STUDENT’S PARTICIPATION IN THE DESIGN PROCESS: A STUDY ON USER EXPERIENCE OF AN EDUCATIONAL GAME-LIKE APPLICATION

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Abstract
Gamification is increasingly used in the education context due to its engaging and motivating features that could enhance the learning/teaching process. While there is rich and growing work on game-like applications across fields, there is little multidisciplinary dialogue between pupils, researchers and game designers about how to design them for more effective mobile educational games. To be able to make the learning experiences more engaging, different methodologies have been used to provide designers with input from their target. Although it is broadly accepted that end users should be consulted when designing information and communication technologies (ICT), when the participants are children, the extent and type of consulting is more controversial. Although some considerations are necessary regarding the conclusions drawn from children’s enthusiastic play behaviours and reactions, they are the tomorrow’s power-users of everything, from the Internet to communications technologies.

This paper explores the concept of participatory design in the process of designing a mobile gamified learning application about recycling and its effects on the ocean. This approach aims to understand how the inclusion of pupils from the beginning of the design process could influence the directions of the prototype. The consideration of pupils’ game-based learning experiences intends to ensure that the prototype design will adapt to the interests, knowledge and styles of the learners who will use it and, therefore, promote a more engaging and effective learning experience. Based on Druin’s framework of children’s roles (as a user, as a tester, and as an informant), pupils (end users) participated since the early stages in the design process, providing different types of inputs. The sample of this study consists of 36 children in Portugal and the UK (PT=20, UK=16) within the age group 12-14 years (digital natives).

Pupils were able to bring and discuss ideas related to game elements (e.g. badges and leader boards), game mechanics (e.g. challenging, progression), graphic image (e.g. illustrations, iconography) and interaction (e.g. animal behaviour). The results suggest that when children are brought into the design process, they can produce new ideas and highlight system interactions in the way they interpret the context.

Keywords: Participatory design, learner experience, gamification, educational technologies.

1 INTRODUCTION
Learning environments which include interactive multimedia attributes provide students with immediate feedback and this encouragement has been instrumental in fostering active student learning, and thereby engaging additional cognitive events, during the learning process [1], [2]. Today we are facing a large increase in educational technologies of all kinds [3]; however, these tend to be more interactive than traditional classroom lectures and their quality seems to have a strong, positive effect on learning [4], [5]. It is important to highlight that learning is both a cognitive and a social process and it cannot be replaced by technology. Commonly, the effective use of technologies is associated with the goal of supporting the learning processes and improving the quality of education [6], [7].

One of the education technological approaches that has been gaining a lot of acceptance from all stakeholders is gamification [8]. Due to its apparent benefits, gamification, together with mobile technology which also appears to have a good influence on the learning and teaching process, has been emerging as a strong support tool to improve learning outcomes. The literature also shows that procedures where end users are consulted when designing ICT may result in more effective learning experiences [9], [10]. Therefore, through a participatory design approach, this study describes a design-based research project of an educational game-like application related to ocean literacy in secondary school education. Based on Druin’s framework of children’s roles, the study gives an insight into children’s experiences with educational games and addresses the following research question: what can we learn from children’s interactions and intuitiveness when they are using technology? Moreover,
it highlights the benefits of including the pupils’ feedback (end users) since the early stages of the design process.

2 LITERATURE REVIEW AND BACKGROUND

As mobile platforms and networks have become more powerful, more dynamic and more available to all, the mobility of ICT has changed the scenario of the two separate spheres of learning: in schools or everywhere. Nowadays, learners can have ICT constantly through platforms such as mobile phones, tablets and laptop computers, and thus there has been a rise in the level of interest in investigating the subject [11]. According to Francesc Pedró, leader of teacher development work and education policies at UNESCO, ‘around the world, technology in education programs are pivoting away from a reliance on fixed line technology and incorporating newer and, typically, less expensive mobile technologies, generally in the form of tablet or compact laptop computers [12]. Furthermore, a previous study conducted in Portugal and in the UK found that most pupils and teachers use mobile devices and applications and they are comfortable with the handling of such technology [13]. Several studies have shown benefits of using mobile platforms in the learning context [14], [15]. However, the gains revealed by the use of technologies should not be the solitary factor attributed to the technology.

Technology plays an important role in learning by playing and in better integrating learners in the field of experience [16]. Combined with the motivating and immersive nature of gamified systems, with actions, challenges, rewards and the central layer called fun, these features enhance the use and interest in learning from games [8], [17]. Although several definitions exist in the literature, in the educational context gamification is known as ‘making learning experiences more engaging and game-like by using game design elements and game mechanics’ [18]. On the other hand, secondary school students’ interest in science is decreasing due to a current educational system that is inadequately designed, and one of the presented reasons is related to how technology is connected to students’ life and its low usage in science classrooms [19]. Although teachers are core agents of implementing these technologies in classrooms, it is also essential to address factors which could benefit or obstruct their use: school factors (e.g. availability and support of technologies, professional development), student factors (class sizes and student skills) and teacher factors (attitudes, beliefs and teaching experience) [6]. Since mobile technology continues to transform various operations within today’s society, it is pertinent that schools become proficient at using and administering these technologies.

Nowadays, there is an increasing emphasis on environmental education. According to John Foster [20, p. 156], an unpublished essay by Robin Grove-White points environmental concern as a movement of consciousness since the 1960s in answer to the new conditions of industrialism: ‘a process which involves, crucially, internalising the notion of limits’. One of the major consequences of this lacking notion of limits affects the ocean. Currently, there is a growing acknowledgement of the ocean’s importance and its influence on the well-being of the planet and on current problems such as climate change, evidenced by many news articles and headlines [21]–[23]. In the UK, the Blue Planet series by BBC played a predominant role in raising awareness. For instance, the first episode of Blue Planet II was seen by 14.1 million people. It was the most watched program of 2017 and the third most watched of the past five years [24]. Despite all these efforts, Guest et al. recognized that the low levels of understanding about ocean science are evident among students, while there is also ‘growing awareness that formal education curricula do not adequately communicate ocean science to young people’ [25, p. 98]. On the other hand, research by Mercer et al. [26] shows much criticism of the secondary school system for not providing robust education on topics related to climate change and sustainability. The reasons pointed are that teachers do not feel prepared to teach these topics and ‘can find the prospect both daunting and challenging due to the subject complexity and perceived controversial nature of the topic as well as its interdisciplinary nature’ [26, p. 360]. The authors assert further that these factors suggest that additional ways of supporting secondary school teachers in addressing sustainability related issues are needed. Education is key to achieve a more sustainable society [27]. In order to promote the approximation between the education system and environment platforms such as Digital explorer [28] – which coordinates Ocean Literacy UK [29] alongside ocean scientists and educators – this latter offers immersive learning experiences related with the ocean in order to give students the necessary understanding and skill sets to tackle the world’s most pressing issues. People and Planet and Sustainability Exchange [30], [31] are two projects which incorporated green leader boards and Green Gown awards in order to increase participation and interest from educational institutions in sustainability. Save the seas is an educational game produced by Not Just Fun Softworks which aims to raise people’s awareness of the serious environmental problems the seas are facing [32].
Science relies heavily on visual representations to help students to understand abstract concepts [33], [34]. Interactive learning experiences through simulations and gamification can assist the cognitive domain of learning [35]. Game-based learning offers several advantages. Students can learn by doing and by failing, without real negative consequences, which is often absent in traditional classroom approaches. It also allows students to play, manipulate, experiment and experience what the consequences are or what they might be [36]. Therefore, engaging learners in experiences related to the ocean can improve their literacy and also motivate them to act on behalf of the ocean [37]. To reach effective education in order to influence sustainable behaviour requires suitable pedagogies and thus a shift away from traditional learning and teaching approaches to more interactive and discursive teaching methods, supporting a move towards more constructive and learner-centred approaches [26].

One crucial aspect of effective educational technology is the capacity to create technology that can meet students’ needs. Development that integrates student feedback results in more effective learning experiences. As the complexity of new educational technologies increases, projects run the risk of failing if end users cannot fully engage with them. Consequently, it is widely accepted that users should generally be consulted when designing information technologies [38], [39]. The study of learner experience is of central importance to the development of gamified applications and several methodologies have been used to provide designers with input from their user target: user-centred design, contextual design, cooperative inquiry, participatory design, informant design, and learner-centred design [40]. However, when the participants are children, the extent and type of consulting is more controversial and commonly children are only involved in testing new applications once the initial prototype design has been completed [40]. Some considerations are therefore necessary regarding the conclusions drawn from children’s play behaviours and reactions [40], [41].

3 METHODOLOGY

Usability is the aspect of Human-Computer Interaction (HCI) committed to ensuring that human-computer interaction is, among other things, effective, efficient, productive, learnable, and satisfying for the user [42]. This definition focuses on having products that allow users to achieve goals and provides a base for measuring usability for different software products. Expert, theoretical and user methods is a broad categorization of the variety of methods typically used to assess usability. Expert methods refer to an experienced evaluation to identify potential pitfalls and usability issues. In theoretical methods, theoretical models of tools and user behaviours are compared to predict usability issues. User methods are those where usability data are gained as a result of end users’ interaction with software prototypes [43]. Two main approaches exist among user methods: observational analysis (the developer observes while the user interacts with the platform) and survey-based methods (users answer a questionnaire after interacting with a platform and give their subjective views) [44], [45]. Although involving users in the design process is deeply integrated into HCI practice [38], [46], the literature presents divergent opinions. Webb [47] questioned the value of involving users as follows: ‘User involvement in the design process is a priori a good thing, but in certain circumstances, it may be neither feasible nor desirable. Not feasible because the design environment is new, innovative, creative and dynamic and users are heterogeneous and difficult to access. Not desirable because user involvement itself may constrain creativity.’ [47, p. 82].

Originated in Europe, especially in Scandinavia, in the workplace democracy movement context [48], Participatory Design (PD) is a user-based approach which considers users as partners in the design process. ‘Many researchers and practitioners in PD (but not all) are motivated in part by a belief in the value of democracy to civic, educational, and commercial settings – a value that can be seen in the strengthening of disempowered groups including workers, children, older adults, in the improvement of internal processes, and in the combination of diverse knowledges to make better services and products’ [9, p. 3]. PD has roots in fields such as user-centred design, graphic design, software engineering, public policy, psychology, labour studies and political science, and brings together researchers and practitioners in the design of information technologies to better meet the users’ needs. This participatory relationship with the user intends to ‘bridge and blur the user-designer distinction from both directions, through mutual learning process’ [49, p. 6] to reach ‘partnership, equity and balance’. Fowles [50] describes the process as a transformation of the ‘symmetry of ignorance’ (incomprehension between designers and users) into a complementary ‘symmetry of knowledge’ through ‘symmetries of participation’ and ‘symmetries of learning’ [9]. ‘Effective methods to achieve this usually rely on prototyping and intensive face-to-face iteration’ [49].

In this context, Druin [10] described her framework for children’s participation in the technology design process: ‘I believe it is in understanding the role that children can play in the technology design process...’
that will lead to answers. The better we can understand children as people and users of new technologies, the better we can serve their needs’ [10, p. 2]. The author suggested that there are four roles children can play in the design process: user, tester, informant and design partner. In each role there is a spectrum of user involvement, at differing points in the design of new technology.

- The role as user: ‘In the role of a user children contribute to the research and development process by using technology, while adults may observe, videotape, or test for skills.’ The intention is to understand the experience of a child with the technology and/or platform in order to improve future technologies.

- The role as a tester: ‘Children test prototypes of technology that have not been released to the world by researchers or industry professionals.’ Through observation of children’s interaction with the prototype and asking for their comments concerning their experiences, it is intended to improve the technologies before their release.

- The role as an informant: ‘Children play a part in the design process at various stages, based on when researchers believe children can inform the design process’. In this role, children can sketch their own ideas, brainstorm and give inputs throughout the design process. Children are involved with design sketches and are observed while they interact with low-tech prototypes.

- The role as design partner: ‘Children are considered to be equal stakeholders in the design of new technologies throughout the entire experience’. As design partners, children contribute throughout the whole process in ways that are appropriate for them and the process. The main goal is to strive for elaboration, which happens when a team member shares an idea which leads to new thoughts or directions [10].

Grounded in PD and based on these different roles that children can play, this study intends to evaluate the end-user experience and the usability of an existing game in the market and to explore pupils’ experiences concerning recycling and ocean protection. The pupils’ contribution throughout the design process aims to help design a game-like application that can reflect the needs of the end-user and, therefore, design more effective learning experiences. This development stage of the design process draws on insights from the different findings of previous research. One study [13] revealed that mobile platforms could be an appropriate media to assist teaching and learning about science, while the affordability of mobile platforms can also contribute to increasing students’ involvement and interactions with mobile educational content. Moreover, the research exposed a widespread use of tablets and smartphones among students and teachers, while the literature showed that most studies reported positive learning outcomes following the use of mobile technology and most of them in the science field. The participants of this study were 36 children from Portugal and the UK (PT=20, UK=16) between 12-14 years. The data were collected between October and December 2018. The questionnaires were anonymous, and no personal information was collected. Permission was obtained from pupils and parents regarding participation in the study in order to comply with research ethics requirements.

4 RESULTS

The results are presented as follows: first, the pupils’ experience with a game as users; second, their interactivity with a paper prototype as testers and, lastly, as informants through sketches and brainstorming.

4.1 Pupils as users

In this role, the pupils contributed to the research and development process by using technology in order to improve the future application. Participant observation and post-questionnaire (see Table 1) were the instruments for data collection. A mobile recycling game existing in the market was used to understand the kind of experiences learners would have while playing. The game aimed to teach how we can contribute to keeping the environment healthy, collecting different types of waste which were falling from the top of the screen, such as newspapers, plastic bottles, cans, etc. and the player had a time limit to target the correct bin. The play session consisted of the pupils freely exploring the game environment, and at the end they were asked to fill in a questionnaire. The questionnaire consisted of questions related to the experience with the game itself and related to the learning experience. The questionnaire was piloted using a small sample of pupils in the UK.

Throughout the observation of the interaction with the application, the pupils' familiarity with mobile platforms was evident and the amount of bodily movement exhibited excitement with trying the
application. The fact that pupils were working in pairs stimulated the interaction with the game. They did not need help to start playing the game and easily learnt how to play. Around 60% of the pupils responded ‘yes’, when asked if they would like to play this game frequently and all of them stated that the game was not too complicated to play. Children were very good at expressing what motivated them or what they found boring. After playing the game around three times, it became evident that the interest in the game started diminishing. Some participants stated some comments regarding the challenge and the progression: ‘If you played it more, it could become easier so I think more items should be dropped every 25 points you score, to make it more challenging’ [United Kingdom pupil]; ‘I think that there could be different levels that you have to complete’; ‘The game was challenging enough, I think the game conveys what should be done well’ [Portuguese pupil]; ‘I think if I played it a lot more it wouldn’t be as complicated and challenging’ [Portuguese pupil]. The difficulty of the game increases as the speed that the waste falls at increases, but as there are no levels, it became difficult to feel the progression. ‘I thought it became a bit repetitive because from the moment all items had appeared, it was always the same thing’ [PT pupil]. Although some pupils showed an apparent decrease in interest after they played the game a few times, the interest in getting the best result at the end continued to spark interest. ‘The game was easy to play, and I think maybe it could’ve been more challenging although I didn’t get the best score’ [UK pupil].

<table>
<thead>
<tr>
<th>Question</th>
<th>PT N=20</th>
<th>UK N=16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think a child between 12-14yrs would need a technician or other to help them play this game?</td>
<td>20% 80%</td>
<td>6,3% 93,8%</td>
</tr>
<tr>
<td>Do you think children would learn to use the game quickly?</td>
<td>100% 0%</td>
<td>100% 0%</td>
</tr>
<tr>
<td>Do you think that, in general, children would need to be very good game players to be able to play the game?</td>
<td>15% 85%</td>
<td>6,3% 93,8%</td>
</tr>
<tr>
<td>Do you think you would like to play this game frequently?</td>
<td>60% 40%</td>
<td>62,5% 37,5%</td>
</tr>
<tr>
<td>Was the game too complicated to play?</td>
<td>0% 100%</td>
<td>0% 100%</td>
</tr>
<tr>
<td>Do you think the game was the right level of difficulty for you?</td>
<td>60% 40%</td>
<td>68,8% 31,3%</td>
</tr>
<tr>
<td>Do you think the topics of the game are easy to remember?</td>
<td>100% 0%</td>
<td>93,8% 6,3%</td>
</tr>
<tr>
<td>Did you always understand what you should do with the objectives in the game?</td>
<td>100% 0%</td>
<td>81,3% 18,8%</td>
</tr>
<tr>
<td>Did you understand what the game was in general about?</td>
<td>100% 0%</td>
<td>100% 0%</td>
</tr>
<tr>
<td>Do you think that children would need to know a lot about recycling before playing the game?</td>
<td>30% 70%</td>
<td>25% 75%</td>
</tr>
<tr>
<td>Have your feelings about recycling changed?</td>
<td>42,1% 57,9%</td>
<td>31,3% 68,8%</td>
</tr>
<tr>
<td>Did you enjoy the game storyline/gameplay?</td>
<td>100% 0%</td>
<td>93,8% 6,3%</td>
</tr>
<tr>
<td>Did you enjoy the graphics in the game?</td>
<td>95% 5%</td>
<td>100% 0%</td>
</tr>
<tr>
<td>Were they (the graphics) adequate to the game topic?</td>
<td>100% 0%</td>
<td>93,8% 6,3%</td>
</tr>
<tr>
<td>Do you think the game could be made more fun?</td>
<td>65% 35%</td>
<td>56,3% 43,8%</td>
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</table>

Related to the learning experience, only around 25% of the pupils think they would need to know a lot about recycling before playing the game, 100% understood what the game was about, and almost 100% stated that the topics of the game were easy to remember (see Table 1). In fact, by playing the game, children started learning about some waste you can or cannot recycle: ‘I can learn while I’m playing the game’ [UK pupil]; ‘I thought that you could put more items in the recycling but you can’t’ [UK pupil]; ‘I have learnt that you can put a washing powder box in the recycling’ [UK pupil]; ‘Some of the packaging that I thought were recyclable after all were not, and vice versa’ [PT pupil]; ‘I learn that I can’t recycle tissues’ [UK pupil]; ‘I have learnt the difference between recyclable and no recyclable things’ [Portuguese pupil]; ‘I understand more about recycling and I’m more wise’ [UK pupil]. One reinforced
his knowledge: ‘I have learnt that I could be more confident in knowing what rubbish goes in each bin’ [UK pupil] and one reported no learning at all: ‘I haven’t really learned anything’ [UK pupil].

Although almost 100% of the pupils answered they liked the graphics and that they were adequate to the game topic, some stated that the inclusion of different scenarios could make the game more appealing. ‘Maybe you could help recycle different cities’ [UK pupil]. Regarding the different types of waste that were falling: ‘some items was not sure of its material’ [UK pupil]; ‘drawings could be better; you might not know what it is’ [UK pupil]. Around 60% of the pupils believed that the game could be made for fun: ‘Perhaps adding for example mini-games, integrated in the main game, with more activities’ [PT pupil]; ‘Add in more obstacles e.g. more bins (non-recyclable items)’ [UK pupil]; ‘The game was quite simple, however, it doesn’t need to be complicated for people to enjoy the game’ [UK pupil]. Children also made comments about the inclusion of some game elements: ‘I think it would be a good thing to have badges it would make the children proud and want to play the game’ [UK pupil]; ‘I like leaderboards as it creates a competition’ [UK pupil]; ‘I think it would be a good idea [Badges and leader boards] to enrich the game’ [PT pupil]; ‘In my opinion, adding other game elements [Badges and leader boards] would make the game more competitive and engaging’ [PT pupil]; ‘High scores gives you something to beat whenever you play the game’ [UK pupil]. Additionally, the visual inclusion of consequences of non-recycling properly was mentioned: ‘more alteration of actions, perceive the consequences of recycling or lack of.’ [PT pupil].

4.2 Pupils as testers

Pupils took part in the design process while they interacted with a low-fi prototype. A paper prototype of the system was developed and presented to the pupils as a basis for discussion in order to test and to explore the functionality of the game-like application in this early stage. The open questions used throughout this phase provided freedom to the participants to express their opinions without being limited to predetermined of forced responses. This allowed understanding the pupils’ viewpoints regarding the use of the application and share ideas that could lead to better directions. Observational data were recorded in field notes. The paper prototype consisted of a game mechanic where the user had to throw each waste item into the right bin. The most important feedback (losing lives) corresponded to 5 levels of water pollution. In sum, every time that a bin was missed or the item was introduced in the wrong bin, the user lost one life which corresponded to a dirtier water level. After failing 5 times, the water became very dark and the game was over. The paper prototype also included three badges as feedback (see Figure 1).

![Figure 1. Paper prototype experience](image)

In this phase, the pupils played in pairs, which stimulated the interaction with the paper prototype and enhanced communication through the combination of different perspectives. Throwing the different items into the right bin had a broad acceptance by the pupils. ‘When you fail the water is more polluted which is what happens in real life, so when you recycle in real life you will think about the effect you create to the ocean’ [UK pupil]; ‘The theme of the game is a very interesting message and put in an easy and fun way to understand. I think it might change some people’s ideas’ [UK pupil]; ‘[…] people will realize that not recycling harms the ocean a lot and may eventually have serious damages on the planet’ [PT pupil]; ‘Seeing pollution in sewers build up is good visual representation if not put in bins’ [UK pupil]. The pupils’ feedback allowed to get a better understanding of what did and did not work with the paper prototype. Through the free experimentation and exploration of new ideas, several pupils mentioned including more visual feedback in order to make the consequences more explicit: ‘could
show sea animals trapped/affected by litter e.g. 6 beer holder plastic around turtle' [UK pupil]; ‘Add fish and marine animals into the sea and every time we lost, the fish died’ [PT pupils]; ‘you could add sea life and when you fail they die or disappear and when there is no sea life left the game ends’ [UK pupil]. In this respect, the children input was essential in terms of clarifying the need for more visual inputs to increase the conscience of the consequences of non-recycling on water. Finally, regarding the graphics information, one pupil mentioned: ‘Clearly label the bins and their purpose [...] maybe change the recycling sign on the bins as a representation of stuff to go in the bin, e.g. black bin could have a banana peel on it’ [UK pupil]. Most of the students did feel that they had learnt new concepts about recycling and also about the effects on the ocean.

4.3 Pupils as informants

As informants, pupils participated in the design process by sketching their ideas. They were asked to draw their own ideas for a game-like application to help players understand the consequences of improper recycling on the ocean, and to share ideas on how the paper prototype could be improved. They drew on a mobile screen template what the interface could look like and how the system could behave in order to make people aware about the need to protect the ocean, through brainstorming and giving inputs (Figure 2).

Figure 2. Examples of pupils’ sketches to improve the learning experience

Pupils frequently generated ideas by building on top of each other’s inputs, which led to the generation of new ideas composed of many elementary ideas. This phase reinforced the need for more visual inputs to clarify the consequences of non-recycling on water. Including sea animals and seeing them die came again. Beer holder plastic around turtles, fish dying or the disappearance of sea life, which meant the end of the game, were drawn several times. One child commented: ‘I think that it is better to show the damage that it’s affecting our environment instead of just the ocean’ [UK pupil].

Naturally, children had more difficulty in verbalizing their thoughts regarding specific game mechanics, especially when technical concepts or game actions were concerned. Despite these aspects, the results helped to confirm what had already been learnt during the previous phase. Children suggested directions for the design process of the software. From these observations, children not only gave details of how to draw animals (e.g. a cross in the eyes of the dead fish), but also regarding the interaction and behaviours of the animals. At the end of one session one pupil stated regarding his experience: ‘I think they [teachers] could talk more in schools about this and the consequences of not doing recycling’ [PT pupil]. Additionally, most pupils felt that they had learnt new concepts about recycling and the effects on the ocean.

5 DISCUSSION AND CONCLUSIONS

A usual way of optimising experiences in HCI is through user-centred design. In the developing process of a new product or service, user input could be critical to success. When participants are children, the extent and type of consulting is more controversial. An underlying assumption behind PD is that users and designers can view each other as equals in the design process. Although some authors stated that the users’ inexperience and lack of design skills could restrain the creative process, the closer involvement of the user with the application can also produce benefits. In fact, this involvement between the end user and designers can help exactly to balance that divergence. It is also true that in some contexts building this relationship could be more challenging. The short periods working together and
interpreting children’s statements, not always straightforward, could be a challenge. The combination of different roles helped to reduce the uncertainty associated with an idea expressed by one pupil and thus enabled a better characterization of the game experience and increased the pupils’ inputs.

This study aimed to understand how the inclusion of pupils from the beginning of the design process could influence the directions of the prototype, particularly if pupils can provide useful feedback in the design of more effective learning experiences. The results show that children can be brought into the design process and make a contribution. The achievements of having involved pupils into the design process and in evaluating an application were inspiring. Interactive multimedia content showed to be a powerful tool, as pupils became engaged with colours, sounds and images in the learning process. Findings show 86% of the children would not need any assistance to play the game. The pupils’ familiarity with mobile platforms was extraordinary, and that fact allowed them to act in a very comfortable way not only with the platform but also with the game. They are confronted everywhere with new mobile technologies, which are available at continually lower costs. Children were able to express in a fascinating way ideas related to concepts such as game elements (e.g. badges and leader boards), game mechanics (e.g. challenging, progression), graphic image (e.g. illustrations, iconography) and interaction (e.g. animal behaviour). It was also interesting to observe that the children’s feedback from both countries (PT and the UK) was very similar, suggesting a similar game culture.

The pupils responded positively to the study and enjoyed the creativity involved in the process of developing games. Many stated that they had learnt about recycling and also about the consequences of not doing it on the ocean. The pupils involved in playing, testing and brainstorming the game found accessible and easy to understand the topic. These overall results suggest that when children are brought into the design process, they can produce new ideas and highlight situations, such as feedback of the system, given the way in which they interpret the context. In order to meet the learners’ needs and therefore produce a more engaging game application, these inputs will be taken into account in the development of the prototype, which is the next stage of the research reported here.

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