Gender HCI Issues in Problem-Solving Software

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ABSTRACT
Thus far, researchers have not investigated gender HCI issues in the context of end-user problem-solving software. Designers' ignorance of gender differences is particularly evident in studies showing software is unintentionally designed for males. We are investigating gender HCI issues using quantitative and qualitative empirical methods, using formative work to consider gender-conscious design features, implementing these features in our research prototype, and following up with summative work to evaluate effectiveness.

AUTHOR KEYWORDS
Gender, HCI Design, end-user engineering

ACM CLASSIFICATION KEYWORDS
H.1.2 [Information Systems]: User/Machine Systems—Human factors

INTRODUCTION

Despite some research on gender HCI [6], to date researchers have not taken into consideration how differences in gender should influence the design of problem-solving software, such as spreadsheets, and CAD systems. We have been investigating whether doing so is necessary, because evidence from other domains, such as psychology and marketing, strongly suggests that females process information and problem solve in very different ways than males do [2]. Without taking these differences into account in the design of problem-solving software, the needs of half the population for whom the software is intended are potentially being ignored. In fact, some research has shown that software is unintentionally designed for males [7].

To consider this issue we are empirically investigating end users (not computer science professionals) engaged in computer-based problem-solving activities to inform the design of problem-solving software for supporting both genders. This research could enable software designers to better support women working with problem-solving software, thereby increasing potential effectiveness of women in the workforce.

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We began by drawing upon the evidence from other domains to derive a set of 11 specific hypotheses related to the potential impact of gender differences in end-user problem-solving software [2]. The literature from which we drew came from computer confidence, perceived risk, information processing, computing gaming, and technology adoption. The essence of these foundations and the resulting hypotheses is:

1. Confidence: Females tend to be less confident and to perceive more risk than males do. Expected to impact users' level of engagement with the software.
2. Support: Females and males not only have differences in learning styles, they also process information differently. Expected to impact users' ability to understand communications and to problem-solve effectively.
3. Motivation: Males and females are motivated to use technology for different reasons. Expected to impact users' interest in pertinent end-user problem-solving features that can aid effectiveness in problem-solving.

EMPIRICAL MODEL

Our empirical explorations into each of the above topics begin with quantitative and qualitative investigations into gender differences which exist in problem-solving software. These investigations are followed up with changes to our prototype aimed at making the design of the problem-solving software gender conscious, and conclude with summative work to evaluate effectiveness. We have begun our explorations on the topic of confidence.

EMPIRICAL EVIDENCE – QUANTITATIVE

In problem-solving software for end users, one of the challenges is enticing users to use new (or rarely used) features. To address this issue we developed a strategy for end-user problem-solving software called *Surprise-Explain-Reward* [9]. At opportune moments the system makes changes to the problem-solving software, surprises, which are intended to capture the user's attention and arouse curiosity. However gender differences in confidence may impact the effectiveness of the strategy.

Gender differences regarding computer confidence have been widely studied, revealing that females (both computer science majors and end users) have lower self-confidence than males in their computer-related abilities [2, 5, 8].

One of our hypotheses is that users with low confidence and elevated perceived risk may be less active with problem-solving software, and will therefore be less successful. We have already discussed low confidence; there is also evidence that high perceived risk leads to excessively high levels of arousal, which at those levels may trigger less user engagement with the software [4] (a crucial component for our Surprise-Explain-Reward strategy). We expect these phenomena to disproportionately affect females, because of their lower confidence and because of their elevated perceptions of risk [2].

We conducted a study to investigate if there were gender differences in engagement with the software. The findings suggest that gender is a factor in both activity level and effectiveness in problem-solving software (for a complete description see [3]). For the study, participants were asked to complete a debugging task in several spreadsheets. Available for their use were features which have been shown to help in debugging tasks. The features were classified into three categories: type familiar (formula edits), type taught (arrows and WYSIWYT, which were explicitly taught during a tutorial), and type untaught (a fault localization technique which was not taught during the tutorial). Prior to the task we measured the participants' computer confidence (using a self-efficacy questionnaire). After the task participants filled out a questionnaire measuring comprehension of the features.

The main results were (as summarized in [3]):

- Females had lower confidence than males did about their abilities to debug. Further, females' self-efficacy was predictive of their effectiveness at using the debugging features (which was not the case for the males).
- Females were less likely than males were to accept the new debugging features (types taught and untaught). One reason females stated for this was that they thought the features would take them too long to learn. Yet, there was no real difference in the males' and females' ability to learn the new features.
- Although there was no gender difference in fixing the seeded bugs, females introduced more new bugs—which remained unfixed. This is probably explained by low acceptance of the debugging features: high effective usage was a significant predictor of ability to fix bugs.

EMPIRICAL EVIDENCE – QUALITATIVE

Why were females less willing to accept the type taught and type untaught features? In order to answer this and other similar questions we are currently pursuing qualitative methods of examining our data using a more in-depth approach. By coding the users' actions we are able to look at the context in which actions were made, providing a comprehensive view of the gender differences.

Since many of our questions have been developed in the context of well known theories, we expect to relate our findings back to those theories (in confirmation or as contrary evidence). The most relevant theories are: the self-efficacy construct [1] (which helps to explain a lack of self-confidence and its effects), the Attention Investment Model (which explains the role of perceived benefits, expected pay-offs, perceived cost, and perceived risk in problem solving), Minimalist Learning (which proposes active and engaged learning), and Norman's Action Cycle (which describes the barriers users face when first deciding upon which action to take and then deciding whether that action was the correct one).

NEXT STEPS AND SUMMARY

The results from both the quantitative and qualitative analyses will be used to guide changes to our prototype. For our most recent confidence findings, the changes will be focused on encouraging females to become more engaged with the features, for example, by providing gender-conscious support for learning unfamiliar features. Once these changes are introduced another empirical study will be conducted to determine the effectiveness of the changes.

The aim of this research is to identify some of the barriers that exist for both genders in problem-solving software. As part of this research we will ensure that any changes made benefit both genders.

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