Play and Learn about Your Learners to Early Form your TEL Design

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Abstract. TERENCE is an FP7 ICT European project that developed a technology enhanced learning system for supporting its learners, who are primary school children, and their educators. In the course of the project, we run field studies with a large number of learners for analysing the context of use of the system. This paper explains what triggered the gamification of the field studies, as well as how the field studies were conducted. It then explains how the gamified field studies were used to inform the early design of the TERENCE system. This paper ends by rummaging over the pros and contras of gamifying field studies as in TERENCE.

1 Introduction

Constructivism states that learning depends on the specific learners and the context in which they learn. TERENCE is an FP7 ICT European project that is developing a *technology enhanced learning* (TEL) system for supporting primary-school children in learning to read and comprehend texts, in the main context in which this form of learning takes place—schools.

A similar TEL system should be designed so as to be usable and pedagogically effective for its learners, according to the learning context. As there is not a single design methodology that takes care of both the usability and pedagogical effectiveness of a TEL system, the TERENCE consortium mixes two design methodologies: one, the *user centred design* (UCD), that is iterative and places users at the centre of the design process for attaining usability; the other, the *evidence based design* (EBD), that stresses the role of empirical evidence for attaining pedagogical effectiveness. See [5]. The methodologies are used throughout TERENCE: the system is iteratively designed, starting with the analysis of the context with all the TERENCE users, and revising prototypes of the system through evaluations with users again.

More specifically, the TERENCE analysis of the learning context is concerned with (1) the characteristics and preferences of the TERENCE learners, (2) the learning tasks and their organisation into a stimulation plan by domain experts for the TERENCE learners, (3) the environment. Now, the main sources for learning about the characteristics and preferences of the learners are the learners themselves, their referent adults,

such as parents and school teachers and domain experts of our learners' characteristics, e.g., education psychologists. Thus the TERENCE consortium planned field studies in UK and Italy with c. 550 learners for "learning about learners", specifically, their characteristics and preferences for the system design, besides contextual inquiries with their school teachers and parents, e.g., via diaries, as well as with domain experts.

However, the TERENCE learners are children, aged 7–11 year old. There are a number of data gathering methods for interacting with learners that are adults, however, the same methods cannot be often used "as is" when learners are young children [4]: for example, [17] explains that children might become anxious at the thought of taking a test, and test taking may conjure up thoughts of school. Hanna et al. [11] give suggestions for interacting with children, in particular, they suggest that *you should not ask children if they want to play the game or do a task, that gives them the option to say no. Instead use phrases such as "Now I need you to…" or "Let's do this…" or "It's time to play…". However, the better thing is playing with them*. Druin [7] moves along the same lines, and suggests to use indirect methods to interact with children when children play the "user" role. More in general, co-design offers a series of suggestions for gathering data with children as users, where co-design is defined as "collective creativity […] applied across the whole span of a design process" [18].

When situated at school and within school activities, however, co-design has some limitations, in particular, if it is done with many learners and strict timings. See [5] for the organisational school constraints of TERENCE. For instance, schools may impose that all children of a class are involved at the same time in the data gathering, as well as that the timing of the gathering is less than a given time. Such constraints place severe limitations on the data gathering methods one can use in a project. In order to overcome such constraints, one can try to engage classes of learners as best as possible in the data gathering, so as to optimise the time constraints and the quality of the gathered data. One way for engaging classes of learners is to gamify the data gathering. Gamification is the usage of game concepts from game design in order to engage learners and solve problems in non-game situation. Therefore, in TERENCE, we planned the data gathering for the context of use (which is not a game situation *per se*) by using gamification. More specifically, we gamified field studies, borrowing and adapting methods from co-design. The results of the analysed data were used to inform the early design of the TERENCE system.

This paper starts outlining the essentials of co-design and gamification and, stronger with that, moves on outlining how we gamified the TERENCE field studies for the context of use analysis. It then sketches how early design decisions were taken in light of the knowledge acquired of users. The paper ends by briefly assessing the pros and contras of our gamified approach to gathering data about learners, that are children, to form the early design of a TEL system for them.

2 The Essentials of Co-design and Gamification

This section serves to outline the essence of co-design and gamification, necessary for the remainder of the paper.

2.1 Co-design Overview

Co-design [18] evolves from cooperative design and participatory design. It attempts to actively involve all users in the design process in order to help ensure that the product under design meets the users' needs, and is usable. Involvement of users early in the research and ideation phases of the design of a new product is often equated to "asking users what they want". However, therein, the key and the main goal of a cooperative session is the collaboration between users for supporting anybody to imagine, express and access their experience and expectations [19]. Co-design sessions can allow us to create a shared understanding and shared language between participants and the designers so as to understand the new product from the point of view of the participants [2]. The outputs are sources of both inspiration and information for designers and participants.

Specifically, in the area of co-designing with children, the work of Alison Druin [6,7] has provided many frameworks and methods that allow us to work with children as partners during a product design. Several co-design methods can be used with children at different stages of the product design and the appropriate methods may vary depending on the purpose of the research [8,10,21].

There are also examples of co-design at school, with users that are school learners. For instance, in [20], the authors explore the applications of co-design methods with 7–9 children. In [9] the authors describe the empirical studies conducted with 36 children at home and in a school environment.

However, to the best of our knowledge, there are no co-design studies with hundreds of school learners and strict timings as required in the TERENCE project.

2.2 Gamification Overview

From both theoretical and empirical points of view, nowadays learners are usually more motivated to participate in school-class activities if these are shaped like games, e.g., see [12]. Gamifing a school class activity requires to introduce specific game elements in the activity [15] in order to motivate students to more actively engage in the learning process, e.g., see [3].

From a purely game-theoretic view point, the necessary elements for turning an activity into a game are the actions or *moves* of the players, with their *outcomes*, so that an action of the players makes the game progress from state to state.

However, from a motivation theory perspective, those elements are not sufficient for making a game engaging. Other elements of digital games such as points, levels, and rewards are therein considered, and have been used to engage learners as players in formal learning contexts. The authors of [16] propose a motivational model that explains more general key factors of game engagement, which encompass other studies in the field. They overview research findings investigating the correlations between the appeal of games and the psychological need satisfaction that play can provide. The surveyed results demonstrate that at least three factors make, in the short term, independent contributions to game engagement:

– *autonomy*, that amounts to experiencing a sense of choice and psychological freedom in playing games;

– *competence*, that is, an individual's inherent desire to feel effective in playing;
– *relatedness needs*, satisfied when learners experience a sense of communion with others.

Autonomy, competence and relatedness needs can be realised by means of diverse game elements. Autonomy can be provided by allowing the player to take decisions, for instance, concerning the player's game levels to play, game avatar or game scenario. Competence is generally realised by carefully balancing the game challenges to the players' skills, providing motivating rewards and feedback. Relatedness needs can be satisfied by allowing collaboration, cooperation or competition, for instance, by means of a personal guide in the form of an avatar or by playing with or against other peers.

3 The Gamified Field Study

The TERENCE data gathering was run as part of the regular school activities in UK and Italy from May to July 2011. The studies involved 2 schools in UK and 5 in Italy, for a total of 282 learners in Italy and 226 in UK. Learners were aged 7–11 year. Like in co-design, the data were gathered class per class, with c.a 20 children per class, two facilitators and the school class teacher, working as informant for the facilitators and familiar referent figure for children. See [13] and [14]. Due to organisational constraints, e.g., minimising changes to school activity schedules, the data gathering with each school class could not last longer than 1 hour and required to involve the entire class.

Despite the number of learners in each school and the strict timing, we aimed at gathering high quality data from learners: we needed genuine and dependable information from children concerning their characteristics, environment and life-style for profiling the learners for the TERENCE system. See [1]. In order to gather high quality data, the data gathering was gamified so as to engage the learners as best as possible and comply with the time constraints. In the planning stage, the protocol of gamified activites was checked and assessed with school teachers so as to meet the needs of school learners and constraints. For instance, if a challenge was deemed too difficult or too boring for a school class, it was then revised according to the teachers' feedback.

The data gathering was organised as 6 different game challenges, and each of these was organised a self-referential independent game. There were 2 collaborative games, involving all class learners at the same time, and 4 single-player games. At the start of each game challenge, the facilitators explained the goal and the learner's moves for advancing through the game. Autonomy, competence and relatedness needs were pursued across the various challenges.

Autonomy was elicited by allowing the learners to choose among several options for tackling a challenge or to take the decision to skip it. Competence was pursued by stimulating diverse skills across game challenges, for instance, some games required mainly verbal skills whereas others required mainly drawing skills. The presence of a facilitator working as guidance through the games helped to satisfy relatedness needs; in two challenges, these were achieved by stimulating the school class to work together.

A framework was created for each challenge specifying the goal of the challenge, its moves, and how autonomy, competence and relatedness needs are pursued. Table 1 is an example of an instantiation of the framework for a specific challenge.

Goals: the goal of the challenge is to describe popular video game characters. **Moves**: each learner has to choose a card from the container. A card depicts a character of a popular console game. The entire class then discuss what they like or dislike about that character. **Autonomy**: each learner can choose whether to extract the card and participate, or not, in the game; each learner can choose what to tell about the selected character. **Competence**: each learner can express their verbal skills. **Relatedness needs**: each learner can feel part of the class by telling about console games characters, or listening to others' preferences.	

Table 1: Game challenge for learning about popular console-game characters.

4 Design Knowing your Learners

In TERENCE, the gathered data were analysed so as to inform the early design of the TERENCE system. The knowledge of users so acquired was enriched with data acquired from educators, parents and experts of text comprehension. Profiles of users were thus created using Chi2 and Fisher analysis. Such profiles were then represented via personas, that is, fictional characters representing real user profiles.

Methods for creating user representations had not been systematically applied to work with children. There are several barriers, which make the direct application of these methods to child audiences either difficult or unrealistic. For instance, these methods rely on market research and fieldwork. Market research for children is rarely segmented beyond broad age ranges and gender. Fieldwork often relies *only* on the interpretation of adult-caregivers and teachers and can lack a true ethnographic focus, leaving interpretation susceptible to observer assumptions and biases.

The child-persona framework used in TERENCE [14] was instead derived from theories about children and practice-based experience about what it is important to know about children in design, as well as the results of the analysis of the context of use, mainly, via the gamified field study reported above.

The three main dimensions considered in the TERENCE persona framework are

– child characteristics such as biographical information and personality traits,
– information concerning the environment, e.g., in which learners typical read,
– information concerning learners' life-style, e.g., if they often play outdoors or not.

For an example of a persona for TERENCE, see 1.

Consistently with the UCD literature, learner personas were used to make the learner profiles seem more real, and to help designers keep realistic ideas of users throughout the early design process of the TERENCE system. An example of a design decision based on the results of the context of use analysis goes as follows. Preferences for avatars of learners are age-range and gender dependent, therefore learner profiles were differentiated for age-range and gender. Therefore the system was designed so as to presents avatars to a learner according to the profile the learner pertains to, that is, depending on the learner's age and gender. For more on this, see [1].

5 Discussion: Pros and Contras of the Method

In the remainder of this paper, we reflect on the pros and contras of the approach adopted for analysing the context of use and hence forming the early design of a TEL product.

Pros. The data gathered via gamified field studies were qualitatively genuine (a child could express his or her true self), and dependable for creating fine-grained profiles of the learners, also considering the preferences of the TERENCE learners. The reliability of data gathered from learners is supported by evidence gathered from teachers and parents of the involved learners, and the data were integrated with knowledge acquired from domain experts, all via diverse types of contextual inquiries such as diaries for teachers. Now, our gamification of data gathering with learners was definitely engaging for children and their teachers to the point that schools became more and more interested in the project, and volunteered to participate in the prosecution of all the TERENCE activities. Moreover, since all children actively participated in the activities under the expert guidance of the facilitator, school constraints for time were respected.

Contras. On the other hand, gamification of field studies require considerable expert human resources and time for constructing material for playing with children, besides integrating the acquired knowledge with information sought by domain experts, e.g., education psychologists, and referent adults of the involved children. Last but not least, the collected data are only semi-structured, therefore their analysis and rendering into useful information for the early design of a TEL system, such as personas, can be long and expensive.

6 Conclusions

In the European TERENCE project, we run field studies with young children for analysing the context of use of the TERENCE system. This paper explains why and how we gamified the data gathering activities with learners, by borrowing and adapting methods from co-design to the specific context of use. Then, we outline how the collected data were

Characteristics	
	**Persona Name: Carla.** **Age: 11.** **Gender: Female.** **Classroom: III.** **Comprehension skill: Poor Comprehender.** **Deaf/hearing: Deaf.**
Summary of the class represented by this persona	Represents the class of children aged between 7 and 11 years old. Deaf belonging to an Italian school. Has passion for drawing. She writes every day in her secret diary. Good use of technologies for research on Internet.
Personality	She is polite and quiet.
Role in classroom	She is active, careful, and diligent.
Role out of the class	She is nice, responsible and kind.
Console/Technology	She plays with the Nintendo WII and DS; she uses the computer to browse and chat with friends. She uses the technology alone.
Socio-Cultural Level of his/her own family	High.
School performance	She learns very easily. Differently than 2 years ago, her level of frustration is increased with age.
Environment	
Time spent with family	She does her homework with her parents, she spends her time with her mother and she draws and reads stories with her father.
Time spent with friends	She meets her cousin every day to do homework or to play with her. She goes out with her friends after her homework.
Homework	She does her homework in the afternoon supported by parents.
Life style	
Outdoors Activities	She likes to see friends regularly, she likes to going out and plays with her dog, and she likes to do shopping with her grandmother.
Indoors Activities	She plays with Nintendo WII, and DS, She read, writes, and draws. She likes to play with her cousin.
Home activities	She read fairy tales with dad, she watch TV and she chat with her friends.
Sport activities	She loves walking and cycling with her mom.

Fig. 1. A TERENCE persona for an Italian learner profile

analysed as well as how the results were supported and integrated with other types of data collections with adults. Finally, we explain how the early design of the TERENCE TEL system was informed by the results of the analysis. We concluded the paper by analysing the pros and contras of a gamification of a data collection for analysing the context of use and hence forming the design of a TEL system.

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