Privacy Awareness by Online Co-Design: Investigating Reflection and Learning Qualities of Card-Based Educational Game Creation

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Abstract: Sharing of personal data, consciously or unconsciously, has become a ubiquitous affair. Even from a young age, students are confronted with privacy choices such as giving consent to sharing personal data when, for instance, using social media or remote learning tools. Despite that, privacy awareness is still an educational area often only addressed superficially. A team-oriented approach through educational game design could help engage students, stimulate thinking, and familiarise them with crucial privacy issues.
This paper investigates the *reflection* and *learning* qualities of *co-designing games for privacy awareness*. Addressing the current pandemic circumstances, a playful online workshop is presented that enables remote co-creation of educational game concepts with design cards. By taking the roles of player, teacher, researcher or designer, students worked together remotely to discuss the subject matter, learning assessment and game mechanics to elaborate a balanced game concept targeting everyday privacy issues.
The qualities of the co-design workshop to induce reflection and learning were examined in a two-stage user study. First, in a between-subjects trial (n = 61), the ability of the online workshop to encourage reflection about privacy decisions was compared to a paper-based offline version. Second, remote co-designing was further examined in a within-subjects evaluation (n = 32) in which students rated their learning gains in terms of privacy compared to their learning gains in designing educational games.
The outcomes of the questionnaire and post-activity feedback indicate that remote and on-location co-design of educational games are equally effective for sparking reflective thinking about privacy decisions. Thus, both can be applied adjusted to contextual conditions regarding social distancing or other requirements. When contrasting learning quality between privacy awareness and game design, remote co-creation showed more supportive of conveying knowledge about balancing the games for learning than about the privacy domain. Conclusively, implications regarding educational game co-design with card toolsets are synthesised from the empirical findings.

Keywords: Educational Game Design, Online Co-Design, Online Co-Creation, Serious Games, Privacy Decisions

1. Introduction: co-designing serious games for privacy education

With advancing digitalisation, decisions about data sharing have become a ubiquitous task. Insufficient knowledge about privacy can, in this context, lead to incorrect risk assessment and poor privacy choices (Wang et al., 2016). However, numerous other threats, such as deceptive design strategies, try to get people to disclose more data. Examples include fine-tuned cookie consent forms or complex/hidden policies that allow companies third party sharing of personal data to monetise (Soe et al., 2020). Teenagers and young adults are particularly susceptible to make less reflected privacy decisions (Jost, 2020). Thus, privacy literacy has become an essential skill to teach and train, with many researchers adopting privacy-related Serious Games (SG) to engage students for the topic (e.g. Bioglio et al., 2018). However, creating an engaging SG that effectively helps people make better privacy choices requires a carefully balanced game design. A card-based toolset to co-create and balance privacy decision games has been recently developed by Jost & Divitini (2020). Through role-oriented affordance analysis of existing privacy games, design toolsets and game design literature, a card-based co-design toolset for educational privacy games was created (Figure 1).

Figure 1: Card-based classroom co-designing and online co-designing to create privacy education games

The design toolset (Challenge Game Frame or CGF) integrates the player, teacher, researcher, and designer's perspectives for balancing engaging game concepts that create awareness about privacy challenges by including in-game reflection and examination strategies. For this, the decks of suggested designs for educators and researchers focus on unobtrusive inquiry strategies that help create concepts that maintain an engaging flow of play (Nakamura & Csikszentmihalyi, 2009). The co-design framework was developed for classroom and online use in distance learning scenarios via video conference software. Therefore, it exists in a paper-based form consisting of cards, role tokens and a playboard with inscribed instructions and in a digital form as a web browser application. While the toolset has shown to support students in co-designing balanced privacy game challenges, the creational co-designing activity itself could be helping to raise privacy awareness. As with other card-based approaches in educational game design (Marchetti & Valente, 2015), the co-design of the privacy game concepts may spark reflection and create learning gains concerning privacy from a constructionist point of view (Kafai, 2006). This paper investigates the qualities of the online game co-design activity for encouraging reflection about better privacy choices and generating learning gains.

2. Related research and research objectives

2.1 Learning through video game design

Helping students to learn by creational activities is an educational practice originating from experiential learning (Kolb, 2014), the constructionist pedagogical approach (Kafai & Burke, 2015) and designerly ways of knowing (Cross, 2006). However, with respect to co-design sessions for game creation, Schön's concept of reflection-in-action (1988) is to regard as well. Dialogical actualising of the game concept in the group has helped students sort out conflicts between the SG parts (Jost & Divitini, 2020). It is one of the research objectives of this study to determine if these dialogues are also encouraging reflection (in-action) about the educational game's subject matter (i.e. better privacy decisions). Taking different roles could make the game concept an "object-to-think-with" through perspective-taking, as was recently suggested by (Dishon & Kafai, 2020).
Empirical research addressing video game design for education goes back several decades and covers a wide range of pedagogical subject matters. Many studies looked at information technology scenarios such as teaching Computer Science (Basawapatna et al., 2010; Claypool & Claypool, 2005; Hosseini et al., 2019) or Human-Computer-Interaction skills (Santana-Mancilla et al., 2019). In recent years privacy literacy became more popular as an educational goal in SG research (e.g. Berger et al., 2019), while specific studies about game design for privacy education remained a rarity. One rare example addressing a privacy related scenario utilised Minecraft as a game design environment where older students created scenarios to learn about being a digital citizen for younger students (Hill, 2015). While the results showed positive effects on learning engagement, learning gain or reflection were not assessed. Weitze and Majgaard (2020) recently investigated VR/AR game design to educate digital literacy and found that it helped students develop digital competencies. In general, the current knowledge base on game design to improve privacy literacy is very limited.

2.2 Card-based approaches to educational game design

When looking at game-based learning approaches with card tools, a few studies can be found to apply cards for educational game creation. Turkay et al. (2012), for instance, investigated a collectable card game creation activity and concluded that it could encourage communicating and making predictions during the creation of new cards. Positive learning effects from card-based game creation were stated by Valente and Marchetti (2015), who found cards represent boundary objects in the game design process that enable reflection-in-action and playful forms of knowledge sharing. In a review of digital card games, Kordaki and Gousiou (2014) reported that card-based game construction supports learning of computer science concepts but recommended further studies in alternate settings. Recently, Wernbacher et al. (2020) extended educational game design with digital cards to the topic of fake news and found the activity stimulates subject matter discussion. However, the tools' abilities to spark reflection or create learning gain were not investigated. The potentials of educational game design with online card tools for encouraging privacy reflection or learning have not yet been explored profoundly.

2.3 Research objectives

To address the research gap outlined, this study explores the qualities of a card-based co-design activity to promote reflection and generate learning gains in terms of privacy education. By evaluating classroom and online co-designing, it is determined if the co-designing activity can inspire reflection in both essential education

scenarios comparably effective. To learn more about educational game design in the increasingly important distance learning scenarios, online co-designing is further researched in terms of students' perceived learning gain. Accordingly, the two research questions for this investigation were:

1. Are card-based classroom and online educational game design comparably effective strategies for triggering subject matter reflection?
2. Is online co-designing of privacy game challenges creating more learning gains on the subject of privacy or the process of educational game design?

3. Research approach

The study follows a cyclic design science approach (Hevner, 2007). In the present design cycle, online co-design artefacts were created from the paper-based card-toolset to enable application in distance learning (3.1). In the subsequent relevance cycle, the toolsets qualities to encourage reflection and learning about privacy through educational game design were evaluated by a two-step user study with student groups (3.2). Therefore, the first step of the study (A) performed a between-subjects trial that investigated classroom educational co-design with the paper-based tools and remote co-design with the online artefacts to determine both toolsets' capabilities to inspire reflection. Secondly, the online co-design toolset was further explored in the second step (B) by conducting a within-subjects investigation to examine students' perceived learning gains about privacy and educational game design. Following the suggestions for mixed-methods research (Creswell & Plano Clark, 2018), quantitative assessment by questionnaire and explanatory group interviews after the co-design sessions were performed. According to the research objectives, the null hypotheses established for the two steps of the empirical investigation were:

H_{0A}: There is no difference in triggering reflection about better privacy decisions between the classroom and online co-designing of a privacy game challenge.

H_{0B}: There is no difference between perceived learning gain for privacy and perceived learning gain for educational game design when online co-designing a privacy game challenge.

3.1 Classroom and online card toolsets for co-designing educational games

The card-based toolset for educational game design was developed by role-oriented affordance analysis (Jost & Divitini, 2020) of privacy-oriented education games, in-game analytics and existing game design toolsets/literature. The following sections describe the parts of the paper-based card toolset and the online co-design app's design, emphasising the different implementation specifics of both variants.

3.1.1 Card decks and playboard

The framework includes game design suggestions for the roles of *player, teacher, researcher and interaction designer*. In total, 150 game design proposals are provided in *twelve role-oriented decks*. The cards include a description of the suggested design and include examples from educational games and game literature. The player decks include game design ideas for *achieving, acting, progressing, engaging, and adapting*. The teacher decks focus on in-game *reflecting* and *examining* designs while the researcher card decks cover designs for in-game *researching, reporting,* and *monitoring* and the interaction designer decks include ideas for *interacting* and *presenting* the game.

Figure 2: Classroom and online card-decks for the player, teacher, researcher and interaction designer roles

For setting the context of the education game, the toolset also features *four role-independent card decks* with suggestions about *who* will play the game and *when* and *where* it should be played and *what* didactic goal is addressed. The current educational domain is set to privacy awareness, focusing on improving childrens', teenagers' and young adults' privacy decision-making. Therefore, the domain goal card deck includes fifteen

privacy challenge cards with descriptions and examples of the problems (Figure 3). Exemplary challenges included sharing fake news, exploitative risk of aggregated data, sharing health-related data, and working with unencrypted devices. The classroom and online toolsets include the same set of cards, descriptions and examples in all decks. The cards can be browsed by using the next/previous buttons in the online tool. New design ideas could be added using the prepared blank cards in the classroom toolset or with the plus-button in the online activity (Figure 2 and 3).

Figure 3: Classroom and online cards with suggestions for the privacy education goal

For the educational co-designing sessions, each student group starts by choosing the education goal and the context first and then co-designs the whole learning game challenge on the playboard. Therefore, the students select their favourite designs from their assigned role card decks individually and place them in the board's corresponding slots (Figure 4). The paper board for classroom co-design is printed in A0 format, while the online board is displayed on the screen as a web browser application. All card movements in the online app are synchronised over the network. Both playboards feature the same slots to place cards for each role-oriented card deck which are organised as one stream from left to right. There is one main game challenge stream and a secondary stream to place alternative cards. An integrated educational game concept is co-designed by the groups by discussing how the different roles' cards match or conflict and corresponding switching of cards.

3.1.2 Roles and instructions

In the classroom activity, each student receives a 3D-printed playing token that displays their selected role, while the online co-design app displays each student's name beside an illustrated role avatar (Figure 4). Research regarding online/remote co-designing suggests including possibilities for qualitative feedback during the activity (Maaravi et al., 2020). Therefore, the online role illustration featured two sliders to express satisfaction with the primary and alternative game designs in percent (Figure 4). The mean group satisfaction is shown to all online co-creators in real-time. As providing stepwise guidelines is recommended for card-based co-design (Mora et al., 2017), the A0 board has imprinted instructions for each step of the design process on the bottom (Figure 4, left) and indicates the designated time for each step. The online co-design app thereby reads out the instructions at the beginning of each step and implements the scheduled time as a countdown (Figure 4, right) to offer better guidance in the distance learning scenario.

3.2 Classroom and online sessions for co-designing privacy decision games

Both toolsets were applied accordingly in either classroom or online sessions to learn about their educational game design aptness (Figure 4). The groups in the courses consisted of three to six members. Therefore, sometimes a student was playing two roles and sometimes a role was shared.

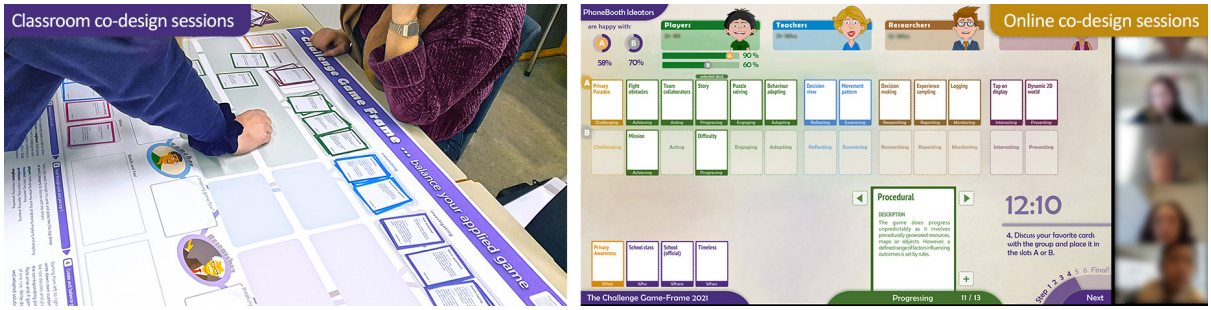

Figure 4: Students co-designing privacy education games in the classroom and online in a video conference

3.2.1 Participants

Two university classes with master students studying Computer Science were randomly selected for co-designing privacy games. While in one course (n = 29), the educational game design was performed in the classroom with the groups using the paper cards and board, the groups in the other class (n = 32) were co-designing remotely via video conference. Before the game design sessions, the students rated their privacy awareness and skill in game design on a 7-point Likert scale (1, none;7 extremely aware/professional). Both classes thereby reported comparable averages on their awareness for privacy (classroom M = 4.7, online M = 4.5) and game design skills (classroom M = 2.2, online M = 2.7).

3.2.2 Educational game-design procedure

The student groups were tasked with co-designing a collaborative game that educates about a privacy issue using either the paper-based card toolset or the online app. The co-design session was scheduled as a two-hour activity. After a basic introduction to Serious Game design that addressed the process of balancing educational goal to game goal, the students provided informed consent and rated their skills on the pre-questionnaire. Next, they were instructed on how to use the toolsets. These initial thirty minutes were followed by the one-hour game design session where the groups followed the given instructions and steps provided on the playboard. The six steps were (i) assign a role to each group member, (ii) set the target group, location/time of play and agree on a privacy education goal, (iii) read individually through cards of the assigned role and select favourite design suggestions, (iv) starting from left to right fill each slot of the game concept by discussing the favoured options or create/place own created ideas, (v) identify conflicting pairs and smooth out flow breaks by discussing alternatives, (vi) agree on the final design picks, write a plot summary and name the privacy education game.

3.2.3 Data collection and analysis

After the co-design session, the students from both classes individually rated their agreement with the statement *"The game design activity made me think about what can encourage better privacy decisions."* on a numerical 7-point Likert scale (1, strongly disagree;7, strongly agree). The students co-designing with the online tool were further asked to rate how much they learned about privacy and how much they learned about educational game design likewise on a 7-point Likert scale (1, very little;7, very much). To answer the second research question in more detail, each group was asked for their feedback on learning gains in 20-minutes post-activity interviews by the lecturer. The quantitative data from the questions were statistically analysed with IBM SPSS Statistics 27. The interviews were transcribed and evaluated by qualitative analysis (Strauss & Corbin, 1998) regarding perceived learning about privacy and educational game design through the online co-design activity.

4. Results

4.1 Encouraging reflection about privacy decisions (A)

Harpe (2015) recommends parametric analysis for Likert scale data with more than five numerically answered categories. Data from the two classes regarding quality to encourage reflection about better privacy decisions met the requirements for t-test analysis, and testing (α = 0.05) showed no significant difference between the classroom and online co-designing, t (59) = .654, p = .516. Both educational game design activities were perceived as triggering privacy decision reflection above average on the rating scale (Table 1/Figure 5).

Table 1: Analysis of perceived reflection encouragement

	Classroom co-designing	*Online co-designing*
n	29	32
Mode	5.0	5.0
Mean	4.4	4.2
Std. Deviation	1.5	1.5
Std. Error	.3	.3
95% Lower CI	3.8	3.6
95% Upper CI	5.0	4.7

Note. CI = confidence interval of the mean

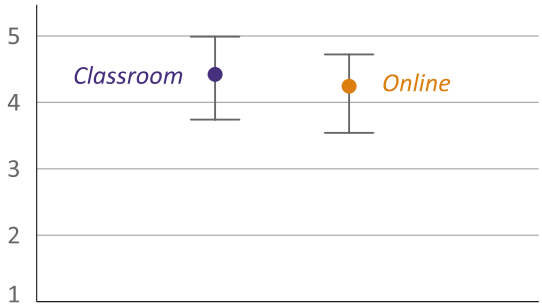

Figure 5: Mean quality to encourage reflection

Most frequently, the students chose to rate 5 in agreement on reflection encouragement with averages above 4 on the scale for both activities. The findings concerning the first research question suggest keeping H_{0A} as classroom and online educational game design did not differ significantly in triggering reflection about privacy decisions. Instead, both educational game design activities were perceived as encouraging reflection comparably effective.

4.2 Learning gains of online educational game design (B)

4.2.1 Quantitative analysis of the questionnaire ratings

Data from the two questions regarding perceived learning gain were not consistently normally distributed. As suggested by Field (2017), the within-subjects data were therefore analysed using a non-parametric signed-rank test (Wilcoxon, 1945) (α = 0.05). The results showed that students perceived learning gains differently in terms of privacy and game design, T = 290, p = .012, r = .31. For both subjects, the students felt a learning gain above scale average with a median of 5 (Table 2/Figure 6).

Table 2: Analysis of learning gains by online co-designing

n = 32	*Privacy learning gain*	*Game design learning gain*
Mode	5.0	6.0
Mean	4.6	5.3
Median	5.0	5.0
Range	4.0	4.0
Std. Deviation	1.0	.9
Std. Error	.2	.2
95% Lower CI	4.2	4.9
95% Upper CI	4.9	5.6

Note. CI = confidence interval of the mean

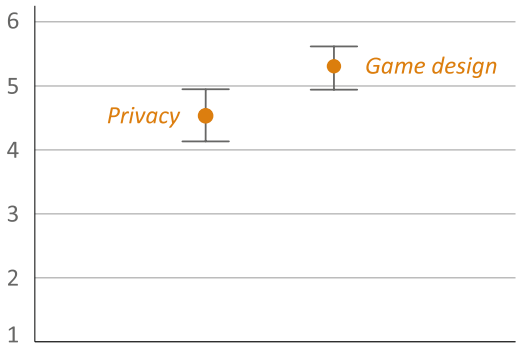

Figure 6: Mean learning gain by online co-designing

When looking exclusively at the median, the origins of the statistical difference are not immediately apparent. However, the mode indicates that most students perceived a somewhat higher learning gain in educational game design than in the subject of privacy. Most frequently, the students chose to rate 5 on the 7-point rating scale for indicating their learning gain on privacy and 6 for rating their learning gain in terms of educational game design.

4.2.2 Qualitative analysis of the post-activity group interviews

Analysis of the eight post-activity group interviews revealed further insight into the differences and origins of learning perceptions. The results thereby supported the findings of the quantitative analysis. Regarding *privacy learning gain,* 73% of the students' remarks were about positive learning effects through the co-design activity. These comments were mostly related to using the *privacy challenge cards*. Often, students expressed surprise about the range and variety of privacy concerns: *"The privacy cards were where I learned the most. Yeah, and that there are so many like sharing fake data and yeah, so many things." (Group A), "Well, I was more like thinking maybe cookies or locations were the main things. But you have like fifteen cards where there are so many different issues like deception and health tracking. I never thought about all of those before." (Group B), "…especially with the privacy cards I think were the ones that sort of show a lot of all the different things that exist within the realm of privacy. It really broadens the horizon." (Group E).*
However, aside from the diversity of privacy challenges, some students also learned about specific details of privacy decisions: *"I read on one of the cards, where it said that some apps ask you to agree that they can send data to a third party or third-party companies. And that is something I was not aware of before." (Group G).* A student of group E mentioned one critical aspect related to activity focus and learning gain: *"I focussed very much on the game design aspect and didn't really consider as much the actual privacy issue we were exploring. Because I was more interested in the tool itself and the game flow."*
Considering *learning gain in educational game design*, 83% of the students' comments were about positive learning effects. Thereby the majority of positive remarks were equally related to the *cards and roles* involved in the online co-design: *"I learned about the different roles, that you see the game from different perspectives with the cards, there is so much more to a learning game than I have thought about before." (Group A), "I felt I*

got a lot more insight in how to design a serious game as in how to balance engagement for the player and the teaching aspect as well as how we can measure how much the player is actually learning from our game." (Group G), "I learned how complex it was and that you have to consider a lot of parts." (Group D).
Lastly, several positive comments regarding the online co-designing were not solely related to a learning gain but linked to support for ideating and balancing education game concepts: *"The different cards were really great for getting new ideas and thinking of how a game could be designed. (Group C), "I learned a lot today when we were discussing conflicting ideas. Because it was much easier to sort out the conflicts and detect them when you can look at all these cards at the same time. (Group B).*
In conclusion, the statistical analysis of the quantitative data suggests the rejection of H_{0B} as students perceived the learning gains for privacy and design of educational games differently, which is further supported by the complementary qualitative results.

5. Discussion

With respect to the *first research objective*, the results of the classroom and online co-designing trials indicate that both activities can encourage reflection about better privacy decisions comparably effective. Most students in both classes rated that the educational co-design sessions made them think about better privacy choices above average with 5 on a 7-point scale. The outcome suggests that collaborative online game design can be applied in distance learning scenarios with the pedagogical goal to encourage reflection. The result supports the suggestion of Valente and Marchetti (2015) that collaborative game design with cards enables reflection-in-action. The studied toolset shows this specifically for triggering thinking about privacy decisions. Future research is encouraged to extend online co-creation with game design card-toolsets to other domains to develop this educational quality.
As regards the *second research objective*, the quantitative and qualitative findings show students perceive learning gain through online co-designing a privacy education game. The learning gain for the subject matter of privacy was perceived as above average, with the most frequent rating of 5 on a 7-point scale. However, the students' perceived even more learning gain regarding educational game design, with 6 as the most frequent rating. When considering the group interviews' detailed feedback, it becomes apparent that the privacy challenge cards were broadening the students' view on privacy concerns, with some students also learning about specific privacy issues like third party consent. On the other hand, the students were very focused on ideating and balancing the educational game, where they learned about the different perspectives involved and how to balance the game for learning and engagement. The students' focus on co-creating the different parts of the game with the role-based design suggestions to maintain an engaging game was apparently sometimes higher than the focus on the addressed privacy challenge. The online tools' success to captivate students is also mirrored in the groups' positive comments about support for sparking new ideas and sorting out conflicts in the education game concept.
However, it is possible that their perception of ideation/balancing support also influenced and incorrectly increased the rating regarding learning gain on educational game design. In consequence, this would suggest more equal learning gains regarding privacy and educational game design. Additionally, there are three other factors to include in evaluating the perceived learning gain through the online game design. First, the participating students reported having a considerably lower knowledge about game design than awareness about privacy before the co-design activity (see 3.2.1). Second, Computer Science students are also, in general, familiar with several data security topics related to privacy issues. These two factors could have influenced the perceived learning gain in favour of educational game design. However, such effects of novelty regarding educational game design can also be expected to lessen through repeated game co-designing sessions. While the role-oriented game design suggestions are well researched and relatively constant, the subject matter can change and include entirely different educational challenges in the next co-design sessions. Lastly, the trials' educational game design procedure included an introduction to Serious Game design but did not include an introduction to privacy challenges. Introducing the co-designers also to concerns and specifics of the subject matter and not only to SG design directly before the session may help set the focus for the activity more on the educational goal. By summarising the findings on both research questions, three main design implications for educational game co-design with card tools can be synthesised:

- Card-based classroom and online co-design of educational games can promote reflection when including cards with described subject matter challenges.
- Students experience learning gains when discussing descriptive subject matter challenge cards and role-oriented educational game design cards.
- Introducing the subject matter challenges before the co-design activity could help to focus the learning gain on the educational game goal.

6. Conclusion

This empirical study investigated the qualities of online educational game co-design for sparking reflection and creating learning gain. The results showed that the online co-design of privacy education games can encourage reflection about privacy decisions. The collaborating students who were taking the different roles of player, teacher, researcher and designer in the co-design activity also reported to learn about the diversity and specifics of privacy issues. The students further reported learning even more about educational game design as the online tool helped discuss conflicts between the roles and balance the educational game concept. Taken together, the results indicate that online co-designing of education games with role-oriented card decks can be applied in a dual-purpose strategy. While the online tool helps non-experts ideate and balance education game concepts, the educational game co-design activity can also trigger reflection and create learning gain regarding the subject matter. Future research should further explore these indicated qualities by additionally employing objective assessment of the learning gains from the online co-design activity. Ultimately, educators and researchers should be included in the co-designing sessions to learn more about the different perspectives and their affordances concerning educational game design.

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