Using Online Games in Textile Engineering Education

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**Abstract.** Recent technological advancements have a fundamental potential to transform 21st century textile engineering [1]. Thus, it is essential to further incorporate innovations in industry. In textile engineering education alike, innovative teaching methods, for instance, learning through virtual reality [2], learning by making [3], and game-based learning [4] are apt, and in fact, required methods to teach these subjects for Industry 4.0 in a more understandable and holistic way. Specifically, game-based learning is seen as beneficial in textile engineering education in the part of knowledge acquisition, student engagement and independent learning [4]. This paper presents a pilot study about how online textile games (‘ChoiCo’-Choices with Consequences) co-created with industry partners in the scope of an Erasmus+ KA2 project (T-CREPE), have been incorporated into a design engineering course in a university in Belgium. The purpose of this paper is to reflect on the impact of using digital games in textile engineering education and students’ gains from this approach. Ten (n = 10) textile engineering students participated in questionnaires providing quantitative and qualitative data about the games. Also, reflection reports written by students for each game provided personal insights. The results have shown that games can be useful in textile engineering education by improving students’ 21st century skills (e.g., critical thinking, problem solving, self-learning).

**Introduction**

Utilizing games for purposes other than fun was first proposed in 1970 by a social scientist Clark C. Abt with his book ‘Serious Games’ [5]. As a way of exploiting games with ‘serious’ purposes, game-based learning refers to using games in education. This approach has been used for various reasons. First, game-based learning is helpful for students to achieve a deep state of engagement, which is also called ‘flow’ state [6]. In flow state, students become fully immersed in the activity and they are thought to experience full involvement and enjoyment, which positively influences the effectiveness of education. Second, using games in class settings can increase students’ motivation for learning by offering new representations and affordances for knowledge and skills development. All these aspects help to create an efficient learning environment [7].

Moreover, game-based learning suggests a learner-oriented exploratory way of teaching and learning which differentiates it from the traditional teacher-centered one-way approaches [8].
Game-based learning is usually based on learning-by-doing, allowing students to learn in a constructivist way and become active participants in the learning process.

Researchers also state that game-based learning is especially convenient in helping students to acquire 21st century skills [9]. In today’s world, acquiring those skills such as creativity, collaboration, communication and critical thinking, is crucial for our students to survive in the contemporary marketplace. In this respect, game-based learning has an important role in the development of this 21st century mindset. Another advantage of using games in education is that students can learn independently through games [4]. This can support the self-learning process, which has become even more essential with the COVID-19 pandemic circumstances and restrictions. Lastly, games can make students reach a sense of achievement and increase their engagement with the course subject [10].

In game-based learning, educators can employ two main approaches: instructionist and constructionist approaches. In the instructionist approach, students play the games for learning as passive consumers. On the other hand, in the constructionist approach students not only play but also design their own games, or modify existing games as active producers [11]. Game modding, which is a constructionist approach, can be seen as the initial step of game-design. It refers to the modifications of existing games [12-13]. It enables students to contemplate on the values and meanings in a game instead of dealing with technical details of game design that may require expertise [14]. In this sense, it can be inferred that game modding combines the roles of students as ‘player’ and ‘designer’ [15]. It has been found by researchers that game modding increases students’ interaction and engagement as well [16].

Even though game-based learning provides a plethora of advantages in education, this approach has not received considerable attention in the textile engineering education field. Starting from these standpoints, this study addresses the following research questions:

- How can game-based learning approach be utilized in textile engineering education?
- What would be the benefits of playing and modding/designing games in textile engineering education?

**Materials and Methods**

In order to answer these research questions, a pilot study about how online textile games (‘ChoiCo’ - Choices with Consequences) co-created with industry partners in the scope of an Erasmus+ KA2 project (T-CREPE), have been incorporated into the ‘Co-creation’ course at Ghent University. ‘Co-creation’ is an elective course open to students from various disciplines. Ten (n = 10) textile engineering students participated in this course and worked in collaboration with students from other disciplines, such as industrial system engineering and product design, psychology and business economics. The aim of this study is to reflect on the impact of using digital games in textile engineering education and students’ gains from this approach.

The T-CREPE project (Textile Engineering for Co-Creation Paradigms in Education) develops an online learning platform called ‘T-Crepe planet platform’ that uses an imaginary planet as a metaphor to represent the four stages of the Design Thinking methodology: Discover, Define, Develop and Deliver [17], as its four fictitious continents. The fundamental principles of this online platform are constructionism, in which students construct their own knowledge, and the game-based learning approach. Hence, the continents on the platform include custom-based ‘ChoiCo’ games designed according to the aims of the course and other tools used during the design process [18].
‘ChoiCo’ is an open source, online authoring tool for playing, designing and modifying choice-driven simulation games related to complex real-life issues [19]. The player makes choices that have arithmetic consequences to a set of game fields. The game goal is to make meaningful choices that will balance the game fields for as long as possible. The gameplay is based on decision making, prediction and balance. ChoiCo games comprise the main game-based learning tools integrated into the T-Crepe planet platform.

For this course, industry partners from the textile field and academic partners from NKUA (National Kapodistrian University of Athens), who are the developers of ChoiCo games, generated four textile-related ChoiCo games. The games are; (1) Textile Strain Sensors Characterization, (2) Design a Smart Fabric, (3) Heating Outdoor Pad-Wheelchair Application, and (4) Heating Outdoor Pad-Cultural Events.

‘Textile Strain Sensors Characterization’ game’s learning outcome concerns the characteristics of different kinds of sensors and the manufacturing processes required for their production (Fig. 1).

Fig. 1: The ‘Textile Strain Sensors Characterization’ ChoiCo game instructions (http://etl.ppp.uoa.gr/choico/?sensors)
The second one is the ‘Design a Smart Fabric’ ChoiCo game. In this game, students make choices to design a smart fabric but they have to consider many parameters, namely, cost, time, durability, and its impact on the environment (Fig. 2).

The third ChoiCo game is titled ‘Heating Outdoor Pad-Wheelchair Application’. Students work on developing a heating pad that will be used on wheelchairs (Fig. 3).

The last one is the same game but set out in a different context: this time it is about cultural events. Students need to consider various aspects when developing the heating pad. Starting with the basic textile structure of the heating textile, the outer cover and the power supply as well as energy saving measures for long operating time with low weight, a textile heating pad has to be developed (Fig. 4).
These textile-related ChoiCo games that are specifically designed for this course by the T-CREPE industry and academic partners aimed to provide an active learning environment for textile engineering education, and ultimately, trigger questions by students in this field.

The textile engineering students played these games and modified them in accordance with their own point of view during the ‘Co-creation’ course. In order to investigate the impact of these specific textile games, students were asked to fill in questionnaires that provided data on whether they ‘enjoyed’, ‘felt competent’, and ‘easily controlled’ these games. Most of the questions were open-ended questions that gave students the ability to share their opinions and suggestions. Second, students were provided with a reflection report template. They were requested to use this report as a journal in order to elaborate more on their thoughts about the ChoiCo games as soon as they played and modified them. These reports were the main data collection method for understanding how students played and modified the games and what they learned from the games both while playing and modifying/designing. In the analysis process, the students’ responses on reflection reports and open-ended questions of the questionnaires were coded on NVivo and certain keywords were created through thematic analysis.

**Results and Discussion**

The results of questionnaires and reflection reports of students have shown that using games can be valuable in textile engineering education in two main ways: In the first one, students play the games. In the second one, students modify the games. Students generally stated that they felt competent while playing the games and they controlled the games easily. Also, this gave them an independent learning opportunity outside of the class. Moreover, games directed students to consider all factors that may have an impact on their goal. For instance, in order to stay longer in the game, the students looked out for ways to balance the ethical values with production costs. The students explained that the opportunity to be able to see the ‘bigger’ picture and to keep all possibilities in their minds, helped them to become more inclusive, open-minded and flexible. In addition, the students contemplated on and learned prioritizing the parameters that may play a role in textile production. For example, in a game, the main priority was making a comfortable wheelchair for users. Students were supposed to make choices that will not jeopardize this factor.
In addition, modifying these games also contributed to students' learning experience as well. Students’ reflection reports provided rich data on gains of students from modifying/designing these textile games. Students stated that they changed the game features, parameters, background, and so on, according to their point of view and created their own games accordingly. In this way, they became the co-creators of this game and actively took part in this learning activity as producers.

“I think the possibility to create new games was interesting. It did not directly help me with visualization. I did appreciate the games more after I tried to edit and create my own games.” - Student 2

Moreover, it was found that modifying the games helped them to improve their critical thinking skills, question the existing structure, and be open to different point of views. Since the games were open to modification, it encouraged them to question the game values. In this sense, the experience allowed an exercise of students’ critical thinking skills; one of the most important 21st century professional assets [9].

Conclusion

The aim of this study was to gain insights into textile engineering students’ experience with utilizing games throughout the semester in a course. The data collected through questionnaires and reflection reports exposed textile engineering students’ thoughts regarding using the ChoiCo games in education. This pilot study has shown that game-based learning can be a useful approach that enhances critical thinking and problem solving skills of textile engineering students. A game-based approach helps them consider a breadth of possible factors that may have an impact on the final outcome. For instance, the ChoiCo game about textile sensors not only teaches students the terminology and the possible options but also gives them a chance to see the consequences of their choices. Furthermore, game-based learning can be seen as an alternative teaching approach that allows textile engineering students to learn independently in a remote learning environment.

In conclusion, it is argued that both playing games and modding or designing new games can contribute to online textile engineering education through helping students to think critically, become creative and find out-of-the-box solutions. This claim, however, should be complemented with motivated and committed educators who are willing to integrate emerging technologies and unconventional teaching methods and use custom-made digital and/or physical games in their courses. Lastly, although this study has shown positive outcomes for online game-based learning in the field, the limited number of participants and the fact that it was an in-progress pilot study cannot allow the generalization of the results. Yet, it was hoped that this study contributed to a useful dimension for future discussions on the topic.

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