Inclusive Gaming Creation by Design in Formal Learning Environments: "Girly-Girls" User Group in No One Left Behind

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Abstract. The education sector in Europe is facing one of the toughest challenges on how to attract, motivate and engage students with content from an academic curriculum and at the same time supporting the formal learning process and providing a learning experience that matches the dynamics of the 21st century. More than ever, Albert Einstein's words are a reality: *"It is the supreme art of the teacher to awaken joy in creative expression and knowledge."* Using games in formal learning situations is an important topic of current research but is still largely underexplored. This paper presents how the "No One Left Behind" project aims at unlocking inclusive gaming creation and experiences, by and for students in day-to-day school life. It outlines the project's use cases as well as explores cultural identity and gender inclusion when games framed in an educational environment are created by and for young girls ("girly-girls").

Keywords: Pocket code · Educational application · STEM · Empowerment of girls · Gender inclusion · Teenage girls · Programming · Mobile learning · GPII · DUXU

1 Introduction

The new generation of youngsters has never known a world without the Internet, social media, and mobile technology (technologically-native children born in the digital era - Generation Z) [1]. Coupled with this trend, there are some alarming statistics related with young people, which show that the risk of exclusion and dropping out of schools remains high. More than one child in four in Europe is at risk of social exclusion [2]

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while six million young people drop out of school each year [3]. As a reaction, there is an extreme pressure on schools to produce outcomes with an imminent need for social innovation. Hence, the use of Digital Games [4] as part of the formal academic curriculum comes as a natural response.

In this context, the European Commission co-funded project "No One Left Behind" aims at unlocking inclusive gaming creation and experiences in formal learning, underpinning meaningful learning and supporting children to realise their full potential. To achieve these goals the project is developing a new generation of Pocket Code software.

"No One Left Behind" pilots validate the project's outputs in different contexts of use, such as: different locations (Austria, Spain and UK), different social context and social inclusion perspectives (gender, special needs and immigrants), and different user characteristics (students from different school levels, ages, and educational conditions). The pilots also approach user and group management from academic and social behavioural perspectives, interaction through virtual environments, social behaviour and academic content adaptation with gaming techniques.

Regarding this context, this paper specially highlights issues and approaches being handled in the city of Graz (Austria) which tackles the gender issue through the "girly-girls" user group.

This paper is organized as follows: Sect. 1 provides information about the software component used in "No One Left Behind". Section 2 analyses the overall pilot strategy and the issues to be approached in each case. Section 3 presents the specific case of "girly-girls" as a user group in "No One Left Behind". Section 4 presents the Design, User eXperience and Usability (DUXU) and methodology for the scenarios and framework development. Finally, Sect. 5 consists of the evaluation process, and gives an outlook over the expectations and objectives we like to achieve.

2 Pocket Code and the "No One Left Behind" Project

Pocket Code is a learning application for mobile devices. This app allows teenagers to create their own games, animations, interactive music videos, and many types of other apps, directly on their phones or tablets. It uses a visual programming language and it is developed by the free and open source project Catrobat [5]. Pocket Code has been initiated and developed in Austria at Graz University of Technology.

Pocket Code allows its users, starting from the age of twelve, to develop games and animations directly on their smartphones and/or tablets. Its aim is to enable teenagers to creatively develop and share their own software online. The app is available on Google Play for Education.

Pocket Code is inspired by, but distinct from, the Scratch programming language developed by the Lifelong Kindergarten Group at the MIT Media Lab. The main differences between Pocket Code and Scratch are:

- Support and integration of multi-touch mobile devices
- Use of mobile device's special hardware (e.g., acceleration, compass, inclination)
- No need for a traditional PC.

Similar to Scratch, programs in Pocket Code are created by snapping together command blocks which are called “bricks”. The bricks are arranged in “scripts” which can run in parallel allowing concurrent execution. Broadcast messages are used to ensure sequential execution of scripts (Fig. 1).

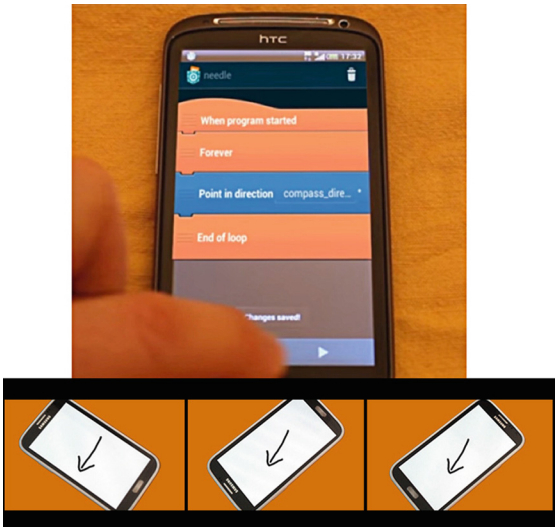

Fig. 1. Making a compass App in one minute with Pocket Code

Currently there are more than 30 ongoing subprojects with the main goal of extending Pocket Code’s functionality, e.g., a 2D physics engine similar to the engine used in the popular Angry Birds game, or an extension allowing the user to record their screen and sound easily while running a program. The recorded video can then be uploaded to an online video sharing site. This high definition video will be created on Pocket Code’s server and uploaded from there to avoid high costs and lengthy file transmissions for its users (Fig. 2).

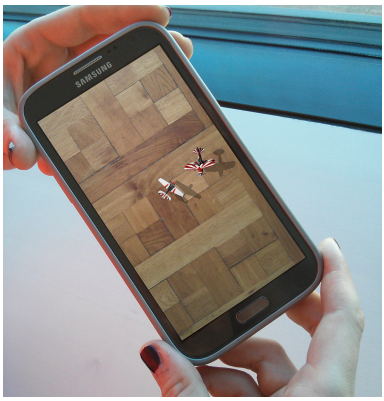

Fig. 2. Making games that play with height and gravity concepts

Pocket Code provides the functionality to share programs among children. The users of Pocket Code are mostly teenagers, who can learn from each other and share their ideas to create new programs and games together. To maximize the pool of programs and games, the Catrobat project team is also developing a tool to convert written Scratch programs to the Catrobat language. A forum was initiated to ensure a better communication between Pocket Code users and also to provide updates and support. This allows users not only to create a knowledge building community but also to help each other when they have questions.

The "No One Left Behind" project creates a new generation of Pocket Code (a mobile media-rich programming environment for teenagers). The teenagers are gaining experiences in gaming creation and in formal learning situations within an academic context. This underpins meaningful learning and supports teenagers to unlock their full potential.

The new generation of Pocket Code integrates an innovative set of game mechanics, dynamics, assets and in-game analytics from leisure oriented digital games. Furthermore it incorporates the current academic curriculum of different primary and secondary grades of the piloting schools. This new generation of Pocket Code allows coding and designing amazing and flexible programs and games. In the future it will be an empowering tool that supports the achievement of learning objectives as well as the development of creativity, problem solving, logical thinking, system design and collaboration skills.

3 The Pilot Sites: Inclusion and Diversity by Design

The project validates its output conducting three pilot studies in Europe (Austria, UK and Spain) targeting 600 children/students between 12–17 years. Each pilot site (country) will address a different social inclusion challenge/scenario: e.g., gender exclusion, disability and immigration.

- The pilot in Austria will target gender exclusion of teenagers. Women are overwhelmingly underrepresented in STEM related fields during their university studies as well as once they enter their professional lives. While younger girls up to the age of 12 do not yet show significant disinterest in topics related to computational thinking, a number of studies [6] show that the majority of teenage girls rapidly drop out of IT related courses during their high school years.
- The pilot in Spain targets educational challenges which occur through increasing immigration flows. Many children are not reaching their full potential and are at risk of exclusion because they have another cultural background. Immigrant student populations in Spain have grown 15 times in last ten years, especially the gypsy community: there are about 350,000 children under 18 years old only in Andalusian Region [7, 8].
- The third pilot in UK targets students with disabilities and special educational needs; the pilot focuses on experiments with multi-modal interactions and inclusive technology through auto-configuration and adaptation of the devices to assist those students. The aim is to bridge the gap between students with and without

disabilities. This inclusive approach will be supported through the use of the Global Public Inclusive Infrastructure (GPII) [9].

Throughout these pilots we are working together with educators to ensure that all participating students will gain the skills and experiences needed to become full participants of the class's social structure. Moreover they learn to articulate their understanding of digital games by means of shaping inclusive and social perceptions as media makers and participants in the digital world while complying with the academic curriculum.

By considering the diversity of users and their different levels of experience we aim at mitigating built-in assumptions of the young game developers and teachers so they can create more inclusive and broadly appealing services. In addition, by teaching inclusive design from childhood, we focus on empowering students, as future innovators in STEM related fields.

4 Empowering Women's Computational Skills: "Girly-Girls" User Group in "No One Left Behind". The Pilot in Austria

Promoting gender equality is a longstanding point at the policy agenda in all European countries, however gender-based discrimination still poses barriers in several areas. For example women are overwhelmingly underrepresented in STEM related fields. East Europe has the highest number of women in Europe enrolled in STEM degrees, and only 8.13 % enrol in those degrees [10]. In Canada, a study about career's interest [11] showed that the lack of interest of women reduced the percentage of people indicating that they were interested or very interested in "High Tech/Computers" to 20 %. Similarly, the 2005 Taulbee survey [12] found that 84.9 % of bachelor's degrees in the U.S. in computer science were awarded to men.

Kelleher et al. [13] report that many girls decide whether or not to seriously pursue the study of math and science based disciplines during their middle school years. Therefore it is important to create not only positive experiences in those fields of studies but also show them a playful way to engage with their subject matters.

In the field of game development the number of women working for this industry still remains very low. That fact is especially interesting because a high percentage of the gaming audience are women. According to a study commissioned by the Internet Advertising Bureau in the UK, women account for 52 % of the gaming audience (surveys conducted in the US and Canada show similar numbers). The total number increased by 3 % over the last three years; however only 12 % of women in Britain are professional game designers and only 3 % are programmers [14].

In order to address these gender bias, in "No One Left Behind" we are evaluating how Pocket Code can become as attractive as possible to different female teenager user groups. Not all of them have the same interests or demographic characteristics, but some groups such as the so-called "girly-girls" group are particularly interesting. These girls constitute a large percentage of all female teenagers. Through prior observations in classrooms we experienced that they constitute a large group of passive smartphone and tablet users but are often the least interested in creating their own programs.

Turning them from mere consumers to active creators is a challenging task for this project. The project experiments with various versions of Pocket Code that optimize the design, usability and user experience for girls by, e.g., offering attractive and appropriate sample content, media assets that can be reused in one's own programs or a special view on what programs have been uploaded to the sharing website.

Supporting young female students is not only an essential part of the project but it is also important for themselves. Through specific developments in "No One Left Behind" we offer young women the opportunity to engage in exciting realms of gaming, enjoyable academic content discovery and technological innovation. This is achieved by:

- Stimulating computational thinking skills, such as thinking abstractly and the deconstruction of a problem into smaller pieces (decomposition and composition).
- Moving beyond participation and creativity thinking via game making and coding.
- Providing skills of game coding that go beyond typical reading, writing, and arithmetic.
- Allowing creative and like-driven game based learning. Therefore students can learn about a specific concept or subject by developing personalized games, allowing students to freely select and use content-related preferences, characters, game dynamics, backgrounds and themes.

These characteristics not only broaden the possibility to include a variety of experiences that are accessible and inclusive to a wider audience but also provide a chance to create "games for all". The enhanced version of Pocket Code also expects to support the ability to diversify the learning process in the future and make the study of STEM subjects more attractive for women. We also expect that the number of women as game designers shall increase in the future; as writer Rhianna Pratchett commented, "young girls need to have their eyes opened to the different avenues open to them in games" [15].

5 DUXU in "No One Left Behind" (Design and Usability Approach)

Design and User eXperience and Usability (DUXU) is very important in "No One Left Behind". Through design and user experience the project focuses on supporting students through ease of use, simplicity and desirability through a coding environment that enables young people to be game makers. By using gaming analytics the behavioural patterns are analysed to better understand the unspoken needs of the students and how they use technology for humanizing and supporting process of social inclusion in the classroom. As explained by Boher et al. [16] the new generation of Pocket Code aims at a model for interaction that is "culturally grounded, dynamically experienced, and to some degree constructed in action and interaction".

In "No One Left Behind" we try to link usability with user experience design. Therefore the Pocket Code user interface (UI) allows the creation of interactive animations and game modules that can be combined, shared and customized by each student for a class project. In order to support easy coding, Pocket Code is providing a

set of pre-programmed modules (e.g., media packages) that allow teachers bridging unequal access to game based academic experiences and balance the students' different skill sets. The students will then complete these games by personal experience, background, gender or likes. While creating programs with Pocket Code, the students not only share their ideas but also work together and support each other in order to respond to the academic objectives given by their teachers.

Through this participatory design approach a useful game Human Computer Interface (HCI) output can be created; which addresses different needs, cultural backgrounds and likes of a group with common and no-common values. As a result DUXU in Pocket Code enables students by developing own programs to combine together the user interface and game design (Fig. 3).

Fig. 3. Interactive Map Game to learn European Countries

While designing games, Pocket Code provides the opportunity for teenage girls to incorporate diversity and inclusiveness, as well as reflect their cultural identity, their emotions, their likes and their way of interacting and thinking. Through sharing those games – in and out of the classroom – the gender bias are not turning but respond to the variety and diversity of girls. With this approach Pocket Code supports participative and user experience design.

6 Status and Further Work

Over the last year, Pocket Code was introduced as a learning tool to teachers and students to use during school lessons. The usage of Pocket Code in computer science and non-computer science subjects increased rapidly, as both teachers and students benefit from it. On one hand students said they enjoy sharing and creating games with an easy to use and fun application that relates with their subjects. On the other hand teachers reported that teaching through innovative and playful tools students are more motivated, enjoy their classes and also take ownership in the project [17].

Over the next year in "No One Left Behind" we will develop preliminary testing of academic modules for teachers in order to create project examples for different subjects (e.g., mathematics, social studies, science, physics). These modules will be based on the objectives of the academic curriculum. Over time these modules will be used by students in real situations, creating interactive stories and animated games that will be then shared with their peers (in class and online communities).

In order to see if those Pocket Code modules fulfil the needs and expectations of both, teachers and students, a qualitative research based on in-depth interviews and focus groups will be performed. Additionally factors which support social inclusion and girls' empowerment within the academic curriculum will be examined. Those factors could be: make use of the benefits of working in groups, train developing ideas from an initial approach to a fully developed program, encourage problem-solving skills and promote the acquisition of transversal competences and creativity.

With this approach we expect that the girls of this so called "girly-girls" group will not only create interactive games based on their academic curriculum and their cultural identity, but also gives them an opportunity to express themselves creatively. Further it will enable them to engage and understand their subject matter in a playful way and increase so their willingness to study further subjects and explore new fields.

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