“This is how I want to learn”: High Functioning Autistic Teens Co-Designing a Serious Game

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ABSTRACT
This paper presents a project that developed a Serious Game with a Natural User Interface, via a Participatory Design approach with two adolescents with High-Functioning Autism (HFA). The project took place in a highly specialized school for young people with Special Educational Needs (SEN). The teenagers were empowered by assigning them specific roles across several sessions. They could express their voice as user, informant, designer and tester. As a result, teachers and young people developed a digital educational game based on their experience as video gamers to improve academic skills in Geography. This paper contributes by describing the sensitive and flexible approach to the design process which promoted stakeholders’ participation.

Author Keywords
Participatory Design; Educational game; Natural User Interface; Autism

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces - User-centered design

INTRODUCTION
Autism Spectrum Disorder (ASD) is diagnosed according to pervasive difficulties in social interaction and communication, coupled with restrictive, repetitive and stereotyped behaviors [1]. ASD affects at least 1 in 68 children in the US [2], with significant social and economic impacts for individuals, families [28], and society [24]. The application of interactive technologies for children with ASD has shown some benefits for supporting learning in the core diagnostic areas of social communication and interaction [37]. Many projects in the field usually prototype activities based on Serious Games (SGs) mechanisms [20] in order to motivate users to improve specific skills. SGs are recognized to be effective mainly due to the engagement and motivation they provide for children [27,39]. SGs developed for children with ASD mainly focus on communication, affective and interaction skills, to the neglect of academic subjects [7]. Although studies present insights of efficacy, there is limited evidence about whether such skills are generalized to real life [38]. This situation could be improved by the integration of these tools at school with greater involvement of, and collaboration with, stakeholders and end-users [31].

Participatory Design (PD) seeks to involve representative users in the design and evaluation processes of technological activities [29]. Furthermore, involving children in the design process acknowledges their expertise [13]. The degree of involvement can be organized by role such as user, tester, informant, or design partner [13] and be influenced by the specific needs of those involved [17]. PD can be a very effective process but methods need to be developed and applied sensitively and creatively when seeking to involve children with special educational needs (SEN), such as those with ASD [15]. This is because particular communication needs and preferences of children may make it difficult for children to participate in standard methods such as the use of personas or usability questionnaires [30]. For example, when involving children with autism, researchers have successfully used more visual and structured methods and materials, and provided concrete examples to initiate and prompt ideas rather than relying on abstract concepts for discussion [4,12,26]. Given the need for sensitivity and different methods, research processes should be rigorously reported [14].

This paper presents a project that developed a SG via a PD approach with the ‘hardest to reach’ teenagers with ASD who had experienced multiple exclusions from previous schools and attended a specialized school for young people with SEN. The contribution of this paper is a description of how teenagers with ASD participated in the co-design of a SG. We also note the novelty of the SG in focusing on academic skills [21,33] using a Natural User Interface (NUI). We focus on the design process that was sustained over a number of weeks, highlighting key elements of the process, using the frameworks [6] and [11]. Below, we summarize the design process, give examples of stakeholders' participation and reflect on how their particular needs were considered.

DESIGN PROCESS

Pre-requisites of the project

NUIs offer natural, intuitive and motion-based ways of communicating [22] that are easily accepted by children [3] and adults [36] with ASD. Additionally, using the body for interaction can improve task engagement [8] and learning [23]. Thus, we wanted to make the body the main element of interaction. The Body Menu (BM) is a technique that uses advantages of proprioception to interact with the software [9]. We used the Kinect [25] since it is affordable, compact and easy to use; all of which are important criteria for planning technology use in schools.

Participants

Key stakeholders were gathered in two groups:
(1) The *designer-team* comprised 4 males with ASD, three of them aged 15 years and one aged 11, the ICT teacher, his teaching assistant and the researcher (first author). However, all the students did not always attend sessions due to timetable clashes. Only two of them (Nathan and Jack (pseudonyms)) participated in most of the sessions.
(2) The *teacher-team* comprised 13 teachers from the same specialized school as the *designer-team*.

Organization

Previous projects involving youth with autism in a PD process organized their sessions based on specific models, such as TEACCH or SCERTS [4,14,26]. Although we did not incorporate these models in their entirety, we drew upon the good practices identified in this research to plan our sessions, for example through using digital prototypes and visual questionnaires within sessions, and clearly communicating the objectives of each session. For each session, the stakeholders flexibly and informally adopted specific roles based on those described in Druin's research [13]: *user*, *tester*, *informant* or *design partner*. The overall sequence of the sessions is presented in figure 1. All the sessions were audio-recorded.

Stakeholders' engagement and motivation

Benton and Johnson [6] defined four levels of engagement on tasks and the relationship between adults and children in PD processes; *viz. indirect*, *feedback*, *dialogue*, *and elaboration*. In our study, teachers' engagement was mostly via *feedback*, before and during the PD process. Crucially, teachers provided initial validation for the project by agreeing that the BM could be applied to the subjects taught at the school (e.g. Math, Geography, English) because of the potential to design the surrounding context or task in a flexible way. They also suggested that the NUI could be valuable for supporting children's interaction with each other and motivation to engage with learning materials.

Previous research recommends the use of specific methods to promote participation in PD [4,12,14,26]. Although we provided tools such as visual schedules, and blank paper to

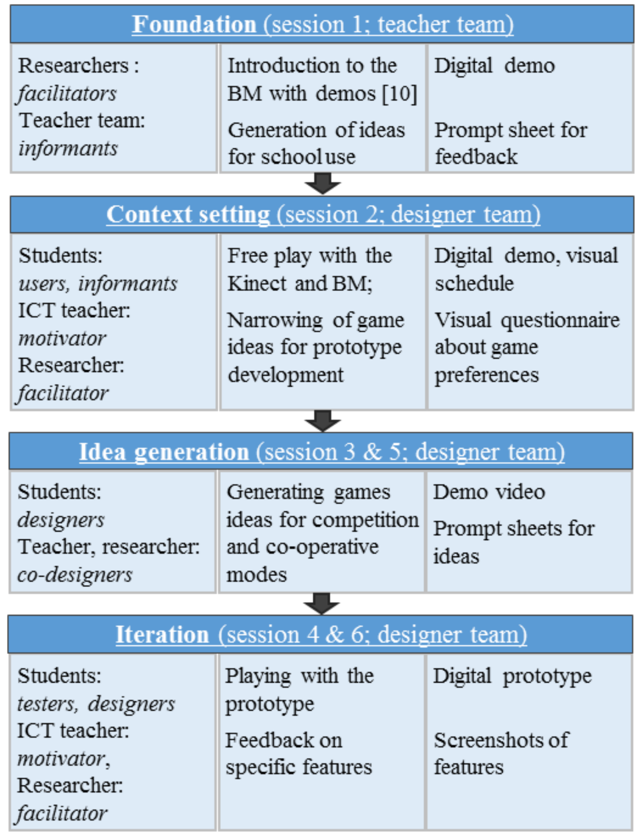

Figure 1: sequence of the PD sessions

sketch ideas or screenshots of the prototype to support further discussion, none of these were used in practice by the teenagers. A visual questionnaire used in the *context setting*, was one of the few tasks which promoted *feedback*; otherwise the tools used by the teenagers were mainly *dialogue*-based.

Nathan's engagement in the PD process was high and consistently at the *dialogue* level across all sessions. This was unusual but welcome, according to the ICT teacher: *"He is usually shy, stays quiet and sits formally, but today he was very active, thinking on how to improve the interaction - sitting on the table touching his chin, moving all over the room and trying and trying again to discover the limits of the Kinect."*

By contrast, Jack's engagement varied substantially. During the *context setting*, he was mainly distracted by the computer games set in the ICT classroom and almost did not play with the demos. Then, during the first *idea generation* session, Jack's participation was high (*dialogue* level) providing several ideas and taking decisions. However, a 'pivotal moment' appeared during the first *iteration* session when Jack lost the game quickly against Nathan. From then, he was demotivated and withdrew from the project being *indirectly* engaged and mostly distracted by playing PC games. Adults tried to integrate him back to further discussions but he mostly answered the questions by "*I don't mind*" or "*I don't know*".

Ideation

In this project, ideation took place through the roles that each designer-team member adopted within each session. Such roles were informal and flexible but were nevertheless shaped by the planned activities and, therefore, led by the researcher based on session objectives. For example, when the students were asked to play with the Kinect they automatically became *users*; when completing the visual questionnaire about game preferences they were *informants*. Consequently, at many points the process was arguably less reciprocal and so the extent to which the students could be considered *co-designers* is questionable. However, there were also key points in the PD process where the students had more decision-making power i.e. as *designers*, and these points proved to be pivotal in the development of the game.

The first pivotal idea generation occurred between the *context setting* and the *idea generation* session. At the end of the *context setting* session, for homework, students were asked to think about a game which takes advantage of the BM and were reminded that the next session would take place the following week during their ICT class. Subsequently Nathan proposed a game for learning Geography because he struggles in learning that subject. This was later checked and agreed with the other student team members via discussion with the ICT teacher, who then communicated back to the researchers. This plan also aligned with the results of the *foundation* session, where it was suggested that the BM could be applied to any part of the curriculum.

The other key exchanges occurred during the *idea generation* sessions. These sessions were organized as a discussion group around a table. For the first session, Jack was the only student and although he had been given one week to think about the game design, he was not able to give initial ideas. Consequently, we showed a prepared video, inspired by Nathan's Geography idea that illustrated a prototype in which users could select countries by using the BM. This provided a concrete starting point for developing the idea [5,32], and this supported Jack in providing suggestions which were then discussed between the team members.

For both *idea generation* sessions, every new idea was verbally integrated within the scenario by the researcher taking into account the possible causes and consequences it would imply. If the new scenario presented incoherence, the idea was discarded, mostly by the researcher but with consent of all the stakeholders, or modified if the stakeholders considered the initial idea important. If no more ideas were given, the researcher asked questions on game features in order to further develop the concept. All the ideas were represented by hand gestures such as pointing or mimicking or were verbally described. This scenario was frequently repeated to detect incoherence or missing features. This process made the development of ideas for the game transparent for all team members, being clear about what decisions were made and why. We suggest this is one of the reasons why the students' engagement in *idea generation* was so high.

Decision making

Decision-making within PD can be classified in four categories: *values and concept*, *implementation*, *negotiations with the outside world* and *non-decision* [11].

The students proposed initial ideas based on *values and concept* such as suggesting Geography as the topic and deciding on the content of the game. However, the final decisions about the *values* were made by the adults. For instance, after watching the video Jack proposed ideas such as a race of country selections where the first player who answers the teacher's questions wins. This idea was rejected by the teacher as content veto because educational content was provided by the teacher only. Then, Jack proposed a war game by attacking countries via missiles, which was rejected by the researcher as ethical veto. Nonetheless, these adult-led decisions enabled Jack to generate more ideas and propose a questions-based game to 'win' the countries, which formed the starting point of subsequent discussion. Most of the students' decisions were *implementation*-based. For instance, Jack proposed a system of hierarchy within the countries where a weak country could not directly access a stronger one. This was appreciated by Nathan who stated: *"It's a mix of Risk and Civilization, I think it is actually a really good idea … I think it is a good balance between fun and education"*.

DISCUSSION

PD approaches give 'voice' to stakeholders by providing roles for them in the design process; therefore, it is important to clarify the different roles and contributions made by the participants within such processes. We have used the frameworks of [6,11] to document the specific contributions made by each participant, how this changed over time and who made decisions at different stages of the design. Full details are not possible within the constraints of this paper, but some of the pivotal moments in the design process are highlighted. These moments raise important questions about whether there are boundaries of participation that need to be considered.

Students and the teacher almost exclusively took on *implementation* roles with the researcher mostly taking decisions about *values and concepts*. This reflects that equity on all aspects was not something that could be achieved consistently through the project [32]. However, this confirms that adults also play an important role [6,16]. Not only did adults' interventions impact the design outcomes by having the final decision [35] but this influenced the students' participation in valuable ways by constraining the design space and encouraging them to think again. Nevertheless, the students' ideas were pivotal when making final decisions and even though adults generated some initial ideas such as the first video for inspiration, the main concept was initiated by one of the students based on his self-identified struggle with learning in Geography. This project's PD process shows how each stakeholder contributed their own spheres of expertise to the task: the researcher regarding programming feasibility and the structure of the design sessions; the teacher in relation to pedagogy of the game itself; and the students about gaming features of technologies based on their familiarity with games more widely. This highlights that equity in design partnership is not about all partners sharing all decisions, but about respectfully managing the different expertise that each partner brings [32].

Relatedly, each of the student participants made very different contributions through the design process: one was less engaged in the process, eventually withdrawing, and one was much more dominant, contributing to more decisions. PD is particularly challenging when it involves children with autism because they can be exposed to excessive pressure [14]. Visual schedules [26], visual recap [4] or physical objects [14] have been shown to support the sustained engagement of children. However, the teenagers ignored the visual schedule and recaps via screenshots. Consequently, we used a more informal approach for prompting ideas and gaining feedback, with the support of teachers who knew the students well. This informal approach led to transparency of decision-making within the *ideas generation* sessions. We suggest that this direct tangibility of the 'trace' [34] between participation and design outcomes could be one of the reasons for high engagement of the students during this stage.

Most of the sessions were long (about one hour) which suggests that the engagement was sustained regardless of design stage or tools used. However, we believe that by being flexible about the context of work the engagement of the stakeholders is naturally strengthened because sessions are tailored specifically for their needs, varied moods and interests. This reflection is in line with [16,32] who emphasize the importance of taking a flexible approach. Although a specific period of time was planned for the session, the amount of effective work achieved during that time varied considerably. Pupils needed time to chat, to speak about their interests, and sometimes they were absent from class or school. Due to other timetabling needs, sometimes the amount of time given to the sessions was reduced or simply cancelled shortly before they were due to start. As a result, we suggest that researchers come prepared for this and be willing to respond flexibly. In this case, it was an advantage because it revealed how differently the students responded in individual sessions compared to group sessions. Furthermore, the varying nature of sessions could be considered a strength because the participants took part on their own terms and we aimed to make the process as natural as possible (e.g. using observations and in-class discussion rather than formal questionnaires). Another aspect that requires a flexible approach is the need for children to be able to explore the features of the technology even if it is not the assigned task. For instance, players tended to play with their own projection giving kicks in the air or "dancing". Exploration and testing the technology boundaries remains an important part of young people's experiences with technologies and so we need to accept and allow space for them to do this constructively, not least so that they can be more informed about the technical possibilities in order to be able to think about how aspects of the game can be designed.

It is also important to consider the context for informing and shaping how and where PD processes take place [12]. There are benefits of context-specific design [19] but potential challenges too. In this case, the sessions took place in the school's ICT room. This supported the initial motivation of the students to attend class. For instance, the ICT teacher observed Nathan's desire to attend the sessions and improvements in his behavior after a difficult week. However, the ICT room easily distracted the students because of familiar expectations about activities that took place there e.g. playing *Minecraft*. Indeed, the growing temptation to play PC games rather than focus on the design sessions led to Jack's withdrawal. Therefore, we recommend integrating sessions during teaching lessons but in a room where students cannot be distracted by the other technologies available [12,18].

CONCLUSION

This project shows what is possible when designers work closely with teachers, and students with ASD, in a flexible and open way. We show that previously published techniques were not always successful here and, instead, a much more informal, discussion-based and experiential approach was taken to the design sessions. The context of work was engaging enough to maintain the interest of the teenagers, especially through transparent discussions when ideas were being generated, retained and rejected. This is important because these were teenagers with histories of exclusion and disengagement from school and so it is vital to understand how engagement of these students can be supported more effectively.

This project was conducted in one school with a small number of participants only and so it would be interesting to reproduce the process with several groups of teenagers in different contexts in order to understand how the methodology could be extended and adapted for different groups. Moreover, more formal evaluation of the potential of the game to support learning outcomes in the area of Geography, for students with and without ASD, is needed to provide further validation for the approach and implementation of this project.

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