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Iterative Process for Developing Digital Games for Adolescent Sexual Health Education in Low-Tech Environments

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ABSTRACT

Digital technology has great potential for educating today's digitally oriented adolescents about health. In particular, digital health games can make the promotion of the sexual well-being of adolescents more effective. Although venereal disease has become a greater problem in some African countries than in any country outside of Africa, little is publicly known about the development of games for use there. This article addresses that deficit by presenting the process of developing one such game. The article highlights the way the My Future Begins Today game for sexual health education was developed, evaluated, and refined in real world settings and made improvements based on response of users. The game was refined in three stages. The evaluation of the effectiveness of iterations of the game was done using a validated MAKE framework we developed on the basis of existing approaches. That framework combines the elements of motivation, attitude, knowledge, and engagement: effectiveness was evaluated based on the game's ability to motivate students, improve their attitudes, increase their acquisition of knowledge, and engage them in the learning. The whole process of game design, testing, evaluation, and refinement as underpinned by activity theory, design-based research, and participatory design.

KEYWORDS

Digital game development, iterative process, sexual health education, SSA, adolescent students, low-tech environment

INTRODUCTION

Digital technology refers to the use and application of information technology resources and devices to support solve problems. Digital technology devices including the internet, smart phones, and tablets, have an increasing influence in the lives of adolescents. It has also been used to educate them about health promotion and behaviour change (Temple-smith, Moore, & Rosenthal, 2016). Digital games are among the digital technology products which refers to "an interactive program for one or more players, meant to provide entertainment at the least, and quite possibly more." In an educational context, digital games sometimes refers to serious games are designed for a meaningful intention of delivery learning rather than entertainment only.

There has been rapidly increasing use of digital games to potentially utilise to support promote adolescent sexual well-being (Shegog et al., 2015). Digital games for sexual health education increase engagement and make the learning environment more interactive (Chu et al., 2015). They also offer practical skills through hands-on learning activities that are translatable to the real world (Hieftje, Fiellin, Pendergrass, & Duncan, 2016). Their repetitive nature is ideal for improving learning. Digital games for sexual health education provide immediate feedback, which is beneficial to the learner.

The use of digital health games has been shown to affect the sexual health behaviour of adolescents. Some digital games focus on a general promotion of sexual health education (Chu et al., 2015), some focus on HIV/AIDS prevention (Hieftje et al., 2016), some focus on preventing the spread of Chlamydia and other sexually transmitted infections (Jiang, McKanna, Calabrese, &

Seif El-Nasr, 2017), some focus on encouraging human papillomavirus vaccination (Cates et al., 2018), and others were aimed at eliminating coercion and pressure in adolescent relationships (Arnab et al., 2013).

Digital game developers have to evaluate the effectiveness of digital games for delivery sexual health education. A number of previous studies evaluated the effectiveness of digital health games in sexual health education using different approaches. For example, Chu et al. (2015), Fiellin et al. (2017), and Jiang et al. (2017) determined how effective games were for acquiring knowledge and changing attitudes. Of these three, Fiellin et al. and Jiang et al. evaluated one more consideration each namely: engagement as the third consideration (Jiang et al. 2017) and evaluated sexual initiation as a third consideration (Fiellin et al., 2017). Cates et al. (2018) and Chib (2011) evaluated motivation. In short, these previous studies demonstrated that the effectiveness of digital health games could be evaluated mainly on the basis of four considerations: motivation, attitude, knowledge, and engagement. Despite this, none of the experimental research combined all four considerations, as we recommend herein.

Digital health games use various learning platforms. While the game Neighbourhood (Jiang et al., 2017) has its video games available on YouTube, it is unclear which learning platform technologies were used even on the Land of Secret Gardens (Cates et al., 2018) and the PR:EPARe (Arnab et al., 2013) video games. PlayForward uses an iPad to play video games during learning (Fiellin et al., 2017). The Making Smart Choices game was developed to educate adolescents using a number of popular digital learning platforms, including iPad, Facebook, and the Web (Chu et al., 2015). Furthermore, the computer multimedia game platform was used in Chib (2011). Of these studies, only one was conducted in a low-income country (Chib, 2011). Together, most of these studies indicate the usefulness of digital game interventions for reducing unhealthy sexual behaviours among adolescents.

Despite these evidence of the usefulness of digital games for sexual health education, the application to improving sexual health education in Sub-Saharan African (SSA) countries, where unhealthy sexual behaviour among adolescents is a critical public health concerns associated with unhealthy sexual behaviours, is not clearly known (Haruna, Hu, & Chu, 2018). Additionally, the motives of the game for educational purposes field focused on: rigorous game development process, consistent instruments including theory-based underpinned learning content, conceptual frameworks, intervention manuals and a sound evaluation strategies for developed intervention using randomised controlled trails to establish the effect of the digital game intervention (Duncan, Hieftje, Culyba, & Fiellin, 2014). Despite all these motives, limited lesson learned of the formative process for development of digital games still exist in SSA. The relevance of this paper is significant given the geographical location to which we focus our intervention and the public health crisis associated with sexually transmitted diseases.

AIM OF THIS ARTICLE

This article informs the design process used for the development of innovative game-based learning solution to educate adolescents on healthy sexual behaviors and reduce the increasing trend in chronic diseases related to unhealthy sexual habits.

THEORETICAL FRAMEWORK

We developed the game named “My Future Begins Today” (MFBT) on the basis of an extended version of activity theory (Engeström, 1987). Activity theory is one of a number of sociocultural learning theories, others being social constructivism, situated cognition, legitimate peripheral participation, actor-network, and distributed cognition. So activity theory shares a family resemblance with them. Like them, it speaks of knowledge construction as a social practice, that is so to say, the design of effective learning depends on communal interactions and analyzed within the social context (Roth & Lee, 2007). While it is used as a framework when developing of educational activities, activity theory is comprehensive and flexible. Hence, this article also employs it for analyzing the development of digital game for sexual health education interventions. Activity theory has seven components: instruments, subject, object, outcome, rules, community, and division of labour (Kaptelinin, 2013). The application of each component in the creation of the game is presented below.

DEVELOPMENT OF DIGITAL HEALTH GAME

Software used

MFBT is a scenario game that uses Unity 5 2D game engine software developed in San Francisco (Unity Technologies, 2016). Unity 5 was used for assembling and bringing together all the game’s components, such as animations, avatars, and sounds. It was also used for scripting the behaviour expected in the application. The game was developed to be played on computers. But plans are underway for adapting it for use on other platforms, including smart phones, web applications, and social media (e.g., Facebook). The Unity 5 technology was used for several reasons. It is freely available, powerful, and flexible when working with animation. It is easy to work with on various platforms. It has the largest user and community support of the game engines on the market today. Finally, it allows the use of the C# language.

Game structure

The game has five topics, each presented in a different scenario. Each topic-in-scenario allows students to acquire a different kind of knowledge or skill. In general, the scenario for each topic consists of teacher and students in the form of avatars. The teacher stands facing students seated in a classroom. There are conversations between the teacher and the students. The teacher asks the students to take quizzes after scenario. There are 10 questions for each topic's quiz. Two points are earned for each correct answer, making a possible 20 points for a topic's quiz. In total, there are 100 points for the five topics/quizzes. Students were challenged with a time limit of 120 seconds for completing a quiz. In order to move to the next topic, students must score more than 12 points. This means out of 10 questions, students must answer at least six questions correctly.

Targeted users

In activity theory, targeted users are referred to as subjects. Targeted users have two roles: using the game for learning and participating in design improvements. MSBT was developed for form one secondary school students, aged 11–15. Before developing the game, the research team spent six months conducting workshops for the purpose of obtaining input from targeted users. This input made it more likely that we would create an game that was reliable and relevant (Hieftje et al., 2016). In the workshops we obtained from students of various levels their experiences with unhealthy sexual behaviour.

Clear goal

In activity theory, the “object” is the end that the students are motivated to achieve through their study (Carvalho et al., 2015). The goal of game is to improve sexual health education, that is to say, ensure that students acquire more sexual health knowledge and better habits than by traditional methods. Thus, a clear general goal was stipulated to make sure that the students motive for learning was satisfied. Furthermore, each topic had a clear goal. Students were informed of what they were to achieve by the end of the topic.

Game instructions

When the game was developed during workshops with participated stakeholders, participants were given norms to follow (respect others, manage your time, and adhere to the schedule, etc.). They were also asked to take into consideration existing social and cultural attitudes, as sex is a sensitive subject (Chu et al., 2015; Haruna et al., 2018). When the developed digital game was tested, students learned the rules for using the game. They were provided clear orientation before game-play. It included the goal of the learning, topics to be taught, how to earn points, the duration of play, how many times the game could be played for each topic, who the game was developed for, the age limit, and how many points must be scored for moving to the next topic.

Stakeholder participation

The digital game was developed using participatory design (PD) approach. Everyone has a stake or interest in attempts to limit the spread of sexual disease and avoidance of teen pregnancy, but some have a more direct stake or interest. Those who might get the disease or become pregnant have the greatest stake. The families of these people also have a stake. The whole society has a stake since everyone is affected by the monetary costs or loss of manpower. In making a game whose goal is to address the problem, there were particular interested parties, or key stakeholders. They include pediatricians, sexual and reproductive health specialists, sexual health teachers from participating schools, computer and information science specialists (including game designer who is computer engineering), and the targeted end-users themselves (secondary school students).

Social roles of key stakeholders in game development

The social roles of the key stakeholder constitute what in activity theory is called the division of labour. During the development of the game, each participating stakeholder had a role to play in the workshops and meetings. For example, students developed a narrative game storyline for each topic, suggested the game structure, proposed types of avatars and characters, and provided initial inputs on their gaming preferences. Pediatricians, specialists on sexually transmitted infections, specialists on adolescent sexual and reproductive health, teachers, and public stakeholders worked together on content, assessment procedures, scores, learning activities, and adolescent sexual health literacy tests (ASHLT). The latter tests were used to examine students' knowledge before and after the intervention and to compare the effects of the three teaching methods. The participating stakeholders also took into account social and cultural norms. Computer and information science specialists provided input on the game structures, user interfaces, and the learning platforms. The initial game developer, who is a computer engineer and information technologist, modified the original design of the game based on information obtained from the other key stakeholders.

Comprehensive evaluation

An earlier study (Hieftje et al., 2016) demonstrated that during digital health game development, it is essential to understand what is going to be assessed. What activity theory calls outcome, herein is the evaluation of the effectiveness of the game. We used randomized controlled trials to compare the effectiveness of two digital health games (game-based learning and

gamification) as the experiment conditions against an existing and widely used traditional teaching as the control condition. The developed digital game for sexual health education was evaluated using different approaches for establishing its effectiveness. The approaches used were: ASHLT was used to evaluate knowledge acquisition through pre-tests and post-tests. Also, we used the framework we developed named MAKE evaluation instrument to assess the efficacy of the digital game for sexual health education. The game was examined the extent to which it improved motivation, changed attitudes, increased knowledge and skills acquisition, and facilitated student engagement using self-ratings and interviews. The essence was to evaluate students' perceptions towards teaching approaches. The results were compared across three teaching approaches.

Iterative Process of Testing and Revision

The testing and refinement of the game was carried out over three cycles. Three secondary schools in Dar es Salaam were selected to participate in the testing, each for a different cycle. Using design-based research, the developed game intervention were tested for there iteration in a cyclic coil face (Kelly, 2004). After tested and evaluated DBR, the limitations identified in the first iteration were addressed in the second iteration. The limitations of the game identified during the second iteration allowed further refinement of the game.

DISCUSSION

This paper aimed at demonstrating the design process used for the development of innovative MSBT digital game for sexual health education suited to an area of SSA where technology is limited. The Activity theory guided the whole process of creating, testing, and refining of the game. This could be a reason the game was easily accepted in testing and showed significant improvement in sexual health knowledge acquisition and attitude change. Activity theory made the participants value their efforts as they felt they were working to address a critical problems facing adolescents. This devotion of efforts to participate in the design of the game was a sign that the game is highly needed by the digital savvy population in the SSA countries. The stakeholders involvement in developing the game provided a good understanding of the importance of game to the adolescent students and of how it was going to be used in addressing the identified problems.

Cycles of testing and refinement were also crucial in developing a sound digital game for sexual health education. As mentioned earlier, the design and development of MFBT was informed by DBR (Reeves, 2006). DBR shares some characteristics with activity theory, including stakeholder and targeted user engagement, outcome orientation, and the addressing of potential problems in a real world setting. The three cycles refined the game through testing and feedback. This ensured that the game was user friendly and able to improve sexual health education. The use of iteration improves the performance of a game. It results in high interactions and performance during learning process when playing, and that leads to better educational outcomes (Hieftje et al., 2016; Jiang et al., 2017).

Lastly, the application of PD contributed to the effectiveness of the game. It involved various actors from various fields who were relevant to the game. Also, engaging targeted users from the beginning resulted in the creation of a better correspondence to the preferences of end users. PD has been recognized as an effective approach for the development of digital health games for sexual health education (Chu et al., 2015; Haruna et al., 2018; Hieftje et al., 2016). It ensures that social and cultural norms are taken into consideration, making the game easily acceptable, usable, and useful (Chu et al., 2015). PD also has a connection with both activity theory and DBR, which were also used in the development of this game.

CONCLUSION AND FUTURE RESEARCH

The digital health game MFBT was developed to address ineffective teaching methods for sexual health education in the limited-resource settings of SSA. In SSA, there has been an increase in unhealthy sexual behavior by adolescents. The goal was to make an interactive learning environment using a game that would improve students' motivation, attitude, knowledge, and engagement. To my knowledge, this is the first digital health game oriented toward the situation in SSA. Given that in most SSA countries teaching sexual health in a regular classroom is uncomfortable if not taboo, My Future Begins Today has the potential for improving sexual health education.

Because MFBT was developed in three cycles of testing and refinement, it best fits the context in which it was tested. So its success cannot automatically be generalized to all the approximately 50 countries of SSA. Future research is need into the contexts of other SSA countries. In total, 348 students participated in all three iterations: the first and third iterations had 120 student each and the second iteration had 108 students. Since only three of its schools participated in the testing, strictly, the testing results could not even be generalized to all of Dar es Salaam, let alone all of Tanzania or all low technology countries globally. Nonetheless, our study no doubt provides a good starting point for work in similar environments. Further evaluation of the effects of the digital health game need to be conducted by involving many schools. Since the digital health game was developed to be used on computers only, further development should be considered using other platforms, such as Facebook, websites, and smart mobile devices. Investigation using various variables, including social economic status, could be a further research direction.

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