Support Designer-Teacher Collaboration in Educational Game Design Using Learning Science Principles

Abstract Educational game design requires interdisciplinary collaboration between game designers and teachers, and tools like learning science principles have been suggested to facilitate this process and help design better-integrated games. However, the translation from learning science theory to practice is not well studied, and no previous study has examined how the presentation format of learning science principles may influence the effectiveness of a realistic, collaborative game design process between designers and teachers. Therefore, this study will examine how the forms and presentation of learning science principles might influence designer-teacher collaboration, which has both theoretical and practical implications in the fields of learning science and educational game design.

Objectives and Contribution to the Research

To scaffold the educational game design process and make better games to be used in education contexts, researchers have proposed several solutions to facilitate this interdisciplinary collaborative endeavor. For example, educational game design frameworks like EDGE suggested the incorporation of learning science principles (Aleven et al., 2010), which are scientific, theoretical, and highly synthesized prescriptions about how students learn and how to optimize learning. Learning science researchers have produced many lists of principles, some of which even specifically target game-based learning (Gee, 2007; Koedinger et al., 2013; Mayer & Moreno, 2003). However, few studies directly examined the application of learning science principles on the design process of educational games.

Other bodies of work on design practice proposed design patterns, which are practical, reusable sets of design solutions (Alexander, 1977; Kelle et al., 2011; Marne et al., 2012). A prior study on another type of serious game (brain injury therapy game) showed that design patterns effectively facilitated designer-therapist collaboration in the game ideation phase, which indicates that presenting design patterns as a prototype tool has the potential to help produce better games when an interdisciplinary team of designers and subject matter experts is involved (Cheng et al., 2017). Therefore, it will be interesting to examine the following research questions: *would the usage of learning science principles also be beneficial in an educational game design context? If so, how would the presentation format of the principles influence the collaboration?*

During the collaborative design process of educational games, design support tools could help designers and teachers build better understanding by presenting additional information like learning science principles, and since information can be presented in a variety of ways to facilitate communication, it's crucial to understand the influence of the specific formats in which the information is presented to the interdisciplinary team. However, a systematic examination of different presentation formats is also lacking. Understanding how to effectively present learning science principles in an educational game design context can shed lights on both theoretical research of learning science principles and applied endeavors of interdisciplinary game development, and it will be a valuable translational resource that helps bridge the gap between theoretical work and practical applications (Colusso et al., 2017).

The proposed study will investigate the following three presentation formats: *prescriptive statements, guided questions,* and *concrete examples*. Most learning science principles that researchers

listed have been presented in a prescriptive statement format; for example, “space practice across time > mass practice all at once” is a prescription of the spacing principle, which describes the benefit of leaving some time in between practices (Koedinger et al., 2013). Nevertheless, it may not be the most effective form of presentation in comparison to guided questions like “When do players get opportunities to practice skills in your game? How many times will they be exposed to each key skill?” or concrete examples like “Duolingo encourages users to take a break in between lessons by providing incentives for streaks of practicing multiple days in a row.” (*Interactive Principles*, n.d.)

Guided questions have been proven effective in supporting complex problem-solving and collaborative learning as they foster students’ higher-order thinking and metacognitive strategies (King, 1994; Suh, 2005). Concrete examples have been extensively used in design disciplines to inspire designers and help them represent and compare different features, with a potential danger of design fixation which limits designers’ creativity (Herring et al., 2009; Purcell & Gero, 1991). Thus, guided questions and concrete examples may foster designer-teacher collaboration in different ways, where the former facilitates higher-order reflections and helps designers or educators better frame their confusions, while the latter helps them quickly see how principles can be applied in practice and transfer useful features to their games. We hypothesize that presenting learning science principles in either guided question or concrete example format will lead to smoother collaboration and better game designs than in prescriptive statements, but presenting any of them is better than providing nothing (control group).

Methodology

To test our proposed hypotheses on the presentation format of learning science principles in realistic design situations and examine their effectiveness in supporting designer-teacher collaboration, we will conduct case studies in the form of game ideation workshops similar to a previous study (Cheng et al., 2017). We plan to recruit 3 pairs of student designers (CMU IDeATe students with Game Design Minor or ETC Masters of Entertainment Technology students) & educators (teachers, learning science experts, or instructional designers depending on the convenience of recruitment) for each of these 4 conditions (prescriptive statement, guided question, concrete example, and control), so a total of 12 pairs of student game designers and educators. Since human subjects are involved in this research, IRB approval will need to be acquired before the research implementation.

Each pair of a student designer and a teacher will be provided with the same design prompt of an educational game in a certain context, and they will be asked to collaboratively conceive a game idea and produce a design pitch in a 90-minute game development workshop. Depending on their assigned condition, participants will (or will not, as in the control group) be provided with a design support tool presenting learning science principles in prescriptive statements, guided questions, or concrete examples format, and the design support tool will be adapted from a website that presents 30 learning science principles (*Interactive Principles*, n.d.; Koedinger et al., 2013).

The workshop will be conducted through Zoom remote meeting, it will be recorded and participants’ use of the design support tool will be click-tracked. After the design ideation workshops, participants’ result design pitches will be evaluated by expert game designers, researchers, and teachers. The recording will then be qualitatively coded in a 10-second window to encode the primary collaboration activity in the window, such as explanation, question, concern, idea suggestion, and etc.

The evidence of expert evaluation results of the design pitches, the qualitative coding of the video, and the click-tracking of the design support tool usage will help us better understand the collaboration dynamics of teams in each condition. For example, if the design pitches in all three conditions are rated as better than those in the control group, it will suggest that the use of learning science principles is indeed beneficial in the educational game design process. If participants in either guided question condition or concrete example condition voice fewer concerns or confusions and suggest more ideas than those in the prescriptive statement condition, it will support our hypothesis that some specific presentation formats contribute to better collaboration in the design process.

Timetable

Spring ‘21	Review literature, write a proposal, apply grant & IRB
May-June ‘21	Finalize design prompts, workshop protocol & evaluation rubrics, apply IRB
July-Aug ‘21	Present learning science principles in different forms of design support tools, recruit participants
Fall ‘22	Run research (workshop & evaluation interview), code data
Spring ‘22	Data analysis, write the paper, dissemination of result

Background

The undergraduate and graduate-level courses I have taken (e.g., experimental design, academic writing, statistics, programming, educational goal, instruction, and assessment, and etc.) provide me with a strong foundation in educational design and research. I’m currently taking the course Design Educational Game with Dr. Erik Harpstead, who will be my primary faculty advisor on this project. I’d also done SURG with Dr. Sharon Carver on a website study, so I have experience applying/modifying IRB protocols, conducting research, and testing participants remotely. I have also completed CITI training and necessary background checks for interacting with human subjects. Thus, I am well-prepared to take a leading role on this project.

Feedback and Evaluation

I will meet with Dr. Harpstead to discuss the study design, design support tool implementation, experiment progress, and data analysis on a bi-weekly basis during the ‘21 Spring semester, and on a weekly basis during the ‘21 Summer and my senior year. I will also meet with Dr. Carver during the design prompt devising and participants recruitment process to recruit the educator participants I need for this study.

Dissemination of Knowledge

I will submit a description of my research plan and preliminary design support tool to the Work in Progress track of the ACM CHI Play conference in July ‘21. I will also present the results of this project in the student paper competition at the Meeting of the Minds Undergraduate Research Symposium in the Spring ‘22 semester. Finally, I plan to submit a full paper on the completed study to the 2022 ACM Designing Interactive Systems Conference or the International Society of the Learning Sciences depending on the timeline.

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