

User Interface Design: Applying Heuristics for Improved Usability

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Abstract

It is critical that human computer interaction and product designers consider their audiences when designing and building user interfaces (UIs). To facilitate effective design of user interfaces (UIs), a course module and report assignment were developed to help students learn about effective UI design. The main goal of this paper is to describe a major graded assignment in this module—the UI Design Report—in depth and discuss its success. The assignment takes place in a three-week UI course module in a required junior level, communication and engineering design course in the Department of Human Centered Design & Engineering in the College of Engineering at the University of Washington. Outcomes were qualitatively assessed by examining samples of students' reports versus requirements and students' reflections on the module and report assignment. Outcomes have been positive and reveal that students gain an understanding of effective UI design and the important role of UI designers, and the impact of UI design on society. Educators from a multitude of disciplines that intersect with human computer interaction can use this assignment in helping design products and services with which users interact.

Keywords

User interface, User experience, Interaction Design, Human Computer Interaction

Introduction

We are surrounded and interact with an increasing number of screens, services, and products, all competing for our time, attention, and money. Poorly designed user interfaces (UIs) that inhibit our ability to function efficiently and effectively in our everyday lives detract from the user experience (UX) and are also costly to companies. Too often, companies focus on the technology or product, instead of on the people who use the technology or product and an effective interface design for these users.

Effective UI design brings together concepts from information architecture, and interaction and visual design to anticipate what a user might need and to ensure that “the interface is “easy to access, understand, and use” [1]. UI designers must consider their user's needs, capabilities, and limitations. Designers can assess their designs through the application of usability heuristics and strategies for effective UI design, e.g., [2] - [5]. Jakob Nielsen's 10 usability heuristics [3] are a useful inspection method for evaluating interface designs and can aid in identifying usability, utility, and desirability with individual user interface elements, interactions, and their impact on the overall user experience.

The goal of this paper is to describe a UI module and specifically the report assignment that help educate students about effective UI design and its assessment. The module and graded report assignment described in this paper provide students with an opportunity to apply usability heuristics to evaluate the effectiveness of everyday UIs and create a high-fidelity mockup of a redesigned UI. An overriding goal of this UI module is to deepen students' understanding of UI design principles as well as heuristics for evaluating effective UIs and in the process gain an understanding of the impact that UI design has in people's lives. Students take an active role in

their own learning in this project-based assignment [6]. The assignment helps students take theory into practice and prepare them for the world of work. Educators in any discipline involved in designing products in which users interact with the product's interface would find this report assignment useful.

The research report assignment described in this paper meets the requirements of ABET criterion 3 (outcomes 1-7) for accreditation of baccalaureate programs, which briefly summarized concerns (1) identifying and solving problems, (2) applying engineering design to produce solutions meeting specific needs, (3) communicating effectively, (4) recognizing ethical and professional responsibilities and considering the impact of engineering solutions, (5) functioning on a team in an inclusive environment, (6) analyzing and interpreting data, and (7) acquiring and applying new knowledge [7].

The UI module and report described here are part of a required 5-credit junior level communication, design, and engineering core course offered in the Department of Human Centered Design & Engineering in the College of Engineering at the University of Washington. The course uses participatory learning and project-based learning approaches in all assignments. The course counts towards the university's required writing credits. The course leans on a number of the United Nations' 17 Sustainable Development Goals as a conceptual framework as they pertain to human-centered design and engineering, sustainability, ethics, communication, and diversity, equity, and inclusion. The UI design module is one of three course modules (UI design, sustainable and ethical design, and cross-cultural UI design) that are taught with a goal of creating "changemaking engineers" [8].

This paper describes UI course module activities that help students succeed in the report, the components of the UI Design Report, and a grading assessment. This paper also describes the assessment of students' reports as well as student feedback in a reflection assignment. The paper ends with a discussion and conclusions.

The UI Design and Assessment Module and UI Design Report

The UI module consists of multiple parts that occur over three weeks with three low-stakes activities (briefly described next) and a major graded assignment—a UI Design Report. With scaffolding of low stakes activities, students are prepared for a successful experience with the major graded assignment.

1. The first low-stakes activity concerns a UI Journaling Activity in which students identify common UIs that they interact with over a 24-hour period and apply some of Jakob Nielsen's heuristics [3] to the UIs they encounter (e.g., an elevator panel, an ATM, a phone app). They take notes about their encounters and if desired, sketch out their interactions with the UIs and the success or difficulties encountered in the interactions. In group discussions in class, students share the highs and the lows of their experiences. In this collaborative learning experience [9], students actively engage in the learning process.
2. In the second low-stakes activity, students summarize 12 brief articles concerning usability heuristics, Gestalt principles, design patterns, color theory, wireframes and design, information architecture, interaction design, and two articles of their own choice. Their summaries range from 3-5 pages and vary in formatting from bullets, to roman

numeral outlines, to phrases, to sentences, to whatever approach students find most helpful in summarizing and retaining information from the readings. Students share their findings in class.

3. Students also participate in interactive lectures, listening and answering questions offered by the instructor and participating in group discussions of 3-4 students/group and reporting out on group findings. These discussions occur regarding class readings, lecture topics, and the assignments listed above and below.
4. A UI Design Report in which students assess an existing UI, identify any issues it might have, suggest solutions, and create a hi-fidelity mockup redesign of at least a portion of the UI.

In the **UI Design Report**, a major graded assignment, students evaluate the effectiveness of a UI in meeting its users' needs by applying usability heuristics and strategies to the interface. Students are tasked with understanding and acting on design values, interaction design principles, including patterns and best practices, as they relate to product interfaces. For the assignment, students write a report concerning the effectiveness of the UI in meeting its users' needs for the hypothetical UX Director whose team designed the UI. They describe the assessment criteria derived from the literature, the methods they used in applying the criteria and evaluating the UI, results, conclusions, and recommendations. Students are given a suggested format of Introduction, Background, Methods, Results and Discussion, Conclusions and Recommendations, and References.

In the recommendation section of their report, students include their recommendations and an annotated high-fidelity mockup of a redesign. They use Figma (a prototype and interface design tool that can be used collaboratively) to create their high-fidelity mockups. Students also peer review other students' draft reports in teams of 3-4 students. During this process, they master a report format, using effective content selection, organization, document design, and style, grammar, and punctuation.

The objectives of this assignment are four-fold. Upon completion of this module and report, students should be able to:

1. Increase their understanding of effective UI design practices and the impactful role of UI designers.
2. Gain an understanding of how to apply heuristics to evaluate a UI and communicate findings and recommendations in a report format.
3. Improve their critical thinking skills.
4. Work effectively in teams and understand the role of effective UI design in the world-of-work.

This assignment involves active, collaborative, problem- and project-based learning [9]. The report assignment counts for 20 percent of the final grade and is holistically graded with guidance from a 26-item grading checklist divided into four categories: content, organization, design, and style/grammar/punctuation (see Appendix A for this checklist). This checklist guides students while writing their reports, students during peer reviews, and instructors during grading. For grading, the checklist is used with about 25% of the grading weight given to each of the four categories. Students, teaching assistants, and instructors have appreciated the detailed guidance

provided by the checklist—assignments that meet all items receive a 100% grade. Across and within the categories, individual instructors may weight what they deem most important given what they have emphasized in class. For instructors who prefer a rubric version, Appendix B provides the checklist in tabular form with the right-hand column providing a three-point scale for evaluating the 26 items.

Assessment and Results

To evaluate the success of the UI Design Report and Redesign, outcomes were qualitatively assessed by analyzing (1) a sample of students' reports versus assignment requirements and (2) whether student feedback in their written reflections about the module and report assignment revealed an impact on learning and a relationship to the learning objectives.

Analysis of Students' Reports

An assessment of students' UI Design Report versus the assignment requirements revealed that students identified a wide variety of product types for the UI they analyzed and redesigned, e.g.,

- Laserjet printer
- Microwave panel
- Amazon Chime
- Websites: Craigslist, Michelin Group, Chess.com, RedShelf textbook, Canvas LMS, Zoom
- Apps: e.g., Steam (cloud-based gaming), Procreate, IOS alarm, IOS timer, IOS camera, Yelp, Slack, LinkedIn, Costco

The students also selected a broad range of well-known usability features for UIs (e.g., [3] - [5]) to use in in their UI evaluations, e.g.,

- Task flow clarity
- Error prevention
- System status visibility of system
- Efficiency of use
- Consistency
- Flexibility
- Intuitiveness
- Simplicity
- Functionality
- Learnability
- User autonomy
- Friendliness

An examination of a some student reports demonstrates that students understood the assignment and performed well, describing the UI they analyzed and its users, applying UI usability heuristics they had identified in the literature to the interfaces they analyzed, detailing problematic and also promising features of the UI in a results and discussion section, and presenting overall conclusions and recommendations that solved identified problems and an annotated redesign in a high-fidelity mockup that demonstrated their suggested solution for at least one part of the UI.

Figure 1 next shows high-fidelity mockups of three redesigned camera screens. The student's explanation of the redesigns point out the advantages of the three redesigned screens. The redesigns are well annotated and the student points out that the new default mode improves speed and efficiency, the pro settings mode makes more camera options and features accessible for

advanced users, and the icon mode facilitates new users without cluttering the screen with non-pertinent information.

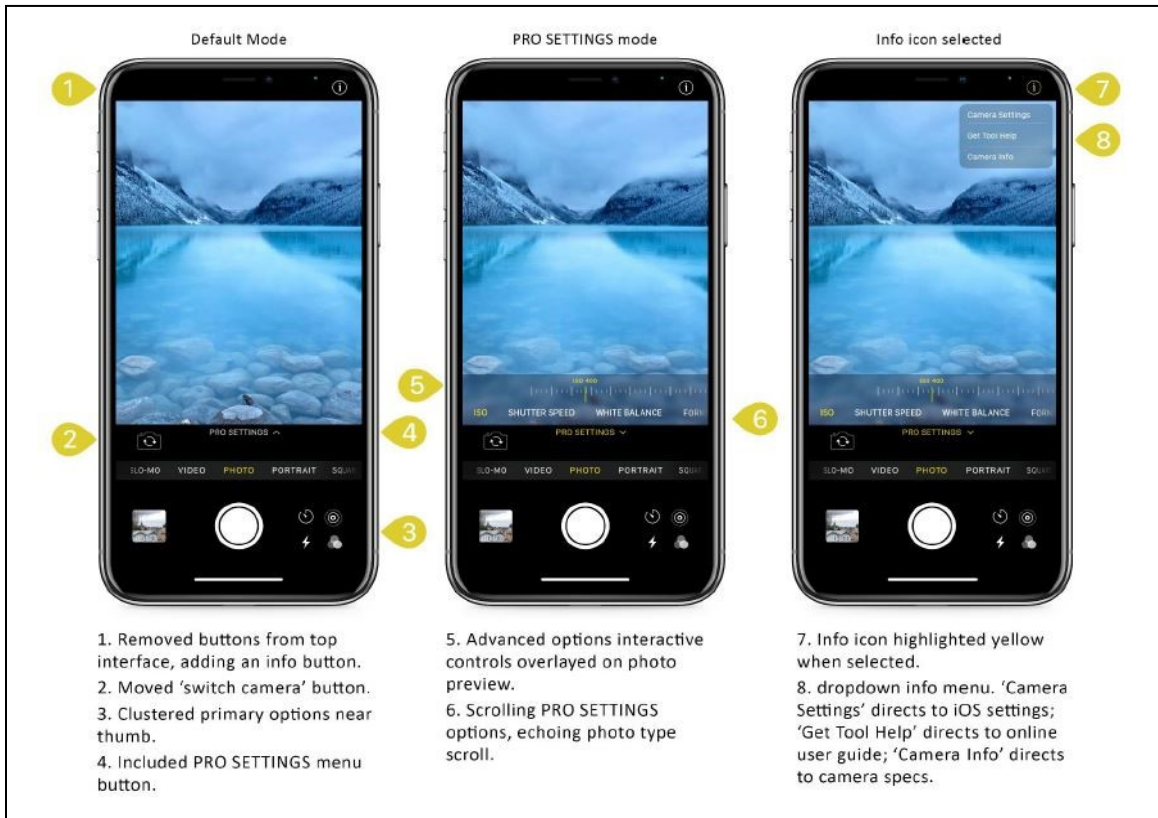


Figure 1. High-fidelity mockups of 3 new screen UIs

Another student sample shows similar excellent work with an analysis of the Costco mobile app. Figures 2a-2b show the existing homepage and the redesigned mockup with annotations.

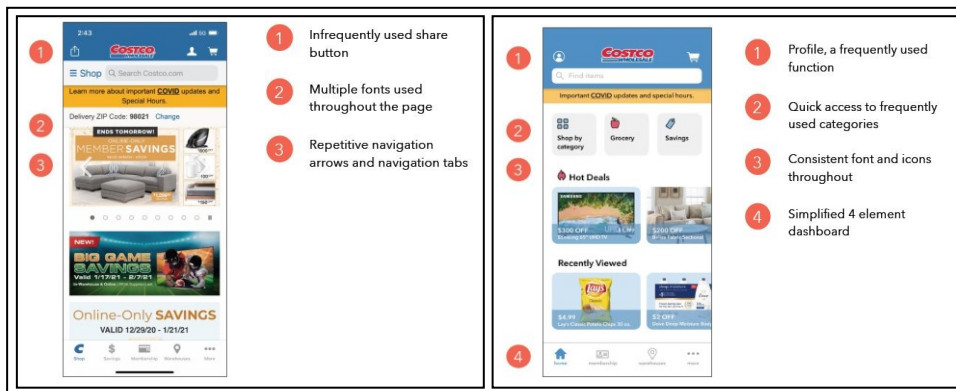


Figure 2a (left). Existing Costco homepage shopping screen
 Figure 2b (right). High-fidelity mockup of redesigned homepage

Analysis of Students' Reflections

The qualitative assessment of students' reflections concerned whether student feedback in written reflections revealed an impact on learning and reflected assignment objectives. Students were asked about key take-aways from the unit. Reflections from 32 students in a recent offering of the course were examined; 18 reflections are shared in Table 1.

All reflections were positive. Based on the learning objectives stated earlier, the reflections are analyzed according to categories related to the learning objectives: (1) understanding the role of effective UI design and UI designers, (2) gaining an understanding of applying heuristics and communicating findings, (3) improving critical thinking, and (4) helping students function in teams and in the world-of-work. Students revealed an understanding of the important and powerful role that designers and effective UI design have in terms of the products they create. As shown in Table 1, category 1, students reveal their thinking on the importance of designer's responsibilities and effective UI design. Table 1, category two, shares two students' reflections on how the assignment improved their research skills. The third category shares four students' reflections on improved critical thinking, with students noting that the assignment stretched their critical thinking skills, making them feel like less of an imposter when it came to design, and another noting that trending designs are not necessarily good designs and calling out the need for accessible design. The fourth category reveals that many students saw a practical value in the unit in terms of their future jobs and internships and could relate their efforts to teamwork (e.g., peer reviews and lab work).

Table 1. Students' Reflection on the UI Module and Report Assignment

1. Acknowledging the responsibilities of designers

- Gaining practice with design critiques based on cognition and user research helped me gain respect for the field of design and the tech sector. Empathy for users is important.
- The UI unit introduced a lot of essential problems in Human Computer Interaction and let us think about our responsibilities in solving them.
- Opened my mind to different innovations that are possible and how **to create good UI designs**.
- Designers and developers have a responsibility to create things with human values at the forefront.
- This unit brought to my attention the power the designers hold and that they need to be aware of how their designs affect people's lives.
- Designers cannot afford to be naive about the repercussions of their products. A UI must account for the emotions, experiences, and social meanings attached to the UX elements.

2. Gaining an understanding of heuristics and how to communicate findings

- One take-away was learning about the usability heuristics. I am interested in user research as a career. These heuristics will be helpful for my future internship in which I might do more user research.
- The user interface report was a great way to examine some real-world objects that could be improved on and then take that step. This unit helped me learn concrete ways to do that.

Table 1 Cont. Students' Reflection on the UI Module and Report Assignment

3. Improving critical thinking

- This assignment stretched my critical thinking, creativity, and technical skills. I now feel like less of an imposter when creating user interface designs.
- It makes you realize that just because something is trending, it doesn't mean it will be the best solution for every problem that arises in society.
- A UI should be accessible at every stage and incorporate visual, hearing, mobility, and cognitive features.
- This assignment helped me develop my analytical thinking skills and helped me determine what makes a good user interface.

4. Helping students function in teams and in the world-of-work

- Content catered toward helping us succeed in industry.
- I was inspired by the User Interface Report assignment and the peer reviews of each other drafts. Since this assignment was built around creating a portfolio piece, I was extra motivated to put in more effort, especially for the Hi-Fi mockup.
- I actually had to apply these same skills for an internship that I applied to. The company had me develop a mockup of a new and improved version of their website.
- One take-away was learning about the usability heuristics. I am interested in user research as a career. These heuristics will be helpful to keep in mind for my future internship.
- It's cool to get the opportunity to apply industry tools in a university class assignment. I liked that we used Figma for our user interface design mockups. My cousin uses Figma at his workplace and this assignment makes me feel like I can hold my own with him!
- I am currently part of a research lab/competition and one of the things that I brought up during a meeting was how we could evaluate our prototypes using the UI principles before shipping them out for usability tests. The group had never heard of it before except for one person. I am glad I brought it up because I ended up teaching them all a lot that day.

Discussion

The UI Design Report and UI module tasked students with understanding and acting on design values, and UI and interaction design principles, patterns, and best practices, as they relate to product interfaces. In the process, students needed to attend to user-centered flow, transparency, biases in design, and designing for different needs. As the student samples and reflections revealed, the UI Design Report helped students stretch their critical thinking skills by applying Jakob Nielsen's usability heuristics [3] to a selected apps, products, or interfaces of their choice. They learned how to apply heuristics to evaluate UI designs as they pertain to usability, utility, and desirability, etc. with individual user interface elements and interactions, concerning how they impact the overall user experience. Students also learned a new vocabulary as it relates to common heuristics in the field as well as best practices in UI design. Further, students gained experience with industry-facing tools such as Figma where they built their high-fidelity UI redesigns and worked collaboratively to help critique the UI designs of peers, simultaneously

demonstrating growth in technical and soft skills. These experiences helped students build not only their expertise and skillset, but their confidence as well.

In this module and report assignment, students gained an understanding of impact that UI design has in people's lives as well as the important role of designers. Additionally, students learned that an understanding and appreciation of ergonomics, cognitive behavior, empathy, as well as attention to a good user experience are the drivers of a successful product that build customer engagement, trust, and loyalty.

Conclusions

This UI Design Report assignment and course module described in this paper prepare students for jobs in User-Experience Design, Interaction Design, Product Design, Human Factors Engineering, and other related fields. This paper described the elements of the report and module with a specific focus on a report in which students evaluated the efficacy of UI design(s) by applying commonly reference usability heuristics and redesigning the UI(s) for optimal usability. Performing well in the report assignment, students found it and the module useful in expanding their critical thinking skills, building their roles as researchers and designers, preparing them for internships and jobs, and creating portfolio artifacts. In completing this report, students gained lifelong skills in understanding design and its impact on the user, society, and the economy.

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Appendix A. Grading Checklist

Please check your final report against the following criteria and bring a blank copy to class peer review day.

Report Content

- ___ Evaluates the interface using at least three criteria that are defined and explained based on existing literature.
- ___ Delivers the results to the UX director concerning the effectiveness of the user interface in meeting its users’ needs.
- ___ Describes the goal and the audience of the interface, the criteria for evaluating it, the findings, and the conclusions and recommendations for improved design.
- ___ Meets criteria in Assignment Prompt Submission Criteria section.

Report Organization

- ___ Follows a logical organization.
- ___ Uses headings and sub-headings to reveal the report organization.
- ___ Uses an overview in present tense at the end of the introduction to announce the main headings.
- ___ Uses and overview in subsections to avoid stacked headings.
- ___ Uses topic sentences.
- ___ Uses transitions sentences.

Document Design

- ___ Uses effective report format, including page numbers.
- ___ Meets document design guidelines specified in Assignment Prompt Submission Criteria.

- _____ Makes effective use of space, color (if applicable), and fonts.
- _____ Employs descriptive headings and makes them visually distinct from body text, keeping new headings closer to the text they introduce.
- _____ Avoids underlined headings.
- _____ Uses clearly labeled and logically placed figures or tables.

Figures and tables:

- _____ Are described **and** referred to **before** they are inserted in the document.
- _____ Use concrete figure titles below figures and table titles above tables with citations.
- _____ Are placed as close as possible to the text that refers to them.

Style, Grammar, & Punctuation

- _____ Uses clear and concise sentences.
- _____ Uses words precisely that relate to the report's purpose, and match audience's background.
- _____ Uses appropriate tone for the UX director.
- _____ Uses correct grammar.
- _____ Uses accurate punctuation.
- _____ Uses accurate spelling.
- _____ Uses APA or IEEE formatting for in-text citations and reference list.

Appendix B. Grading Rubric

Please check your final report against the following rubric and bring a blank copy to class on peer review day.

Document Features	Assessment Criteria	Meets Criteria
Content	Evaluates the interface using at least three criteria that you defined and explained based on existing literature.	Exemplary / Proficient / Emerging
	Delivers results to the UX director about the effectiveness of the UI in meeting its users' needs.	Exemplary / Proficient / Emerging
	Describes the (1) goal and the audience of the interface, (2) the criteria for evaluating it, (3) the findings, and (4) the conclusions and recommendations for improved design.	Exemplary / Proficient / Emerging
	Meets criteria described in Assignment Prompt Submission Criteria.	Exemplary / Proficient / Emerging
Organization	Follows a logical organization.	Exemplary / Proficient / Emerging
	Uses headings and sub-headings to reveal report organization.	Exemplary / Proficient / Emerging
	Uses an overview in present tense at the end of the introduction, announcing the main headings.	Exemplary / Proficient / Emerging
	Use overviews in subsection introductions and avoids stacked headings.	Exemplary / Proficient / Emerging
	Uses topic and transitions sentences.	Exemplary / Proficient / Emerging
Design	Uses effective report format, including page numbers.	Exemplary / Proficient / Emerging
	Meets document design guidelines specified in Assignment Prompt Submission Criteria.	Exemplary / Proficient / Emerging
	Makes effective use of space, color (if applicable), and fonts.	Exemplary / Proficient / Emerging
	Employs descriptive headings, keeping headings closer to upcoming text and further from preceding text.	Exemplary / Proficient / Emerging
	Avoids underlined headings.	Exemplary / Proficient / Emerging
Design cont. Figures and Tables	Uses clearly labeled and logically placed figures or tables.	Exemplary / Proficient / Emerging
	Use concrete figure titles below figures and table titles above tables with citations.	Exemplary / Proficient / Emerging
	Figures and tables are described and referred to before they are inserted in the document.	Exemplary / Proficient / Emerging
	Figures and tables are placed as close as possible to the text that refers to them.	Exemplary / Proficient / Emerging

Document Features	Assessment Criteria	Meets Criteria
Style, Grammar, Punctuation	Uses clear and concise sentences.	Exemplary / Proficient / Emerging
	Uses precise words and phrasing that relate to the report's purpose and match the audience's background.	Exemplary / Proficient / Emerging
	Uses appropriate tone for the UX director.	Exemplary / Proficient / Emerging
	Uses correct grammar.	Exemplary / Proficient / Emerging
	Uses accurate spelling.	Exemplary / Proficient / Emerging
Style, Grammar, Punctuation	Uses accurate punctuation.	Exemplary / Proficient / Emerging
	Uses APA or IEEE formatting for in-text citations and reference list.	Exemplary / Proficient / Emerging