIO AND GAME SCENES	A set of game scenes describing the entertainment aspects of the game which are in turn combined into an entertainment scenario
GAME STORYBOARD	A combination of the educational and entertainment scenarios
MOCK-UP MODEL ART	The audiovisual details of the game
MOCK-UP MODEL	All previous results are combined into the mock-up model
TEST RESULTS	The results from the pedagogical quality tests into the form of a game evaluation
MOCK-UP UPDATES	A list of the updates on the mock-up model based on the feedback from the evaluation
EVALUATION RESULTS	The results from the evaluation which could lead to mock-up model refinements
PROJECT DEFINITION	The game as a product including the game scope and game concept. It is based on the opinion of experts
TASK	The document that includes all the tasks and assigns them to employees
GAME DESIGN DOCUMENT	The document that includes all the elements of the game design
ART DOCUMENTATION	A document that provides details about the art of the game
CONTEXTUAL GAMEPLAY	A contextual description of the gameplay for the game
STORY	A document that provides the story of the game
REQUIREMENT	Development specifications
CORE GAMEPLAY	The core gameplay is included in this document
VISUALIZATION	A document that provides details about the graphics of the game
TECHNICAL DESIGN DOCUMENT	The document with all the technical design details
SOFTWARE ARCHITECTURE	The structure of the game, for example middleware, game engines and 3rd party software to be used
FUNCTIONAL DESIGN DOCUMENT	User cases, user experience, music and sound design and interaction design are elements of this document that are tested with the target group
PRESENTATION	A presentation of the game design
RISK CLASSIFICATION	A classification of the project risks

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GRID	
RISK	The project risks
TASK LIST	A list of all required tasks for the project
TASK	A task required for the completion of the project
GANT CHART	The gant chart illustrates the project schedule
PERT CHART	This chart analyzes and demostrates the tasks needed for completing the project
BUDGET	The budget for the project is reevaluated at this point
DELIVERABLE	A complete set of features as a game deliverable
PROFIT AND LOSS ACCOUNT	A complete account of profits and losses
WORKLOAD DOCUMENT	The document that includes all the tasks and assigns them to employees
EMPLOYEE	A person working at the project
STAFFING PLAN	A complete plan of all the employees needed for the project
EXTERNAL DEVELOPER	An external developer that is working with the company for various projects depending on the project needs.
DEVELOPMENT AGREEMENT	An agreement which includes the responsibilities of each developer
JOB DESCRIPTION	The description of each specific job
PROTOTYPE REQUIREMENTS	The prototype requirements, a sub-set of system requirements
PROTOTYPE DESIGN	An analysis including the alignment of prototype requirements with the implementable modules and functions
SOFTWARE REPRESENTATION	A document included the translation from requirements to software representation
PROTOTYPE COMPONENTS	The set of prototype components: data and control structure, interface relations, algorithms, assumptions etc.
PROTOTYPE CODE DESIGN	The prototype design is translated into code
PROTOTYPE	The playable prototype of the game, it contains the essence of the game for intensive testing
GRAPHIC FILE	Graphic files of the prototype.
BUG	An error in the game code
REQUIREMENT	Development specifications
TEST REPORT	The report with the results of the prototype testing
COMMENTS	Comments made by the development team
VISUAL ASSET	The graphics of the game
AUDIO ASSET	The audio of the game
GAME CODE	The game code
TEXT ARTWORK	The texts of the game
FINAL VERSION	The final version of the game
GDD	During game implementation the GDD document is frequently updated
TDD	The TDD is updated
ALPHA VERSION	The alpha version of the game
BETA VERSION	The beta version of the game
TEST GROUP	The game version that is going to be tested by the users

VERSION	
TESTING SCHEDULE	The schedule for the tests
TESTING PLAN	The planning process for the game tests
BUG REPORT	A report of a game bug
BUG	An error in the game code
SCREENSHOT	A screenshot of the game
DEMO	A playable demo
VISUAL DEMO	A non-playable demo

Table 14: Concept table for literature reference serious game production method

Figure 41: Create Game Concept phase for the literature reference serious game production method

Figure 42: Pre-production phase for the literature reference serious game production method

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Figure 43: Production phase for the literature reference serious game production method

Appendix B

Figure 44: General Production Process – Interview 1

Figure 45: Game Concept Phase - Interview 1

Figure 46: Pre-Production Phase - Interview 1

Figure 47: Production Phase- Interview 1

Activities	Activities Description	Sub Activities	Sub-Activities description
Elicit Game Idea	During this activity the game idea is brought in by the client or by a team member and consequently formulated as a problem through internal brainstorming	Identify initial game idea	The idea is presented to the team by a client or a team member
		Formulate Game Problem Statement	The idea is formulated as a problem through a round of internal brainstorming
Research	The idea is	Business Case feasibility	A feasibility research (Market size,

Game Idea Feasibility	researched. If it is a client based the project parameters are set but if it is market based a feasibility study is conducted to identify whether the team will take the project or not	research (for market based games)	potential revenue, marketing costs, etc.) is conducted to determine whether the team should start the project or not
		Project parameters research (Budget, time to market, etc.)	After the feasibility research a number of important parameters is decided (Budget needs, time-to-market, etc.). These parameters are really important for the game proposal to the client
		Informal GDD creation	An informal Game Design Document (GDD) is created mostly for client needs
		Game proposal to client	A game proposal is handed to the client to decide whether they want to continue with the game project
Create Game Concept	Game concept creation step	Team brainstorming	Team brainstorming session to elicit features and details for the game concept
		Client interviews	The team interviews the client to elicit features and details for the game concept
		Literature research	A literature research is conducted for features elicitation for the game concept
		Target audience research	A target audience research is conducted for features elicitation for the game concept
		Draft Game Concept design	A draft game concept is created
		Draft Game Concept evaluation	The team evaluates the draft game concept with the client
		Final Game Concept creation	A final game concept is created
Create Pen and Paper prototype	Pen and paper creation and analysis	Client interviews for features elicitation	Based on the game concept further interviews with the client take place for specific features and needs the pen and paper prototype should address and are included in a pen-

			and-paper-prototype backlog
		Literature research (for market based games)	Based on the game concept further literature review is conducted for specific features the pen and paper prototype must include in order to be representative of the game and are included in a pen-and-paper-prototype backlog(only for market based games)
		Internal Brainstorming	A round of internal brainstorming takes place to evaluate the results of the previous steps and update the pen and paper prototype backlog
		Design prototype gameplay elements and storyline	A first gameplay design and important elements and a storyline for the pen-and-paper prototype are decided
		Pre-sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Pen and Paper prototype sprint	During the sprint a playable pen and paper prototype is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the pen and paper prototype increment created during the sprint. This process leads to improvements
		Sprint retrospective (post sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Create Game Design	Game Design creation	Identify extensive Gameplay elements and storyline	After the pen-and-paper-prototype has been approved the extensive gameplay for the whole game and the storyline are designed
		Design Educational mechanics and "Game Missions"	The educational objectives and the domain knowledge are translated in the game mechanics and missions
		Design SG components and behaviors	Further Serious Game components (player avatars, characteristics, etc.) and associated behaviors are decided
		Create Visualization prototypes	Some first visualizations are designed as draft prototypes

		Create Game Design	The complete game design document which includes the previous steps is created to guide the rest of the production process
Prototyping	Prototype development (SCRUM type approach)	Product Backlog creation	The complete product backlog is created which includes the game features and details in a prioritized list
		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game prototype increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the prototype increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective (post-sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
		Alpha Version build	After the prototype has been approved by the client and the team the alpha version is build
		Internal Testing	The alpha version is tested internally which leads to proposed improvements and a revised product backlog
Pedagogical quality assessment (In parallel with playtesting)	Evaluation whether the game actually educates its users	Pre-testing meeting (pedagogical quality assessment)	Before the user group testing the members of the group take a knowledge test to identify their knowledge status before the use of the game. This will allow later to identify the effects the game had on them (if any)
		User group pedagogical quality test	After the user group plays the game they take a knowledge test again to see any changes in their knowledge status
		Post-testing meeting (pedagogical quality	The test results are analyzed and compared to identify whether the

		assessment)	game had any significant effect in the knowledge status of the users. This process can lead to changes in the game design and the product backlog
Playtesting (In parallel with pedagogical quality assessment)	Game play testing by test user groups for feedback and updates	Beta Version	After the alpha version has been approved a beta version for playtesting is created
		User group testing	The beta version is tested by user groups which leads to a lot of feedback on the game and naturally updates and changes in the product backlog
Final Art Creation		Design final game Art assets (i.e., graphics, sound, music, models, etc.)	The final game art is designed in various art concepts
		Art assets evaluation	The client evaluates the art assets concepts and chooses what they want
		Include art assets in Product backlog	These art assets are translated into features and included in the product backlog for implementation
Final Implementation		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the game increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Final Game delivery	The final game is delivered		
Final Game documentation delivery	The game documentation is delivered to the client		
Closed phase -	Out of scope		

No specific activities mentioned			

Table 15: Activities table - Interview 1

Concepts	Concepts description
IDEA PROPOSAL	Contains the details of the initial game idea
BUSINESS CASE RESULTS	Contains the results of the business case
PROJECT PARAMETERS	Contains the project parameters
INFORMAL GDD	Includes the details of the project in a structured style for the client
GAME PROPOSAL	A complete game project proposal for the client to evaluate
GAME CONCEPT FEATURES LIST	A list of all the features and their details for the game concept
DRAFT GAME CONCEPT	Includes the details of the game concept which lead to the next steps of the game design
FINAL GAME CONCEPT	Includes the complete details of the game concept which lead to the next steps of the game design
PEN AND PAPER PROTOTYPE BACKLOG	Includes all the features which are going to be included in the pen and paper prototype in a prioritized list
SPRINT BACKLOG	Includes a sub-set of features from the pen-and-paper-prototype product log which are going to be included in the next increment
PEN AND PAPER PROTOTYPE INCREMENT	A playable pen and paper prototype increment for the client to use and evaluate
REVISED PEN AND PAPER BACKLOG	An updated pen and paper prototype backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
GAMEPLAY ELEMENTS AND STORYLINE	This document includes the descriptions of the gameplay elements and of the storyline
GAME MISSIONS	This document includes the domain knowledge required to be taught and the missions where this knowledge is going to be tested
SG COMPONENTS AND ASSOCIATED BEHAVIORS	The rest of SG components (avatars, characteristics, etc.) and their descriptions along with allowed behaviors
VISUALIZATION PROTOTYPE	A first crude description of some basic visualizations
GAME DESIGN	The results of the previous steps are combined in a complete document entitled "Game Design"
PRODUCT BACKLOG	Includes all the features which are going to be included in the game product in a prioritized list
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME PROTOTYPE INCREMENT	A playable prototype increment for the client to use and evaluate
REVISED PRODUCT BACKLOG	An updated prototype product backlog based on the results of the

	previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
ALPHA VERSION	The alpha version of the game
REVISED PRODUCT BACKLOG	An updated product backlog based on the results of the alpha version testing
PRE-TEST RESULTS	The pre-test knowledge test results from the test group
TEST RESULTS	The test knowledge test results from the test group
PEDAGOGICAL QUALITY ASSESSMENT ANALYSIS AND REVISED PRODUCT BACKLOG	An analysis and comparison of the test results before and after the use of the game
BETA VERSION	The beta version of the game
GAME FEEDBACK AND REVISED PRODUCT BACKLOG	An updated product backlog based on the results of the beta version testing
GAME ART ASSETS DESIGN CONCEPTS	This document includes sets of art assets concepts
ART ASSETS	The final art assets chosen by the client and the team
UPDATED PRODUCT BACKLOG	An updated product backlog which now includes the art assets for the final implementation rounds
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME INCREMENT	A playable game increment for the client to use and evaluate
UPDATED PRODUCT BACKLOG	An updated game product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
FINAL GAME	The final game
GAME DOCUMENTATION	The final game documentation

Table 16: Concepts table - Interview 1

Figure 48: General Production Process - Interview 2

Appendix B

Figure 49: Game Concept Phase - Interview 2

Figure 50: Pre- Production Phase - Interview 2

Appendix B

Figure 51: Production Phase - Interview 2

Activities	Activities Description	Sub Activities	Sub-Activities description
Elicit Game Idea	During this activity the game idea is brought in by the client or by a team member and consequently formulated as a problem through internal brainstorming	Identify initial game idea	The idea is presented to the team by a client or a team member
		Formulate Game Problem Statement	The idea is formulated as a problem through a round of internal brainstorming
Research Game Idea Feasibility	The idea is researched. If it is a client based the project parameters are set but if it is market based a feasibility study is conducted to identify whether the team will take the project or not	Business Case feasibility research (for market based games)	A feasibility research (Market size, potential revenue, marketing costs, etc.) is conducted to determine whether the team should start the project or not
		Project parameters research (Budget, time to market, etc.)	After the feasibility research a number of important parameters is decided (Budget needs, time-to-market, etc.). These parameters are really important for the game proposal to the client
		Conduct workshop or case study at client environment	Conducting a case study or even a workshop at the client environment allows the team to gain a much better understanding of what the client wants and needs
		Informal GDD creation	An informal Game Design Document (GDD) is created mostly for client needs
		Game proposal to client	A game proposal is handed to the client to decide whether they want to continue with the game project
Create Game	Game concept	Team	Team brainstorming session to elicit

Appendix B

Concept	creation step	brainstorming	requirements and details for the game concept
		Client interviews	The team interviews the client to elicit requirements and details for the game concept
		Literature research	A literature research is conducted for requirements elicitation for the game concept
		Target audience research	A target audience research is conducted for requirements elicitation for the game concept
		Draft Game Concepts design	A dozen of draft game concepts are created
		Draft Game Concepts evaluation	The team evaluates the draft game concepts with the client
		Final Game Concept creation	A final game concept is created
Create simple prototype	"Simple" prototype (i.e., playing cards, dice and poker chips) creation and analysis	Client interviews for requirements elicitation (parallel)	Based on the game concept further interviews with the client take place for specific requirements and needs the pen and paper prototype should address and are included in a pen-and-paper-prototype requirements set
		Literature research (for market based games) (parallel)	Based on the game concept further literature review is conducted for specific requirements the pen and paper prototype must include in order to be representative of the game and are included in a pen-and-paper-prototype requirements set(only for market based games)
		Internal Brainstorming (parallel)	A round of internal brainstorming takes place to evaluate the results of the previous steps and update the pen and paper prototype requirements set
		Design prototype gameplay elements and storyline (parallel)	A first gameplay design and important elements and a storyline for the pen-and-paper prototype are decided
		Iterative development step pre-meeting	A meeting before the development round to decide the goal and the set of requirements to be included in the prototype increment
		Simple prototype development	During the development round a playable simple prototype is created
		development round review with client	After the development round a review meeting with the client takes place to review the simple prototype increment created during the development round. This process leads to improvements

		development round retrospective (post development round review)	An internal retrospective meeting takes place to analyze the comments from the development round review meeting, the suggestions for improvements and potentially add more to the next development round requirements set
Playtesting	Game play testing by the development team, the client and test user groups from the target audience for feedback and updates	Internal Playtesting (parallel)	The game is play tested internally which leads to proposed improvements and a revised product requirements set
		User group testing (parallel)	The game is tested by user groups which leads to a lot of feedback on the game and naturally updates and changes in the product requirements set
		Client Playtesting (parallel)	The game is tested by client representatives which leads to proposed improvements and a revised game requirements set
Create Game Design	Game Design creation	Identify hiring needs	Based on the results from the previous phase a list of hiring needs for the project at hand is created
		Identify extensive Gameplay elements and storyline	After the simple prototype has been approved the extensive gameplay for the whole game and the storyline are designed
		Design Educational mechanics and "Game Missions"	The educational objectives and the domain knowledge are translated in the game mechanics and embedded in the gameplay
		Design SG components and behaviors	Further Serious Game components (player avatars, characteristics, etc.) and associated behaviors are decided
		Create Visualization prototypes	Some first visualizations are designed as draft prototypes
		Create Game Design	The complete game design document which includes the previous steps is created to guide the rest of the production process
Prototyping	Prototype development (SCRUM type	Product requirements set creation	The complete product requirements set is created which includes the game requirements and details in a prioritized list

		approach)	
		Pre-development round meeting	A meeting before the development round to decide the development round goal and the development round requirements set
		development round	During the development round a playable game prototype increment is created
		development round review/playtesting with client	After the development round a review meeting with the client takes place to review the prototype increment created during the development round. This process leads to proposed improvements
		development round retrospective (post-development round review)	An internal retrospective meeting takes place to analyze the comments from the development round review meeting, the suggestions for improvements and potentially add more to the next development round requirements set
Playtesting	Game play testing by the development team, the client and test user groups from the target audience for feedback and updates	Internal Playtesting (parallel)	The game is play tested internally which leads to proposed improvements and a revised product requirements set
		User group testing (parallel)	The game is tested by user groups which leads to a lot of feedback on the game and naturally updates and changes in the product requirements set
		Client Playtesting (parallel)	The game is tested by client representatives which leads to proposed improvements and a revised game requirements set
Final Art Creation		Design final game Art assets (i.e., graphics, sound, music, models, etc.)	The final game art is designed in various art concepts
		Art assets evaluation	The client evaluates the art assets concepts and chooses what they want
		Include art assets in Product requirements set	These art assets are translated into requirements and included in the product requirements set for implementation
Final Implementation		Identify further hiring needs	The team evaluates the project progress and identifies any further hiring needs
		Pre-development	A meeting before the development round to

		round meeting	decide the development round goal and the development round requirements set
		development round	During the development round a playable game increment is created
		development round review with client	After the development round a review meeting with the client takes place to review the game increment created during the development round. This process leads to proposed improvements
		development round retrospective	An internal retrospective meeting takes place to analyze the comments from the development round review meeting, the suggestions for improvements and potentially add more to the next development round requirements set
Playtesting	Game play testing by the development team, the client and test user groups from the target audience for feedback and updates	Internal Playtesting (parallel)	The game is play tested internally which leads to proposed improvements and a revised product requirements set
		User group testing (parallel)	The game is tested by user groups which leads to a lot of feedback on the game and naturally updates and changes in the product requirements set
		Client Playtesting (parallel)	The game is tested by client representatives which leads to proposed improvements and a revised game requirements set
Final Game delivery	The final game is delivered		
Final Game documentation delivery	The game documentation is delivered to the client		
Closed phase - No specific activities mentioned	Out of scope		

Table 17: Activities table - Interview 2

Appendix B

Concepts	Concepts description
IDEA PROPOSAL	Contains the details of the initial game idea
BUSINESS CASE RESULTS	Contains the results of the business case
PROJECT PARAMETERS	Contains the project parameters
CASE STUDY RESULTS	Contains the results of the case study and a crude set of initial requirements for the game
INFORMAL GDD	Includes the details of the project in a structured style for the client
GAME PROPOSAL	A complete game project proposal for the client to evaluate
GAME CONCEPT REQUIREMENTS LIST	A list of all the requirements and their details for the game concept
GAME CONCEPT REQUIREMENTS LIST	A list of all the requirements and their details for the game concept
DRAFT GAME CONCEPTS	Includes the details of the game concept which lead to the next steps of the game design
FINAL GAME CONCEPT	Includes the complete details of the game concept which lead to the next steps of the game design
SIMPLE PROTOTYPE REQUIREMENTS SET	Includes all the requirements which are going to be included in the simple prototype in a prioritized list
REQUIREMENTS TO BE DEVELOPED LIST	Includes a sub-set of requirements from the simple prototype requirements list which are going to be included in the next increment
SIMPLE PROTOTYPE INCREMENT	A playable prototype increment for the client to use and evaluate
REVISED PEN AND PAPER REQUIREMENTS SET	An updated prototype requirements list based on the results of the previous development round
NEXT DEVELOPMENT ROUND UPDATES	A list of updates for the next development round
REVISED PROTOTYPE REQUIREMENTS SET	An updated product requirements set based on the results of the playtesting
GAME FEEDBACK AND REVISED PROTOTYPE REQUIREMENTS SET	An updated product requirements set based on the results of the playtesting
HIRING NEEDS LIST	A list which includes all the hiring needs for the current project
GAMEPLAY ELEMENTS AND STORYLINE	This document includes the descriptions of the gameplay elements and of the storyline
UPDATED GAMEPLAY	This document includes the domain knowledge required to be taught and the updated gameplay where this knowledge is embedded
SG COMPONENTS AND ASSOCIATED BEHAVIORS	The rest of SG components (avatars, characteristics, etc.) and their descriptions along with allowed behaviors
VISUALIZATION PROTOTYPE	A first crude description of some basic visualizations
GAME DESIGN	The results of the previous steps are combined in a complete document entitled "Game Design"
PRODUCT REQUIREMENTS SET	Includes all the requirements which are going to be included in the game product in a prioritized list
DEVELOPMENT ROUND GOAL	Includes a sub-set of requirements from the product requirements

AND REQUIREMENTS SET	set which are going to be included in the next increment
GAME PROTOTYPE INCREMENT	A playable prototype increment for the client to use and evaluate
REVISED PRODUCT REQUIREMENTS SET	An updated prototype product requirements set based on the results of the previous development round
NEXT DEVELOPMENT ROUND UPDATES	A list of updates for the next development round
REVISED PRODUCT REQUIREMENTS SET	An updated product requirements set based on the results of the playtesting
GAME FEEDBACK AND REVISED PRODUCT REQUIREMENTS SET	An updated product requirements set based on the results of the playtesting
GAME ART ASSETS DESIGN CONCEPTS	This document includes sets of art assets concepts
ART ASSETS	The final art assets chosen by the client and the team
UPDATED PRODUCT REQUIREMENTS SET	An updated product requirements set which now includes the art assets for the final implementation rounds
HIRING NEEDS LIST	A list which includes all the hiring needs for the current project
DEVELOPMENT ROUND GOAL AND REQUIREMENTS SET	Includes a sub-set of requirements from the product requirements set which are going to be included in the next increment
GAME INCREMENT	A playable game increment for the client to use and evaluate
NEXT DEVELOPMENT ROUND UPDATES	A list of updates for the next development round
REVISED PRODUCT REQUIREMENTS SET	An updated product requirements set based on the results of the playtesting
GAME FEEDBACK AND REVISED PRODUCT REQUIREMENTS SET	An updated product requirements set based on the results of the playtesting
THE FINAL GAME	The final game
GAME DOCUMENTATION	The final game documentation

Table 18: Concepts table - Interview 2

Figure 52: General Production Process - Interview 3

Figure 53: Game Concept Phase - Interview 3

Figure 54: Pre- Production Phase - Interview 3

Figure 55: Production Phase - Interview 3

Activities	Activities Description	Sub Activities	Sub-Activities description
Elicit Game Idea	During this activity the game idea is brought in by the client and consequently formulated as a problem through internal brainstorming	Identify initial game idea	The idea is presented to the team by a client

		Formulate Game Problem Statement	The idea is formulated as a problem through a round of internal brainstorming
Articulate Problem Question	An investigation whether the initial question by the client corresponds with the actual problem the client faces. Usually this is not the case so this step is quite crucial.	Conduct Literature Review on the Problem (Parallel)	A literature review on the problem domain
		Conduct Expert Interviews (parallel)	Interviews are conducted with experts from the client side to identify the parameters of the problem the company faces
		Conduct Internal Investigation/Brainstorming on the Problem domain (parallel)	An informal Game Design Document (GDD) is created mostly for client needs
		Design Requirements/Project parameters research (Target Audience Characteristics, Budget, time to market, etc.)	A number of important design requirements is researched (Budget needs, time-to-market, etc.). These requirements are important for the game proposal to the client
		Game proposal to client	A game proposal is handed to the client to decide whether they want to continue with the game project
Create Game Concept	Game concept creation step	Identify Strategists	Identify the persons from the team who will act as strategists. Their responsibilities are to gain a broader perspective about the project, look at the market and the position of the client within it and potential future developments. This perspective allows better understanding and quicker choices about the specific project at hand

		Internal Brainstorming (parallel)	Team brainstorming session to elicit features and details for the game concept
		Client interviews (parallel)	The strategists visit and interview the client to elicit features and details for the draft game concept
		Literature research (parallel)	A literature research is conducted for features elicitation for the game concept
		Target audience research (parallel)	A target audience research is conducted for features elicitation and is combined with the target audience characteristics provided by the client experts for the game concept
		Draft Game Concept design	A set if draft game concepts is created
		Final Game Concept creation	The team evaluates the draft game concepts and combines them to create a final game concept for the client
		Final Game Concept evaluation	The final game concept is evaluated with the client. This phase could provide some updates to the game concept
Create Pen and Paper prototype	Pen and paper creation and analysis	Client interviews for features elicitation	Based on the game concept further interviews with the client take place for specific features and needs the pen and paper prototype should address and are included in a pen-and-paper-prototype backlog
		Literature research (for market based games)	Based on the game concept further literature review is conducted for specific features the pen and paper prototype must include in order to be representative of the game and are included in a pen-and-paper-prototype backlog(only for market based games)
		Internal Brainstorming	A round of internal brainstorming takes place to evaluate the results of the previous steps and update the pen and paper prototype backlog
		Design prototype gameplay elements and storyline	A first gameplay design and important elements and a storyline for the pen-and-paper prototype are decided
		Pre-sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Pen and Paper prototype sprint	During the sprint a playable pen and paper prototype is created

		Sprint review with client	After the sprint a review meeting with the client takes place to review the pen and paper prototype increment created during the sprint. This process leads to improvements
		Sprint retrospective (post sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Playtesting	The first playtesting sessions	Identify playtesting groups	A set of playtesting groups is identified from the client side and from the target audience
		Conduct playtesting with client expert group (parallel)	The game is tested by the client expert group which leads to proposed improvements and a revised product backlog
		Conduct playtesting with target audience group (parallel)	The game is tested by the target audience groups which leads to proposed improvements and an updated product backlog
		Conduct internal playtesting (parallel)	The game is tested by the team which also leads to improvements
Create Game Design	Game Design creation	Identify extensive Gameplay elements and storyline	After the pen-and-paper-prototype has been approved the extensive gameplay for the whole game and the storyline are designed
		Embed educational content into the gameplay	The educational objectives and the domain knowledge are translated in the game mechanics and missions
		Create Visualization prototypes for client to choose	Some first visualizations are designed as draft prototypes
		Create Game Design	The complete game design which includes the previous steps is created to guide the rest of the production process
Prototyping	Prototype development (SCRUM type approach)	Product Backlog creation	The complete product backlog is created which includes the game features and details in a prioritized list
		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game prototype increment is created
		Sprint review	After the sprint a review meeting with the client

		with client	takes place to review the prototype increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective (post-sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Playtesting	The playtesting sessions	Identify playtesting groups	A set of playtesting groups is identified from the client side and from the target audience
		Conduct playtesting with client expert group (parallel)	The game is tested by the client expert group which leads to proposed improvements and a revised product backlog
		Conduct playtesting with target audience group (parallel)	The game is tested by the target audience groups which leads to proposed improvements and an updated product backlog
		Conduct internal playtesting (parallel)	The game is tested by the team which also leads to improvements
Final Art Creation		Design final game Art assets (i.e., graphics, sound, music, models, etc.)	The final game art is designed in various art concepts
		Art assets evaluation	The client evaluates the art assets concepts and chooses what they want
		Include art assets in Product backlog	These art assets are translated into features and included in the product backlog for implementation
Final Implementation		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the game increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Final Game	The final game		

delivery	is delivered		
Final Game documentation delivery	The game documentatio n is delivered to the client		
Closed phase - No specific activities mentioned	Out of scope		

Table 19: Activities table - Interview 3

Concepts	Concepts description
IDEA PROPOSAL	Contains the details of the initial game idea
LITERATURE REVIEW	Contains the results of the literature review
INTERVIEW RESULTS	Contains the results from the expert interviews
INTERNAL INVESTIGATION/BRAINSTORMING RESULTS	Contains the results from the internal investigation/brainstorming
DESIGN REQUIREMENTS SET	Contains the Design Requirements
GAME PROPOSAL	A complete game project proposal for the client to evaluate
STRATEGIST LIST	A list of the persons who will act as strategists
USER STORIES	A list of all the features and their details for the game concept
DRAFT GAME CONCEPTS	Includes the details the strategists elicited along with the User stories from the brainstorming and reviews into various draft game concepts
FINAL GAME CONCEPT	Includes the complete details of the game concept which lead to the next steps of the game design
FINAL GAME CONCEPT	The final game concept is updated with feedback from the client
PEN AND PAPER PROTOTYPE BACKLOG	Includes all the features which are going to be included in the pen and paper prototype in a prioritized list
SPRINT BACKLOG	Includes a sub-set of features from the pen-and-paper-prototype product log which are going to be included in the next increment
PEN AND PAPER PROTOTYPE INCREMENT	A playable pen and paper prototype increment for the client to use and evaluate
REVISED PEN AND PAPER BACKLOG	An updated pen and paper prototype backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
PLAYTESTING GROUPS	A set of playtesting groups description
REVISED PROTOTYPE BACKLOG	An updated prototype backlog based on the results of the playtesting
GAMEPLAY ELEMENTS AND STORYLINE	This document includes the descriptions of the gameplay elements and of the storyline
GAME MISSIONS	This document includes the domain knowledge required to be taught and the missions where this knowledge is going to be tested

VISUALIZATION PROTOTYPE	A first crude description of visualizations
GAME DESIGN	The results of the previous steps are combined
PRODUCT BACKLOG	Includes all the features which are going to be included in the game product in a prioritized list
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME PROTOTYPE INCREMENT	A playable prototype increment for the client to use and evaluate
REVISED PRODUCT BACKLOG	An updated prototype product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
PLAYTESTING GROUPS	A set of playtesting groups description
REVISED PRODUCT BACKLOG	An updated product backlog based on the results of the playtesting
GAME ART ASSETS DESIGN CONCEPTS	This document includes sets of art assets concepts
ART ASSETS	The final art assets chosen by the client and the team
UPDATED PRODUCT BACKLOG	An updated product backlog which now includes the art assets for the final implementation rounds
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME INCREMENT	A playable game increment for the client to use and evaluate
UPDATED PRODUCT BACKLOG	An updated game product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
FINAL GAME	The final game
GAME DOCUMENTATION	The final game documentation

Table 20: Concepts table - Interview 3

Figure 56: General Production Process - Interview 4

Figure 57: Game Concept Phase - Interview 4

Figure 58: Pre- Production Phase - Interview 4

Figure 59: Production Phase - Interview 4

Activities	Activities Description	Sub Activities	Sub-Activities description
Elicit Game Idea	During this activity the game idea is brought in by the client or by a team member and consequently formulated as a problem through internal brainstorming	Identify initial game idea	The idea is presented to the team by a client or a team member

		Formulate Game Problem Statement	The idea is formulated as a problem through a round of internal brainstorming
Research Game Idea Feasibility (parallel)	The idea is researched. If it is a client based the project parameters are set but if it is market based a feasibility study is conducted to identify whether the team will take the project or not	Business Case feasibility research (parallel)	A feasibility research (Market size, potential revenue, marketing costs, etc.) is conducted to determine whether the team should start the project or not
		Project parameters research (Budget, time to market, etc.) (parallel)	After the feasibility research a number of important parameters is decided (Budget needs, time-to-market, etc.). These parameters are really important for the game proposal to the client
		Initial Target audience research (parallel)	A target audience research is conducted for features elicitation for the game concept
		Evaluate game feasibility	An evaluation of the game feasibility is conducted and based on the results a choice to invest or not in the game is made
		Game proposal to client	A game proposal is handed to the client to decide whether they want to continue with the game project
Create Game Concept (parallel)	Game concept creation step	Team brainstorming (parallel)	Team brainstorming session to elicit features and details for the game concept
		Client interviews (parallel)	The team interviews the client to elicit features and details for the game concept
		Literature research (parallel)	A literature research is conducted for features elicitation for the game concept
		Target audience research (parallel)	A target audience research is conducted for features elicitation for the game concept
		Draft Game Concept design	A draft game concept is created
		Draft Game Concept evaluation	The team evaluates the draft game concept with the client
		Final Game Concept creation	A final game concept is created
Elicit functional	Elicit the functional	Team brainstorming	Team brainstorming session to elicit functional requirements for the game side

requirements	requirements for the game and serious side	(parallel)	
		Client interviews (parallel)	The team interviews the client to elicit the functional requirements for the serious side
		Literature research (parallel)	A literature research is conducted to elicit functional requirements for both game sides
		Target audience interviews (parallel)	A target audience research is conducted to elicit requirements for both game sides
		Stakeholder Interviews (parallel)	Interviews are conducted with all the stakeholders to elicit requirements from all the influencing groups
		Track Game origins/conduct case study client environment (parallel)	A study is conducted in the client environment to identify the needs the target audience has and how the game might cover those needs
Create Pen and Paper prototype	Pen and paper creation and analysis	Client interviews for features elicitation	Based on the game concept further interviews with the client take place for specific features and needs the pen and paper prototype should address and are included in a pen-and-paper-prototype backlog
		Literature research (for market based games)	Based on the game concept further literature review is conducted for specific features the pen and paper prototype must include in order to be representative of the game and are included in a pen-and-paper-prototype backlog(only for market based games)
		Internal Brainstorming	A round of internal brainstorming takes place to evaluate the results of the previous steps and update the pen and paper prototype backlog
		Design prototype Gameplay elements and storyline	A first Gameplay design and important elements and a storyline for the pen-and-paper prototype are decided
		Pre-sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Pen and Paper prototype sprint	During the sprint a playable pen and paper prototype is created
		Sprint review with	After the sprint a review meeting with the

		client	client takes place to review the pen and paper prototype increment created during the sprint. This process leads to improvements
		Sprint retrospective (post sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Create Game Design	Game Design creation	Identify extensive Gameplay elements and storyline	After the pen-and-paper-prototype has been approved the extensive Gameplay for the whole game and the storyline are designed
		Embed educational objectives in the Gameplay	The educational objectives and the domain knowledge are translated in the game mechanics and missions
		Design SG components and behaviors	Further Serious Game components (player avatars, characteristics, etc.) and associated behaviors are designed and embedded in the Gameplay
		Create Visualization prototypes	Some first visualizations are designed as draft prototypes
		Create Game Design	The complete game design document which includes the previous steps is created to guide the rest of the production process
Prototyping	Prototype development (SCRUM type approach)	Product Backlog creation	The complete product backlog is created which includes the game features and details in a prioritized list
		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game prototype increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the prototype increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective (post-sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Playtesting	Conduct Playtesting for further features	Conduct Playtesting with client (parallel)	The game is tested by the client for further feedback and proposed updates

		elicitation	
		Conduct Playtesting with end users group (parallel)	The game is tested by the end users for further feedback and proposed updates
		Conduct Playtesting with important stakeholder groups (parallel)	The game is tested by the rest of the stakeholders for further feedback and proposed updates
Pedagogical quality assessment	Evaluation whether the game actually educates its users	Identify pedagogical assessment expert	An expert (usually a PhD student) who is going to assess the game pedagogical quality is identified
		Conduct Playtesting for pedagogical assessment (parallel)	The expert plays, tests and evaluates the pedagogical quality of the game
		Conduct literature review for pedagogical assessment (parallel)	A literature review is conducted by the pedagogical assessment expert
		Evaluate pedagogical assessment	The game pedagogical assessment is analyzed and updates and changes are proposed
Final Art Creation		Design final game Art assets (i.e., graphics, sound, music, models, etc.)	The final game art is designed in various art concepts
		Art assets evaluation	The client evaluates the art assets concepts and chooses what they want
		Include art assets in Product backlog	These art assets are translated into features and included in the product backlog for implementation
Final Implementatio n		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game increment is created

		Sprint review with client	After the sprint a review meeting with the client takes place to review the game increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
Final Game delivery	The final game is delivered		
Final Game documentation delivery	The game documentation is delivered to the client		
Closed phase - No specific activities mentioned	Out of scope		

Table 21: Activities table - Interview 4

Concepts	Concepts description
IDEA PROPOSAL	Contains the details of the initial game idea
PROJECT PARAMETERS	Contains the results of the business case
GAME FEASIBILITY ANALYSIS	Includes the details of the project in a structured style for the client
GAME PROPOSAL	A complete game project proposal for the client to evaluate
GAME CONCEPT FEATURES LIST	A list of all the features and their details for the game concept
DRAFT GAME CONCEPT	Includes the details of the game concept which lead to the next steps of the game design
FINAL GAME CONCEPT	Includes the complete details of the game concept which lead to the next steps of the game design
FUNCTIONAL REQUIREMENTS LIST	Includes the functional requirements for both the game and serious side
PEN AND PAPER PROTOTYPE BACKLOG	Includes all the features which are going to be included in the pen and paper prototype in a prioritized list
SPRINT BACKLOG	Includes a sub-set of features from the pen-and-paper-prototype product log which are going to be included in the next increment
PEN AND PAPER PROTOTYPE INCREMENT	A playable pen and paper prototype increment for the client to use and evaluate
REVISED PEN AND PAPER BACKLOG	An updated pen and paper prototype backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
GAMEPLAY ELEMENTS AND STORYLINE	This document includes the descriptions of the Gameplay elements and of the storyline
VISUALIZATION PROTOTYPE	A first crude description of some basic visualizations

GAME DESIGN	The results of the previous steps are combined in a complete document entitled "Game Design"
PRODUCT BACKLOG	Includes all the features which are going to be included in the game product in a prioritized list
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME PROTOTYPE INCREMENT	A playable prototype increment for the client to use and evaluate
REVISED PRODUCT BACKLOG	An updated prototype product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
REVISED PRODUCT BACKLOG	An updated product backlog based on the results of the Playtesting
PEDAGOGICAL QUALITY ASSESSMENT EXPERT	Includes the details of the pedagogical quality assessment person
TEST RESULTS	The results from the pedagogical quality assessment
PEDAGOGICAL QUALITY ASSESSMENT ANALYSIS AND REVISED PRODUCT BACKLOG	An analysis and comparison of the test results before and after the use of the game
UPDATED PRODUCT BACKLOG	A set of proposed updates for the product backlog considering the educational nature of the game
GAME ART ASSETS DESIGN CONCEPTS	This document includes sets of art assets concepts
ART ASSETS	The final art assets chosen by the client and the team
UPDATED PRODUCT BACKLOG	An updated product backlog which now includes the art assets for the final implementation rounds
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME INCREMENT	A playable game increment for the client to use and evaluate
UPDATED PRODUCT BACKLOG	An updated game product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
FINAL GAME	The final game
GAME DOCUMENTATION	The final game documentation

Table 22: Concepts table - Interview 4

Activities	Sub Activities	Interview 1	Interview 2	Interview 3	Interview 4
Elicit Game Idea	Identify initial game idea	=	=	>	=
	Formulate Game Problem Statement	=	=	=	=
Research Game Idea Feasibility	Business Case feasibility research (for market based games)	=	=	><	=

	Project parameters research (Budget, time to market, etc.)	=	=	><	=
	Informal GDD creation	=	=		
	Game proposal to client	=	=	=	=
Create Game Concept	Team brainstorming	=	=	=	=
	Client interviews	=	=	=	=
	Literature research	=	=	=	=
	Target audience research	=	=	=	=
	Draft Game Concept design	=	<	<	=
	Draft Game Concept evaluation	=	=	=	=
	Final Game Concept creation	=	=	=	=
Create Pen and Paper prototype	Client interviews for features elicitation	=	=	=	=
	Literature research (for market based games)	=	=	=	=
	Internal Brainstorming	=	=	=	=
	Design prototype gameplay elements and storyline	=	=	=	=
	Pre-sprint meeting	=	=	=	=
	Pen and Paper prototype sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective (post sprint review)	=	=	=	=
Create Game Design	Identify extensive Gameplay elements and storyline	=	=	><	=
	Design Educational mechanics and "Game Missions"	=	=	><	><
	Design SG components and behaviors	=	=	><	=
	Create Visualization prototypes	=	=	<	=
	Create Game Design	=	=	=	=
Prototyping	Product Backlog creation	=	=	=	=
	Pre-Sprint meeting	=	=	=	=
	Sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective (post-sprint review)	=	=	=	=
	Alpha Version build	=			
	Internal Testing	=			=
Pedagogical quality assessment (In parallel with playtesting)	Pre-testing meeting (pedagogical quality assessment)	=			
	User group pedagogical quality test	=			
	Post-testing meeting (pedagogical quality assessment)	=			
Playtesting (In parallel with pedagogical quality	Beta Version	=	><	><	><

assessment)					
	User group testing	=	<	<	<
Final Art Creation	Design final game Art assets (i.e., graphics, sound, music, models, etc.)	=	=	=	=
	Art assets evaluation	=	=	=	=
	Include art assets in Product backlog	=	=	=	=
Final Implementation	Pre-Sprint meeting	=	=	=	=
	Sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective	=	=	=	=
Final Game delivery	Deliver Final Game	=	=	=	=
Final Game documentation delivery	Deliver Final Game Documentation	=	=	=	=
Elicit Game Idea	Identify initial game idea	=	=	=	=
	Formulate Game Problem Statement	=	=	=	=
Research Game Idea Feasibility	Business Case feasibility research (for market based games)	=	=	><	=
	Project parameters research (Budget, time to market, etc.)	=	=	><	=
	Conduct workshop or case study at client environment		=		><
	Informal GDD creation	=	=		
	Game proposal to client	=	=	=	=
Create Game Concept	Team brainstorming	=	=	=	=
	Client interviews	=	=	=	=
	Literature research	=	=	=	=
	Target audience research	=	=	=	=
	Draft Game Concepts design	>	=	=	>
	Draft Game Concepts evaluation	=	=	=	=
	Final Game Concept creation	=	=	=	=
Create simple prototype	Client interviews for requirements elicitation (parallel)	=	=	=	=
	Literature research (for market based games) (parallel)	=	=	=	=
	Internal Brainstorming (parallel)	=	=	=	=
	Design prototype gameplay elements and storyline (parallel)	=	=	=	=
	Iterative development step pre-meeting	=	=	=	=
	Simple prototype development	=	=	=	=

	development round review with client	=	=	=	=
	development round retrospective (post development round review)	=	=	=	=
Playtesting	Internal Playtesting (parallel)		=	=	
	User group testing (parallel)		=	=	
	Client Playtesting (parallel)		=	=	
Create Game Design	Identify hiring needs		=		
	Identify extensive Gameplay elements and storyline	=	=	=	=
	Design Educational mechanics and "Game Missions"	=	=	><	><
	Design SG components and behaviors	=	=	><	=
	Create Visualization prototypes	=	=	=	=
	Create Game Design	=	=	=	=
Prototyping	Product requirements set creation	=	=	=	=
	Pre-development round meeting	=	=	=	=
	development round	=	=	=	=
	development round review/playtesting with client	=	=	=	=
	development round retrospective (post-development round review)	=	=	=	=
Playtesting	Internal Playtesting (parallel)	>	=	=	=
	User group testing (parallel)	>	=	=	=
	Client Playtesting (parallel)	>	=	=	=
Final Art Creation	Design final game Art assets (i.e., graphics, sound, music, models, etc.)	=	=	=	=
	Art assets evaluation	=	=	=	=
	Include art assets in Product requirements set	=	=	=	=
Final Implementation	Identify further hiring needs		=		
	Pre-development round meeting	=	=	=	=
	development round	=	=	=	=
	development round review with client	=	=	=	=
	development round retrospective	=	=	=	=
Playtesting	Internal Playtesting (parallel)		=		
	User group testing (parallel)		=		
	Client Playtesting (parallel)		=		
			=		
Final Game delivery		=	=	=	=
Final Game documentation delivery		=	=	=	=
Elicit Game Idea	Identify initial game idea	=	=	=	=

	Formulate Game Problem Statement	=	=	=	=
Articulate Problem Question	Conduct Literature Review on the Problem (Parallel)	=		=	
	Conduct Expert Interviews (parallel)	=	><	=	
	Conduct Internal Investigation/Brainstorming on the Problem domain (parallel)	=	><	=	=
	Design Requirements/Project parameters research (Target Audience Characteristics, Budget, time to market, etc.)	><	><	=	><
	Game proposal to client	=	=	=	=
Create Game Concept	Identify Strategists			=	
	Internal Brainstorming (parallel)	=	=	=	=
	Client interviews (parallel)	=	=	=	=
	Literature research (parallel)	=	=	=	=
	Target audience research (parallel)	=	=	=	=
	Draft Game Concept design	>	=	=	>
	Final Game Concept creation	=	=	=	=
	Final Game Concept evaluation	=	=	=	=
Create Pen and Paper prototype	Client interviews for features elicitation	=	=	=	=
	Literature research (for market based games)	=	=	=	=
	Internal Brainstorming	=	=	=	=
	Design prototype gameplay elements and storyline	=	=	=	=
	Pre-sprint meeting	=	=	=	=
	Pen and Paper prototype sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective (post sprint review)	=	=	=	=
Playtesting	Identify playtesting groups			=	
	Conduct playtesting with client expert group (parallel)	><	=	=	
	Conduct playtesting with target audience group (parallel)		=	=	
	Conduct internal playtesting (parallel)	><	=	=	
Create Game Design	Identify extensive Gameplay elements and storyline	=	=	=	=
	Embed educational content into the gameplay	><	><	=	=

	Create Visualization prototypes for client to choose	>	=	=	=
	Create Game Design	=	=	=	=
Prototyping	Product Backlog creation	=	=	=	=
	Pre-Sprint meeting	=	=	=	=
	Sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective (post-sprint review)	=	=	=	=
Playtesting	Identify playtesting groups			=	
	Conduct playtesting with client expert group (parallel)	><	=	=	=
	Conduct playtesting with target audience group (parallel)	><	=	=	=
	Conduct internal playtesting (parallel)	><	=	=	
Final Art Creation	Design final game Art assets (i.e., graphics, sound, music, models, etc.)	=	=	=	=
	Art assets evaluation	=	=	=	=
	Include art assets in Product backlog	=	=	=	=
Final Implementation	Pre-Sprint meeting	=	=	=	=
	Sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective	=	=	=	=
Final Game delivery		=	=	=	=
Final Game documentation delivery		=	=	=	=
Elicit Game Idea	Identify initial game idea	=	=	=	=
	Formulate Game Problem Statement	=	=	=	=
Research Game Idea Feasibility (parallel)	Business Case feasibility research (parallel)	=	=		=
	Project parameters research (Budget, time to market, etc.) (parallel)	=	=	><	=
	Initial Target audience research (parallel)	=		><	=
	Evaluate game feasibility				=
	Game proposal to client	=	=	=	=
Create Game Concept (parallel)	Team brainstorming (parallel)	=	=	=	=
	Client interviews (parallel)	=	=	=	=
	Literature research (parallel)	=	=	=	=
	Target audience research (parallel)	=	=	=	=
	Draft Game Concept design	=	<	<	=
	Draft Game Concept evaluation	=	=	=	=
	Final Game Concept creation	=	=	=	=

Elicit functional requirements	Team brainstorming (parallel)				=
	Client interviews (parallel)				=
	Literature research (parallel)				=
	Target audience interviews (parallel)				=
	Stakeholder Interviews (parallel)				=
	Track Game origins/conduct case study client environment (parallel)		><		=
Create Pen and Paper prototype	Client interviews for features elicitation	=	=	=	=
	Literature research (for market based games)	=	=	=	=
	Internal Brainstorming	=	=	=	=
	Design prototype Gameplay elements and storyline	=	=	=	=
	Pre-sprint meeting	=	=	=	=
	Pen and Paper prototype sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective (post sprint review)	=	=	=	=
Create Game Design	Identify extensive Gameplay elements and storyline	=	=	=	=
	Embed educational objectives in the Gameplay	><	><	=	=
	Design SG components and behaviors	=	=		=
	Create Visualization prototypes	=	=	=	=
	Create Game Design	=	=	=	=
Prototyping	Product Backlog creation	=	=	=	=
	Pre-Sprint meeting	=	=	=	=
	Sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective (post-sprint review)	=	=	=	=
Playtesting	Conduct Playtesting with client (parallel)	<	=	=	=
	Conduct Playtesting with end users group (parallel)	<	=	=	=
	Conduct Playtesting with important stakeholder groups (parallel)				=
Pedagogical quality assessment	Identify pedagogical assessment expert				=
	Conduct Playtesting for pedagogical assessment (parallel)				=

	Conduct literature review for pedagogical assessment (parallel)				=
	Evaluate pedagogical assessment	><			=
Final Art Creation	Design final game Art assets (i.e., graphics, sound, music, models, etc.)	=	=	=	=
	Art assets evaluation	=	=	=	=
	Include art assets in Product backlog	=	=	=	=
Final Implementation	Pre-Sprint meeting	=	=	=	=
	Sprint	=	=	=	=
	Sprint review with client	=	=	=	=
	Sprint retrospective	=	=	=	=
Final Game delivery		=	=	=	=
Final Game documentation delivery		=	=	=	=

Table 23: Activities Comparison Table

Concepts	Interview 1	Interview 2	Interview 3	Interview 4
IDEA PROPOSAL	=	=	=	=
BUSINESS CASE RESULTS	=	=		=
PROJECT PARAMETERS	=	=		=
INFORMAL GDD	=	=		
GAME PROPOSAL	=	=	=	=
GAME CONCEPT FEATURES LIST	=	=		=
DRAFT GAME CONCEPT	=	=	=	=
FINAL GAME CONCEPT	=	=	=	=
PEN AND PAPER PROTOTYPE BACKLOG	=	=	=	=
SPRINT BACKLOG	=	=	=	=
PEN AND PAPER PROTOTYPE INCREMENT	=	=	=	=
REVISED PEN AND PAPER BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
GAMEPLAY ELEMENTS AND STORYLINE	=	=	=	=
GAME MISSIONS	=	><	=	><
SG COMPONENTS AND ASSOCIATED BEHAVIORS	=	=		
VISUALIZATION PROTOTYPE	=	=	=	=
GAME DESIGN	=	=	=	=
PRODUCT BACKLOG	=	=	=	=
SPRINT GOAL AND BACKLOG	=	=	=	=
GAME PROTOTYPE INCREMENT	=	=	=	=
REVISED PRODUCT BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=

ALPHA VERSION	=			
REVISED PRODUCT BACKLOG	=			
PRE-TEST RESULTS	=			
TEST RESULTS	=			><
PEDAGOGICAL QUALITY ASSESSMENT ANALYSIS AND REVISED PRODUCT BACKLOG	=			><
GAME FEEDBACK AND REVISED PRODUCT BACKLOG	=			=
GAME ART ASSETS DESIGN CONCEPTS	=	=	=	=
ART ASSETS	=	=	=	=
UPDATED PRODUCT BACKLOG	=	=	=	=
SPRINT GOAL AND BACKLOG	=	=	=	=
GAME INCREMENT	=	=	=	=
UPDATED PRODUCT BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
GAME DOCUMENTATION	=	=	=	=
IDEA PROPOSAL	=	=	=	=
BUSINESS CASE RESULTS	=	=	><	><
PROJECT PARAMETERS	=	=		=
CASE STUDY RESULTS		=		><
INFORMAL GDD	=	=		
GAME PROPOSAL	=	=	=	=
GAME CONCEPT REQUIREMENTS LIST	=	=	><	
DRAFT GAME CONCEPTS	=	=	=	=
FINAL GAME CONCEPT	=	=	=	=
SIMPLE PROTOTYPE REQUIREMENTS SET	=	=	=	=
REQUIREMENTS TO BE DEVELOPED LIST	=	=	=	=
SIMPLE PROTOTYPE INCREMENT	=	=	=	=
REVISED PEN AND PAPER REQUIREMENTS SET	=	=	=	=
NEXT DEVELOPMENT ROUND UPDATES	=	=	=	=
REVISED PROTOTYPE REQUIREMENTS SET	=	=	=	=
GAME FEEDBACK AND REVISED PROTOTYPE REQUIREMENTS SET	=	=	=	=
HIRING NEEDS LIST		=		
GAMEPLAY ELEMENTS AND STORYLINE	=	=	=	=
UPDATED GAMEPLAY		=		
SG COMPONENTS AND ASSOCIATED BEHAVIORS	=	=	><	
VISUALIZATION PROTOTYPE	=	=	=	=

GAME DESIGN	=	=	=	=
PRODUCT REQUIREMENTS SET	=	=	=	=
DEVELOPMENT ROUND GOAL AND REQUIREMENTS SET	=	=	=	=
GAME PROTOTYPE INCREMENT	=	=	=	=
REVISED PRODUCT REQUIREMENTS SET	=	=	=	=
NEXT DEVELOPMENT ROUND UPDATES	=	=	=	=
REVISED PRODUCT REQUIREMENTS SET	=	=	=	=
GAME FEEDBACK AND REVISED PRODUCT REQUIREMENTS SET	=	=	=	=
GAME ART ASSETS DESIGN CONCEPTS	=	=	=	=
ART ASSETS	=	=	=	=
UPDATED PRODUCT REQUIREMENTS SET	=	=	=	=
HIRING NEEDS LIST		=		
DEVELOPMENT ROUND GOAL AND REQUIREMENTS SET	=	=	=	=
GAME INCREMENT	=	=	=	=
UPDATED PRODUCT REQUIREMENTS SET	=	=	=	=
NEXT DEVELOPMENT ROUND UPDATES	=	=	=	=
REVISED PRODUCT REQUIREMENTS SET	=	=	=	=
GAME FEEDBACK AND REVISED PRODUCT REQUIREMENTS SET	=	=	=	=
THE FINAL GAME	=	=	=	=
GAME DOCUMENTATION	=	=	=	=
IDEA PROPOSAL	=	=	=	=
LITERATURE REVIEW			=	
INTERVIEW RESULTS	><		=	
INTERNAL INVESTIGATION/BRAINSTORMING RESULTS	><		=	
DESIGN REQUIREMENTS SET	><		=	
GAME PROPOSAL	=	=	=	=
STRATEGIST LIST			=	
USER STORIES		><	=	><
DRAFT GAME CONCEPTS	=	=	=	=
FINAL GAME CONCEPT	=	=	=	=
PEN AND PAPER PROTOTYPE BACKLOG	=	=	=	=
SPRINT BACKLOG	=	=	=	=
PEN AND PAPER PROTOTYPE INCREMENT	=	=	=	=
REVISED PEN AND PAPER BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
PLAYTESTING GROUPS			=	
REVISED PROTOTYPE BACKLOG	=		=	
GAMEPLAY ELEMENTS AND STORYLINE	=	=	=	=

GAME MISSIONS	=	><	=	
VISUALIZATION PROTOTYPE	=	=	=	=
GAME DESIGN	=	=	=	=
PRODUCT BACKLOG	=	=	=	=
SPRINT GOAL AND BACKLOG	=	=	=	=
GAME PROTOTYPE INCREMENT	=	=	=	=
REVISED PRODUCT BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
PLAYTESTING GROUPS			=	
REVISED PRODUCT BACKLOG	=		=	
GAME ART ASSETS DESIGN CONCEPTS	=	=	=	=
ART ASSETS	=	=	=	=
UPDATED PRODUCT BACKLOG	=	=	=	=
SPRINT GOAL AND BACKLOG	=	=	=	=
GAME INCREMENT	=	=	=	=
UPDATED PRODUCT BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
GAME DOCUMENTATION	=	=	=	=
IDEA PROPOSAL	=	=	=	=
PROJECT PARAMETERS	=	=		=
GAME FEASIBILITY ANALYSIS	=	><		=
GAME PROPOSAL	=	=	=	=
GAME CONCEPT FEATURES LIST	=	=	><	=
DRAFT GAME CONCEPT	=	=	=	=
FINAL GAME CONCEPT	=	=	=	=
FUNCTIONAL REQUIREMENTS LIST				=
PEN AND PAPER PROTOTYPE BACKLOG	=	=	=	=
SPRINT BACKLOG	=	=	=	=
PEN AND PAPER PROTOTYPE INCREMENT	=	=	=	=
REVISED PEN AND PAPER BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
GAMEPLAY ELEMENTS AND STORYLINE	=	=	=	=
VISUALIZATION PROTOTYPE	=	=	=	=
GAME DESIGN	=	=	=	=
PRODUCT BACKLOG	=	=	=	=
SPRINT GOAL AND BACKLOG	=	=	=	=
GAME PROTOTYPE INCREMENT	=	=	=	=

REVISED PRODUCT BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
REVISED PRODUCT BACKLOG	=	=	=	=
PEDAGOGICAL QUALITY ASSESSMENT EXPERT				=
TEST RESULTS	><			=
PEDAGOGICAL QUALITY ASSESSMENT ANALYSIS AND REVISED PRODUCT BACKLOG	><			=
UPDATED PRODUCT BACKLOG	=			=
GAME ART ASSETS DESIGN CONCEPTS	=	=	=	=
ART ASSETS	=	=	=	=
UPDATED PRODUCT BACKLOG	=	=	=	=
SPRINT GOAL AND BACKLOG	=	=	=	=
GAME INCREMENT	=	=	=	=
UPDATED PRODUCT BACKLOG	=	=	=	=
NEXT SPRINT UPDATES	=	=	=	=
GAME DOCUMENTATION	=	=	=	=

Table 24: Concepts Comparison Table

Figure 60: Serious Game Reference Production Method Concept Phase- Industry

Appendix B

Create Game Design

Identify Extensive Gameplay Elements and Storyline
Design Educational Mechanics and Game Missions
Design Serious Game Components and Behaviors
Evaluate with Client
[else]
[approved]
Create Visualization Prototype
Create Game Design
Validate Game Design with Client

Identify Extensive Gameplay Elements and Storyline
Design Educational Mechanics and Game Missions
Design Serious Game Components and Behaviors
Create Visualization Prototype
Create Game Design

[market-based game]
[client-based game]

GAMEPLAY ELEMENTS AND STORYLINE
ARE INCLUDED IN
VISUALIZATION PROTOTYPE
GAME DESIGN

[approved]

Develop Game Prototype

Create Product Backlog
Conduct Pre-Sprint Meeting
Conduct prototype Sprint
Conduct Sprint Review
Conduct Sprint Retrospective Session
[else]

Create Product Backlog
Conduct Pre-Sprint Meeting
Conduct prototype Sprint
Conduct Sprint Review with Client
Conduct Sprint Retrospective Session
[else]

GAME BACKLOG
SPRINT BACKLOG
PROTOTYPE INCREMENT
REVISED GAME BACKLOG
NEXT SPRINT UPDATES

[approved]

Conduct Playtesting

Conduct User Group Playtesting
Conduct stakeholder groups Playtesting

Conduct User Group Playtesting
Conduct Client Playtesting
Conduct stakeholder groups Playtesting

[else]

Assess Pedagogical Quality

Hire Pedagogical Assessment Expert
Conduct Playtesting Pedagogical Assessment
Conduct Literature Review Pedagogical Assessment
Evaluate Pedagogical Assessment

Hire Pedagogical Assessment Expert
Conduct Playtesting Pedagogical Assessment
Conduct Literature Review Pedagogical Assessment
Evaluate Pedagogical Assessment with Client

PEDAGOGICAL ASSESSMENT EXPERT
PEDAGOGICAL ASSESSMENT RESULTS

[approved]

Create Game Art

Design Game Art Assets
Revise Product Backlog with Art Assets

Design Game Art Assets
Evaluate Art Assets with Client
[else]
Revise Product Backlog with Art Assets
[approved]

ART ASSETS

Figure 61:Serious Game Reference Production Method Pre-Production Phase- Industry

Figure 62: Serious Game Reference Production Method Production Phase- Industry

Appendix B

Phase	Activity	Sub-Activity	Sub-Activity Explanation
Concept phase	Elicit Game Idea	Identify initial game idea	The idea is presented to the team by a client or a team member
		Formulate Game Problem Statement	The idea is formulated as a problem through a round of internal brainstorming
	Business Case feasibility research (for market based games)		A feasibility research (Market size, potential revenue, marketing costs, etc.) is conducted to determine whether the team should start the project or not
		Project parameters research (Budget, time to market, etc.)	After the feasibility research a number of important parameters is decided (Budget needs, time-to-market, etc.). These parameters are really important for the game proposal to the client
		Conduct Case Study at Client Environment	A case study is conducted on the client environment for gaining a better understanding of the problem
		Conduct Internal Investigation/Brainstorming on the Problem domain (parallel)	An internal brainstorming is conducted to identify the parameters of the problem
		Game proposal to client	A game proposal is handed to the client to decide whether they want to continue with the game project
	Create Game Concept	Team brainstorming	Team brainstorming session to elicit requirements and details for the game concept
		Client interviews	The team interviews the client to elicit requirements and details for the game concept
		Literature research	A literature research is conducted for requirements elicitation for the game concept
		Target audience research	A target audience research is conducted for requirements elicitation for the game concept
		Draft Game Concepts design	A dozen of draft game concepts are created
		Draft Game	The team evaluates the draft game concepts with the client

		Concepts evaluation	
		Final Game Concept creation	A final game concept is created
	Elicit functional requirements	Team brainstorming (parallel)	Team brainstorming session to elicit functional requirements for the game side
		Client interviews (parallel)	The team interviews the client to elicit the functional requirements for the serious side
		Literature research (parallel)	A literature research is conducted to elicit functional requirements for both game sides
		Target audience interviews (parallel)	A target audience research is conducted to elicit requirements for both game sides
		Stakeholder Interviews (parallel)	Interviews are conducted with all the stakeholders to elicit requirements from all the influencing groups
		Track Game origins/conduct case study client environment (parallel)	A study is conducted in the client environment to identify the needs the target audience has and how the game might cover those needs
	Create Pen and Paper prototype	Client interviews for features elicitation	Based on the game concept further interviews with the client take place for specific features and needs the pen and paper prototype should address and are included in a pen-and-paper-prototype backlog
		Literature research (for market based games)	Based on the game concept further litearture review is conducted for specific features the pen and paper prototype must include in order to be representative of the game and are included in a pen-and-paper-prototype backlog(only for market based games)
		Internal Brainstorming	A round of internal brainstorming takes place to evaluate the results of the previous steps and update the pen and paper prototype backlog
		Design prototype gameplay elements and	A first gameplay design and important elements and a storyline for the pen-and-paper prototype are decided

		storyline	
		Pre-sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Pen and Paper prototype sprint	During the sprint a playable pen and paper prototype is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the pen and paper prototype increment created during the sprint. This process leads to improvements
		Sprint retrospective (post sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
	Playtesting	Identify playtesting groups	A set of playtesting groups is identified from the client side and from the target audience
		Conduct playtesting with client expert group (parallel)	The game is tested by the client expert group which leads to proposed improvements and a revised product backlog
		Conduct playtesting with target audience group (parallel)	The game is tested by the target audience groups which leads to proposed improvements and an updated product backlog
		Conduct internal playtesting (parallel)	The game is tested by the team which also leads to improvements
Pre-Production	Create Game Design	Identify extensive Gameplay elements and storyline	After the pen-and-paper-prototype has been approved the extensive gameplay for the whole game and the storyline are designed
		Embed educational content into the gameplay	The educational objectives and the domain knowledge are translated in the game mechanics and missions
		Create Visualization prototypes for client to choose	Some first visualizations are designed as draft prototypes
		Create Game Design	The complete game design which includes the previous steps is created to guide the rest of the production process
	Prototypin	Product	The complete product backlog is created which includes the

		Backlog creation	game features and details in a prioritized list
	g		
		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game prototype increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the prototype increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective (post-sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
	Playtesting	Conduct Playtesting with client (parallel)	The game is tested by the client for further feedback and proposed updates
		Conduct Playtesting with end users group (parallel)	The game is tested by the end users for further feedback and proposed updates
		Conduct Playtesting with important stakeholder groups (parallel)	The game is tested by the rest of the stakeholders for further feedback and proposed updates
	Pedagogical quality assessment	Identify pedagogical assessment expert	An expert (usually a PhD student) who is going to assess the game pedagogical quality is identified
		Conduct Playtesting for pedagogical assessment (parallel)	The expert plays, tests and evaluates the pedagogical quality of the game
		Conduct literature review for pedagogical assessment (parallel)	A literature review is conducted by the pedagogical assessment expert
		Evaluate pedagogical	The game pedagogical assessment is analyzed and updates and changes are proposed

		assessment	
	Final Art Creation	Design final game Art assets (i.e., graphics, sound, music, models, etc.)	The final game art is designed in various art concepts
		Art assets evaluation	The client evaluates the art assets concepts and chooses what they want
		Include art assets in Product backlog	These art assets are translated into features and included in the product backlog for implementation
Production Phase		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the game increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog

Table 25: Serious Game Reference Production Method Activities Table – Industry

Concept	Concept Explanation
IDEA PROPOSAL	Contains the details of the intial game idea
BUSINESS CASE RESULTS	Contains the results of the business case
PROJECT PARAMETERS	Contains the project parameters
CASE STUDY RESULTS	Contains the results of the case study
GAME PROPOSAL	A complete game project proposal for the client to evaluate
GAME CONCEPT REQUIREMENTS LIST	A list of all the requirements and their details for the game concept
DRAFT GAME CONCEPTS	Includes the details of the game concept which lead to the next steps of the game design
FINAL GAME CONCEPT	Includes the complete details of the game concept which lead to the next steps of the game design
FUNCTIONAL REQUIREMENTS LIST	Includes the functional requirements for both the game and serious side
PEN AND PAPER PROTOTYPE BACKLOG	Includes all the features which are going to be included in the pen and paper prototype in a prioritized list
SPRINT BACKLOG	Includes a sub-set of features from the pen-and-paper-prototype productlog which are going to be included in the next increment
PEN AND PAPER PROTOTYPE	A playable pen and paper prototype increment for the client

INCREMENT	to use and evaluate
REVISED PEN AND PAPER BACKLOG	An updated pen and paper prototype backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
PLAYTESTING GROUPS	A set of playtesting groups description
REVISED PROTOTYPE BACKLOG	An updated prototype backlog based on the results of the playtesting
GAMEPLAY ELEMENTS AND STORYLINE	This document includes the descriptions of the gameplay elements and of the storyline
GAME MISSIONS	This document includes the domain knowledge required to be tought and the missions where this knolwedge is going to be tested
VISUALIZATION PROTOTYPE	A first crude description of visualizations
GAME DESIGN	The results of the previous steps are combined
PRODUCT BACKLOG	Includes all the features which are going to be included in the game product in a prioritized list
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the produc backlog which are going to be included in the next increment
GAME PROTOTYPE INCREMENT	A playable prototype increment for the client to use and evaluate
REVISED PRODUCT BACKLOG	An updated prototype product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
REVISED PRODUCT BACKLOG	An updated product backlog based on the results of the Playtesting
PEDAGOGICAL QUALITY ASSESSMENT EXPERT	Includes the details of the pedagogical quality assessment person
TEST RESULTS	The results from the pedagogical quality assessment
PEDAGOGICAL QUALITY ASSESSMENT ANALYSIS AND REVISED PRODUCT BACKLOG	An analysis and comparison of the test results before and after the use of the game
UPDATED PRODUCT BACKLOG	A set of proposed updates for the product backlog considering the educational nature of the game
GAME ART ASSETS DESIGN CONCEPTS	This document includes sets of art assets concepts
ART ASSETS	The final art assets chosen by the client and the team
UPDATED PRODUCT BACKLOG	An updated product backlog which now includes the art assets for the final implementation rounds
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME INCREMENT	A playable game increment for the client to use and evaluate
UPDATED PRODUCT BACKLOG	An updated game product backlog based on the results of the previous sprint

NEXT SPRINT UPDATES	A list of updates for the next sprint
THE FINAL GAME	The final game
GAME DOCUMENTATION	The final game documentation

Table 26: Serious Game Reference Production Method Concepts Table - Industry

Appendix C

Activity	Industry Method	Literature Method
Identify initial game idea	=	
Formulate Game Problem Statement	=	
Project parameters research (Budget, time to market, etc.)	=	><
Conduct Case Study at Client Environment	=	
Conduct Internal Investigation/Brainstorming on the Problem domain (parallel)	=	=
Game proposal to client	=	
Team brainstorming	=	=
Client interviews	=	><
Literature research	=	
Target audience research	=	><
Draft Game Concepts design	=	><
Draft Game Concepts evaluation	=	><
Final Game Concept creation	=	><
Team brainstorming (parallel)	=	
Client interviews (parallel)	=	><
Literature research (parallel)	=	
Target audience interviews (parallel)	=	
Stakeholder Interviews (parallel)	=	><
Track Game origins/conduct case study client environment (parallel)	=	
Client interviews for features elicitation	=	><
Literature research (for market based games)	=	
Internal Brainstorming	=	><
Design prototype Gameplay elements and storyline	=	><
Pre-sprint meeting	=	
Pen and Paper prototype sprint	=	
Sprint review with client	=	
Sprint retrospective (post sprint review)	=	

Identify Playtesting groups	=	
Conduct Playtesting with client expert group (parallel)	=	
Conduct Playtesting with target audience group (parallel)	=	
Conduct internal Playtesting (parallel)	=	><
Identify extensive Gameplay elements and storyline	=	><
Embed educational content into the Gameplay	=	><
Create Visualization prototypes for client to choose	=	=
Create Game Design	=	=
Product Backlog creation	=	
Pre-Sprint meeting	=	><
Sprint	=	
Sprint review with client	=	
Sprint retrospective (post-sprint review)	=	
Conduct Playtesting with client (parallel)	=	><
Conduct Playtesting with end users group (parallel)	=	
Conduct Playtesting with important stakeholder groups (parallel)	=	
Identify pedagogical assessment expert	=	
Conduct Playtesting for pedagogical assessment (parallel)	=	
Conduct literature review for pedagogical assessment (parallel)	=	
Evaluate pedagogical assessment	=	
Design final game Art assets (i.e., graphics, sound, music, models, etc.)	=	=
Art assets evaluation	=	=
Include art assets in Product backlog	=	=
Pre-Sprint meeting	=	
Sprint	=	
Sprint review with client	=	
Sprint retrospective	=	
Set Goals and Analyze them	><	=
Set Timeframe	><	=
Identify Available Money	><	=
Identify Resources	><	=
Perform Risk Analysis		=
Have brainstorm session	=	=
Define Game Ideas	><	=
Evaluate Ideas with Client	=	=
Create Game Synopsis (parallel)	><	=

Create Game Concept (parallel)	<	=
Create Global Planning (parallel)	><	=
Consult Domain Experts (parallel)	=	=
Create Visualizations (parallel)	=	=
Create Knowledge Model (parallel)	>	=
Present Concept to Client	=	=
Have Final Decision Meeting	=	=
Sign Contract	><	=
Domain knowledge formalization	><	=
Define pedagogical objectives	><	=
Identify Target audience profiles	=	=
Create educational scenario	><	=
Create entertainment scenario	><	=
Create a game storyboard	><	=
Create mock-up model art	><	=
Create mock-up model	><	=
Evaluate educational nature of the game	><	=
Include feedback to mock-up model design	=	=
Brainstorm	=	=
Delegate Design		=
Create Game Design Document		=
Create Visualizations	=	=
Create Technical Design Document		=
Create Functional Design Document	><	=
Present Game Design	><	=
Perform Risk Analysis		=
Define Milestones		=
Define Project Management Charts		=
Create Budget	><	=
Define and Prioritize Game Features	><	=
Conduct Profit and Loss Analysis		=
Create Workload Document		=
Create Staffing Plan		=
Contact and Select External Developers		=
Sign Development Agreements		=
Specify prototype requirements	=	=
Create prototype design	><	=

Translate requirements into software representation	><	=
Define prototype components	><	=
Prototype development	><	=
Create Prototype Graphics	=	=
Test Prototype	><	=
Create Test Report	><	=
Present Prototype	><	=
Update Game Requirements	=	=
Create Visual Assets	<	=
Create Audio Assets	<	=
Develop Game Code	><	=
Create Text Artwork	=	=
Update GDD		=
Update TDD		=
Implement and Test Alpha Version		=
Implement and Test Beta Version		=
Implement Test Group Version	><	=
Define Testing Schedule and Testing Plan	><	=
Identify and Report Bugs		=
Fix Bugs		=
Track Tasks		=
Measure Progress		=
Control Feature Creep		=
Manage Teams		=
Manage Problems/Changes		=
Replace Working Title with Final Title		=
Release Screenshots		=
Release Demo Versions		=

Table 27: Activities Comparison Table

Concept	Industry Method	Literature Method
IDEA PROPOSAL	=	
BUSINESS CASE RESULTS	=	><
PROJECT PARAMETERS	=	><
CASE STUDY RESULTS	=	

Appendix C

GAME PROPOSAL	=	><
GAME CONCEPT REQUIREMENTS LIST	=	><
DRAFT GAME CONCEPTS	=	
FINAL GAME CONCEPT	=	=
FUNCTIONAL REQUIREMENTS LIST	=	><
PEN AND PAPER PROTOTYPE BACKLOG	=	><
SPRINT BACKLOG	=	><
PEN AND PAPER PROTOTYPE INCREMENT	=	
REVISED PEN AND PAPER BACKLOG	=	
NEXT SPRINT UPDATES	=	
PLAYTESTING GROUPS	=	
REVISED PROTOTYPE BACKLOG	=	><
GAMEPLAY ELEMENTS AND STORYLINE	=	><
GAME MISSIONS	=	><
VISUALIZATION PROTOTYPE	=	=
GAME DESIGN	=	=
PRODUCT BACKLOG	=	><
SPRINT GOAL AND BACKLOG	=	
GAME PROTOTYPE INCREMENT	=	
REVISED PRODUCT BACKLOG	=	
NEXT SPRINT UPDATES	=	
REVISED PRODUCT BACKLOG	=	
PEDAGOGICAL QUALITY ASSESSMENT EXPERT	=	
TEST RESULTS	=	><
PEDAGOGICAL QUALITY ASSESSMENT ANALYSIS AND REVISED PRODUCT BACKLOG	=	
UPDATED PRODUCT BACKLOG	=	
GAME ART ASSETS DESIGN CONCEPTS	=	><
ART ASSETS	=	><
UPDATED PRODUCT BACKLOG	=	
SPRINT GOAL AND BACKLOG	=	
GAME INCREMENT	=	
UPDATED PRODUCT BACKLOG	=	
NEXT SPRINT UPDATES	=	
THE FINAL GAME	=	
GAME DOCUMENTATION	=	
PROJECT TRIANGLE	><	=
GOAL		=
PROJECT DEADLINE	><	=
BUDGET	><	=

RESOURCE SHEET	><	=
RISK		=
RISK CLASSIFICATION GRID		=
GAME GOAL	><	=
GAME CONTEXT	><	=
GAME MECHANISM	><	=
IDEA	><	=
IDEA		=
GAME SYNOPSIS	><	=
GAME CONCEPT	=	=
GLOBAL PLANNING		=
DOMAIN EXPERT		=
VISUALIZATION	><	=
KNOWLEDGE MODEL	><	=
PRESENTATION		=
CONTRACT	=	=
DOMAIN SPECIFIC KNOWLEDGE		=
PEDAGOGICAL OBJECTIVES	><	=
TARGET AUDIENCE PROFILES	><	=
EDUCATIONAL GAME MODULES AND EDUCATIONAL SCENARIO	><	=
ENTERTAINMENT SCENARIO AND GAME SCENES	><	=
GAME STORYBOARD	><	=
MOCK-UP MODEL ART	=	=
MOCK-UP MODEL	=	=
TEST RESULTS	><	=
MOCK-UP UPDATES	><	=
EVALUATION RESULTS	><	=
PROJECT DEFINITION		=
TASK		=
GAME DESIGN DOCUMENT		=
ART DOCUMENTATION	><	=
CONTEXTUAL GAMEPLAY	><	=
STORY	><	=
REQUIREMENT	=	=
CORE GAMEPLAY	><	=

Appendix C

VISUALIZATION	=	=
TECHNICAL DESIGN DOCUMENT		=
SOFTWARE ARCHITECTURE		=
FUNCTIONAL DESIGN DOCUMENT		=
PRESENTATION		=
RISK CLASSIFICATION GRID		=
RISK		=
TASK LIST		=
TASK		=
GANT CHART		=
PERT CHART		=
BUDGET	><	=
DELIVERABLE	><	=
PROFIT AND LOSS ACCOUNT		=
WORKLOAD DOCUMENT		=
EMPLOYEE		=
STAFFING PLAN		=
EXTERNAL DEVELOPER		=
DEVELOPMENT AGREEMENT		=
JOB DESCRIPTION		=
PROTOTYPE REQUIREMENTS	><	=
PROTOTYPE DESIGN	><	=
SOFTWARE REPRESENTATION		=
PROTOTYPE COMPONENTS	><	=
PROTOTYPE CODE DESIGN	><	=
PROTOTYPE	=	=
GRAPHIC FILE	><	=
BUG		=
REQUIREMENT	=	=
TEST REPORT	><	=
COMMENTS		=
VISUAL ASSET	><	=
AUDIO ASSET	><	=
GAME CODE	><	=
TEXT ARTWORK	><	=
FINAL VERSION	=	=
GDD		=
TDD		=

ALPHA VERSION		=
BETA VERSION		=
TEST GROUP VERSION	><	=
TESTING SCHEDULE	><	=
TESTING PLAN	><	=
BUG REPORT		=
BUG		=
SCREENSHOT		=
DEMO		=
VISUAL DEMO		=

Table 28: Concepts Comparison Table

Phase	Activity	Sub-Activity	Sub-Activity Explanation
Concept phase	Elicit Game Idea	Identify initial game idea	The idea is presented to the team by a client or a team member
		Formulate Game Problem Statement	The idea is formulated as a problem through a round of internal brainstorming
	Business Case feasibility research (for market based games)		A feasibility research (Market size, potential revenue, marketing costs, etc.) is conducted to determine whether the team should start the project or not
		Project parameters research (Budget, time to market, etc.)	After the feasibility research a number of important parameters is decided (Budget needs, time-to-market, etc.). These parameters are really important for the game proposal to the client
		Conduct Case Study at Client Environment	A case study is conducted on the client environment for gaining a better understanding of the problem
		Conduct Internal Investigation/Brainstorming on the Problem domain (parallel)	An internal brainstorming is conducted to identify the parameters of the problem
		Game proposal to client	A game proposal is handed to the client to decide whether they want to continue with the game project
	Create Game	Team brainstorming	Team brainstorming session to elicit requirements and details for the game concept

	Concept		
		Client interviews	The team interviews the client to elicit requirements and details for the game concept
		Literature research	A literature research is conducted for requirements elicitation for the game concept
		Target audience research	A target audience research is conducted for requirements elicitation for the game concept
		Create Game Synopsis	A short description of the game that is used as input for the GAME CONCEPT
		Create Global Planning	Planning the project and finalizing the budget. Defining Possible problems
		Create Visualizations	The preliminary visualizations for the game concept are created
		Create Knowledge Model	The knowledge model for the serious game is created
		Draft Game Concepts design	A dozen of draft game concepts are created
		Draft Game Concepts evaluation	The team evaluates the draft game concepts with the client
		Final Game Concept creation	A final game concept is created
	Elicit functional requirements	Team brainstorming (parallel)	Team brainstorming session to elicit functional requirements for the game side
		Client interviews (parallel)	The team interviews the client to elicit the functional requirements for the serious side
		Literature research (parallel)	A literature research is conducted to elicit functional requirements for both game sides
		Target audience interviews (parallel)	A target audience research is conducted to elicit requirements for both game sides
		Stakeholder Interviews (parallel)	Interviews are conducted with all the stakeholders to elicit requirements from all the influencing groups
		Track Game origins/conduct case study client environment (parallel)	A study is conducted in the client environment to identify the needs the target audience has and how the game might cover those needs
	Create Pen and Paper prototype	Client interviews for features elicitation	Based on the game concept further interviews with the client take place for specific features and needs the pen and paper prototype should address and are included in a pen-and-paper-prototype backlog

		Literature research (for market based games)	Based on the game concept further literature review is conducted for specific features the pen and paper prototype must include in order to be representative of the game and are included in a pen-and-paper-prototype backlog(only for market based games)
		Internal Brainstorming	A round of internal brainstorming takes place to evaluate the results of the previous steps and update the pen and paper prototype backlog
		Design prototype Gameplay elements and storyline	A first Gameplay design and important elements and a storyline for the pen-and-paper prototype are decided
		Pre-sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Pen and Paper prototype sprint	During the sprint a playable pen and paper prototype is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the pen and paper prototype increment created during the sprint. This process leads to improvements
		Sprint retrospective (post sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
	Playtesting	Identify Playtesting groups	A set of Playtesting groups is identified from the client side and from the target audience
		Conduct Playtesting with client expert group (parallel)	The game is tested by the client expert group which leads to proposed improvements and a revised product backlog
		Conduct Playtesting with target audience group (parallel)	The game is tested by the target audience groups which leads to proposed improvements and an updated product backlog
		Conduct internal Playtesting (parallel)	The game is tested by the team which also leads to improvements
		Evaluate educational nature of the game	It includes a set of tests on the storyboard to eliminate potential dead ends and ensure that all modules allow the players to learn.
		Include feedback to prototype	The game evaluation is translated into prototype updates and refinements

		design	
Pre-Production	Create Game Design	Identify extensive Gameplay elements and storyline	After the pen-and-paper-prototype has been approved the extensive Gameplay for the whole game and the storyline are designed
		Embed educational content into the Gameplay	The educational objectives and the domain knowledge are translated in the game mechanics and missions
		Create Visualization prototypes for client to choose	Some first visualizations are designed as draft prototypes
		Create Game Design	The complete game design which includes the previous steps is created to guide the rest of the production process
	Prototyping	Product Backlog creation	The complete product backlog is created which includes the game features and details in a prioritized list
		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game prototype increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the prototype increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective (post-sprint review)	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog
	Playtesting	Conduct Playtesting with client (parallel)	The game is tested by the client for further feedback and proposed updates
		Conduct Playtesting with end users group (parallel)	The game is tested by the end users for further feedback and proposed updates
		Conduct Playtesting with important stakeholder groups (parallel)	The game is tested by the rest of the stakeholders for further feedback and proposed updates
	Pedagogical quality assessment	Identify pedagogical assessment expert	An expert (usually a PhD student) who is going to assess the game pedagogical quality is identified
		Conduct	The expert plays, tests and evaluates the pedagogical

		Playtesting for pedagogical assessment (parallel)	quality of the game
		Conduct literature review for pedagogical assessment (parallel)	A literature review is conducted by the pedagogical assessment expert
		Evaluate pedagogical assessment	The game pedagogical assessment is analyzed and updates and changes are proposed
	Final Art Creation	Design final game Art assets (i.e., graphics, sound, music, models, etc.)	The final game art is designed in various art concepts
		Art assets evaluation	The client evaluates the art assets concepts and chooses what they want
		Include art assets in Product backlog	These art assets are translated into features and included in the product backlog for implementation
Production Phase		Pre-Sprint meeting	A meeting before the sprint to decide the sprint goal and the sprint backlog
		Sprint	During the sprint a playable game increment is created
		Sprint review with client	After the sprint a review meeting with the client takes place to review the game increment created during the sprint. This process leads to proposed improvements
		Sprint retrospective	An internal retrospective meeting takes place to analyze the comments from the sprint review meeting, the suggestions for improvements and potentially add more to the next sprint backlog

Table 29: Combined Method Activities Table

Concept	Concept Explanation
IDEA PROPOSAL	Contains the details of the initial game idea
BUSINESS CASE RESULTS	Contains the results of the business case
PROJECT PARAMETERS	Contains the project parameters
CASE STUDY RESULTS	Contains the results of the case study
GAME PROPOSAL	A complete game project proposal for the client to evaluate
GAME CONCEPT REQUIREMENTS	A list of all the requirements and their details for the game

Appendix C

LIST	concept
GAME SYNOPSIS	A short description of the game
GLOBAL PLANNING	First project planning including milestones and development risks
VISUALIZATION	Preliminary graphics for the Game Concepts
KNOWLEDGE MODEL	The model that represents the knowledge that is included in the game. The company develops training Games and therefore this deliverable is crucial
DRAFT GAME CONCEPTS	Includes the details of the game concept which lead to the next steps of the game design
FINAL GAME CONCEPT	Includes the complete details of the game concept which lead to the next steps of the game design
FUNCTIONAL REQUIREMENTS LIST	Includes the functional requirements for both the game and serious side
PEN AND PAPER PROTOTYPE BACKLOG	Includes all the features which are going to be included in the pen and paper prototype in a prioritized list
SPRINT BACKLOG	Includes a sub-set of features from the pen-and-paper-prototype productlog which are going to be included in the next increment
PEN AND PAPER PROTOTYPE INCREMENT	A playable pen and paper prototype increment for the client to use and evaluate
REVISED PEN AND PAPER BACKLOG	An updated pen and paper prototype backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
PLAYTESTING GROUPS	A set of Playtesting groups description
REVISED PROTOTYPE BACKLOG	An updated prototype backlog based on the results of the Playtesting
PEDAGOGICAL EVALUATION RESULTS	The results from the pedagogical quality assessment
GAMEPLAY ELEMENTS AND STORYLINE	This document includes the descriptions of the Gameplay elements and of the storyline
GAME MISSIONS	This document includes the domain knowledge required to be taught and the missions where this knowledge is going to be tested
VISUALIZATION PROTOTYPE	A first crude description of visualizations
GAME DESIGN	The results of the previous steps are combined
PRODUCT BACKLOG	Includes all the features which are going to be included in the game product in a prioritized list
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME PROTOTYPE INCREMENT	A playable prototype increment for the client to use and evaluate
REVISED PRODUCT BACKLOG	An updated prototype product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
REVISED PRODUCT BACKLOG	An updated product backlog based on the results of the Playtesting
PEDAGOGICAL QUALITY	Includes the details of the pedagogical quality assessment person

ASSESSMENT EXPERT	
TEST RESULTS	The results from the pedagogical quality assessment
PEDAGOGICAL QUALITY ASSESSMENT ANALYSIS AND REVISED PRODUCT BACKLOG	An analysis and comparison of the test results before and after the use of the game
UPDATED PRODUCT BACKLOG	A set of proposed updates for the product backlog considering the educational nature of the game
GAME ART ASSETS DESIGN CONCEPTS	This document includes sets of art assets concepts
ART ASSETS	The final art assets chosen by the client and the team
UPDATED PRODUCT BACKLOG	An updated product backlog which now includes the art assets for the final implementation rounds
SPRINT GOAL AND BACKLOG	Includes a sub-set of features from the product backlog which are going to be included in the next increment
GAME INCREMENT	A playable game increment for the client to use and evaluate
UPDATED PRODUCT BACKLOG	An updated game product backlog based on the results of the previous sprint
NEXT SPRINT UPDATES	A list of updates for the next sprint
THE FINAL GAME	The final game
GAME DOCUMENTATION	The final game documentation

Table 30: Combined Method Concepts table

Phase	Activity	Description
Requirements pre-elicitation	Identify contextual situation	The identification process of the current values for all the attributes present in the contextual situation matrix. This phase results into a contextual situation matrix.
	Apply adequacy technique matrix on contextual situation	An adequacy technique matrix, which includes 16 elicitation techniques and all possible values for the contextual attributes is used with the current contextual situation. The result is an adequacy matrix fit to the current situation.
	Elicit requirements elicitation technique	The adequacy matrix is prioritized based on a mathematical formula based on the values of each technique for each situational attribute. This step results into a prioritized list of all the elicitation techniques and (mostly) a selection of the most appropriate techniques for the current project.
	Improve contextual situation	In case the pre-elicitation process

		didn't return any clear preferences for an elicitation technique, then an improvement on the current contextual situation must take place. This happens by re-evaluating some of the situational attributes, which leads to a slightly different matrix and different results. Not all attributes can be improved, since some of them are quite crucial and stable. The list of attributes is categorized into four distinct categories, based on the importance and improvement capabilities of each attribute.

Table 31: Requirements pre-elicitation activities matrix

Concept	Description
CONTEXTUAL SITUATION MATRIX	A matrix that includes the values for all the contextual attributes of the current project.
ADEQUACY LEVELS	The adequacy levels for each elicitation technique obtained after the application of the current contextual situation onto the adequacy technique matrix.
REQUIREMENTS ELICITATION TECHNIQUE SET	A set of requirements elicitation techniques prioritized based on the current project attribute values.
IMPROVED CONTEXTUAL SITUATION MATRIX	An improved contextual situation matrix based on the improvements round after the failed elicitation identification process.

Table 32: Requirements pre-elicitation concepts table

Phase	Activity	Description
Requirements Agile Prioritization	Estimate requirements value based on prioritization criteria.	Every requirement value is calculated based on prioritization criteria such as business value, negative value (i.e., how necessary to support the main user scenario the requirement is) and risk. This step leads to a list of all the requirements with their calculated value.
	Prioritize requirements based on their value.	Based on the results of the previous stage, the experience gathered from the project up to that point, any external changes and the project constraints the list is prioritized.
	Create prioritized product	The prioritized list is used to

	backlog.	create a prioritized product backlog with all requirements.
	Plan iterations.	The prioritized backlog is used to plan the future project iterations and which requirements will be implemented during each iteration.

Table 33: Agile Requirements prioritization activity table

Concept	Description
REQUIREMENTS VALUE LIST	A list that contains all the project requirements with their specific values.
PRIORITIZED REQUIREMENTS LIST	A list that contains all the requirements in a prioritized order based on their specific values.
PRIORITIZED PRODUCT BACKLOG	All requirements for the product are included into this list based on their priorities.
ITERATION PLANNING	The future iterations are planned.
ITERATION BACKLOG	The requirements for each iteration are identified.

Table 34: Agile Requirements prioritization Concept table

Appendix D

Serious games: how to get them right?
* Required

1. **What is your principal current role in (serious) game development?** *
   Mark only one oval.

   ◯ Game developer (coding)
   ◯ Game designer
   ◯ Game producer
   ◯ Game art designer
   ◯ Educational specialist
   ◯ Researcher
   ◯ Other: ....

2. **How many years experience do you have in serious game design and development?**
   *

   ....

3. **What is your age?** *

   ....

4. **In which country are you currently based and working?** *

   ....

General game production process questions

For each of the following statements, please provide your degree of (dis)agreement. At the end of the section, a free-text field is available for you to provide further comments on the game production process.

5. **The development process of a (serious) game should not be based on whether it is aimed for the market or created for a specific client.** *
   Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

Figure 63: Validation questionnaire page 1

2/1/2015   Serious games: how to get them right?

6. **I conduct thorough research on the specific target audience for the game.** *
   Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

7. **When developing client-based games, I conduct research on the client environment for gaining an understanding of the game background.** *
   Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

8. **I conduct literature reviews when developing games** *
   Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

9. **I research the specific learning capabilities of the game target audience** *
   Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

10. In the following paragraph provide any additional feedback on the previous questions

   ....

   ....

   ....

   ....

   ....

Game development techniques

Figure 64: Validation questionnaire page 2

11. **The prototype of the game should be included in the production process from the very early stages.** *

Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

12. **I conduct playtesting during the development of a game** *

Playtesting means testing a playable game version with a group of users
Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

13. **How often do you conduct playtesting during the development process?** *

....

14. **I create a knowledge map/model during the development of the game** *

A knowledge map/model maps the educational objectives of the game and the strategy followed in the game for their achievement.
Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

15. In the following section provide any additional feedback on the previous questions

....
....
....
....
....

Game educational quality evaluation

16. **I would conduct an educational evaluation session starting early in the production, and continuing in all the game increments** *

Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

Figure 65: Validation questionnaire page 3

17. I would employ a permanent educational specialist who would evaluate all the game increments for their educational quality *

Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

18. The educational activities present in the game should not be created separately from the game scenario and later merged together *

Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

19. In the following section provide any additional feedback on the previous questions

....

....

....

....

....

Requirements in game production process

20. I believe the choice of a requirements elicitation technique is project specific and heavily influences the final outcome *

Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

21. I would employ a systematic method for the identification of the elicitation techniques to be followed during the game requirements elicitation process *

The systematic method is based on the identification of the specific project characteristics and through their mapping results in a set of elicitation techniques applicable to the specific project

Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

Figure 66: Validation questionnaire page 4

22. **I would use requirements documentation in the game development process (e.g., during SCRUM sprints, when the backlog items are evaluated and implemented)** *
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

23. **I never conduct an educational evaluation session early in the production process on the first simple prototype or even earlier game concepts** *
During an evaluation session educational theories are applied on the game to determine the level of educational quality
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

24. **I would never apply a systematic method to prioritize the game requirements.** *
The systematic method calculates a specific value for each requirement based on the specific project conditions resulting in a prioritized items list.
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Completely agree

25. In the following section provide any additional feedback on the previous questions

....
....
....
....
....

Figure 67: Validation questionnaire page 5

Timestamp	What is your age?	What is your principal current role in (serious) game development?	In which country are you currently based and working?
12-8-2014 11:41:31	38	a team (developer, designer, educator and subject specialists)	Brazil
12-8-2014 23:16:04	58	Game designer	US
12-9-2014 11:26:14	29	Game developer (coding)	Netherlands
12-9-2014 14:16:02	26	Game designer	USA
12-10-2014 10:41:23	28	Researcher	Australia
12-10-2014	33	Game designer	Germany

19:06:17			
12-11-2014 17:35:45	25	Game developer (coding)	Georgia
12-11-2014 19:31:11	31	Game designer	Netherlands
12-11-2014 19:45:14	37	Researcher	Italy
12-12-2014 8:55:53	32	Researcher	UK
12-12-2014 23:17:24	23	Game developer (coding)	Portugal
12-16-2014 15:30:35	35	Educational specialist	Norway
12-16-2014 15:46:44	30	All of the above, except art	Denmark
12-16-2014 15:51:49	55	Game designer	Canada
The development process of a (serious) game should not be based on whether it is aimed for the market or created for a specific client.	I conduct thorough research on the specific target audience for the game.	When developing client-based games, I conduct research on the client environment for gaining an understanding of the game background.	I would always conduct brainstorming sessions for the creation of game concepts
4	5	4	
3	1	5	
1	4	5	
1	5	4	
5	5	4	
1	5	5	
4	3	2	
4	5	4	
1	4	3	
1	5	5	
3	2	3	
2	5	5	
3	5	5	
1	5	4	
When developing client-based games, I would	I conduct literature reviews when	How important is target audience research for the creation of game concepts?	I research the specific learning capabilities of

Appendix D

always conduct client interviews for the creation of game concepts	developing games		the game target audience
	5		4
	5		4
	4		4
	3		1
	4		3
	4		4
	3		1
	3		4
	4		5
	5		4
	1		3
	5		4
	5		5
	4		4
	The prototype of the game should be included in the production process from the very early stages.	I conduct playtesting during the development of a game	I create a knowledge map/model during the development of the game
	4	4	5
For every project, I attend to the contextual details and conduct intensive iterative user-testing to refine the fit between product and user. I am motivated by the observation that many initial assumptions turn out to be unfounded, and some of our "best" ideas are flops when tested.	4	5	5
exact information not always possible. The responsibility of matching content	5	5	1

to audience is not always clearly defined between client and developer.			
I look at recreational games for inspiration. I do a lot of research into existing games that have mechanisms (serious or not) that help players best interact with the concepts I want them to understand.	5	5	4
	4	5	4
	4	5	4
Right questions	5	5	2
	5	5	3
	4	5	4
It is difficult to talk of "learning capabilities". If the game is designed for a narrow audience (I'd question whether a digital game would be an adequate response in such case), we might be talking of common background and knowledge which would make communication easier to streamline. **I tend to work with web-based education and awareness games**	5	5	4

where your audience is virtually the entire world. Then doing background research is very restricted process. Yet, references to "popular culture" are a good aid.			
	4	3	2
	3	4	5
This answer to this question: The development process of a (serious) game should not be based on whether it is aimed for the market or created for a specific client. * **- completely depends on the project IMO.**	4	5	3
I work with an instructional designer who does some of the above work.	5	3	2
	I never conduct an educational evaluation session early in the production process on the first simple prototype or even earlier game concepts	I would conduct an educational evaluation session starting early in the production, and continuing in all the game increments	I would employ a permanent educational specialist who would evaluate all the game increments for their educational quality
	2	3	5
The use of underlying theory and model maps has proven to be very helpful - developed/revised through group brain-storming that then proceeds to	2	5	5

prototype building and user-testing.			
	2	2	1
	2	5	2
	4	2	1
	4	4	4
Good questions again :)	3	2	2
	3	3	2
	2	4	5
A knowledge map or model is a very good guide, but it is only a master solution and should not restrict users to it. Especially with grown-ups and wider audiences, people have very different backgrounds and understanding of theory. This leads to extremely diverse knowledge models, which is the best, not the worst part of the experience.	3	4	5
	2	2	2
	2	5	5
I create a knowledge map/model during the development of the game * **- yes, though we use other terms we always conduct significant amounts of background**	2	2	2

research before even starting development.			
	4	2	5
The educational activities present in the game should not be created separately from the game scenario and later merged together		I believe the choice of a requirements elicitation technique is project specific and heavily influences the final outcome	I would employ a systematic method for the identification of the elicitation techniques to be followed during the game requirements elicitation process
1		4	4
4	Although I create the educational activities and game scenarios in tandem, I could envision situations in which them might be developed separately and later merged.	4	5
5		5	3
5	When you are making a serious game, education of some sort is the desired outcome. If that isn't being achieved you're wasting your time. However, you need to see how people are interacting with the game material and what they think they are getting out of it. You don't want to sacrifice gameplay (not necessarily fun gameplay but it	3	3

	must be interesting) for the sake of learning outcomes but since learning is the ultimate outcome you must make sure the message is being understood. It is a fine line.			
5			4	3
5			5	2
1	good questions		4	1
5			3	3
5			3	4
3	It is very difficult to evaluate the learning value of early prototypes, because study subjects' perceptions are overwhelmed by the incompleteness of the game. However, if there's a smart way of doing such evaluations, it is critical to conduct such studies. I'd always hire dedicated professionals, if I could afford it, but typically I cannot. It is difficult to have a great design working at once.		5	5

I would use requirements documentation in the game development process (e.g., during SCRUM	I would never apply a systematic		How many years experience do you have in	How often do you conduct playtesting during the development process?
	Typically different components need to be designed separately. However, merging them is often more difficult than designing the components themselves.			
5			3	3
4			3	3
5	I would conduct an educational evaluation session starting early in the production, and continuing in all the game increments * - depends on the project and the kind of learning that is the intended. I would employ a permanent educational specialist who would evaluate all the game increments for their educational quality * - too expensive for us, unfortunately.		5	3
1	I work with an instructional designer who does some of the above work.		5	3

sprints, when the backlog items are evaluated and implemented)	method to prioritize the game requirements.		serious game design and development?	
4	2		15	It depends of project's scope. In general, I can say 1 time for each month of developing period.
5	2	Systematic methods support validity and reliability when applying what is learned to other projects.	10	Daily to weekly during the build, depending on budget and accessibility to testers
5	3		2	every sprint
3	5	Not all educational games are best served digitally.	2	As often as possible as changing as being made. You can't know how people will interact with your game if you don't have people playing it. It's better to get feedback asap and learn about what works and what doesn't so you can give players the best experience possible. Get people playing your game early and often is my mantra.
2	3		3	3
3	2		4	depends, but a couple of times with the client/audience, internally a lot
5	5		4	every time! it's very important!
3	3		8	At least once every two weeks (with members of the team) and occasionally request testers to see if any bottlenecks arise.
3	1		4	it depends
5	1	See my previous comment about evaluation of learning in early prototypes. However, evaluation of educational quality cannot be conducted, based on theories only. It needs to be performed with actual learners. Theories often are not specific enough to provide the necessary distinction between	10	Depending on the size of the team, aim for short iterations. Even in very rigid environments, one study quarterly is a must.

	successful and failing applications of their principles. See a review by Kebritchi & Hirumi 2008 that empirically shows the shortcomings of theoretical approaches: http://www.citeulike.org/user/ma pto/article/3097073 Also, see literature on Design-Based Research (also known as Development Research) for highly productive methods for design for technology-enhanced learning, that are compatible with agile software development.			
3	4		1	Whenever I make a significant change (like a new mechanic or feature)
4	2		2	most of the time
4	2		7	Every day?
2	1		8	As often as funding allows