Emotions and Inclusion in Co-Design at School: Let's Measure Them!

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Abstract. Co-design with children comes with methods and techniques for creating technological products with children, such as video-game prototypes. When co-design takes place in schools, learners' involvement and enjoyment of co-design become crucial concerns for researchers. But how to measure emotions, more in general, and involvement in a co-design study with children? This paper presents a co-design study, run with a novel co-design method at school, for involving children in co-design groups and emotionally engaging them in producing game prototypes. It explains how emotional engagement and inclusion can be and were operationalized and measured in the co-design study, thereby providing feedback to co-design researchers interested in measuring the same constructs.

Keywords: Game design; co-design; gamification; cooperative learning; experience design; emotional engagement; inclusion; measure; children; schools

1 Introduction and Related Work

Co-design, in the sense of [1], is a general approach to design that extends several others, such as participatory design and co-creation, involving potential users as collaborative designers. In principle, it can be used in any step of the design process for enabling "collective creativity", i.e., in the steps of (1) conceptualization of design solutions, (2) prototyping and development, (3) evaluation.

When users are children, specific methods are used. Notice that the word "method" is hereby used as in Fails et al. [2]: whereas a technique is a focused design activity used at varying points in the design process and with specific goals or outputs, a co-design method is a collection of techniques within an overall design philosophy. In the majority of co-design methods, children usually work in teams, often with adults. Team members have diverse functions: children become co-designers as "experts of their experience"; expert designers, with experience of the product under design, bring in their professional expertise. See [2] for an overview of co-design methods.

When co-design studies take place at school, teachers can also be members of the co-design team, mainly as experts of education and of their school context. Co-design at school, albeit not new, has received increasing attention in recent years, e.g., [4].

This paper presents a co-design study at school for allowing children to create their own game prototypes. The study was conducted in Spring 2014. It used a novel co-design method for working at school with children organized in teams of 3–5 members, namely, *GAmified CO-design with COoperative learning* (GaCoCo). Its ideas were for the first time advanced in [5], and iteratively refined across 4 years of work with schools, so far involving circa 140 children and 8 teachers of different ages; an example of an iteration from a study to another is reported in [6].

The majority of co-design studies at school aim at including all children and engaging them emotionally in the experience [7]. However, to the best of our knowledge, we did not find research work that, so far, operationalized and measured both group inclusion and children's emotions in co-design, as in quantitative research [8]. This paper presents a way to do it, in the context of the 2014 study conducted with GaCoCo in classroom. Moreover, the paper investigates dependencies among the two constructs.

The GaCoCo co-design method is outlined in the first part of this paper, after introducing the necessary background information. The second part reports the GaCoCo study run in primary schools: it explains how emotions and inclusion were measured, and results concerning their dependencies.

2 GaCoCo Method

2.1 Introduction

GaCoCo is a co-design method with techniques that researchers can use to work with a school class, divided in groups, for the conceptualization and prototype development of games [9]: conceptualization techniques, for releasing parts of the so-called game design document; prototyping techniques, which leverage on existing co-design ones and specialize them to the release of a paper-based version of a game prototype with levels, in brief, a low-fidelity prototype. An example prototype by children is in Fig. 2.

Participants in GaCoCo have different functions. Children are the main designers, often working in groups of 3–5 members. Teachers take care of illustrating the daily work organization, and of moderating the class behavior. Researchers are usually two per class, with two different functions: one of expert (game) designer, who follows each group for providing rapid scaffolding feedback, and for conducting a formative evaluation of each group work at specific moments; the other, more experienced of child development studies, acts as passive observer, referred to as observer henceforth.

Moreover, GaCoCo comes with its own co-design philosophy, based on its unique blend of gamification and cooperative learning, whose contributions to GaCoCo are outlined in the remainder of this section.

2.2 Gamification Contributions

In its most common acceptation, gamification means properly using game-based elements, such as story lines and progression bars, for a non-game goal and in a non-game context in order to engage people, regarded as players, with positive emotions, e.g., see [10]. Following gamification principles, GaCoCo organizes co-design sessions as

missions of a game via adequate gamified objects, and with a goal valuable for all co-designers. The relevance of the expert designer of the co-designed product fades though missions. According to their complexity, GaCoCo chunks missions into small progressive challenges, disclosed when needed with clear rules, of which the first challenge is easy to take up by all learners. Progression maps or completion rewards, which are contingent to co-design, are used by GaCoCo for conveying the idea of growth. Rewards can be tangible or not. Examples of GaCoCo tangible rewards are (fake) coins, earned on completion of co-design challenges; positive failure feedback in case of errors in challenges is an example of a non-tangible reward.

A co-design context that invites children's free exploration and choice, like an unexplored game world, can even more tangibly promote a sense of autonomy and control over their co-design work. A simple example is as follows: on completion of a mission, children are invited to choose one among different completion rewards, which they may also customize, and to use the reward for their next co-design mission. In this manner they gain the feeling that their actions have a tangible effect on their co-design work, and that they are in control of choosing parts of this. See the shop for buying co-design objects as rewards, using coins, at the end of a co-design mission, in Fig. 2.

Relatedness needs are also important components of games. Gamification of co-design contexts, however, should be done fostering cooperation, so as to be faithful to the co-design partnership principle, e.g., without increasing competition within groups. Such a constraint can be met by providing rewards that mildly favor only inter-group competition so as to promote "intra-group positive interdependence" and cooperation [11], and still satisfy relatedness needs. Progression maps can also be used to connect with others and satisfy relatedness needs. Shared maps can show other learners that a group or an individual could overcome a co-design mission, and are available for sharing their co-design experience and acquired expertise.

Fig. 1. Signaling disk (black and brown) and scepter (yellow) usage (left), and a screenshot of a progression map for challenges (right)

Fig. 2. The shop in the classroom for buying objects for game prototypes or the expert help card (left), and a game prototype (right)

2.3 Cooperative Learning Contributions

Co-designers need to develop a sense of partnership, which is crucial to manage complex group dynamics when co-designing with children [12]. Cooperative learning is an instructional methodology that can help in organizing and managing group dynamics in classroom. How this can be done varies according to the chosen cooperative learning model. GaCoCo adopts the Complex Instruction model [13]. Heterogeneity, in this model, becomes a growth opportunity at the cognitive and social levels. The strategies for organizing the work of heterogeneous groups, the rules and roles for children are all important cooperative learning means that GaCoCo acquires and adapts from the Complex Instruction model to the end of co-design, making them tangible via gamified objects, as those in the above examples. The following part exemplifies how.

There are a number of *strategies* for organizing group work in cooperative learning; examples are co-op co-op, for organizing work for groups of 4, and gallery tour, for sharing opinions or products across groups [14]. GaCoCo employed several of them, e.g., gallery tour. In GaCoCo studies, gallery tours were used for sharing opinions on game prototypes, and gamified via specific objects, e.g., banknotes for voting the preferred prototype. The voting box is highlighted at the bottom of Fig. 2 with blue.

Roles facilitate the management and working of the group as a team. Each member of a group is assigned a role. In GaCoCo, roles are not fixed but rotate among members so that all train different skills. The group ambassador is an example of a cooperative learning role for children adopted in GaCoCo studies. Ambassadors ask for clarifications; more generally, they are responsible for exchanging information with the teacher and design expert. Roles can be conveyed via specific objects. For instance, in GaCoCo

studies, ambassadors had their gamified object, the expert card, for asking the help of the game expert at critical points. The card is highlighted in green in Fig. 2.

Besides strategies and roles, and in support of them, cooperative learning considers a set of *rules* necessary for working in group and including all. Rules are concerned with social skills such as reciprocal listening and respect of different views. Examples of cooperative learning rules that GaCoCo employs are taking turns in voicing opinions, and reconciling different views, e.g., concerning game concepts or prototypes. GaCoCo studies made such rules clear and easy to recognize by using ad-hoc gamified objects. For example, each group was endowed with a scepter for organizing turns in speaking. Each child could vote on different views by drawing smileys on signaling-disks. See a scepter and a signaling-disk in Fig. 1.

3 Study Design

The GaCoCo study hereby reported was in two primary schools, involving a class of 15 8–9 year olds, and a class of 20 9–10 year olds (females 59%). It was organized as an empirical one along 3 main activities: pre-activity, main activity, post-activity. Only the relevant details of the study are reported below.

3.1 *Aims and Data Collection Instruments*

Our general aim was to investigate relationships in GaCoCo between emotional engagement, which is claimed to be activated by gamification and to contribute to learners' performance at school [15], and social inclusion, assumed to be fostered by a cooperative learning approach. We operationalized emotional engagement in terms of achievement emotions—linked to learning activities or outcomes—experienced by children as co-designers at school. The reference theoretical framework is Pekrun's control-value model [16]. We operationalized social inclusion using a specific sociometric status indicator, that is, peer reciprocity [17].

3.2 *Hypotheses*

We hypothesized positive links between positive emotions and peer reciprocity, and negative links between negative emotions and peer reciprocity, extending current literature [17]. We also explored whether achievement emotions played a partial or total mediating role between pre-intervention peer reciprocity and post-intervention peer reciprocity; in other terms, we examined how important emotions were in determining changes in the sociometric status.

3.3 *Pre-activity: Training*

During the pre-activity, designers organized a meeting with the school dean and interested teachers in each school in order to explain and discuss the project. A week before the main activity, a workshop for teachers, lasting circa 6 hours, was organized and a

more focused training was thus performed. For instance, during the workshop, the protocol of each mission was explained by expert designers, and so were the main ideas of gamification and game design. Teachers worked in group and experimented the protocol for children by prototyping games themselves. After the workshop, teachers were asked to create heterogeneous groups of children in terms of learning and social skills. Also children were trained to game design principles. This training lasted circa 20 minutes. Moreover, teachers administered children a sociometric task to obtain a peer reciprocity score [17], which included three questions asking each child to choose one classmate in relation to three contexts. We calculated a peer reciprocity score as mean of the total number of reciprocated choices obtained by each child in the three contexts, divided by the number of children included in each class. This is referred to as the pre-reciprocity score.

3.4 *Main Activity: GaCoCo Co-design*

The main activity had six sessions, each of which was gamified and presented as a mission, as explained in Subs. 2.2, and organized with cooperative learning rules, roles and strategies, outlined in Subs. 2.3. The last mission was run in the university premises, whereas all the others were run in classroom. This paper focusses on the five missions in classroom.

Each mission at school took a different day, lasting circa 2 hours and a half. Missions were done every week, the same day of the week. All missions were organized linearly with challenges, different from mission to mission. Each challenge came with its specific conceptualization and prototyping techniques for releasing parts of groups' game design documents and prototypes. In the second mission, each group released the high-level concept document; then they used it for prototyping their game characters and objects. In the third and fourth missions, each group conceptualized and prototyped two game levels, working first in pairs and then sharing results in group. In the fifth mission, each group firstly conceptualized and secondly prototyped the passage between levels, thereby releasing a single game prototype. Groups also tested their presentation of their game in view of the sixth mission at university.

After each mission, children were administered the Graduated Achievement Emotion Set (GR-AES) of [18], a verbal-pictorial instrument currently under development, aiming at assessing the intensity of ten achievement emotions. Children were asked to rate each emotion with a 5-point Liker-type scale with 5 faces corresponding to different levels of emotion intensity (from 1, for "not at all", to 5, for "extremely"). Our study considered the following achievement emotions: three positive-activating emotions (enjoyment, hope, pride), two positive de-activating emotions (relief, relaxation), three negative-activating emotions (anxiety, anger, shame), two negative de-activating emotions (boredom, sadness).

3.5 *Post-activity: Debriefing*

In the post-activity, debriefing interviews with children were run by teachers with the help of researchers. The same sociometric task of the pre-activity was administered by teachers to children, so as to obtain the post-reciprocity score.

4 Results and Discussion

In statistics, path analysis is used to describe the directed dependencies among a set of variables. A series of path analyses was carried out to study the relationships between achievement emotions, measured at the end of each mission at school, and peer reciprocity scores, measured both pre and post activity. We computed a composite score of emotion intensity across missions calculating the mean value for each emotion. We included the pre-reciprocity score as predictor of achievement emotions, in turn predictors of the post-reciprocity score, to verify the mediating role of achievement emotions. Our hypothesis was confirmed for two emotions, which are among the most salient in learning contexts. The pre-reciprocity score positively predicted enjoyment ($\beta = .35$, $p < .05$), that in turn positively predicted the post-reciprocity score ($\beta = .34$, $p < .05$), whose explained variance was 11%. The mediating role of enjoyment was partial (indirect effect $= .12$, $p < .05$) because the path between pre-reciprocity score and post-reciprocity score was statistically significant ($\beta = .67$, $p < .001$). In turn, anxiety negatively predicted the post-reciprocity score ($\beta = -.37$, $p < .05$), and it explained the 13% of its variance.

Summing up, we found that the emotions of enjoyment and anxiety were crucial to influence learners' sociometric status. Future studies including a larger number of participants could examine the generalizability of such effects. On the whole, our results suggest that monitoring achievement emotions within a co-design study assumes particular relevance in order to track and possibly stir changes in group dynamics in co-design learning contexts.

5 Conclusions

This paper briefly presents a co-design study in primary schools for realizing paper-based prototypes of games for children, by children, run in Spring 2014. The study used the GaCoCo co-design method and techniques, organizing co-design work for groups of children with cooperative learning, and presenting co-design sessions as missions with specific gamified material. Gamification and cooperative learning were used in the study for soliciting children's emotional engagement and for including all children in the co-design work. Such constructs (emotional engagement and inclusion) are only qualitatively assessed in general in the co-design literature. The paper, for the first time, presents a specific way for operationalizing and hence measuring, using quantitative data collection instruments, in the context of the 2014 study: sociometric status was operationalized considering peer-reciprocity, whereas emotions were operationalized in terms of achievement emotions.

The paper concludes presenting the results of a series of statistical path analyses for studying the relationships between achievement emotions and peer-reciprocity scores. According to the available results, enjoyment played a significant role in improving learners' sociometric status, while anxiety was associated with a significant deterioration of the sociometric status. Such data support the relevance of fostering positive emotions and reducing negative emotions for favoring inclusion and properly managing group dynamics across a co-design journey in a school context.

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