STUDENTS' ROLE IN GAMIFIED SOLUTIONS IN HEALTHCARE RDI PROJECT

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ABSTRACT

Turku University of Applied Sciences has focused on game development education since 2009. In Turku Game Lab facilities, students and engineers have worked in a close cooperation in Gamified Solutions in Healthcare RDI project (GSH in brief) funded by Tekes (the Finnish Funding Agency for Innovation). In this paper, we will report how our students have worked in various roles in this project. The main focus in the GSH project has been on new services and effective activity solutions to elderly people through gamification. That is to say our objective is to offer more options for the elderly's self-care and eases the healthcare professional's work load. Our ICT engineering students specializing on game development and health informatics have participated from planning and idea generation phase to game development and testing, according to CDIO standards. This project has had relatively large international research exchange program. So our students have been able to work closely with international experts both in our game lab and Japan.

KEYWORDS

CDIO, Rehabilitation games, Health informatics, Gamification, CDIO Standards 1, 5, 7 and 8

INTRODUCTION

Turku University of Applied Sciences has cooperated with its Japanese partners for over ten years. As a result, cooperation has progressed in a level which is covering also large international research exchange activities. In this paper, we will describe how this cooperation has influenced in our engineering education, following the CDIO standards. That is to say we will report how we as teachers and researchers have followed the CDIO standards and based on this how our students have participated in GSH project in various roles. In 2013, before our RDI project called Gamified Solutions in Healthcare (GSH) we conducted a usability evaluation for Serious Games Finland's Glider game. This game is a motion based rehabilitation game designed for stroke patients in a close cooperation with Finnish physical therapists and medical doctors. Our industrial partner requested us to evaluate this game with Japanese elderly people. As we all know Japan is aging rapidly and we were interested in learning more about this relatively new business field. One student from Sendai National College of Technology (SNCT) visited early 2013 in our game lab. During this stay we designed the plan and conducted the pilot test. Kansei Engineering was selected as a research method. This Japanese research philosophy was chosen to get better understanding how Japanese researchers are conducting feasilibility (especially usability) evaluations for designed software

artifacts. During spring 2012, totally 12 Japanese test subjects from SNCT participated in our evaluations and the results have been published in [1].

Thanks to this successful test phase in Japan, GSH project was accepted by Tekes. GSH project develops new services and effective activity solutions to elderly people through gamification. This RDI project combines the expertise of many different disciplines and is linked to company-driven projects that develop scalable international serious games solutions for healthcare utilization. As the result this research project offers more options for the elderly's self-care and eases the healthcare professional's work load. In addition, the project targets to provide support for the Finnish health-care service industry in an endeavour to become World's top provider of gamified healthcare solutions. During this project new rehabilitation game prototypes were developed in our game lab. One of the first game prototypes tested in the project was so called SportWall game. Originally this game was designed by Puuha Group (one of our industrial partner) for children and in this project SportWall was redesigned by our game developers for elderly people. Results reported in [2] were promising compared to commercial games and it encouraged us to continue game development process in GSH project. Next Skiing Game was developed using SportWall game mechanics as a starting point. In spring 2015, this game was tested in Sendai Finland Wellbeing Center (SFWC) with 24 elderly people and later in Finland. These results have now been analyzed and are under evaluation process. The latest game concept called Hiking Game has a bit different approach in aims of rehabilitation. Glider, SportWall and Skiing Game are all so called rehabilitation games with exercise effect. The Hiking Game has been designed to give experiences and entertainment elderly people who are not anymore able to attend outdoor activities nor have long walks in nature. This game has social aspect because it can be played in a group of people. This game together with Skiing Game along with several other games will be tested in spring 2016 also in Singapore.

Another gamified application focusing on social functioning is Old Photos on a Map. This one has been designed for elderly people to share their memories using photos placed on a city map. The concept design of the application has been published in [3]. This application has been developed in a cooperation with Waseda University from Tokyo and we have plans to start testing this application with Finnish elderly people in spring 2016. Another application developed in a close cooperation is CADo flower arrangement application which has been developed with Ochanomizu University from Tokyo as well. In addition, we have developed in GSH project a Clinical Layer which is a virtual physical therapy application. This application was presented in Singapore in World Federation for Physical Therapy 2015. Based on achieved promising feedback these results have now been sold to our industrial partner which has commercialization targets.

In the next chapters, we will report how our students have participated in GSH project in various roles. By presenting these activities we try to illustrate how serious RDI activities can be combined with CDIO principles. As a background information, we have experiences of using CDIO standards in our engineering education since 2007 [4]. In our previous papers we have also reported how important teaching methods namely industry driven projects, learning by doing, and certain case studies in which CDIO standards have been applied are in our engineering education [5-8.]

STUDENT'S ROLE IN GSH PROJECT

The following case studies will be used as examples how we are organizing RDI integrated education in Turku Game Lab facilities nowadays. In GSH project, our students have participated from the planning and idea generation phase until the game development and testing phase. As described above we have tested rehabilitation in various field experiments during the GSH project. Students have participated in preliminary tests and events in which

elderly people have played motion detection games such as SportWall and Skiing Game. Students have also been in essential role in the game development itself. In addition, students have conducted and gathered relevant state of the art material for the utilization of game developers. Not only our students but also students from our international cooperation universities (Japan and Singapore) have been involved in the GSH project activities.

Case Glider Game

One student and his professor from Sendai National College of Technology participated in the Glider game testing. This student introduced himself in Kansei Engineering research philosophy. He was also responsible of designing, conducting, and analyzing the field experiments under supervision of professors from Sendai and Turku. In addition, totally 12 college students from Sendai were participating in the tests as test subjects. More information about the designing and conducting can be found from [1].

Students' role: one Japanese student from Sendai National College of Technology has designed and conducted the game testing, 12 Japanese students participated in as test subjects.

Figure 1. The Glider game tested in Sendai National College of Technology in spring 2013.

Case SportWall Game

As already mentioned, SportWall game was originally designed for children. To redesign the game for elderly, we initially studied the usability and usefulness of commercial games that have potential to be used for the elderly's physical rehabilitation such as Nintendo Wii games, Xbox Sport games, and PlayStation Sport games [2]. Moreover, we consulted with the physiotherapists to effectively design the game in terms of therapeutic movements, game design and customization, and assessment to meet individual needs in doing rehabilitative exercises. Basically, this game was designed and integrated with different therapeutic actions such as side-swaying, sit-to-stand, and jump actions based on the therapist' inputs to the physical rehabilitative exercises for the elderly. Along the SportWall, another game called PhysioWall, was developed with a slower pace with clean physiotherapy moves. The game graphics were developed with students, as well as the gamification concept and preliminary testing activities were done by students.

Students' role: Our students have participated in graphical and game design, game testing and demonstrating game in exhibitions and other events. In addition, one Myanmarian PhD student has conducted studies in feasibility evaluation, social functioning, and cultural difference comparison.

Figure 2. Two graduates from our university testing SportWall game with elderly people (left) and developing graphics for PhysioWall game (right).

Case Skiing Game

In GSH, project we have developed the Skiing Game which is designed for engaging elderly people in regular physical exercise that is required for their general wellbeing. We carefully planned and implemented the game based on the findings from the pre-studies [9]. Our main objective in the game design and development was to provide an elderly-friendly, simple, and intuitive game system for the elderly and their physical exercises. The objective was also to appeal to something familiar to Finnish elderly generation, in this case cross-country skiing, because the technology would be something new to them. Based on gathered feedback during the development by our test-volunteers, we have followed the desired landscapes of snowy mountains and forest as the game context and background. The game play is simply based on steering a pair of skiing poles (double pole skiing technique), which is relatively easy and familiar exercise technique to elderly people who have previous experiences about cross country skiing. We have used a traditional web-cam based controller-free interaction and simple game labels and instructions using English language.

Student's role: Our students have participated in graphical design, game development, and game testing. In addition, one Myanmarian PhD student has conducted studies in feasibility evaluation, social functioning, and cultural difference comparison.

Figure 3. Our students have participated in Skiing Game development.

Case Hiking Game

This game consists of three different scenes from Finnish summer, made into three levels. In the first level, we are walking through Finnish forest environment. While walking in the forest we are able to explore Finnish forest. We are able to meet pines and spruces, as well as elks,

and birds. The second one is about following a beautiful river by paddling your canoe until we will go ashore a mountain in Lapland. We will see salmons jumping ahead of our canoe. In addition, we will be again meeting animals and cottage in the riverside. In the last level, we are climbing up in the mountain. Compared to the first level now we are moving more vertically through causeways and ladders. We can again meet animals such as hedgehogs. The game has been designed to be played in groups or alone. Kinect sensor will be recognizing player's movements so the idea is that elderly people are exercising together ahead of the sensor and based on this we are able to navigate through predefined path successfully. The players are able to see the progress in the user interface as a vertical progress bar. This progress bar will visualize for the players 3-4 task locations in which we are able to take pictures of animals and other interesting objects which can be later shared with each other.

Student's role: Our students have participated in graphical design, game development, and game testing.

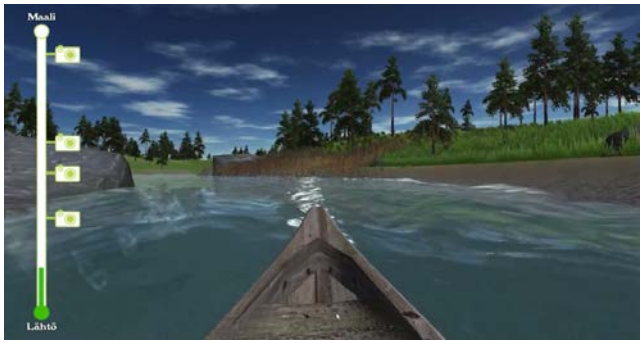

Figure 4. One student based game company has participated in Hiking Game development.

Case Old Photos on Map

This gamified solution has been designed for elderly people to collect, share and memorize old photographs together. Elderly people are able to store their photos including some metadata such as the location and the date when it has been photographed. This system has features to filter photos by are the location or by the year. In addition, when these photos have been shared with other elderly people everyone has rights to comment or memorize these photos on map. TUAS Social sciences students have participated in the development of Old Photos on a Map by conducting a theory framework of elderly memory issues and brain health for the developers.

Old Photos on Map application has also an agent which has been designed in a close cooperation with Waseda University from Japan. The agent will help elderly people to use the application and try to raise conversation to help elderly people to memorize something while browsing photos on map.

Student's role: Our students have participated in the software development, pre-testing and in graphical design (two students have researched and designed Japanese graphics while working in Sendai). In addition, one PhD student from Waseda University has developed the agent as one of the advanced features in the application.

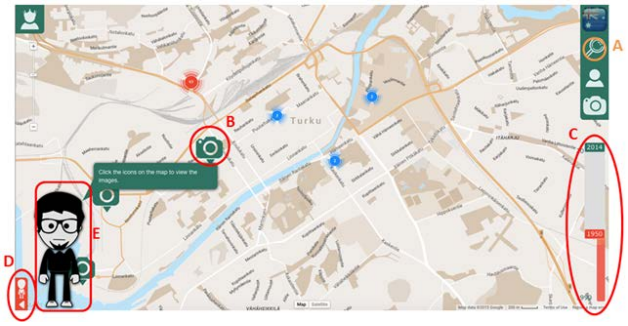

Figure 5. Our students have finalized the Old Photos on Map application for the upcoming tests.

Case CADo

CADo is a mobile application designed for recreating traditional Japanese flower arrangements in virtual reality [cf. 10]. Flower arrangements are fully following traditional Japanese techniques of ikebana. This application is designed for elderly people and necessary exercise in maintaining fine motor skills. In practice, user needs to handle uniquely designed controller that serves as an actual physical controller in an application (initiating start, cancel, confirm, delete functions) and a visual marker for system to use in triggering augmentative reality. The controller also serves as a model of a flower that needs to be virtually cut and arranged in chosen arrangement from given collection. Long with the rehabilitation goal, this application provides soothing setting in which time is no pressure and hint-system would give unlimited number of trials.

Visual language together with the core mechanics of this application provide a calming and yet necessary activity for the elderly people, who wish to improve or maintain the vital senses of coordination. Each session is providing a short entertainment with rich 2D and 3D graphics and interactive setting. This application uses augmentative reality as the main settings for users' interaction. The controller which would be designed as a stick with variety of sensors and markets, would additionally serve as a scanning market which holds information that user wishes to send to the virtual setting. In each stage of the project development, our students found a solution in challenging tasks of creating a virtual ikebana in own everyday surrounding. Additionally, programmers have created a possible use of sensors for more sufficient practice of the application, which is aimed for the users that have conditions with side-effects of trembling hands. In our next phase, we plan to conduct tests in Finland and Japan among elderly people and develop the application further according to the received feedback and test-results.

Student's role: Our students have participated in the software development, and in graphical design. In addition, one PhD student from Ochanomizu University has developed advanced features in the application.

Figure 6. User interface design and use of application in practice.

Case Clinical Layer

Clinical Layer is a solution which is able to interpret physical therapy movements utilizing motion detection sensor called Microsoft Kinect for Xbox One. This motion based sensor together with physical therapy exercise libraries enables innovation creation which is a combination of real time tracking and playful exercising. Clinical Layer as a tracking system is sufficient detecting variety of body-movements. This tracking system (including TV, PC, and Kinect sensor). It has been tested with a couple of game prototypes namely Chair Exercise and Swimming Game.

Student's role: Our students (including both our university and University of Turku) have participated in the software development in a close cooperation with our industrial partner GoodLife Technology.

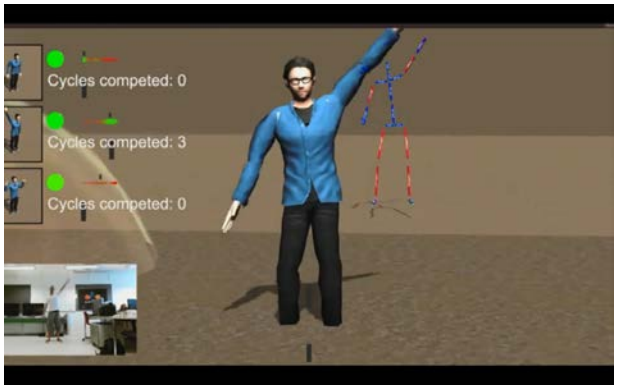

Figure 7. Our students have developed this solution in a close cooperation with GoodLife Technology.

STUDENT PROFILES IN GSH

As described above our students have worked widely in GSH project in various roles. Typically students can be classified in four categories. The first and second year students are mainly participating in our introduction courses. These students have not worked in GSH because they have not enough experiences in game development. The second category is our students studying in Game Development specialization area. These students are working in game development projects in which our game lab experts together with the GSH project manager have coached them in the game development activities. In this phase, students have earned credit points and our game lab experts have been responsible of the achieved results e.g. game testing.

In the third category, our advanced students have worked in GSH project as student assistants. Their role has been essential in the means of programming, visual designs and usability testing. Sometimes they have coached and supervised other students, integrating GSH activities widely in our curriculum. These student assistants have shown their expertise not only in programming or graphical design but also in the frequent communication with our industrial partners. Finally in the fourth category, we have students who have graduated and have continued working in our game lab as engineers (they have possibilities to continue their studies in scientific university or continue their working careers with industrial partners.

In addition, several game development and health informatics students have made their final thesis work for GSH project. These more extensive research works have turned out valuable to the project. They have been utilized for example in requirement analyses, background analyses, theory concepts, user interface designs, game development and programming.

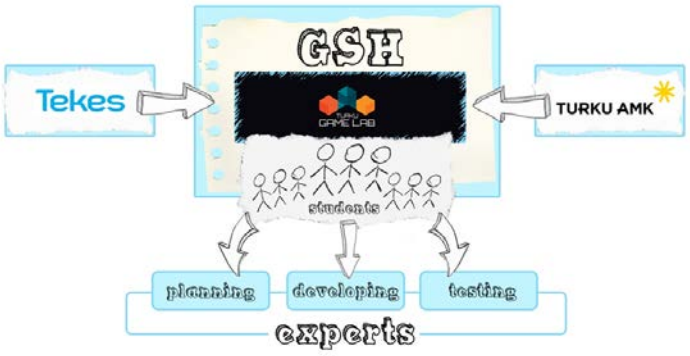

Figure 8. Our students' roles in GSH project.

CONCLUSIONS

All in all, we can summarize that GSH project has opened various ways to utilize CDIO standards in our engineering education. This project has been a valuable platform (as visualized above in Fig. 8) that has joint multidisciplinary students working towards a common goal, each utilizing their own expertise. A multidisciplinary project needs many experts and GSH has succeeded in acquiring and combining these skills both from our university, University of Turku, industrial partners and international cooperation partners. The project has involved students over the course of several years and has both offered and demonstrated them more innovative viewpoints to apply their expertise. Some students have grown with the project, from second or third category onwards becoming project engineers and perhaps later being employed by TUAS industrial partner companies. The possibility to combine project work with studies offers a unique path for TUAS students to build their future.

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BIOGRAPHICAL INFORMATION

Adj. Prof. Mika Luimula is working as a Principal Lecturer in game development for Turku University of Applied Sciences. He also holds the position of Adjunct Professor at University of Turku. He holds a PhD in Information Processing Sciences and a MSc in Mathematics. Dr Luimula is a Research Group Leader of Futuristic Interactive Technologies and is leading game development R&D activities in Turku Game Lab. His research interests include game development, gamification, serious games, health informatics, and location-aware systems. Dr Luimula has also extensive research and industrial expertise on mobile and ubiquitous computing and cognitive transportation systems. He has published around 70 scientific papers in the above mentioned research areas.

Paula Pitkäkangas is working as a Project Advisor and Project Manager in Turku University of Applied Sciences RDI Services. Pitkäkangas holds a M.Sc. in economics and an eMBA in general management. She is currently participating in several industry-related projects and acts as project manager for Gamified Solutions in Healthcare –project. She has an interest in the field of game technology and serious games and has extensive experience in working in research projects and other RDI activities.

Teppo Saarenpää is working as a Senior Lecturer in health informatics for Turku Univesity of Applied Sciences. He holds a M.Sc. in Electrical Engineering (major in Biomedical Engineering). His research interests include usability, wellbeing technology, software testing, eHealth, and information systems.

Natasha Bulatovic Trygg is working as a Project Manager and Graphics in Turku University of Applied Sciences – Turku Game Lab. She holds a M.A. in classical arts and currently finishing her PhD dissertation at University of Turku. Ms. Trygg is actively working in Finnish national game development association (IGDA Finland) along with the interests in serious games development and game research.

Aung Pyae is currently a doctoral candidate at the department of information technology, University of Turku, Finland. His PhD research studies the usability and effects of gamified exercises on the elderly. His research areas are Human-Computer Interaction, Usability, and Culture.

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