Co-creative Serious Games Design Process using Nonlinear Storyline Editing

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Abstract: Here we present a serious game development process. The process is characterized by the collaboration in the development by contributors of wide range of skills, including end-users with no special skills in information technology. The aim of the game is to teach a broad range of information and communication technology skills as well as general practices required in the working life. For this purpose a rich content open world multiplayer game has been developed. The game design is highly modular allowing concurrent and continuous development process. Modular tasks are learning experiences crafted by experts in certain aspect of target skills. But tasks themselves can be customized easily without special skills. Especially, interactive non-linear dialogues between user and computer controlled characters inside the tasks can be created by end-users.

1 INTRODUCTION

This paper is based on work and research done in an on-going project Competent Employees for Digitalizing Work carried out by the Workers' Educational Association of Finland (WEA) with the South-Eastern Finland University of Applied Sciences (XAMK) and the University of Eastern Finland (UEF). The aim of the project is to enhance ICT-skills and working life skills of people who have no or a very low level on ICT-skills accordingly to the demands required in working life today.

The target group is people over the age of 30 years who are either unemployed or in transition of losing their jobs, who have no vocational qualification, or whose vocational qualification is no longer coherent with the requirements of work. Participants with low qualification are at risk of social exclusion, which can lead to staying completely outside the labor market. With its objectives the project will raise the skills, competences and courage to search for jobs or further learning possibilities.

The project will create a comprehensive training which ensures all participants with basic ICT-competencies and additional learning possibilities in areas of digital storytelling, digital media, social skills at work, knowledge of employee rights, social media, and mobile games. Traditional classroom teaching is mainly used in teaching, but it is complemented by an online multiplayer learning game described in this paper. The game provides alternative methods of learning and improving information and communications technology skills as well as other skills required in today's work life such as work ethics, interaction in the workplace and maintaining learned skills by self-learning.

In this paper we present the methodology of developing a serious game with high level collaboration between experts and end-users. The game is developed with agile and user-centered methods. End-users are involved throughout the complete development process.

Collaboration is an important feature because the end-users often know best the environment where they will apply the knowledge in practise. In classroom situation students can ask teacher questions and clarify their view of the subject. This is not possible in educational games, unless teacher assistant is specifically provided. Therefore taking the end-users as participants already in the development phase of the game is important. Furthermore, participation improves motivation and self-confidence of the target audience as well as empowers them.

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2 METHODS

2.1 Game Design

The traits of a good serious game design can be traced back to designing good learning materials and to efficient teaching methods in general. It can even be what is it to be a good teacher. The topic is vast and we only make here a reference to different learning theories (Olson & Hergenhahn, 2016; Mayes & de Fretas 2004) and Shulman's concept of pedagogical content knowledge (Shulman, 1986).

In a more focused and practical approach we study the relationship between the subject matter and the learning process, and how this affects the game design. Therefore we are interested in theories of knowledge. In the seminal research by de Jong and Ferguson-Hessler (de Jong & Ferguson-Hessler, 1996) knowledge is classified by its qualities of level, structure, automation, modality and generality.

Especially the level and the structure of the subject matter define the cognitive learning process. As de Jong and Ferguson-Hessler conclude, these qualities are not independent: "*It is evident from this discussion that depth* [level] *and structure of knowledge are not independent. Only the introduction of deep elements makes possible the generalizations and abstractions that are required for the construction of (problem) schemata and the building of a hierarchical structure.*" (de Jong & Ferguson-Hessler, 1996)

From this we derive terms progressive and scattered knowledge, or progressive and scattered skill set in the context of applicable practical knowledge. Progressive knowledge has both depth of level and hierarchical structure. Learning more of a progressive skill set relies heavily on earlier skills. The hierarchical nature makes learning process a sequential task.

Skill set can alternatively be formed of skills that are largely independent of each others and require little prerequisites. This kind of knowledge or skill set lacks the depth of level and has simple structure and can therefore be described as scattered knowledge or skill set.

For example arithmetics is a highly progressive skill set. Methods of mathematical expression manipulation rely on simpler techniques, and mathematical proofs often use earlier results. Another common example is learning a language. The process of expressing complex ideas requires earlier knowledge of vocabulary and grammar. Grammatically correct use of language requires the knowledge of basic grammar rules which are then completed by exceptions and context dependant subtleties.

Learning geography or identification of wild animals are examples of more scattered skill sets. Scattered knowledge can be organized in groups by association. For example the identification of wild animals can be studied according to their commonness (young children), their ecological significance (elementary school), or taxonomy (higher education). But grouping is not a strict property of the skill set but a chosen arbitrary method to organize the subject.

No subject is purely progressive or scattered of course. But this rough division can be seen as a major component in the serious game design. Progressive skill set is something that makes gamification natural as there is implicit progression in the subject of learning. This progression can give an increasing challenge to the player which can be translated into a game engagement.

For a scattered skill set, such natural engagement by increasing challenge is not available and it must be created separately. The learning content can for example be embedded using more traditional computer games techniques such as storylines or challenges not directly related to the learning content.

In this project, the end-users are unemployed or in transition of losing their jobs with low level information technology skills. Basic information technology skills and general working life skills are the essential learning content of the game. This skill set is fairly scattered by nature and does not provide a progressive approach by itself.

We wanted the game development process to be modular, so an episodic structure (Baranowski et al, 2008) of game was chosen. The constructed game world is an open world game world. This means that player has a great freedom in exploring the game world (Juul, 2002). In this world player can find tasks. Tasks are small minigames concentrating on certain subject of the learning (Van Geit et al, 2015). Access to tasks is controlled by rule based system, which makes it possible to create progression. In this way the structure of the game resembles the subject matter of learning.

2.2 Technology

We chose the Unity game engine (Unity 3d Website. 2016) to be the technology of choice for the game project. Unity is used because of its multi platform capabilities and popularity. It can support all most common device platforms, including game consoles, smartphones and tablets.

Unity game engine is also used in the

information technology department computer game development courses which allows us to enable participation of more advanced students to the project. Permissive licensing allows anyone to install and use fully usable software on any computer. License will restrict only notable commercial development.

The game will be released with an open source license, as is appropriate for a publicly funded software development project. This allows us to utilize resources with open licenses.

An extensive study of suitable open license 3d world models was carried out (Letonsaari, 2016). There is significant amount of open license 3d models, including real buildings and even sizeable parts of real cities. However many of these models are not suitable to be used in game engines without modifications. For example models for city planning often do not have textures. Automatically generated 3d models on the other hand often do not scale well but loose detail.

The user interface of the game utilises an open licence 3d city model from the centre of the city of Mikkeli, Finland. This was largest available textured 3d city model. It is constructed with 3d primary objects with photographed textures attached to them and is highly compatible with 3d game engines. An overview of the city model is presented in figure 1.

Figure 1: The Open 3D City Model from the centre of the city of Mikkeli, Finland (in Unity editor).

The city model works in the game as the framework of the UI. The players walk to different educational events in the gamified city model. As an example they can enter an interactive job interview by opening a door of a building in the city model. The user interface to the city with player character and minimap is presented in Figure 2.

For the 3d character customization we use open source Unity add-on Unity Multipurpose Avatar, UMA (UMA 2 Website, 2016). UMA is a platform for dynamically modifiable avatars and allows users to create a playing character they enjoy to play. This

Figure 2: The user interface (UI) of the game.

increases the engagement of the game and makes characters distinguishable for multiplayer purposes.

The open 3d game world allows multiplayer participation to the game. Players can see each others and communicate in the game world. For multiplayer functionality we use Unity Networking (UNET) technology which is an integrated part of Unity game engine.

2.3 Collaboration with End-Users in the Game Development

End-users in this project are people with low level information technology skills attending to a course on basic training on using computers. Therefore collaboration should require minimal amount of technical knowledge from the end users.

A non-integrated method of collaboration with end-users and experts is to collect stories, use-cases and ideas before the development process and integrate the knowledge to the development process (All et al, 2013). Experts and end-users can also operate in software testing and validation and provide feedback to developers (Bossavit & Parsons, 2016; Cosma et al, 2015).

Simple integrated method for co-operation with low skill level participants in the game development is often implemented by enabling editing visual components of the game. Users may be able to modify characters by customizing physical attributes and for example by choosing the clothing and accessories. There may be possibility to edit the game world with graphical editors such as level editors. Graphical editing of characters and the game world is an engaging activity as the results are easily recognizable in the game. Graphics are easily separated from the game logic and require very little understanding of the game design.

Here we wanted deeper and more conceptual involvement of end-users. To this end, a participation method for creating dialogs between player and computer controlled characters was

developed. Dialogs between player and computer controlled characters are important plot devices. Interactive computer controlled characters create another, social dimension to the game world, even if computer controlled characters work with seemingly simple logic. By letting end-users to create dialogs we let them to retell the story with their own voice. This is not only an engaging activity, but lets user to understand game logic more deeply.

The idea here is to let end-users to create dialogs for several different types of interaction: how to communicate with a random encounter person, in job interview with the interviewer, or with your boss, coworker or customer in different working life situations. The player can choose good or bad ways to interact and feedback is given accordingly. Planning these interactions makes the end-user to consider different aspects of the situations. Subject of the dialogs can of course be changed to accommodate the target user needs.

To create dialog for a game, it must be coded into computer understandable format. Writing can be done with free form, and coding can be done manually. There also exists automated tools for writing dialogs which provide speed for the workflow and save manual work. In this project we use open source software Twine, which is a tool for writing interactive non-linear stories (Klimas, 2016). Stories or dialogs generated with Twine can be easily integrated into Unity game engine using UnityTwine addon.

Writing a passage or single part of the dialog with Twine is not different than filling a form in web browser. Passage window is shown in Figure 3. Each passage has title and passage text. It is also possible to add tags to the passage.

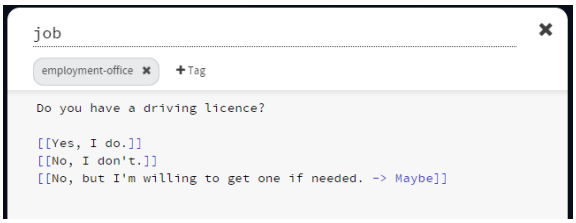

Figure 3: Editing a passage of a nonlinear story in Twine.

Links to other passages are marked with double brackets. These work quite similar as HTML links. When text, as shown in Figure 3, is written, Twine automatically creates new passages using the names of the links text, here “Yes, I do.”, “No, I don’t” and “Maybe”. The link name can also be changed to something more convenient using an arrow notation as shown in the last link.

Linked passages are shown as a directed graph in the story editing mode of Twine, as shown in the Figure 4. The story or dialog structure is clearly visible. User can move passage boxes and edit them by using doubleclick. User interface is very intuitive and Twine has been used for a writing workshop for children (Davis, 2013).

Figure 4: The story structure in Twine. Interactive passages and possible transitions create an easy to understand visual representation of the story structure.

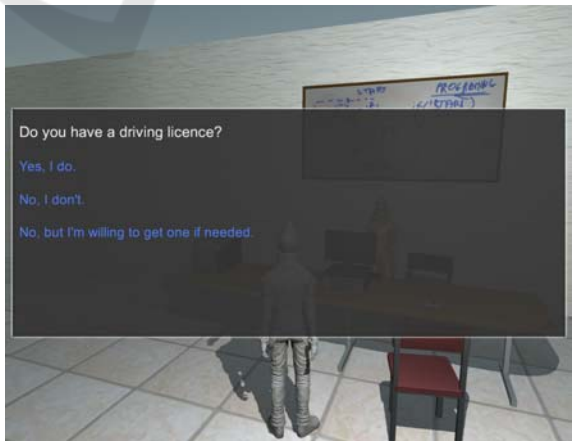

Figure 5: User generated game content inside the game.

The story file must then be imported to Unity using the UnityTwine addon, which generates a C# script from the Twine code. When generated script is

connected to a Unity scene, the dialog script can be played in 3D game world as seen in Figure 5.

3 VALIDATION, USER PROFILING AND RESULTS

A process for developing a serious game was developed in this project. The project is interesting in that the game is created by many contributors of diverse fields. It takes the learning subjects and ideas from the experts in information technology and working life. These are implemented in a game world with latest gaming technology by university students supervised by computer game programming experts.

Open source materials and components are used to create a rich game world. Depth is created to the game by enabling the end-users to collaborate with game development in creating interactive dialogs between the player and computer controlled characters. The complex process is summarized in Figure 6.

The game and development participation has been piloted with a group of students attending to

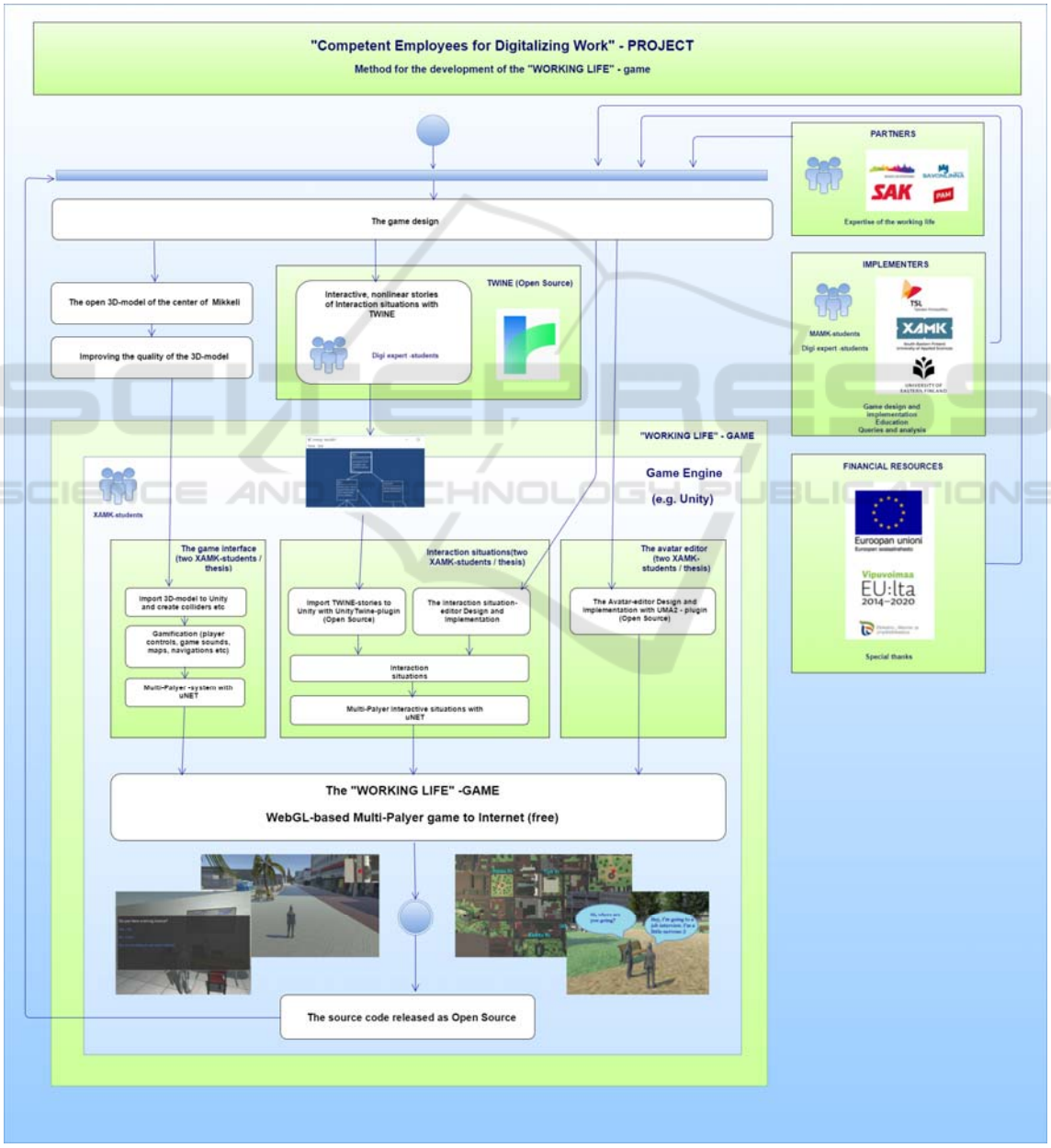

Figure 6: Flowchart of the process for developing a serious game used in this project.

the basic information technology and working life skills course. The target group for the course was people over the age of 30 years who were either unemployed or in transition of losing their jobs, who had no vocational qualification or whose vocational qualification were no longer coherent with the requirements of work.

The course had 14 participants in this group and their age distribution in ten year cohorts is given in Table 1.

Table 1: Test group age distribution.

Age group (years)	Percentage of participants
from 36 to 45	23 %
from 46 to 55	31 %
from 56 to 65	46 %

For each participant, a questionnaire was sent before the start of the course. Out of 14 participants, 13 answered the questionnaire (n = 13).

All of the participants did have an access either to a computer, a tablet computer, or a mobile phone. And almost all had access to an Internet connection. All participants had mobile phones and 69% had Internet connectivity on their phone. 85% of the participants had a computer with Internet connection. 61% of the participants had a tablet computer, but only 64% of the tablet computers had Internet connection.

Relevant to the development of the learning game, participants' previous experience with electronic games was surveyed. None of the participants had any experience with console gaming, including hand held consoles, downloaded games, or multiplayer online games. Participants did have some experience with single player computer games with 42% of the participants, mobile gaming with 34% of the participants, Facebook games 20% and other games played with Internet browser 25%.

At this phase, only qualitative testing was performed. Participants with little experience with gaming were given opportunity to try the game. The game did not have any tasks, but was a open world city, where player could learn character control (walking, running, jumping) and explore the world.

It was recorded by observation and interviews that the game was user friendly and had low learning curve due to responsiveness and logical operation. All participants quickly learned how to move around in the game using the keyboard. Participants were fascinated with the possibility of exploring the city they already knew in real life.

Participation to the game development generated excitement amongst the participants.

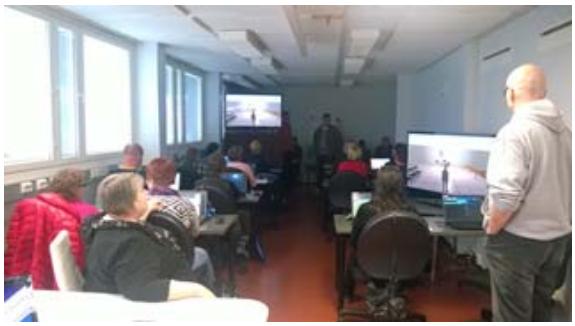

Figure 7: Testing the game in a classroom environment.

4 CONCLUSIONS

Games are used in many kinds of learning tasks and in education. They provide an engaging activity which can be directed into learning activitíes. Usually these games have a certain well defined domain and they are created using traditional software development methods.

In this project our goal was to develop a computer game to teach some basic information technology and working life skills to adult students. The topic is informal and not well defined. We have therefore developed a flexible method for game creation. In this method participants of very different skill levels can contribute to the development process: minigames or tasks can be created by advanced users who can use Unity game engine. Anyone without specific skills can participate by creating dialogs to interaction between players and computer controlled characters.

Co-creation in the game development is a way to create rich content. It is not one or few developers who create the game content, but expertise of end-users is taken into account. This expertise can be surprisingly important as end-users have often the best knowledge on what working environment the skills will be applied in practise.

The game development process is also educational itself. In this project some participants are information technology students and some students learning basic computer skills. For both the game creation process is an integral part of the learning. Analyzing and designing the learning subject in game development gives new insights and provides deeper understanding of the subject.

The end-product is richer in the sense that it is less conventional than when produced with traditional methods. This is an alternative method of game development and can be considered to have similarities with crowdsourcing. Several fields such as open source software or Wikipedia we can see

that crowdsourced content can sometimes as desirable as, or even superior to professional or commercial efforts. These differences may not be clearly quantifiable but qualitatively accounting for a wider range of use-cases.

The next step after this pilot study is to explore further possibilities of co-creative game development. We have seen lately a great success in popularity of serious games. This has happened due to more advanced tools for computer game development, more accessible playing platforms such as laptops, tablet computers and smartphones, and raise of the popularity in online gaming.

As more online learning possibilities, and wider range of serious games is required, serious game development processes will gain more importance. Methods of co-operative development for non information technology professionals should therefore be developed and tested.

The computer game developed in this project will be released as an open source software later in 2017.

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