Teaching User Interface Evaluation Methods with Games

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***Abstract*— We present an experience report detailing the use of games as a means of teaching empirical evaluation of user interfaces. We discuss the implementation of a similar course project structures in an engineering course on human-computer interaction (HCI) and a humanities course on game design. Both courses featured a milestone-driven, iterative approach to student projects, which provided students with a great deal of diverse feedback throughout the duration of the course. Parallels are drawn between player experience testing and HCI methods.**

***Keywords*— Game design, player experience testing, human-computer interaction, research methods, pedagogy.**

I. INTRODUCTION

A cornerstone of human-computer interaction (HCI) is the empirical evaluation of user interfaces via human participant experimentation. Unlike related fields (e.g., computer science), user interface (UI) evaluation requires participant involvement to evaluate practical benefits of a UI with its intended users. However, human experimentation introduces several challenges not typically addressed in pedagogical practice.

In some ways, game development is more similar to HCI than other areas of computer science, since the focus is on developing and evaluating interactive systems. Game testing is not only used to detect bugs, but to assess user experience with the game – i.e., to determine if players enjoy playing it. Based on this similarity, we argue that game development provides an excellent platform within which to teach UI evaluation.

This main contribution of this experience report is a reflection upon lessons learned from instructing several offerings of two very different courses: a humanities course on game design and an engineering/computer science course on human-computer interaction. Although the concerns of these disciplines are quite different, HCI and game design serve as an interesting "cross-over" point between these fields. We detail the structure of these courses and provide suggestions for educators considering incorporating user testing into their curriculum. The cross-disciplinary nature of the courses makes it easy for our suggestions to be applied to any course in a broad range of disciplines.

II. RELATED WORK

Several educators have proposed using games to teach traditional computer science topics [1-3]. Haden [1] used game programming to teach fundamental topics in computer science, including algorithm design, data structures, recursion, and class architecture. Similarly, Leutenegger and Edgington [2] propose a game-based approach to teaching introductory computer programming. Like Haden, they suggest that this approach not only motivates novice programmers, but also improves student understanding of programming topics.

Overmars [3] suggests that there is a strong link between gaming and affinity for computer programming. An interest in the former can be used to improve learning the latter. Overmars developed the *Game Maker* engine (yoyogames.com), which has been successfully used to teach programming to young girls, promoting their interest in computer science [4].

Based on the success of applying game development in other computer science topics, we argue that HCI education could benefit similarly. While the link between HCI and games has been noted before [5, 6], we propose that a project-based pedagogical approach informed by an HCI research process provides students with a great deal of diverse feedback throughout the course.

Finally, it is worth noting the contrast between different types of evaluation methods used in game design and HCI. Player-focused evaluation methods can be broadly broken down into two foci: playability methods and player experience methods [7]. Playability methods focus on the usability of a game, while player experience methods focus on the interactions between player and game. Of the courses discussed in this report, the HCI course largely focuses on the former, while the game design course focuses on the latter. We chose to include these two very different courses in this paper in order to provide a more holistic reflection on these practices.

III. COURSE OVERVIEWS

This section details the milestone-based structure of the two courses discussed: a computer science HCI course, and a humanities game design course. Both courses are project-based, and involve a research/design project with a user evaluation. Milestones break the project into manageable parts, giving numerous opportunities for instructor feedback.

A. HCI Course Overview

The HCI course is offered by a computer science/software engineering department. The software engineering students can

optionally enrol in a game development stream. Hence three main groups of students take the course: computer science, software engineering, and game development students. Typical enrolment is about 90 students, and research projects are usually completed in teams of 3 to 4 students.

This is the first (and only) course on HCI offered by the department. Consequently the course covers a wide breadth of HCI topics. These include basic usability guidelines such as those proposed by Norman [8], general UI design (e.g., what UI elements to use under certain circumstances), special topics in HCI (e.g., virtual reality, mobile user interfaces), and UI evaluation. The UI evaluation component includes an in-depth overview of experimental methods. This material was largely based upon the course text, MacKenzie's *Human-Computer Interaction: An Empirical Research Perspective* [9].

Student project topics ranged from text entry to UI widget placement to 3D user interfaces. However, about half were either based directly on games, or on game-related topics. For example, some evaluated control options for games – e.g., empirical comparison of touch control to physical gamepads in mobile games. Others focused on game-related topics, such as target selection in 3D games where targeting also rotates the viewpoint (as in first-person shooter games).

Since the research aspect was the primary focus, students were not explicitly required to develop software. Consequently, some groups developed custom software. For example, the aforementioned 3D targeting project was developed in Unity 3D. Others used commercial mobile games for their experiment. One project, for example, compared tilt and touch control using EA's *Need for Speed* on Android.

B. Game Design Course Overview

The game design course is offered as part of a multi-disciplinary programme on digital media and games. In this course, students are invited to engage both with theory and praxis, the process of "practicing" theory [10]. Praxis is achieved by not only reading and writing about games, but through the simultaneous design and development of one.

Student projects fell into one of three sub-categories of serious games: persuasive games, educational games, or newsgames. Persuasive games use their rules and mechanics to convey an argument [11]. Educational games are intended to teach players about a given topic by interacting with the game [12]. Finally, newsgames are effectively the interactive equivalent of political cartoons, applying interactive journalistic commentary on current events [13].

The focus of the course is player experience testing. This parallels the usability evaluation the HCI course. Projects were largely informed by Flanagan's model for designing critical play [14] and Fullerton's playercentric design [15]. Flanagan's critical play model re-frames the existing iterative design process to be relevant to serious game design [14]. The traditional game design model focuses on the design, prototyping, usability testing, and subsequent re-design of a digital artefact [15]. Flanagan's model further includes an evaluation component to support critical game design.

Beyond typical game design issues (e.g., interface, controls, etc.), students designing serious games must also consider how the "serious" elements of their game are expressed. For example, students designing a persuasive game or a newsgame must be mindful of how alternative play styles can yield alternative understandings of their game [13]. Students designing educational games must ensure that gameplay is not overshadowed by the game's educational content [16]. Player experience testing helps students evaluate their games for both playability and effectiveness as serious games. Students in the most recent offering of the game design course used the heuristics to evaluate the playability of games (HEP) proposed by Desurvire et al. [17].

C. Project Milestones

This section describes the breakdown of course projects into milestones. While most milestones are used in both courses, certain exceptions are noted. The similarity of the project structure and content of the two courses illustrates how these pedagogical approaches may be applied within different disciplines.

1) Project Proposal

The first phase of the project is a proposal. In the HCI course, this effectively served as the introductory material of a research paper. This included a literature review of at least 8 academic papers on the students' chosen topic. The main objective of this phase was to allow the instructor to gauge if the students were planning a project that would cover required pedagogical objectives. Since the purpose of the project was to teach UI evaluation and HCI research methods, students had to pick a topic that included an experiment comparing at least two different conditions. This gave the instructor an early opportunity to better guide the students, for example, if they picked a pure design or development-based project (without any evaluation component).

In the game design course the proposal is like an extended abstract. Students identify the style of serious game they would like to build, to propose how the game's genre and design would support its rhetoric or leaning goals. Like the HCI students, the game design students provide a literature review to situate their project in the greater body of literature.

At this stage, many details are not yet decided and the proposal can be somewhat vague. In previous offerings of our courses, it was sufficient if students had an idea of the topic they were interested in, even if they didn't yet specifically know what factors they would evaluate. These details are partly informed by the literature review, and are finalized by the later methodology proposal milestone.

2) Poster Presentation

The poster presentation has been recently incorporated into the game design course to great success. To date, it has not been used in the HCI course. In this milestone, students prepare research poster presentations after receiving instructor feedback on their proposals. The students then participate in a group poster presentation, similar to posters sessions at academic conferences.

The class is divided up into two or three groups. While one group of individuals presents their posters, the remaining students are invited to view the posters, listen to presentations, and ask questions. It is especially helpful to open these sessions up to other faculty, students, and staff. This gives the students a chance to communicate their ideas to a diverse audience. The poster session helps students to reflect on how effectively they communicate their ideas to their peers, and receive feedback on their proposed projects from multiple sources. We have found that adding a poster session has strengthened student projects considerably. It also helps students determine how well they are engaging with the theories discussed in class.

3) Methodology Proposal

The next milestone in both courses is a methodology proposal. Essentially, the objective of this phase is for the students to propose the experiment they will conduct in their research project. This milestone is typically due approximately mid-way through the course. Consequently, by this point, students are familiar with the structure of research papers, and empirical research methodology.

In both courses, students are taught to conform their methodology write-up to standard HCI practice, as discussed in detail by MacKenzie [9]. That is, their write-up should include the following sub-sections:

- **participants**: details of the (planned) number of participants, any salient features that might be relevant, e.g., handedness, visual capabilities, game playing experience, etc.
- **apparatus**: details of the equipment and software used in the experiment.
- **procedure**: details of the task performed by the participants.
- **design**: details of the conditions used in the evaluation - i.e., a summary of what factors are compared with a specific focus on the independent and dependent variables.

In all cases, students are encouraged to provide sufficient detail that their evaluation/experiment could be replicated by another practitioner. To this end, they are encouraged to show their methodology proposal to other students *prior* to submission so their peers can help the gauge the replicability of their proposal. This is also used as grading criteria.

This milestone refines their project proposal from a vague idea in a topic area to a specific UI evaluation. It forces them to think about specific conditions being investigated (design section), the hypotheses of their work, the equipment they will use (apparatus), the task participants will perform (procedure), and who the experimental participants actually are.

Like the project proposal, this methodology proposal gives a further opportunity for the instructor to guide the students. However, because this phase is far more specific and detailed than the proposal, there is a real opportunity to ensure that students understand methodology and will correctly conduct their evaluation/experiment.

Note that human participant experiments conducted in a university setting are typically subject to an ethics review. This includes user interface or game evaluations like those used in our courses. Consequently, course-based ethics protocols were obtained prior to the start of both courses. To stress the importance of dealing with human participants appropriately, both courses also included human research ethics as a lecture topic. A representative from our university's research ethics office was invited to give a presentation to students covering the basics of working with human participants. This included discussion of the informed consent process, upholding participant privacy, the right to withdraw, and so on.

4) Prototype and Evaluation

The prototype and evaluation is a pseudo-milestone, as there is no actual submission. However, instructors can optionally schedule appointments with individual student groups to review their prototype/experimental design for a final round of feedback before they run their evaluation. At this point, students prepare to run their evaluation as detailed in their methodology proposal. This implies that their software prototype or game must be (mostly) ready

Both courses consistently support three options in using games in an evaluation or experiment:

1. Students can develop a game from scratch for their evaluation
2. Students can use a commercial game
3. Students can modify an existing game

Each option presents different opportunities and challenges. Students of game or software development programmes may favour option #1. Game development students, for example, may be more interested in developing a game, and consider the evaluation a secondary objective. Their evaluation helps them determine if their game is playable and reasonably bug-free. Similarly, software engineering students may be interested in this option as a chance to practice their programming skills. The main advantage of developing a custom game is the ability to instrument the prototype to collect data automatically during the evaluation.

Option #2 is likely to be favoured by students without a strong development background. This may be advantageous to students of humanities programmes. However, numerous students in the HCI course chose this option despite having software development backgrounds. This may be because it provides students an opportunity to focus on a different skill set than the programming/development skills they commonly use. The choice to use a commercial game often arises from students debating game UI designs amongst themselves. For example, there has been considerable debate if a mouse and keyboard, analog joystick, or *Wiimote* provides the best performance in shooter games [18]. An evaluation of a commercial game can offer students empirically-based answer to these debates.

The primary advantage of using a commercial game is the time saved in development. The games are often of considerably higher quality than custom-developed games too. The main disadvantage is the comparative difficulty in recording relevant data [19]. This often must be done manually by the student experimenter, e.g., timing user actions with a

stopwatch. Some games, however, provide metrics (e.g., level completion times) which can serve as crude experimental dependent variables.

The third option involves modding existing games. There are numerous pedagogical benefits of modding games [20]. A major benefit is that modding allows students to side-step technical barriers to focus on more meaningful design activities. Notably, modding also allows the automation of data collection. However, for game design students, it is important that the modding go beyond the addition of data collection functions to include changes to the graphical and mechanical aspects of the game as well.

5) Final Paper

While the outcome of the project in both courses is a final paper, students are typically also asked to submit their prototype (if applicable) and evaluation data. The final paper is a report structured similar to a research paper on their topic. In general, students are encouraged to re-use materials previously written for the earlier milestones, subject to any changes (e.g., to the methodology) based on instructor feedback.

A key challenge is that students can often lose sight of the fact that the paper is the main outcome. Unsurprisingly, students in computer science, software engineering, and game design are often more enthusiastic about the development aspect than writing. After all, this is their core skill set developed in their respective curriculums. Since a major objective of our courses is to teach them evaluation methods, they often need reminding that the development is actually secondary to the evaluation itself. The final report is the detailed description of the evaluation with summaries of the results. Obviously the instructor cannot be present for each individual participant's evaluation. Hence these reports are taken as the "proof" that the evaluations were conducted.

IV. Discussion and Conclusions

Although the topics covered by the game design and HCI courses vary, both teach the same core principles of user interface evaluation. This is reflected in the structure of the course projects, which outline the similarity in the expectations put on the students by the instructors of these courses. Effectively, while the overall objectives are different, the same practical methods can be applied to determine if a UI or game is usable. Moreover, the fact that many HCI students actually use games as their experimental platforms further reinforces the compatibility of these topics.

We strongly argue for the milestone-based approach described above. This provides instructors numerous opportunities to give students feedback and ensure that they are meeting the learning objectives. As discussed, user research is not at the core of either program these courses are housed in, yet structuring projects in this fashion helped students engage in these research practices. This is why extensive feedback is so important; students simply have no exposure to human research prior to taking these courses.

Finally, we recommend HCI educators consider the practicality of allowing students to use games as experiment platforms, despite the challenges they pose to controlling experiments [19]. As reported in the literature [1-3], we have found this improves student engagement with the topic. The ultimate goal is to teach students about research methods; we argue that the actual platform that accomplishes this goal is irrelevant.

The milestones reflected upon in this paper were applied in two very different courses, highlighting how they may be used in different educational contexts. We argue that these milestones provided students with an opportunity to obtain feedback that was able to be easily incorporated into the project, and that this provided students with a highly reflective educational experience.

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