Semester Projects on Human–Computer Interaction as Service and Outreach

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Abstract Student projects at all levels can have impact. I present an approach for using class projects in Junior level and above human-computer interaction (HCI) classes to have a social and economic impact. This approach can make your teaching improve by being more motivating to students, to be more interesting to you, and to have more impact. I provide an example project description used at Penn State's College of IST since 2000, and example projects that have suggested useful interface changes to the websites of a variety of government, non-profit, university, and small and medium-sized businesses. These reports fulfill a pedagogical goal by having students demonstrate mastery of the material, particularly evidence- and theory-based suggested changes to improve the usability of websites. The reports provide (in the best cases) strong, correct suggestions for improving the usability of these websites. The use of these reports also helps reduce plagiarism because the sites and thus work are unique.

Introduction

In my experience, students in the last 2 years of their undergraduate degree programs in most American, British, and German universities have enough knowledge and skills to contribute to research and engineering. They cannot do this on their own typically (although there are, of course, exceptions), but they can participate in guided class projects have impact on outreach and application.

This approach of student work on projects is used at other places as part of service clubs, and for example, at Purdue as a special projects course (EPICS), but here it is applied in a standing course. Students in my Human-Computer Interaction (HCI) course at Penn State (IST 331 and a related graduate course, IST 521) provide contributions to local industry, the local university, non-profits, and other organizations through a focused, real-world group project over a semester

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Table 1 Example websites and systems analyzed

Free Software Foundation	Community Help Center
Centre County United Way	Source Forge
DBLP (computer science publication database)	Citeseer
Clinton Township, Wayne County, PA	PSU webmail
PSU undergraduate degree programs Bulletin	U. of Iowa Computer Science Department
Wanamaker's Entertainment Group	Campus Concierge
Security Risk Management Association	PSU ITS Lab Consulting
Oktavamod.com (microphone sales)	Your Conversation ConnectionPenn State
Habitat for Humanity	Deihls' Flowers Inc.
Centre Volunteers in Medicine	Penn State Office for Disability Services
Shakespeare's works as an App for the iPhone	
eLion, PSU registrar's website for students dropping classes	

examining a website or other system interface. Chapters by Cameron and by Bagby in this volume present similar approaches. Successful reports provide a set of suggestions based on applying the material in the course about how to make systems more usable to the system being studied (Cameron, accepted number 2977; Bagby, accepted number 2965).

Where I say website, you can read this as meaning any system with an interface. Students projects have examined and in some cases created mobile websites for mobile devices, skins for applications, and room numbering in buildings. Table 1 provides a set of example interfaces examined.

What is novel, I believe, is the set of constraints of this approach to add a project to the course, and the scaffolding provided. The rest of this chapter attempts to describe the approach in enough detail that you can create similar projects in similar courses.

The Class Project

The project is for each group of four students to provide a 10–20 page report providing 3–5 concrete, supported suggestions for changes to an interface. This approach does not have students simply act as HCI consultants for a fictitious interface, but to serve directly as consultants on a real interface. The suggestions may first arise from the student group's opinions of the website, but the groups are strongly told not to just complain that they do not like the website. They are required to support their suggested changes. Support for changes can come from theories, analyses, or empirical studies. They are encouraged to use the methods taught in the course, but in some cases, groups have had to find and use additional methods or to develop modified methods. The reports are supposed to have an abstract, an introduction with a picture of the system, several analyses that lead to suggested changes, a summary, and appropriate references to the theories and methods used.

The theories that are taught include the basic psychology of how users will interact with websites (Ritter et al. 2014, in press): the ABCS of anthropometrics, behavioral aspects of the senses, cognition, and social factors. Suggestions in this area can be based on knowing how people read and how they see colors, how they represent the world (mental models), the limitations of memory and problem solving, and other aspects of cognition and social behavior. Most reports also use a task analysis that can include time predictions. A task analysis of an interface can usually provide suggestions for changes, including making interaction more regular, or supporting important tasks more directly.

Empirical analyses involves recruiting users to test the interface. These are small studies that typically involved 5–10 users. Creating these studies requires discussions between the group and the teaching team about how many users to study, representativeness between the users they can recruit and the actual users of the systems, and what tasks should be done in the study. Bagby (The Cyber Forensic War Room: An Immersion into IT Aspects of Public Policy) notes similar problems and some types of advice for creating war rooms as student projects.

Sometimes the point of the analysis is to explore and document how usable the interface is (including if it can be learned at all). And sometimes the analyses are used to explore or to show that a particular task is not as easy as might be expected. Discussions about the users to recruit can be very informative when done across projects. The class can see that sometimes the target users are very similar to the users that can be recruited, and sometimes the users and those that can be recruited are quite different. How to find more appropriate users to study is a useful discussion point.

Thus, the report's suggestions are supported by published papers, analyses performed on the website, or empirical studies of the website. This should not only make the resulting suggestions more believable but also more accurate.

The project does not require going beyond providing suggestions—revising or redesigning the website is often not possible directly, and doing so for an external site within a semester time-period is difficult. Revision is difficult not only because of the direct system changes, but more often because of social and administrative processes). Some groups have gotten the changes implemented, but it seems inappropriate to require students to organize changes from an organization neither of us control. What is required, though, is being able to submit the report to someone who could make these changes, such as a webmaster, vice-president, or lab manager.

The groups are given feedback at several stages of the process. We are lavish with our feedback, treating the reports as early drafts that we would like to co-author, in that the reports have got to start to have author, dates, and page numbers, the writing has to be organized by headings, and it must look like a paper that can go outside the class. Aspects of word processing that are helpful with this are taught. These aspects include how to outline a report, spell, and use paragraph styles.

Groups propose a system with a paragraph in the first two or three weeks. They write up an outline and a one page version before the final version, and give

an oral presentation 2 weeks before the final report is due. The oral presentation allows feedback from the teaching team and joint lessons to be learned across groups. Sometimes it allows groups to collaborate or cross-cite. Many groups can use their system as the topic in a lab applying a particular method, and they get feedback on these lab write-ups that they can use to improve that aspect of their final report. (One early group figured this out before the first lab, and made every lab a part of their final report, using feedback from each lab grade to improve the final report.) After they turn in their final report we provide suggestions on what they should do before sharing the report with the organization, and whether we encourage them. For some reports we also ask permission to add them to the website as useful examples, and students can point back to these reports as an accomplishment.

To illustrate what the reports are like I cover two of them in more detail. Additional reports are available online at http://acs.ist.psu.edu/ist331/example-projects. Most are password protected because I have permission to share them with the class but not further, but some I have permission to share more widely (a form granting or denying permission is now included as part of the final project submission). A example plain text form is included as an appendix. As a group they show the diversity of projects.

Example 1

As an example, a group looked at the website for Jozart Studios, a community arts center in California, PA. This website was chosen because the center was run by the father of one of the group members. A website related to a group member's family's business is a typical type of website to be analyzed. Other groups have done dentist and doctors' offices, online mail order companies, and retail stores with an online presence.

Their report made concrete suggestions for improving the website. Some suggestions were based on task and content analysis, including considering what information users were looking for and running a survey of users, and then suggesting making this information easier to find by both location and size.

The report also did a Keystroke Level Model (KLM) analysis (Card et al. 1983) to suggest changes to make the website easier to interact with, including revising its structure. The suggestions are typically to reduce keystrokes and mouse moves during navigation, and to make the interaction more regular across pages or sections. The report also tested the predictions of the KLM model with data to provide further support for the model and the suggested changes. The report also looked at what font users preferred, and examined empirically how font influenced reading speed. This report was well received by the web master, and we believe it led to changes in the website.

Example 2

The second example has been used before in a College of IST press release because it is an example of a project worked particularly well. DiscipleMakers is a Penn State on-campus student organization. One of the group members was an officer in DiscipleMakers and helped maintain their websites. She believed that their websites for the public and for their staff could be improved. A student organization's website is a typical type of system to examine. Groups have done analyses of social housing, student government, and other student clubs. Based on her recommendation, the group examined this website.

They did several analyses. The first analysis was to get traffic logs from the website they were analyzing using a commercial logger that they could install for free. These traffic logs told the group how and how often the website and its pages were used (and what was not used). This analysis told them what were the most commonly used pages and activities. They also did a task analysis for the most commonly used pages using the KLM and GOMS approaches (Card et al. 1983). These analyses (validated with a small study of users doing these tasks for comparison) suggested some changes to the pages and both website's structures to make the common tasks easier to perform by making the targets easier to find by making the font larger and the targets placed differently on the pages. Other groups have used a KLM/GOMS analyses as a way to suggest consistency across pages.

Their final analysis was not one typically taught in the course, but arose in discussions about how to improve the website. They examined some similar websites to find out what content was being served and also examined a small set of user perceptions of the websites and the similar websites they had found. This analysis examined the esthetics of the sites, and led to some suggestions about fonts, picture quality, and picture significance and explanation on the website.

Conclusions

This approach of applying HCI evaluation techniques to a real world, live, site seems to provide motivation and a useful learning environment. Students have generally found it motivating and the class is more fun to teach, and there are plenty of examples from the group projects to ground the topics discussed in class.

Basing these reports on real world systems also helps reduce plagiarism because the sites and thus work are unique. I have had two groups examine the same site, but even then collaboration remains academically safe—most sites are large enough and the study results different enough that collaboration is both worthwhile and yields distinct reports.

Most projects end up good enough to encourage the students to share with the organizations, about 60%. About half of the other projects (20%) are good projects

Table 2 Some of the features that may help this process work	Group-based
	Lots of low hanging fruit to improve interfaces
	Contact information for the system analyzed
	Teaching assistants helped coach the groups
	Reuse and revision of class exercises into the final report
	Motivated by their parents, colleagues, family, work associates to do a good job

pedagogically, but the results are either not clear, or not well presented enough to act upon.

Discussions about all of the projects in class can lead to additional learning across groups. An exercise that I particularly recommend is asking each group to describe one good thing to do and one bad thing that they have learned from their project so far. This is usefully done about 1/2 and 7/8's of the way through the semester. If the students listen to their peers describe these lessons they can learn not just from one project but from a room full of projects' lessons learned.

Graduate students in a related graduate class do similar projects using this same approach. These reports are useful to organizations, and have also lead to publications (Stark and Kokini 2010; Yeh et al. 2010). The contributions of this approach have been recognized by the college in two press releases (cached at http://acs.ist.psu.edu/ist331/News-Full-Story1782.pdf and http://acs.ist.psu.edu/ist331/IST-331projects-make-real-world-impact-on-community.pdf).

Why I Think It Works

Table 2 summarizes my anecdotal beliefs about why this approach has worked. Some of these features are probably not necessary and most alone are not sufficient. It is probably the case that you would not need all of them to have this work in your course.

The first item is that the projects are group-based. This provides more 'horse-power' to get the projects completed. Two people groups appear to get less done than four person groups. Also, four person groups provide some buffer if a student is having difficulty in the class. While the project work and groups require more support from the teacher than traditional lecture only courses, the groups can also help reduce teacher workload because they can provide some help to students in their group with a problem, including help with other class-related problems, such as what was assigned, what was covered in lecture, or what will be on the test. Also, larger groups seem to have more trouble meeting and end up with more free riding. Joint authorship but with named sections help reduce loafing.

The second item is that there is still a lot of low-hanging fruit in website and interface design. Students and faculty have no difficulty identifying systems that violate good design. The project can then document how, why, and how much they do so. There may be a relatively large disparity in this area between the ability to

implement and design and basic knowledge about the material. In designing civil engineering structures, for example, the designer has to know about bridges, and students will have to know nearly as much to critique a design. In interfaces, it seems that anyone can create a site, but many creators lack basic knowledge about users and their tasks.

The third item that helps it work is requiring contact information for the project. Some early projects looked at car manufacture's websites (e.g., Chevy and Ford). These are large, complex sites that are justifiably hard to develop and a lot of work goes into them. There is less low-hanging fruit, and the reports would almost certainly be ignored if they are turned in without an initial contact. So, requiring a contact helps reduced the size of the site examined because the developers of the larger sites are not as available. Having a contact also means that the teacher has some help in focusing the students because the designers/contacts often have some idea of what could be improved and can help coach the students. Having a contact provides an additional and slightly unusual upside in that someone can thank them and implement the changes, which is more satisfying than just suggesting changes. Non-profits appreciate this more; universities sites do thank the students but seem to act on the supported changes less often. (These may have hidden users and uses, institutional inertia, or special security challenges.)

The fourth item is the teaching assistant (TA) or assistants. There is a lot of coaching required to make these projects work. In addition to providing more resources and time periods, teaching assistants also provide a different level, perhaps a more approachable level, of support. That is, students sometimes have concerns that they would rather discuss with a TA. And, a good TA, which I have generally had, knows when to escalate concerns and when not to. That is not to say that you have to have a TA to do this type of work, but I attribute some success to the TAs that I have had.

The fifth item that has lead to success is the reuse of class exercises in the final report. The class typically includes about four class exercises to apply an evaluation method to an interface that the group selects, not necessarily the final project interface (to allow for groups to test other interfaces or to allow work to proceed before the class project interface is selected, or to allow interfaces to be examined when the class project interface does not readily support that exercise).

These methods have included analyses of search logs, examining a learning curve in an interface, doing a task analysis, and looking at reading speed in an interface. The students do not have to use their class exercise's interface on these projects, but many groups learn that these smaller exercises are useful precursors to the final report. Not requiring use of the class project allows groups some flexibly to choose their project and to change interfaces if required due to unforeseen circumstances, and if the interface does not adapt well to the class project. The groups then reuse the previous smaller projects. Better groups also revise and sometimes extend the class project, either running a few more subjects or doing more or better analyses. In all cases they seem to improve the presentation of the work.

This reuse provides the additional teaching benefit of providing students a chance to revise their writing and work, each time for a grade. I fear that too often

in current undergraduate education students do not see the writing revision process that is taught in graduate school and used in business, government, and academia.

The sixth and final item, the context of the interface provides additional motivation to do well at least for one of the students on the group, but often several. If a site is chosen based on a student's family business, then at least one student is very motivated, and the others can see the impact. If the students jointly agree on a university or local site, they are all motivated in additional ways to contribute to improving that site. Having a social tie to the interface provides additional motivation beyond doing a 'task' for a fictional XYZ Corp.

Limitations

There are limitations to this approach. In contrast to a course with multiple choice exams, this approach requires much more work from the teaching team than a non-project based course. The project aspects have to be coached at each level. This coaching is often group-specific as the method has to be applied to a novel situation, but the associated pleasure is that the teacher and student can both learn something.

There is a small risk of having students go out into the wild and run studies and interact with people outside the university. Some students lack the social skills, knowledge, interest, or time to do well on this task. Monitoring the materials and checking in with groups appears to ameliorate this risk. Also, the students can be referred to professional etiquette classes, coached directly, and referred to books on how to run studies (e.g., Ritter et al. 2011, 2013).

Finally, this approach is limited to courses that have methods that can be applied easily to real world problems. Areas like industrial engineering may find that this approach can be applied in many courses. Courses with more theoretical material will have a harder time finding problems and applying methods.

Final Thought

This approach of using student projects is not completely innovative; the idea of doing guided professional work has been done for years by apprentices who work under supervision to perform useful activities. It is just a new kind of apprenticeship in a classroom setting. And, at the end of the semester, rather than just turning in grades, the teaching team has the satisfaction of having helped the students do something more with their learning than just classroom exercises—the teaching team and their students end up helping their neighbors, their current and future employers, their universities, and local non-profits.

Appendix

This is the form that groups are required to return by email with their final report. It helps know how to distribute the final report.

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Name, group name, and date: _____

Contact at the organization:

What did the contact do during the semester, how did it work?

Have you shared the report with the contact?    Yes/No

Do you grant permission to Ritter to share the final report with the
contact with a cover letter?    Yes/No

Do you grant permission to Ritter to share the final report on the IST 331 web
site?    Yes/No

How likely are you to revise the report before sharing based on
feedback?
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