Health-Game Development in University – Lower Secondary School Collaboration

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Abstract. This paper describes and analyses a case of multidimensional collaboration of in the development of an educational game. The parties included Metropolia University of Applied Sciences from Finland, Tokushima University from Japan, and a lower secondary school in Helsinki. The development team involved students from three different departments of Metropolia. The two-year project produced two successive prototypes of the game, which contained two hundred questions about health and well-being including oral health. School pupils tested the game several times and commented on its features. They gave critical comments relating to its design and visual properties, even though they were positive about the idea of learning health facts in an entertaining way. Even though the coordination of such a project with many parties involved is challenging, the actual design of the real content and functionalities of a serious game pose more challenges. Effective advance preparation and research on educational game designs and aims will be needed in the following phases of the work.

Keywords: e-health, health education, serious games, co-development

1. Introduction

Universities are increasingly employing multidisciplinary projects in order to insert understanding of real-life practices to the curriculum [1]. The Metropolia University of Applied Sciences that is located in the Helsinki area in Finland has adopted a concept called “innovation projects” to all its curricula, in which all third-year bachelor students are required to participate in a multidisciplinary product development project. The projects respond to product challenges from real world problems that have been presented by a company or an outside organization. The project teams are gathered from two or three different disciplines such as engineering, ICT, oral health, nursing, occupational health, media, or business studies. This paper describes one innovation theme that went beyond a single project to expand into several separate projects, as well as student final theses.

There has been a long-standing cooperation between the two universities involved, Tokushima University in Japan and Metropolia in Finland, which both have departments of Oral Health and Welfare. The cooperation activities included a two-

year (2010-2012) project Evidence -Based Oral Health Promotion that developed a description of evidence-based oral health promotion for children, youth and the elderly. Health promotion competence profile in the degree programs in oral hygiene of both countries was expanded and strengthened to the evidence-based practice according to national and international recommendations. The shared knowledge, which was based on the collaboration, produced new tools for education. Another multi-disciplinary project was planned to continue the cooperation, with a wider perspective to the promotion of the health and well-being of adolescents, in particular. Due to different funding situations, each institution agreed to implement a project of its own. At Metropolia, degree programs in oral health care, public health nursing and information technology participated in this new project.

In this paper, we describe the course of the project and its results in terms of product and educational achievements. First, we explain how the project was embedded in the curriculum, and how collaboration with a lower secondary school evolved. We discuss the results based on feedback and interviews gathered by students, records of project meetings and intranet repository, and completed student work. Finally, we discuss the future of serious game development for health education in collaboration with many actors.

2. Background

National and international health policy guidelines address the promotion of health and well-being of different age groups in multidisciplinary collaboration, in networking and in cooperation among regional actors [2]. When the interest is the health promotion among children, the primary responsibility belongs to the family and the child. Nevertheless, this should take place in close collaboration with communal social and health care services, school teachers and nurses, and the school well-being group if such a group exists. In this project the focus was the health and well-being education of lower secondary school adolescents (14-16 years) in Finland and Japan. Official recommendations for the education include several components of health promotion, such as nutrition, physical activity, alcohol and drug use, injury prevention, oral health, prevention of communicable diseases, and promotion of sexual health.

Contemporary adolescents are often called digital natives referring to their fluency in using internet, mobile devices, and games. In this project, mobile technology was seen as a modern and efficient channel in getting young people to reflect on their health. Therefore, the market of health promotion applications in Finland was explored in the first phase of the project. No such mobile applications available in the promotion of health and well-being of adolescents where adolescents were the key actors when developing ones were detected. However, there were numerous web sites that provide information and guidance on well-being, such as the internet-based School Well-being Profile which was developed already in 2004, and which was well accepted in Finnish schools [3].

The promotion of the health and well-being of adolescents is presumably best achieved in the everyday environment, such as at school. Involving adolescents and giving them responsibility for their own health related issues seems to be the best way

to recognize the need for support and help of networks and experts. In this project, a school in the metropolitan area, which provides primary and lower secondary education, was chosen as a partner. The collaboration between the school and the degree program in Oral Hygiene had started from the initiative of the school's well-being working group in the autumn of 2013. Based on the national school health survey results [4] the working group identified a need to improve the lifestyle and oral health of their pupils. The first step was to give an oral health educational session in the school, which was followed by an oral health fair the next year.

The main themes of the fair included avoidance of tobacco and alcohol use, promotion of oral self-care, prevention of oral infectious diseases, good nutrition and its impact on overall health, and aesthetic dental oral health. The methods included interactive discussions, demonstrations and a quiz. Learning materials included pictures, health indicators, and iPads, from which pupils could search for more evidence-based information. In total 150 pupils in the seventh grade participated in the activities of the fair.

1.1 Aims of the project

The aim of the project that was called Umbrella was to involve adolescents as partners in developing mobile tools for the promotion of their health and well-being. Collaboration in the development of the tool was presumed to motivate young people based on reported experiences elsewhere [5]. They would feel ownership of the resulting product, and they would more willingly employ it later. The adolescents could actively take the responsibility for monitoring and promoting their own health and well-being. In addition, the purpose of the project was to motivate adolescents to self-care and improve their health literacy. The goal was active participation in developing a mobile application with close cooperation and support of peers, the school support network and experts.

The total time for development was planned for two years, consisting of two innovation project course cycles at the university. The innovation project usually lasts one semester, and includes 10 ECTS credits, which is equivalent of 270 hours work. Each project course was implemented in its own department, but the development efforts were coordinated by instructors. Students in different teams met only once or twice during each course. The areas of oral health, clinical nursing, public health nursing, and information technology were involved. Moreover, in the partner school the health education teachers and the well-being working group were involved. The project followed Design-Based Research Model as its backbone [6].

1.2 Games in education

Gamification and the use of educational games is currently increasing in primary schools despite it still being debated to some extent. There is no consensus on the usefulness of games in learning in general according to Kapp [7]. Kapp presented six carefully chosen meta-analysis studies that each examined between 7 and 105 studies that attempted to resolve the issue of effectiveness of games in education. The studies compared reported learning outcomes of game use to other methods, but the result

was, not surprisingly, inconclusive. Overall, in more than half of the cases games were found somewhat beneficial. Nevertheless, meta-analyses tell little of individual cases as they could differ widely. Much depends on the type of game, how it is supported in the classroom, and what kind of learning it is designed to produce.

Dicheva et al. [8] conducted a literature survey on gamification in education, and found 34 empirical case studies, most published in 2013-14. According to their selection criteria, most research on gamification concerned higher education, as only two reports concerned the K12 education. Most cases (18) reported blended learning applications. The subject domain of the application of gamification was in most cases Computer Science or IT courses. They identified the following game mechanics: points, badges, levels, progress bars, leader boards, virtual currency, and avatars. As can be concluded from this list, the definition of gamification in the study was rather narrow. Games for building virtual worlds and other highly developed collaborative games were not necessarily included in the study. The majority of the papers that were examined reported encouraging results from the experiments, including significantly higher engagement of students in forums, projects and other learning activities, increased attendance, participation, and material downloads, positive effect on the quantity and quality of students' contributions, increased percentage of passing students and participation in voluntary activities and challenging assignments, and minimizing the gap between the lowest and the top graders. The papers also report that students considered gamified instances to be more motivating, interesting and easier to learn as compared to other courses.

Business games have been commonly included in the curricula of business studies and economics since the 1970s. However, the learning outcomes are somewhat controversial. In some cases, playing games could even lead to learning wrong behavioural patterns [9]. If the game design is based on extrinsic motivation such as collecting badges or points or winning other teams, such as reported in studies in Dicheva et al. [8], deeper meanings in the game world might be forgotten, and actual understanding of the phenomena does not increase as expected. In Harviainen et al.'s case, experienced business people were frustrated when playing business games where the winning strategy would not have been appropriate in real world [9]. On the other hand, simulation games that have been used in teaching vocational and professional skills, tend to result in more positive learning outcomes than traditional teaching [7].

The most recent meta-study by Hamari et al. in 2017 found education and health as the most common application areas for gamification studies [personal communication], which was the case also in their previous study in 2014 [10]. Obviously, there is a multitude of games and gamified applications offered for schools and young children. Moreover, virtual worlds and game environments such as Second Life, Minecraft and Sims are widely used in schools. Additionally, there is a great variety of games for science and mathematics, as well as language learning. Kevin Devlin and his company BrainQuake create mathematics learning video games such as Wuzzit Trouble, which is based on the idea that the game has to incorporate the logic of mathematics. The learning outcomes and results of game playing have been a subject of continuous scientific research. Overall, the group who played Wuzzit Trouble in an experiment showed a significant increase in number sense between the pre- and post-assessment, compared to the control group who did not

[11]. Another mathematics game with similar principles called Semideus Schools was developed by a research team at Tampere University of Technology (TUT). Its learning outcomes have been studied over the years, and also found to be positive. [12]

Moreover, there is ample evidence that a constructivist approach where students participate in the design of the game and plan how to use it, yields very good results, especially in primary schools as reported by Kafai [5], [13]. Kafai has extensive experience in developing game design in school education, and the experiences of her teams have been successful in many kinds of schools, also where the pupils have been socioeconomically disadvantaged.

2. Research and results

2.1 Development process

Teachers in Oral Hygiene and ICT at Metropolia together with oral health professionals from the municipality originally planned the project based on benchmarking the application that had previously been developed by University of Tokushima. However, the focus immediately shifted from checking the dental status of individual pupils to educating pupils in taking care of their teeth and health. Collecting individual data from school children is strictly regulated by privacy protection, therefore the idea of follow-up of individuals was abandoned. The emphasis was placed on providing information in an easy to digest way and to let pupils experiment with their knowledge.

Oral hygienist students and public health and nursing students started working on the information content with 8th grade pupils as a target group. ICT students formed a team that started generating ideas for the game and writing a script for the game. Initially, all teams reported difficulties in orienting themselves as 13-year-old adolescents, and they were unsure whether they could reach the target group. How to design the game to look appropriate to the age-group was much discussed. However, as there was an agreement with the school, the possibility to test the appropriate level was anticipated. None of the students in these teams were familiar with an iterative and flexible development process that is common in game industry, which added to their anxiety. Altogether six ICT students joined the project at different times, 12 nursing students, and three oral hygienist students.

The first version of the game was designed to be tested in the annual oral health promotion fair in the school. The fair was being organized by another group of oral hygiene students for 8th grade pupils in the school gym and assembly hall. There were displays for pupils on tooth care that also offered samples such as toothpaste, which were provided by collaborating companies. The pupils participated in groups of seven, and they visited each display for 5 minutes where they were guided by oral hygienist students. One stand had four iPad tablets for testing the demo version of the game. After playing the game, the pupils were interviewed on their experience. A week later, the oral health students attended a health education lesson where they collected opinions of pupils through a feedback form, and conducted further interviews. Pupils were asked about the outlook of the game and its sound effects,

functionality, structure, contents, as well as the formulation of the questions and their comprehension.

According to interview results, most pupils had a positive view of the game, but many felt that the content and questions were too demanding. When discussing the game they also raised wider questions such as what health actually means. The game inspired them to reflect on health issues which was an expected and successful outcome. On the other hand, some terms used in the game were unfamiliar, and therefore, students preferred to work with the game during health education lessons but they would not play in their leisure time. The visual implementation was too simple and not attractive enough. The pupils would have preferred more vivid colours, varied sound effects, and possibly 3D effects. [14]

The next round of game development was based on the feedback from the school. New content was added and functionalities were improved. Some of the students continued in the same project but working on their final thesis project, whereas three groups of new students worked again on the health questions and information sources, improving the content of the game. The technical team also changed, and a graphical artist joined it. Unfortunately, there was a skill gap in the technical team and many aspects had to be reprogrammed. However, two successive prototypes were developed, which also could be tested in the following school fairs. [15]

Some challenges in the setup of the project influenced the quality of results. The student teams in the three departments had vastly different schedules and they were working in different campus locations. Therefore, they met each other only a couple of times during completion of the project. The information was conveyed through instructors and a common intranet working space, where all intermediate deliverables were placed. The working space acted as an information repository also for successive student teams.

2.2 Results of collaboration

The progress of the project was monitored in regular meetings of the instructor team, and regular collaborative discussions in video conferences with the Japanese partner. Students completed their assignments on schedule, and they analysed in their reports the success of their respective tasks. All that material is available on the project repository in the university intranet. Therefore, a continuous evaluation of the progress has been available for analysis.

The main results of the project were undoubtedly educational. Students had an opportunity to work with students from other professions, to work with a public school and its pupils, and to participate in a design project with stated aims. For most students, this was their only multidisciplinary experience during their studies. Moreover, the Finnish oral hygienist and nursing students got an opportunity to work in a multicultural setting and practice their language abilities, because all ICT students were immigrants who studied using English. Moreover, about one third of the school pupils had an immigrant background. Students produced material for the project as well as their course reports or final theses. They had an opportunity to see how their design was received by school children, which also helped them to understand customer opinions in their work.

The resulting application has a great amount of information on adolescent health through 200 questions, and the data presentation could further be tested and developed to be even more appropriate for the age group. The application works on a website where it can be tested, although it is still in need of technical fine-tuning. The game is a simple quiz-type of game with the possibility of choosing one of three difficulty levels. Players get points of each correct answer, which they have an option of sharing on Facebook [15]. This type of game allows knowledge testing, and as the correct answers can be expanded with an explanation, the player can also accumulate knowledge on individual topics. However, the learning effects were not tested yet, as the tool has only been used in usability testing situations.

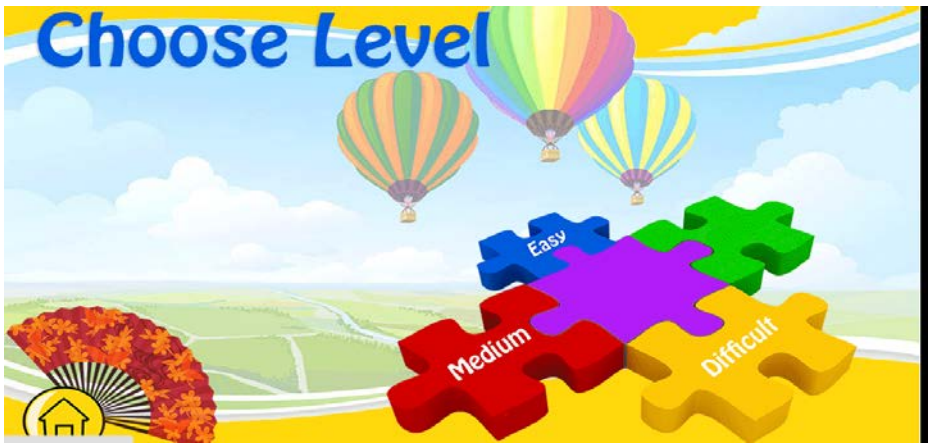

Fig. 1. Starting page of the game

The pupils of the school had been offered a glimpse into the game development process. In their answers to the opinion survey, they gave their opinions on game design and visual outlook, but unfortunately, the same pupils did not get an improved version which would have shown how their opinions influenced the design. Therefore, pupil involvement in the design could be thus far assessed as marginal from their point of view.

Somewhat similar efforts were conducted in other universities in Finland around the same time. The University of Applied Sciences in Kajaani developed a life planning game for 16 to 19 year olds called Game of My Life. The game was developed by information technology students specialized in game development together with health care students and the local support centre for mental health patients [16]. Health promotion indeed is to a strong trend in the serious game field.

3. Discussion

The resulting game still needs to be redesigned to look more professional in order to be fully translated into English and Japanese for the partner university. Many of the original game ideas were not implemented but they have potential for making the

game more engaging. The surveyed pupils gave mainly positive assessments, even though it was observed in the classroom that they did not sustain interest for a long time. They also commented on the modesty of graphics, due to their experience of commercial products that are more polished.

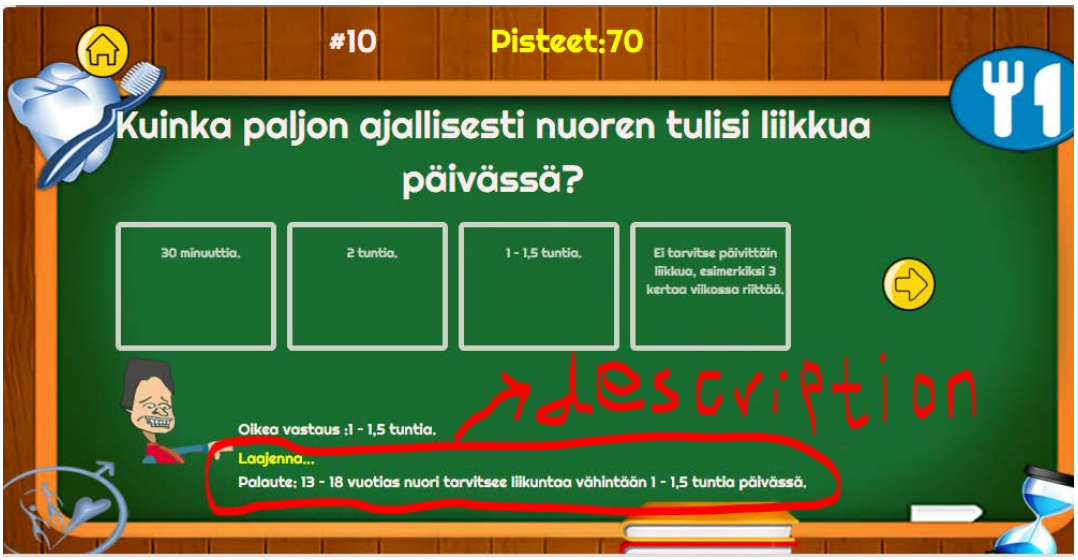

Fig. 2. A question page of the game

The ICT students certainly learnt how demanding game development in reality is. The cross-cultural aspect of the Finnish-Japanese collaboration remains to be tested. The preliminary application developed by the Japanese university was in the Japanese "cute" (kawaii) style, similar how public instructions are often displayed in Japan. The Finnish application had graphics that were developed in an international student team, which cannot be located to any cultural style. It would be an interesting step to see whether such a game can cross cultural barriers in terms of visuals, gaming logic or health education contents, particularly because of the large differences between primary education systems of the two countries.

Collaboration of many parties that were physically separated was a challenge. The varied course schedules and deadlines had to be negotiated in the project plan. In this case, teams could work quite independently as the tasks were not highly dependent on each other. Moreover, teacher collaboration faced challenges despite the efforts of all parties involved because of professional cultures in the participating departments were in many ways different. The busy schedules of instructors were another impediment that prevented close monitoring of student progress.

The team's lack of experience in serious game development became evident in the process. Unfortunately, there was hardly any research on the subject to be found, either, nor could any established models for this kind of development be detected. Game development for entertainment is done in an iterative manner, and after each

round, the reception of the game is tested and the direction for next version is decided on feedback [17,18,19]. In the case of an educational game, the goals are wider than just entertainment: the learning goals are more important than attractiveness [7]. Often there are no straightforward procedures for measuring learning except simply examinations. In this project, the idea of iteration was followed but the interview results from school pupils could not be utilized optimally, because the student development teams had little knowledge of educational goals. The design principles for simulation games that were developed in another Metropolia project could largely be applied in the case of a mobile game, as well. The simulation games were developed in multidisciplinary teams where the students of critical care acted simultaneously as subject experts and learners. [18]

4. Conclusion

The mobile application was built in multidisciplinary collaboration between ICT students and oral and general health care students. The impact of the lower secondary school pupils in successive phases of the development was significant. The main goal of the game was to support health education and control of adolescent personal health knowledge. It was concluded that a mobile application of this kind is an appropriate tool in advancing health awareness, as well as oral health practices. Therefore, producing an international version would make sense, particularly in this setting where multicultural aspects are inherent.

Certainly, a multidisciplinary and cross-cultural project like this requires good planning and experience that the project team acquired through this work. Based on the current experience, the goals of the game can be set accurately both in terms of immersion and learning objectives. Participating students would need advance training in understanding the use of educational games and in adapting the iterative development in design. Also, an experimental language game project that was conducted around same time in Finland recommends an agile, iterative model for the development [19]. There will definitely be more similar projects in near future, and it is hoped that they can benefit from the experiences of these initial trials.

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