

# Understanding Development of Social Games Through Diary Studies

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**Abstract**—In this research-to-practice full paper, we describe our approach to using diary studies and social games to help Computer Science students develop their understanding of how application design influences user engagement and behavior over time. Social games are an engaging target for junior and senior-level courses like Human-Computer Interaction (HCI) and Mobile Software Design. While guidelines for designing social games can be conveyed through lectures and course materials, research shows the value of student-centered, hands-on learning experiences in fostering deep understanding. Inspired by Constructivism, which emphasizes that people construct understanding and knowledge through lived experiences and reflection, we incorporated a diary study assignment into an undergraduate HCI course. Although demoing a technology in class, or even having students use it in a controlled short-term activity, can convey lessons about usability, feature intent, and slips and errors, long-term use provides a better understanding of how technologies remain engaging and enjoyable (or how this can fade over time) and how social connections can evolve through repeated engagements. Diary studies, an established approach to field research, offer researchers a reflective view of how technology use may evolve over time. When employed as a pedagogical tool, diary studies create opportunities for students to capture and critically analyze their experiences through the lenses of a user, researcher, and designer. The social games served as a vehicle for active engagement, prompting students to apply critical thinking and reflection skills within a controlled setting. Analysis of students' diaries and post-study focus group discussions revealed common themes that can be incorporated into learning activities to help students understand how to develop apps that encourage certain behaviors among users. We outline how these lessons would be difficult to convey with more short-term use and identify techniques useful for development of social games. This diary study assignment approach increased students' appreciation of diary studies as a research method for collecting qualitative data about user behaviors and experiences over time and enhanced their understanding of the practical challenges of using diary studies for such a purpose. Further, we observed that the experience also deepened students' understanding of designing for user retention and social connection, and the importance of considering real-life application challenges in game design, such as concerns associated with safe usage and privacy.

**Index Terms**—Diary Studies, Social Games, CS Education

## I. INTRODUCTION

Social games present an engaging target for junior and senior-level Computer Science courses, such as Human-Computer Interaction (HCI), Mobile Software Design, and the like. The widespread adoption and use of social games into everyday life create rich opportunities for Computer Science students to explore the many facets of technology design and research in a very tangible way. However, teaching students how to effectively design and study social games and mobile apps can be challenging to educators. Students often struggle with learning, integrating, and applying new knowledge and complex concepts [1], [2], while educators often struggle with tailoring instruction to accommodate the diverse needs of students within their classes [3].

Prior research offers valuable insights and evidence-based strategies to educators seeking to design effective teaching and learning experiences that address such challenges. For example, Chickering and Gamson [4] advise that good instruction should be active, provide significant opportunities for students to receive meaningful and timely feedback, support and encourage student reflection, and help students make connections between new and existing knowledge. These and other researchers propose that learning should be collaborative and social, while promoting critical thinking, accountability, and adaptability [4], [5]. Proponents of Constructivism further emphasize that people learn by constructing their own knowledge of the world through engaging in and reflecting upon lived experiences [6]–[8]. While research on pedagogical principles and teaching philosophies are well-documented, translating these into practical and authentic learning experiences remains a challenging task for educators.

Diary studies, a qualitative research method commonly used in education and Human-Computer Interaction (HCI), present a promising approach for educators seeking to craft

authentic learning experiences that embody the characteristics of effective instructional design. This paper describes our implementation of a diary study assignment in an undergraduate Computer Science course, designed to foster an authentic learning experience intended to help students develop the knowledge and skills to effectively design and study social games and mobile apps. The assignment required students to choose one game from a curated selection of options, play their chosen game under certain conditions for a specified period, and to reflect on their experiences by maintaining a diary. Additionally, students were also required to participate in a focus group reflective activity following the diary study period and produce a final report that synthesized their experiences and insights.

Analysis of students' diary entries and post-study focus group discussions revealed common themes highlighting how Casual Game Design Values [9] facilitate shared experiences and social connection, the importance of designing for the social experience afforded by the game and not just the game itself, and the consequences of designing social features that bring only of limited value in certain play contexts.

Through analysing student feedback on the diary study assignment, we observed that students gained a deeper understanding of how the design of applications can influence user engagement and behavior, and how social connections and relationships can evolve through repeated engagements with and through technology over extended time periods. Drawing from our experiences using the assignment in multiple semesters, we offer insights to aid others educators in integrating diary studies into their curriculum.

## II. RELATED WORK

A diary study is a research method used across various fields of study including psychology, sociology, human-computer interaction, marketing, and education. Diary studies have emerged as a popular tool for qualitative research as they provide a means for researchers to capture detailed, in-situ insights into the experiences of study participants [10]–[12]. Diary studies involve participants maintaining a diary of their experiences of a particular phenomenon being studied. For example, in a diary study investigating smartphone and tablet use, such as the one conducted by Müller et al. [13], researchers may ask study participants to maintain a daily log documenting the activities performed using their smartphone and tablet devices, including the specific times throughout the day that they used their devices for each activity, as well as other aspects of their usage experiences.

A unique aspect of diary studies is the dual role of study participants, acting as both subjects of the study, as well as collectors of data. Diary study participants are tasked to make diary entries at regular intervals, essentially capturing a chronological record of their activities, interactions, and other aspects of their lived experiences [10]. Participants log entries as events occur or shortly thereafter. It is important to note that diary entries are more than simply an objective record of

events. Participant reflection and interpretation are key characteristics of diary studies [11]. When properly designed, diary studies enable participants to record not just what they do and when they do it, but also prompts them to think critically about their cognitive processes, motivations, thoughts, feelings, and the context of their experiences [10]–[12].

When designing a diary study, researchers must make decisions regarding the study length, the frequency of diary entries, the medium to be used to record diary entries, and the information to be included. Diary studies can span days, weeks, or longer if needed. Interval-based, signal-based, and event-based protocols are three common designs in diary research [12]. Interval-based protocols require participants to make entries at predefined intervals such as daily, weekly, or periodically through the day. Signal-based protocols require participants to make entries in response to prompts provided by some signaling device. Event-based protocols require participants to make diary entries when a specific event occurs. Diary entries can be hand-written, typed, or audio or video recorded. Bolger et al. caution that diary studies can place significant demands on participants, highlighting the potential impact that an onerous design may have on participants' adherence to study protocols, particularly those guiding the frequency, quality, and consistency of log entries throughout the duration of the study [12]. Researchers must therefore carefully consider the design of a diary study to ensure that meaningful and sufficient data can be captured without the task becoming burdensome to study participants.

In Human-Computer Interaction (HCI), diary studies have been used to capture in-depth data on user interactions and experiences with technology in real-world settings [13], [14]. In education, diary studies have proven to be an effective tool for supporting individual reflection and skill development, and for investigating teaching and learning across different contexts [11], [15]–[17]. Zimmerman and Wieder [10] were among the first to utilize diary methods in educational research, choosing to leverage this approach as a means of navigating the challenges associated with directly observing participants in certain settings.

Reflective diaries have been particularly useful in understanding teaching and learning processes. They encourage students to think deeply about learning processes, challenges, and other interesting aspects of their lived experiences [15]–[17]. Respectively, they also encourage teachers to think deeply about their teaching processes, the effectiveness of instructional strategies, challenges, opportunities for improvement, and other relevant concerns. Through reflecting, writing diary entries, and later sharing diaries, students become more self-aware and teachers gain valuable insights into the processes of their students. For example, Wallin and Adawi [16] used reflective diaries for the formative assessment of self-regulated learning (SRL) in engineering education. Through thematic analysis of diary entries submitted by students, the researchers developed deep insights into students' beliefs, learning processes, challenges, and self regulation strategies. The researchers were able to understand their students' pre-

ferred approaches to learning, the reasons for their preferences, and garner insights into how students set learning goals and monitor their learning. The researchers demonstrate how this deeper understanding equips educators to provide tailored feedback that better supports individual student needs. The study highlights that reflective diaries can reveal aspects of students' learning experiences that may not be easily discernible through other assessment methods.

Huff and Brinkley [17] used diary studies to understand the learning experiences of high school students with visual impairments, as well as their teacher's experiences, during the programming portion of an introductory Computer Science course. Over a period of four weeks, the study captured student reflections of daily activities, challenges, and perceptions of course material, tools used, and the teacher's instructional approach. Since the teacher also maintained a diary, the study also captured teacher reflections of their students' experiences learning to code across the various lectures and assignments. The findings revealed that students with visual impairments faced specific challenges reviewing and debugging programming code, including difficulties reviewing code presented as small and thin text and the use of color in code editors to highlight programming errors. Awareness of these challenges help educators understand how to modify their instructional approaches to better support students with visual impairments. Despite these challenges, students reported generally positive learning experiences, with the study revealing that students with visual impairments can effectively learn to code with appropriate support and accessible tools [17].

The flexibility offered by diary studies as a research method allows researchers to tailor study design to best fit the research questions and population of interest. Unlike surveys or interviews, which typically capture data at a single point in time, or experimental studies, which often involve a single session or multiple sessions across a shorter period of time, the extended duration and continuous data collection offered by diary studies provides researchers with opportunities to study how patterns, attitudes, behaviors, and experiences emerge or evolve over a period of time [12]. Diary studies foster reflective practices that develop critical thinking and specialist skills [15], showcasing its potential as both a research method and an educational intervention.

### III. DIARY STUDY ASSIGNMENT

#### A. Assignment Overview

Students were first asked to choose one game from a selection of options. The selection varied across different cohorts, with each semester's combination carefully curated to offer students a broad spectrum of options. Given our interest in studying the social experiences afforded by digital games across different contexts, the selection of games fell into two broad categories: those with features heavily oriented towards social play in an indoor setting or those designed for outdoor play with opportunities to support social interaction.

The indoor games included Among Us, Charades, Code-words, and Draw Something Classic; games which emphasize

social play within a confined space. These games could be played on either a personal computer or a mobile device. The outdoor games included Pokemon GO, Orna: The GPS RPG, Pikmin Bloom, and Walkr; games focusing on physical movement and interaction with real-world outdoor environments, with opportunities for players to extend play to include social interaction with other players or with companions who accompanied players during their time outdoors. These outdoor games could only be played on a mobile device. Students were free to choose a game they had played before or one that they were unfamiliar with that they wished to explore.

Students were advised to play their chosen game for a minimum of ten play sessions across at least seven different days, ensuring that each session lasted at least 20 minutes in duration. Since our focus was to study social experiences mediated through the use of the games, students were directed to play their chosen game with one or more companions, in any manner that they felt was safe and appropriate. We made sure to address what constituted safe and appropriate play, and examples of unsafe or inappropriate play experiences, in our lectures and course activities before releasing the assignment.

We gave students the option to play with family or friends, other students from the class, or, when available, strangers matched through the game itself. Students were given the freedom to extend the number of play sessions or session duration as they saw fit, allowing for a more in-depth engagement with the game and the natural progression of any social experience that may have emerged through play. This structure was intended to strike a balance between not making the task overly onerous, with ensuring that students had ample opportunity to play their game in a manner which would allow social experiences to unfold naturally over time. Further, we felt that this structure would best facilitate the learning experience, providing students with sufficient time to experience and reflect upon their chosen game and experience the diary study as a means of conducting research.

#### B. Diary Entries and Data Collection

Students were required to maintain a shareable diary using either the in-situ logging or snippet technique [18]. Students were reminded that each diary entry should be made shortly after each play session. Recognizing that this would be a new experience for many students, we were concerned that some may not know how to report on their play experiences, and that this may cause undue duress, and negatively affect the learning experience and the quality of the data captured. We were also concerned that poor quality entries presented in an inconsistent format would negatively affect our ability to grade submissions efficiently and consistently, limit our ability to provide students with timely and effective feedback, and would also complicate the process of coding and categorizing diary entries during later qualitative analysis. To address these concerns, we provided students with exemplars and a template, advising them that diary entries should include brief descriptions of their experience playing the game, the features of the game they used and found engaging or off-putting, how

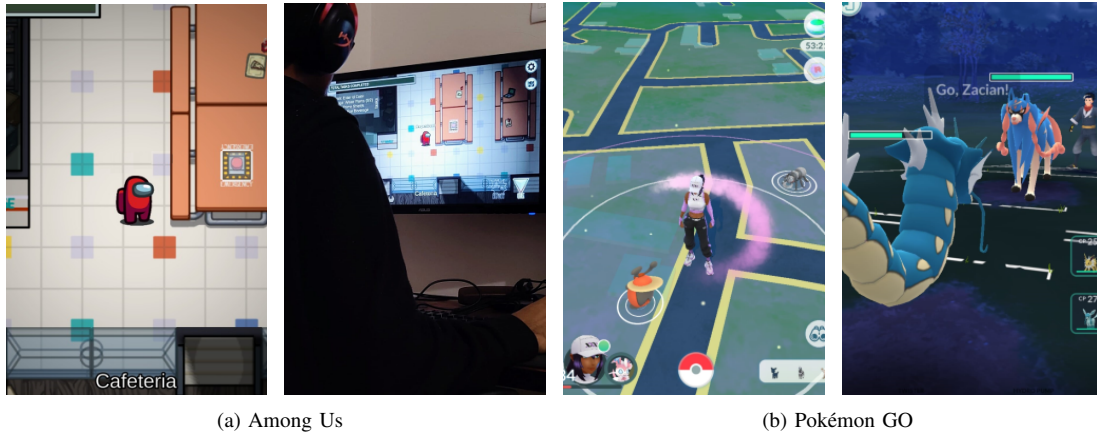


Fig. 1

many people they connected with through the game and their level of connection with those people, their enjoyment, and any other outcomes of the experience.

#### C. Post-study focus group interview and Final Report

For the final part of the assignment, students were required to participate in a post-study focus group interview and to compile their diary entries and concluding thoughts into a comprehensive report. To prepare for the activity, we reflected on our own experiences playing the games and used thematic analysis to analyze student diary entries. We then prepared a list of post-study questions. Using these questions we facilitated the focus group activity, and led a guided discussion that helped students share and reflect on their experiences with their game and the research method.

### IV. THE GAMES AND THE PLAYERS

Due to page limitations, this paper will focus on the results from three selected games: **Among Us** ( $n = 111$  across two semesters, i.e.  $66 + 45$ ), **Pokémon GO** ( $n = 6$ ), and **Pikmin Bloom** ( $n = 5$ ).

#### A. Among Us

**Among Us** is an online multiplayer murder mystery game developed by InnerSloth LLC [19]. The game is set in a space-themed environment, with play often centered on navigating and maintaining a spaceship or base. Players are assigned the role of crewmate or impostor. Crewmates explore their environment and complete maintenance tasks. Imposters masquerade as crew members, pretending to perform the duties of a crewmate while covertly attempting to sabotage their environment and kill crewmates. Each game has at least one impostor. Throughout the game players hold emergency meetings to vote on the identity of the impostor. Players with enough votes are assumed to be the impostor and are then ejected into space. Crewmates must complete all tasks or eject impostors to win the game. On the other hand, imposters win by avoiding detection. Imposters strive to convince the crew that they are one of them while framing others as a potential impostor.

#### B. Pokémon GO

**Pokémon GO** is a location-based multiplayer game developed by Niantic in collaboration with Nintendo. The objective of the game is for players to find, catch, hatch, train, and battle creatures called Pokémon [20], [21]. **Pokémon GO** utilizes each player's real-world location and movement as part of the play experience. Each player's location is captured and used to render a map-based view of the game world, essentially an in-game replica of the player's real-world location and surroundings. The player's map is augmented to depict their avatar and Pokémon and other game objects near the player's real-world location. Movement in the real-world updates a player's in-game location and their view of the virtual game world. The game relies on proximity-based mechanics, requiring players to move within range of game objects in order to interact with them. For example, players must first move within close proximity of the Pokémon depicted on the game map to catch them. The game also relies on player movement, requiring players to walk, run, or wheel specific distances to accomplish game objectives. For example, players must travel distances of 2km or more to hatch eggs and evolve caught Pokémon. Through exploration of the real-world, players can search or and interact with Pokémon, PokéStops, PokéGyms, and other players.

#### C. Pikmin Bloom

**Pikmin Bloom** is a mobile augmented reality (AR) game also developed by Niantic, the creators of the popular location-based games **Pokémon GO**. The game combines elements of outdoor exploration, exercise, and social interaction. Similar to **Pokémon GO**, the game uses a map of the player's real-world location as the game environment. The goal of the game is to collect and grow plant-like creatures called Pikmin by walking in the real world. The more players walk, the more Pikmin seeds they can collect and grow. The game offers players different challenges and social features. For example, players can use the "flower planting" feature to leave a trail of flowers on the game map that matches the player's real-world walking path. Once planted, the flower trails are visible

to other nearby players for a period of time [22]. This allows players to leave traces of their presence and perceive other players who travelled a similar path. Players also have the option of planting flowers with others.

## V. RESULTS

### A. Game Selection

Students chose games based on their interests, familiarity with the game (or prior versions of the game), curiosity about specific features, and perceived effort required to complete the various assignment deliverables. For instance, **Pokémon GO** was popular among students interested in spending time outdoors, or interested in or familiar with the story and lore associated with the game. **Among Us** was popular among those interested in maintaining social connections; many felt that the game would provide opportunities for them to bond with friends and family and offer a fun distraction from daily stressors. **Pikmin Bloom** was favored by students who wanted to walk more or were interested in an experience involving the outdoors. Some students picked games that could naturally fit into their lifestyle. For example, one student walked his dog daily and chose **Pokémon GO** since it could be played during those walks. Students also picked games that they knew their friends played or were familiar with. Part of this was motivated by the assignment's requirement that directed students to play with one or more companions. Though students were given the option to play with members of the class or with strangers matched through the game itself, most preferred to play with friends and family. These students desired to accomplish this without needing to make significant demands on their companion(s). They therefore chose games that required a minimal investment of time and effort.

### B. Among Us

**Among Us** was a popular choice among students. In addition to the other factors which influenced student's choice of game, the motivation to play **Among Us** was partly due to its popularity in mainstream media at the time of the study. We found that most **Among Us** participants crafted their own social play experience by combining the game with video or voice conferencing technology and custom rules governing play and social communication [23]. This approach contrasted with the game's original rules, which restrict the mode, timing, and content of player communication. Instead of using the game's built-in text chat option, many students used third-party Computer-Mediated Communication (CMC) software, such as Discord and Zoom, to support and enhance their play experience. Furthermore, instead of adhering to the game's rules which limit player communication to emergency meetings for discussing and voting on the identity of imposters, students and their friends used the play sessions to converse, catch up, and share amusing experiences.

At first, students new to the game reported that it was difficult to learn and use, with some fearing that they would do something wrong within the game, which they felt would negatively affect the experience of others. Over the course of

the diary study, students found that their feelings towards the game changed. These students shared that their initial difficulties lessened as they became more familiar with the game and its nuances. They gradually became more comfortable with the game and came to enjoy the social experience the game offered.

Most students shared that the game was not cognitively demanding, thus affording them the opportunity to talk and bond while simultaneously playing the game. While there were periods of play that required focused attention, student participants agreed that much of the game could be played even if a player's attention was divided. Students shared that gameplay drove them to think deeply about their companions, their past experiences with them, and their behaviour under certain conditions. Participants used this in their efforts to discern whether or not companions were telling the truth during emergency meetings.

Many students shared that the game provided opportunities to bond with friends and family and an easy way to build better relationships, particularly when augmented by third-party Computer-Mediated Communication software (Discord, Zoom, etc.). They deeply cherished these opportunities and marvelled at how such a simplistic game could facilitate such enjoyable experiences that could be shared with those they care about. Students felt that the simple graphics and low-effort game play made the game accessible to a wide variety of players. When combined with the interdependent game mechanics and rich communication opportunities afforded by third-party (CMC) software, students felt that the play experience afforded by the game contributed to feelings of connection.

In contrast, a few participants expressed that the play experience was actual stressful when played with close friends. These participants felt that the game did not offer an enjoyable bonding experience, but rather an often unpleasant one filled with heated discussions. Some participants disliked the deceptive nature of the game. They did not enjoy being deceived by friends playing the role of imposter. These participants shared that they preferred playing with strangers for this reason. Similarly, friends seeking a light fun experience did not enjoy playing the game with highly competitive individuals, as their focus on winning had a negative effect on feelings of shared experience and connection.

In general, most students were able to connect with companions through their experiences playing **Among Us**, though, in most cases, this connection had little to do with the game itself. Participants found the game to be simple and interchangeable. Feelings of connection occurred when players' experienced fun and a strong sense of shared participation in the leisure activity. We observed that the game embodied Casual Game Design Values of Acceptability, Accessibility, and Simplicity [9]. Such games typically provide "a light interaction loop for secondary activity" [9], i.e. required low levels of focused player attention or varied game play between moments of high immersion/focused attention to low. Many students agreed that this "light interaction loop" was a key design element as it

allowed players to split their attention between playing the game and socializing with companions.

1) *Pokémon GO*: Students who played **Pokémon GO** shared that the game motivated them to go outdoors, walk more, and to explore both new and familiar outdoor locations. The game's map made players aware of their location and the relative position of nearby Pokémon, PokéStops, and other game objects. This awareness and the game's "catch them all" theme, motivated players to move within range of these items in order to find, catch, hatch, train, and battle Pokémon. One student who played as part of his regular running routine, found that he ran further and explored new outdoor areas when he saw that Pokémon, PokéStops, and other game objects were nearby. Other participants shared similar experiences, remarking that they enjoyed this opportunistic exploration of unfamiliar outdoor spaces, especially when accompanied by a companion.

Some students invited friends to play with them, while others invited friends to accompany them during their time outdoors while they played. Similar to **Among Us**, participants created their own social experience with the game as a medium. Friends and family, motivated by curiosity, interest in the game, the opportunity to connect socially, or a desire to exercise or spend time outdoors, either played with the student or accompanied them during play. During such occasions, students would engage socially with their companions before, during, and after play.

Students indicated that they enjoyed their time outdoors, though most admitted that their focus was usually on the achieving objectives within the game. Only on few occasions, would a student complete a game objective then stop play to "disconnect" from technology and simply enjoy their time in nature. Many would choose to move to another location to continue making progress within the game. Students noted that the game offered few opportunities to connect with remote companions, with many expressing interest in enhancements that could support remote outdoor play with distant companions. At the time of the diary study, **Pokémon GO** did not include such remote play features; however, these features were introduced in later updates.

### C. *Pikmin Bloom*

Students who played **Pikmin Bloom** shared that the desire to collect, plant, and grow Pikmin motivated them to go outdoors and walk more. Unlike **Pokémon GO**, the game did not directly drive players to explore new outdoor locations, though some students shared that they sometimes walked longer to make progress in the game. As a result, students may have inadvertently wandered into previously unexplored areas. Collecting and growing more and different Pikmin greatly appealed to a few students. Students also appreciated the game's low-effort nature, the ability to "run it in the background", and the "cuteness" of the Pikmin. Students generally enjoyed leaving flower trails and seeing the flower trails left on prior walks. One student expressed concerns about the flower planting trail feature, perceiving the

feature to be unsafe, fearing that it might reveal her location and route to nearby strangers. This student valued privacy and desired more explicit control over such location sharing features. With respect to the social features involving seeing the flower trail left by others, most students did not get to experience this firsthand. This was due to the newness of the game and the limited adoption within the geographic area that students played within. Students recognized that a player's experience could be significantly influenced by the game's popularity within a given geographic area. They understood that limited adoption could hinder a player's ability to fully experience and derive value from features designed to foster social interaction with others who played within the area. Despite the enjoyment derived from growing and tending to Pikmin, planting flowers, and using other game features, many students felt that the game was monotonous. Such students observed that their feelings towards the technology remained the same over multiple interactions and their diary entries were often similar to the day before. One student expressed that they could see themselves getting bored with the game over a longer period of play. The student suggested that the game could be improved by more effectively managing player expectations about the specific features and challenges that would be unlocked as they progressed in the game. The student felt that such enhancements would help the game remain engaging and enjoyable over extended periods of play.

### D. *Student Reflections on Using Diary Studies to Conduct Research*

In our post-study focus group discussions, we asked students to reflect on diary studies as a research method for investigating peoples' experiences with technology and their own experiences using diary studies to conduct research exploring the design of social games. Many students reported that the assignment experience provided a deeper understanding of the game design elements that meaningfully contributed to user engagement and social connections. For example, **Among Us** players recognized that high-fidelity graphics and complex game play was not necessary for meaningful social experiences mediated through the use of a game. These students appreciated the value of explicitly driving player communication through the game mechanics, while also giving players the freedom to fill the less cognitively demanding moments of play with casual conversation and socializing with companion players. Most students recognized that games embodying Casual Design Values [9] could still be engaging and enjoyable, maintaining their appeal over long periods. Many of these students understood that designing a social game should go beyond focusing on graphics, advanced game mechanics, and other typical concerns; it should also consider the overall experience that the game offers (or had the potential to offer) to players. Students appreciated how the post-study focus group session helped them learn about the perspectives of other players, some of which were significantly different from their own. They recognized that the discussion prompted

them to think about what companion shared, and reflect on its relevance to their own experiences.

Students shared that the assignment experience helped them to appreciate how using this research method could be frustrating to both participants and researchers. Students admitted that playing the game and making the diary entries could sometimes be tedious. They expressed that they developed a better understanding of how the design of a diary study could make it challenging for participants to consistently adhere to the study protocol. Additionally, the students recognized that exploring technology-use through a diary study could yield few meaningful insights in cases when a participant's experience — and consequently, their diary entries — remained similar throughout the course of the study. Students also appreciated in-class discussions and the post-study focus group session, as these allowed them to learn about the experiences of their classmates and provided opportunities to connect concepts taught with their own experiences. They appreciated how the diary study method helped them capture the variability and evolution of their experiences over time. In particular, students appreciated how the diary study and post-study activity gave them a better understanding of how experiences with the same technology could be extremely different across different users and times. These students acknowledged that the design of social games and mobile apps should incorporate diverse perspectives and not be solely driven by the perspectives of a single designer.

## VI. DISCUSSION

This approach to using the diary study and post-study focus group session facilitated active learning and student reflection, crucial components in helping students understand how to design and study social games. Students provided positive feedback about their experiences with the assignment, as they were able to choose and study a game that appealed to their interests. By documenting, reflecting upon, and analyzing their own gaming experiences, students were able to make connections to theory and lectures, internalize design principles, positioning them to apply these insights in novel ways. Collaborative discussions further enriched the teaching and learning experience, offering diverse perspectives and fostering social learning opportunities.

### A. Designing Diary Study Assignments

Within the sections to follow, we draw from our experiences to provide guidance for educators seeking to utilize diary studies as part of their teaching strategy in courses related to Human-Computer Interaction (HCI) and technology design.

1) *Understanding the strengths and weaknesses of Diary Studies:* Educators should begin by helping students understand the strengths and weaknesses of diary studies as a research method. Within learning activities, educators should compare and contrast diary studies with other research methods, discuss appropriate use cases, and highlight the advantages and disadvantages of the various methods. In particular, educators should convey that diary studies can reveal insights

into user behaviors, needs, and challenges, and how these may evolve over time. Where possible, educators should reference real-world applications of diary studies, particularly those which may have contributed meaningfully to design decisions relevant to the context of the course. Educators should create opportunities for students to reflect on their experience maintaining a diary, reflect upon and analyse their diary entries (or entries submitted by others), and use the insights derived from the study in some meaningful way. At the end of the diary study, educators should prompt students to reflect upon the strengths and weaknesses of diary studies as a qualitative research method and express their thoughts in their own words. This activity would help to reinforce lessons on diary studies and other research methods.

2) *Integrating Theory and Practice:* The rich data captured and shared through diary study assignments can provide meaningful opportunities for students to integrate theory and practice. Where possible, educators should encourage students to apply theoretical concepts from HCI and design. These concepts can be leveraged in different ways, from capturing log entries to supporting analysis and interpretation of diary study findings. This could involve exposing students to theories related to user experience, human behavior, or design ethics. For example, for learning experiences such as ours, which explored how game design supports social play and human connection, we have the opportunity expose students to recognized research instruments such as the Inclusion of Other in Self scale, which is often used in research studies to quickly capture and measure interpersonal closeness between study participants and others [24]. In addition to applying theory, diary entries can be used in exercises that help students connect lessons to their experiences and develop practical qualitative research skills, including positionality and reflexivity in research, coding qualitative data, maintaining and using a code book, developing themes, memo writing, and more. By giving students opportunities to analyze their own diary entries or anonymous versions of the diary entries of their peers, students can practice coding qualitative data, developing themes, and discovering insights that emerge from the data.

3) *Technology Access Considerations:* When designing assignments that require technological resources, educators should take steps to ensure that all students have the necessary tools to participate fully. A good way to approach this is by first understanding the technology requirements of the selected applications. Reading published documentation for each of the games being considered is a good start. However, we recommend that educators go further to play each of the games in advance of finalizing the assignment. This will help educators better understand the experiences their students may have with the game, which in turn may help educators identify research questions that the diary study may intend to answer. Having clear research questions for each game helps educators design diary study templates, diary entry prompts, related in-class activities, and post-study focus group questions.

Another step is to develop an understanding of the tech-

nologies available to your students. Although most students may have personal computers or tablet devices as per university requirements, it is crucial that educators take steps to identify students who might face barriers. In our case, incoming undergraduate students are expected to have access to a personal computer or tablet computer. While this factored into our assignment design, provisions were still available for students who did not have access to a personal computer or mobile device. Where possible, educators seeking to leverage diary studies involving game or app usage should make similar provisions for students to borrow devices. Many universities have established facilities for loaning devices to students who lack access to a personal computer or mobile device. This may be through the university's library, the resources available to the course team via their research lab, or through some other means. At the beginning of the course, the course team should identify or develop mechanisms for device loaning, and inform students about the technologies available for loan and how these may be accessed. In addition, course material and assignment guidelines should include information on the options available to students in need of loaner devices, a listing of the devices available, detailed instructions on how students can borrow these devices on their own, and how they can contact the course team to arrange for device borrowing. Course team members should strive to keep communication lines open for students to reach out with any issues regarding device access or challenges encountered throughout the course.

4) *Assessment Evaluation:* Similar to other assessments, educators must establish clear criteria for evaluating the various diary study assignment deliverables submitted by students. Evaluating criteria should be clear and aligned with the learning objectives. Some possible criteria could include the thoroughness of the data collected by the student, the quality of their reflection, any theoretical integration, the quality of the insights drawn from the experience, and how the student uses (or intends to use) those insights to inform future design decisions. In addition, students can be assessed based on any reflection associated with diary studies as a research method, and the challenges and opportunities with using a diary study to conduct research.

5) *Creating Rubrics:* Grading deliverables from a diary study assignment can seem particularly daunting given the complexity and volume of qualitative data collected over the course of the students' interaction with the technology being studied. Creating a rubric to grade diary study assignment deliverables is highly advisable, as rubrics provide a clear, standardized approach for assessing submitted work [25]–[27]. This is beneficial to educators and students in a number of ways. A well-defined rubric sets and communicates clear expectations for students and educators. This helps students understand what is expected of them from the assignment and provides students with opportunities to assess and improve their work [27].

The process of creating a rubric provokes educators to reflect on what they expect from students, which can help them consider challenges that students may encounter in

satisfying the criteria and identify weaknesses in the assignment and supporting materials (resource materials, templates, checklists, etc.). This may lead to refinement of assignment or scaffolding materials and approach to teaching [25].

Rubrics help ensure consistency in grading across student submissions; this is particularly important in courses with multiple graders or a large number of students [26], [27]. Furthermore, the use of a rubric facilitates quicker evaluation of student work, reducing grader subjectivity and deliberation, making grading more straightforward and less time-consuming [25], [27]. Where possible, rubrics should be shared with students at the beginning of the assignment. Rubrics also provide support for grading deliverables presented in different formats. For example, in a diary study assignment, educators may choose to give students the option of submitting diary entries in different mediums (for eg. text, handwritten, audio, or video) and channels (course platform, shared document, online survey, messaging technology, custom-made mobile app, etc.). A properly designed rubric can help reduce grader bias for or against a given media and channel by helping them focus on the content and other essential aspects of the deliverable.

6) *Providing feedback and support:* Providing students with timely, rich, and effective feedback is a critical part of teaching and learning. However, providing meaningful feedback can be an overwhelming task for educators if not planned or resourced properly. To design an effective learning or assessment experience, educators must carefully consider how to monitor student progress in a manner that is not intrusive, when and how to provide feedback, and how to provide meaningful formative and summative feedback in a manner that was not overly onerous on the course team. Additionally, educators need to ensure that they are able to identify when students are struggling or instances when the learning experience is not unfolding as expected, and intervene to support students and get things back on track.

We reviewed student diary entries throughout the diary study to ensure that students were completing their diary entries and that these entries were appropriately detailed and reflective. Requiring students to maintain a shareable diary, allowed us to quickly review entries, provide constructive feedback to help students understand if their entries were appropriate or not and how to improve them. Depending on the size of the class, the composition of the course team and the resources available, feedback and intervention could take different forms. Educators may choose to provide feedback to each student directly, to student groups, or to the class as a whole. Feedback could be specific or general. For example, educators may choose to select good and bad examples of diary entries, anonymize them, then review the examples with the entire class to highlight the characteristics of high-quality diary entries vs entries that could be improved. Rubrics are also a good way to provide rich feedback on student work. They can act like a checklist ahead of the submission and as rich feedback following formal evaluation.

7) *Supporting Data Collection, Student Reflection, and other Learning Activities:* We were concerned that students,

as novice researchers and practitioners, may not know what or how to report on their experiences with their chosen game within diary study entries. We recognized that students may struggle to express their thoughts and feelings in a cohesive way, may provide poor quality or incomplete data, and may provide data that did not adequately support subsequent learning activities. From a grading point of view, we were also concerned about the consequences of capturing a poorly organized data of varied quality and themes. The quality, consistency, and organizational structure of the data provided by students would naturally affect our ability to grade consistently. Educators should provide students with templates and tools for supporting data collection, which could include digital diaries, mobile apps, or traditional pen-and-paper methods. Each has its benefits and drawbacks, and the choice of data collection technique can depend on the study's focus and the educator's approach to providing informal and formal feedback.

## VII. CONCLUSION

Diary studies are a powerful tool in CS education, as they offer avenues for enhancing students' understanding of research methods and user experiences with technology, and insights into the design elements that make social games and mobile apps engaging. Through careful design of a learning experience, a diary study can help students gain a multi-faceted perspective on technology design and use that can serve them well as Computer Scientists. Through engaging in a diary study assignment, educators can help students experience and reflect upon the diary study method, creating opportunities to link theory and lectures to real-life usage considerations.

Diary study assignments, such as the one described in this paper, provide student with opportunities to use and reflect on technology, and to draw lessons from their experiences that can inform their approach to designing and studying technology. The various activities preceding, during, and after the diary study provide numerous opportunities to actively engage students, both for the purpose of supporting learning and understanding of course concepts and for the purpose of improving their capacity for research. Such activities can be used to get students thinking about design concerns that may be specifically applicable to capstone projects or other deliverables.

While we found that the diary study assignment provided a meaningful experience for our students, we recognize that it may not be universally applicable. Educators must carefully evaluate their teaching and learning context to determine if this approach is appropriate. However, in the right circumstances we believe that diary studies can be used to provide active and authentic learning experiences that place students at the center of the learning process.

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