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Original Research

Developing an Online Community for Women in Computer and Information Sciences: A Design Rationale Analysis

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Abstract

We analyze the evolutionary design of an online community system designed to support a developmental learning community of women: wConnect Online. The goal of this community is to engage, connect and support women at different developmental levels with respect to education and career goals in the computer and information sciences. We chronicle the system's development as an instance of action design research, showing how a sequence of four design phases were motivated by different design goals that led to systems with differing design rationales. After motivating the research program, we describe each design phase in detail, followed by a general synthesis and discussion of lessons learned.

Keywords: Action design research, online community, women in computing

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INTRODUCTION

The problem of attracting and retaining women in careers related to the computer and information sciences (CIS) is well established. With support from the Broadening Participation in Computing program of the National Science Foundation (recently merged with Computing Education for the 21st Century, see www.nsf.gov/pubs/2010/nsf10619), our research team has been exploring solutions to this problem using a design research approach. We have been studying the evolutionary design of an online community of women who vary in their levels of development with respect to CIS education and careers. In this paper we summarize background literature relevant to the problem and opportunities that have motivated our work. We then present a systematic exegesis of the design processes followed thus far and lessons learned.

The Problem of Attracting Females to Computing Careers

In the U.S. the number of women graduating with CIS degrees has dropped by almost 25% in the past ten years (Leonard, 2003). In 2009, while females earned 57% of all undergraduate degrees, the corresponding proportion of degrees in CIS was only 18% (National Center for Women in Information Technology, <http://ncwit.org/resources.scorecard.html>). This trend threatens the future availability of qualified CIS professionals, and particularly the diversity and vitality of the profession.

A wide range of contributing factors have been linked to the decreasing numbers of women pursuing education and careers in CIS (for a comprehensive review see the volume edited by Cohoon and Aspray, 2006). One pervasive contributor appears to be differences in learning motivation among girls and boys regarding computer skills. For instance, girls' interest in learning computer-related skills begins to drop as early as middle school (AAUW 2000). While some of these declines may be due to the influence of peers, another contributor seems to be variations in intrinsic enjoyment; studies of computer playfulness have suggested that women in general score themselves lower on this scale (Coleman 2009). Note that variations in a summative measure like computer playfulness may be due at least partly to boys spending more time than girls using computers for "fun" activities (e.g., computer games). In general however, the theme of intrinsic motivation has had an important effect on efforts to reach out to girls regarding computing, with considerable effort spent on finding CIS learning activities that are more appealing to females. For instance educators have observed some success when girls learn programming through media-based computation (Guzdial, 2003; Guzdial and Tew, 2006) or by building visual games and animations (Kafai et al., 2010). Another general area of concern is in the sense of asociality that is sometimes attributed to computer-based tasks. An influential book by Margolis and Fischer (2002) portrays young women's views of computer programmers as males who work alone while sitting in front of a computer, and who love to sink their teeth into complex coding tricks, a view often summarized as the "geek" stereotype. Young women who do choose to pursue computer science education are likely to be in a considerable minority and may experience the classroom culture as uncomfortable or even hostile (Barker and Garvin-Doxas, 2004). Fortunately, young women seem able to avoid adopting negative expectations like this if they have personal experience with IT professionals, for instance in their own family (Sashaani, 1993).

Considerable research has focused on creating classroom learning experiences that will be more attractive and supportive of young women, particularly in university settings. For example, some educators have introduced pair programming activities in computer science courses, to counter the expectation that programming is an asocial task; such interventions have been seen to make introductory programming courses more attractive to males and females alike (McDowell, et al., 2003). Cohoon (2007) is experimenting with a novel introductory programming sequence that includes an explicit focus on building social connections and a shared culture among students that can be extended beyond the classroom. The hope is that encouraging more peer interaction in course assignments or some mechanism to promote extra-curricular social activity will help to break down some of the attitudinal barriers that young women have regarding pursuit of a CIS education.

In sum, the literature reveals a number of factors that influence women's interest in computing education and careers. One particularly important factor is the social context of female students' learning, where they tend to represent a small minority of students taking computing-related courses, and their access to other females as instructors and role models is quite limited. In our work we have been investigating a community-building approach to addressing issues concerning the social context available to women in computing.

A Developmental Community for Women in CIS

The wConnect project (<http://wconnect.ist.psu.edu>) can be seen as a complement to the institutional interventions related to classroom culture and computer science curricula; we are considering instead the opportunities that inhere in social interaction among females outside the classroom. Students in any school setting regardless of level have

many opportunities for personal interaction; our approach is to extend the everyday social networks that emerge out of such interactions using the technology of online communities. More specifically within the domain of computing education, survey studies have pointed to a mediating role of socio-cognitive factors in undergraduates' attitudes about their longer term career plans in the computing industry; perceived social support is a predictor of retention for both males and females (Barker et al., 2009; Rosson et al., 2011a). Our approach is to extend the social context that is created through the coursework required of a student. By adding support for online interactions and discussion we can integrate across the limited number of females who are enrolled in any specific course, and can also provide a more persistent and continuing infrastructure for social exchange. By creating a community for females only, we can minimize the influence of any pre-existing negative stereotypes or avoidance behaviors concerning males who enroll in CIS courses.

wConnect is a developmental community – its members organize their own developmental goals into phases (i.e., of increasing interest and expertise), take on developmentally-appropriate community roles, and share the overarching goal of helping one another to transition among stages (Rosson and Carroll, 2006). This general concept of developmental community is grounded in social constructivist theories of learning that emphasize the critical contributions of peers and other learners who have more advanced knowledge or skills and can serve as mentors or role models (Vygotsky, 1978). In related work we have shown that the presence of strong peer networks is an important predictor of both one's self-efficacy with respect to CIS activities and one's orientation toward careers in CIS; these relationships are present for both males and females (Rosson et al., 2011a). Thus the community not only extends female students' options for social exchange but does this within a developmental structure.

The wConnect developmental community project has been underway since 2007 (see Rosson et al., 2010a for an overview). The developmental character of community is apparent in its members who operate at different levels of interest and knowledge about computing: high school girls who have not yet chosen CIS as a career direction, lower-level undergraduates who are exploring CIS-related education as an option; upper-level undergraduates who are preparing for CIS careers; graduate students who are pursuing advanced education in CIS; and female IT professionals and mentors who have graduated from CIS university programs or have expressed commitment to increasing the proportion of women in CIS education and careers. A unifying attribute is members' shared identity with respect to our university program (Rosson et al., 2009a): they either are considering the major, are already enrolled in it, have recently graduated, or have adopted the role of mentor.

The community activities within wConnect depend on developmental level. For instance alumnae may join the undergraduates online for Q&A panels, general chats, or for a more structured video interview of advice and reflections; undergraduates may organize and deliver workshops in their former high schools; advanced undergraduates or graduate students may blog about their experiences with internships and job searches; and high school students may help to build recruiting content or activities for even younger (middle school) girls. Several prior publications report on the emergence and deployment of these developmental activities in wConnect (Rosson et al., 2009b; Rosson et al., 2009a; Rosson et al., 2010b).

Our action research goal for the developmental community has been to promote interaction and social exchange. The simplest measure of this is participation, for example the number of members has grown from an initial seed group of 5-6 undergraduates to about 150. Of course within this community members vary in their activity levels. Many members simply sign up to receive the bi-monthly newsletter; about 50 members are more active, in that they have registered a profile that makes them more visible and enables them to make contributions online. Looking in more detail at the activities conducted by this core group of community members, the undergraduates have created tools and activities in support of nine separate workshops with female high school students; a more prolonged series of workshops has recently been conducted with middle school girls as well. Alumnae in the community have presented material in virtual panels (e.g., tips and experiences from their current professional lives). However the primary activities of the community have involved the creation of online content, including blogs, discussion forums, a photo gallery, games and visualizations, video interviews and product reviews, and regular online meetings (text chats). We turn now to the design research that has supported these online activities.

wConnect Online: Community Tools and Activities

From the beginning of the wConnect project, a pervasive design focus has been on envisioning and building a set of online community tools and activities that can be used to engage and support the developmental community. Over the past 20 years, much has been written about online communities, including considerable debate about what "counts" as community when people are connecting and interacting online (Preece and Maloney-Krichmar, 2005). Some of the indicators suggested by researchers include the intimacy or responsiveness with which members respond to one another (e.g., see examples in Preece, 2000), the degree of participation across the community (Kelly et al., 2002), or the emergence of regularized rituals and community-specific behaviors (Kim, 2000). In the case of wConnect, we set out to reinforce and extend a community that already existed in an implicit form – the shared identity and social connections that exist among females who are considering, pursuing, have recently completed, or are mentoring other students in a specific university program. Like a geographic community network, members of the

developmental community would from the start have considerable overlap in interests and values (Rosson et al., 2009a), and the goal of our design work would be to make these shared values and interests more visible and to use them to encourage mutual interaction and support.

Figure 1 contains two screenshots from the current online community system; to distinguish our discussion of this software system with the developmental community in general, we will refer to it as wConnect Online. On the left is a home page that invites members to sign in, or to follow the community on Facebook or Twitter; on the right is a member blog in the topic area of education. The tabs across the top provide access to forums, blogs, games, other members, a chat room, and a variety of other online activities and resources. In addition to the community site, the community has created an outreach site for the general public, and tools that are used to support hands-on web programming workshops for high school girls. All of these software tools are currently implemented in Drupal, an open source content management system (<http://drupal.org>).

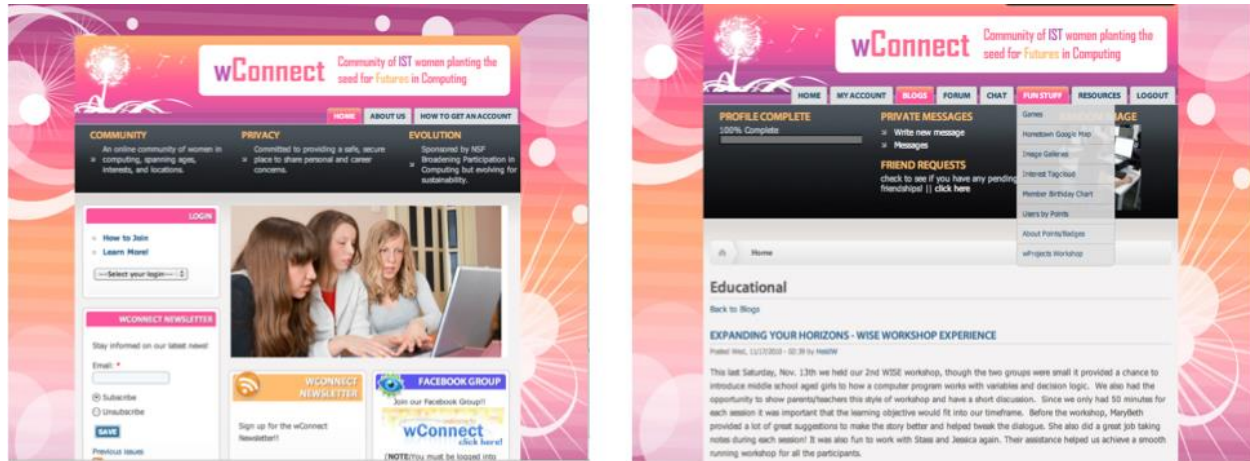


Figure 1: Screenshots from wConnect Online (<http://collab.ist.psu.edu/wConnect>)

The current version of wConnect Online has 52 registered members; of these, 4 are high school girls; 24 are undergraduates; 4 are graduate students; and 20 are professionals or other mentors. Note however that this number somewhat underestimates the size of the community, because some individuals have created only a weak tie (e.g., they have joined the group on Facebook or LinkedIn, or have signed up to receive the newsletters, but have not yet created a profile or contributed in an active way to the online resources); 146 individuals receive the bi-monthly newsletters. The community also hosts an online chat every other month and has organized a number of other events, for example virtual panels and alumnae interviews. In terms of member-generated content, wConnect Online contains 60 blog posts; 20 member-submitted games; 24 video interview segments; 17 forum posts; 85 photos or images; 11 newsletters; and 70 other instances of announcements, meetings, and so on. The research investigation of wConnect will soon be ending, and the group is considering mechanisms to maintain its momentum into the future. For example, the developmental community is transitioning to become a part of a sister organization focused on women in CIS (a college student club), so that its distributed members and activities will continue to have an organizational home.

From the start an important design research commitment has been to engage wConnect members in the design and construction of developmental activities and tools that meet their own needs. As the project has evolved and grown, the community's needs and preferences have become more articulated, and the supporting software infrastructure, tools, and online activities have expanded in parallel. The goal of the current paper is to analyze and document this evolutionary software design process; in this we expand an earlier discussion that summarized key elements of the community system's design rationale (Rosson et al., 2011b, and we position the work as an instance of action design research (ADR; Sein et al., 2011).

In the balance of the paper we first motivate the use of ADR as a methodological framework. We then describe the evolution of wConnect's online community system as a case study in ADR, documenting an evolutionary process that comprises four phases. At each phase, we introduce and motivate the design goals that were in focus at that point, describe the online system produced at that phase, and reflect on each system's strengths and weaknesses. After summarizing each phase we generalize the lessons learned, and conclude with plans for continued community system evolution as well as more broad-based design implications.

WCONNECT ONLINE AS ACTION DESIGN RESEARCH

Like other cases of ADR, our work on wConnect Online has two parallel high level research goals; the activities are a design intervention with particular goals (increasing women's interest and success in CIS) but also a theoretical investigation (articulating and evaluating design principles useful in evoking and building developmental communities). In this sense, ADR synthesizes the goals and methods of design research (e.g., Hevner et al., 2004) and action research (e.g., Baskerville, 1996). The method is conceived as a set of three interleaved and evolutionary processes – problem formulation; building, intervention and evaluation; reflection and learning – that are capped with the formalization of the learning gained through the design activities. Note that this particular case of ADR is participatory in that from the start, our vision was of a community that is built both for and by its stakeholders.

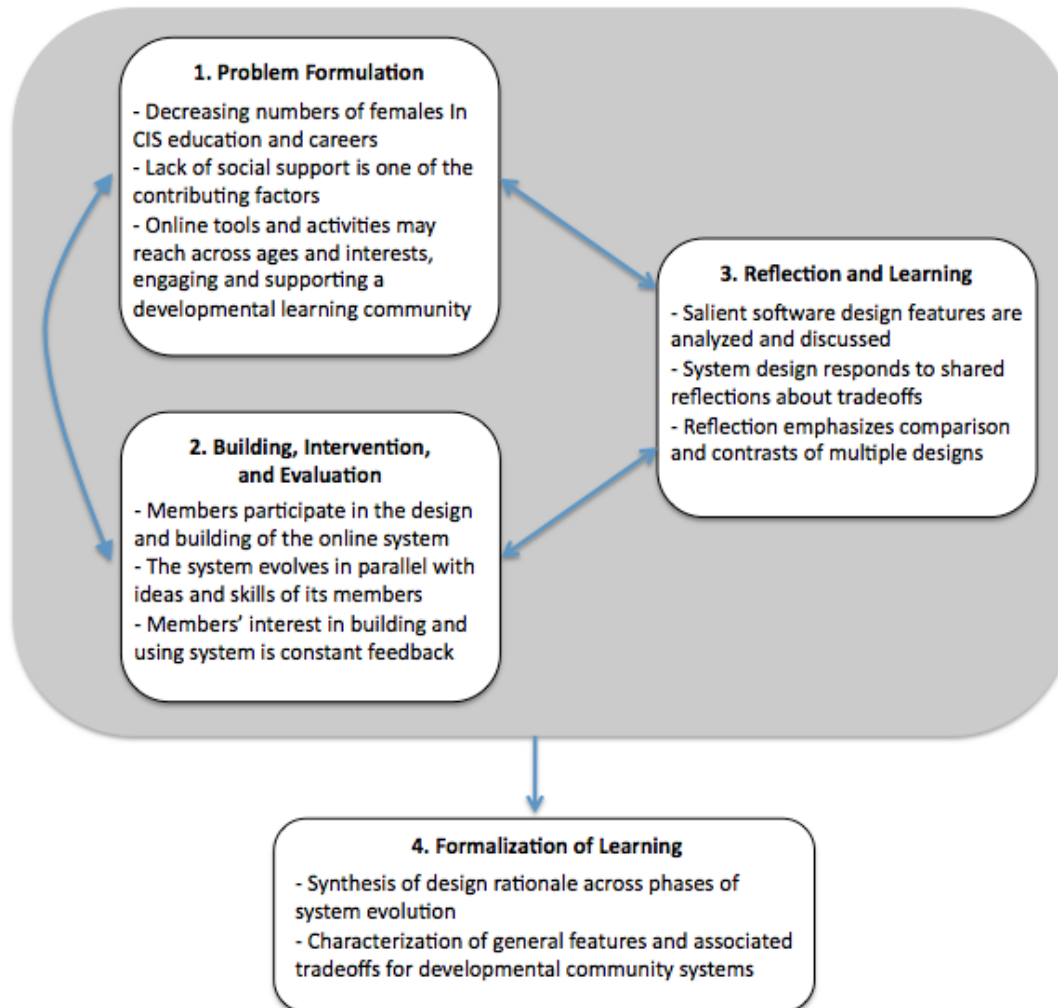


Figure 2: The Action Design Research Method for wConnect Online

The diagram in Figure 2 depicts how the four elements of ADR have transpired in the evolution of wConnect Online. With respect to Problem Formulation, the project was grounded in an extensive literature regarding women in CIS, with a particular focus on the social and motivational factors that have been discussed in this literature (e.g., Barker and Garvin-Doxis, 2004; Margolis and Fischer, 2002). We considered these problematic aspects of the CIS pipeline through the lens of community building, which drew from research on learning communities (e.g., Wenger, 1998); social constructivist learning theory (e.g., Vygotsky, 1978), online communities (Kelly et al., 2002; Kim, 2000; Preece, 2000), and community networks (Carroll, 2012; Carroll and Rosson, 2003a; Kavanaugh et al., 2005; Schuler, 1994).

With respect to the Building/Intervention/Evaluation component of ADR, the design of wConnect Online began with a resolute commitment to participatory development. This approach was inherited from the larger project context, with the general rationale that participatory design methods evoke increased buy-in and satisfaction from stakeholders

(Costabile et al., 2006; Muller, 2003), promote mutual learning among designers and end users who have differing expertise (Greenbaum and Kyng, 1991), and enable a co-evolutionary process that integrates domain and technical concerns (Stevens et al., 2009). Because of the IT learning motivations of wConnect, this ADR project also borrowed from the meta-design perspective (e.g., Costabile et al., 2006; Fischer, 2003): that is, we sought to provide community building tools that could be learned and applied by the community members themselves. In so doing, not only could we offer opportunities for professional development (i.e., through the growth in technical skills for web development), but also work toward longer term sustainability of the online community (i.e., when the research team is no longer building tools or applications). As a result of this commitment to participatory development, an ongoing evaluation metric is the members' interest and capability to construct, enhance and maintain the software system itself.

The third aspect of ADR – Reflection and Learning – was realized through the continuing discussion of specific design features along with their pros and cons. The resulting design rationale was in the form of claims analysis, a method used to hypothesize features of an artifact in use (e.g., as illustrated by a usage scenario) that have causal relations with a set of positive and negative consequences for end users (Carroll, 2000; Rosson and Carroll, 2002). Claims analysis was developed to articulate the causal relations inhering in artifacts-as-theory (Carroll & Kellogg, 1989). At any given point in a design process, the artifact under construction (assuming some context of use) has one or more design features in focus, and claims analysis helps a design team to reflect and learn from their design discussions and experimentation.

Finally, after an interleaved series of design efforts and reflection in ADR, Formalization of Learning occurs. It is at this step that more general lessons are framed and disseminated for continuing or future design efforts. In wConnect Online, these general lessons were constructed by synthesizing across the similarities and differences of alternate design approaches in the context of sensemaking with respect to related work (Section 4). We turn now to a more detailed discussion of wConnect Online as an instance of design research.

THE EVOLUTION OF WCONNECT ONLINE

As depicted in Figure 2, the design process for wConnect Online began with a formulation of the problem of attracting and retaining women in CIS, complemented by the opportunities inherent in socially-mediated learning communities. The process throughout had a participatory commitment and as design alternatives were conceived and developed, the understanding of the problem evolved, as did our reflections about design tradeoffs. The process can be summarized as a series of four phases, each focused on a different composite of design goals and producing a different version of the online community system.

In the balance of this section, we describe these four phases that comprise the evolution of wConnect Online thus far. For each phase we first discuss the goals that were driving the wConnect Online design exploration at that point. We then summarize key aspects of the system that was produced, and document the design rationale with claims analysis. Note that the format for a claim is a design feature followed by a set of analyzed upsides (+) and downsides (-) that hypothesize tradeoffs associated with that design choice. Claims analysis helps to motivate refinements or transformations of design ideas under the general heuristic that designers intend to enhance or capitalize on upsides while removing or mitigating downsides (Rosson and Carroll, 2002).

Phase 1: A Skeleton Website

The first phase of wConnect Online consisted of a very basic website – essentially a set of empty web pages ready to be filled in by community members. This initial website was constructed with a pre-existing set of research tools.

Orienting Design Goals

There were two design goals in focus in this first project phase. One of these was *member appropriation*, a process of sociotechnical evolution during which a system's users discover new uses for a system and find ways to tailor the system to better meet these needs (Costabile et al., 2006; Wulf et al., 2008). Fischer and Ostwald (2003) discuss a related concept in the Seeding, Evolution and Re-seeding framework (SER), suggesting that early versions of a system should be designed to seed new ways of thinking about use, that these new ideas will lead to an evolution in how a system is used, and that eventually a new version will be built so that the SER process can begin again. In the first phase of wConnect Online, we designed for appropriation by offering members a website that was both incomplete and tailorable.

One boundary condition for member appropriation is whether members will be able to change the software itself (i.e., in addition to modifying their tasks and information). To ensure that the prototype system was tailorable, we built it in a tool-rich environment that had been designed for end-user programming (Rosson et al., 2007). This also allowed us

to explore the second design goal of *member development*. In concert with the overarching wConnect goal of enhancing members' professional development in CIS, we wanted to provide members the opportunity to enhance their technical skills in website design and construction.

A Website Built With the BRIDGE Toolkit

The Phase 1 prototype was built with the web authoring objects and tools of BRIDGE (Basic Resources for Integrated Distributed Group Environments), a Java-based toolsuite for collaborative applications (<http://bridgetools.sourceforge.net>). Earlier research had demonstrated that the flexible library objects and services offered by BRIDGE can be combined and tailored to support many different goals (Rosson et al., 2007). For instance, it can support seamless integration of synchronous and asynchronous interaction and content creation; most content is viewable and editable using either web browsers or real-time object-specific editors. If and when needed, new object types can be created (using a mix of Java and HTML) to provide completely new functionality. These characteristics seemed to match well our orienting goals of appropriation and member development, so the research team created a "shell" web site and encouraged wConnect members to adapt it to their own purposes (Figure 3).

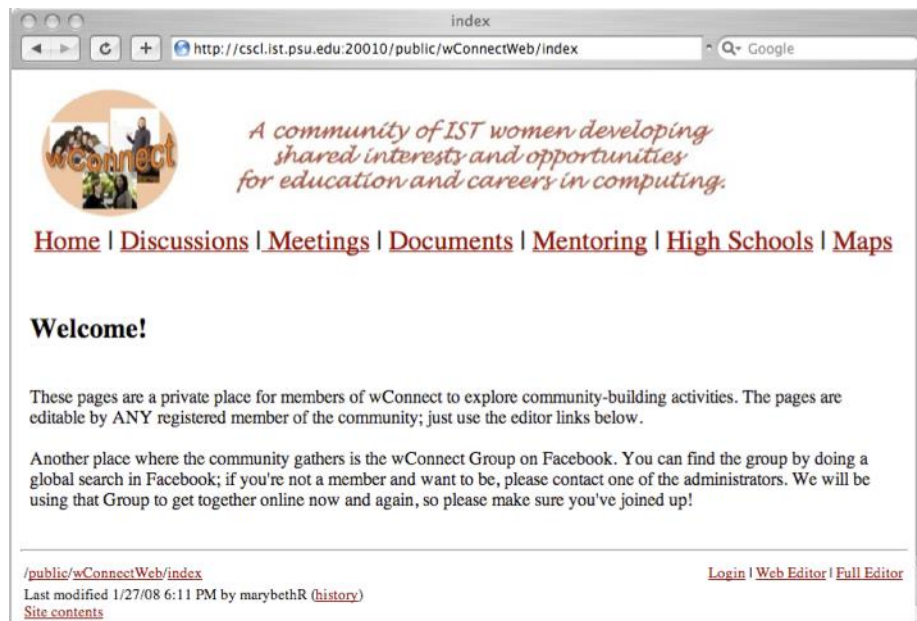


Figure 3: Home Page of wConnect Online Built with the BRIDGE Toolkit

At this early point in the project, the core members of wConnect were a small and personally recruited group of undergraduates who were closely supervised and supported by the research team. These members were slow to take advantage of the web authoring and content management tools provided by BRIDGE; only one individual took the initiative to add content (some basic information about a high school).

Part of the delay in member appropriation may have been critical mass, but it was clear from discussion that at least some of the problem came from the platform – BRIDGE components have a user interface and features that are quite different from common social networking sites like Facebook, where these community members went for social interaction and content creation. Even the simple tasks of getting a user account, logging on to the system and editing a single web page required learning a number of new skills. When they did attempt tasks with the new website, the user experience was one of leaving behind a familiar context of online interaction to move into a "research" space. Furthermore, none of the members had the interest or skills to take on the more substantial development needed to tailor or construct new objects for use by the community (i.e., by programming in Java). Ultimately, the separation between the Phase 1 system and members' everyday online interaction practices was too great to invite the sustained use needed for appropriation, and the BRIDGE platform was too complex and rich for the member development we had hoped to initiate. We were not achieving our goals for community participation in developing and enriching the online materials.

Design Rationale

Our choice of BRIDGE as the underlying infrastructure was founded on its diverse set of content objects and its extensibility; we hoped that regular users would appropriate the tools and create content to meet their own purposes. In the course of doing this the members would also have the opportunity to expand their technical skills in web

programming. Importantly, the toolkit enables tailoring at multiple levels of complexity: users can create content with WYSIWYG editors; they can control the content more precisely using HTML; and they can even program new objects or visualizations in Java and HTML. These bits of design rationale are captured in the upsides (+) in the central claim analyzed for Phase 1 (Table 1). The italics are used to highlight the specific design goals we were emphasizing at this phase.

Table 1: Claims Analysis for Phase 1

The Java-based suite of interactive objects and content types offered by BRIDGE...
+ reinforces the vision of an open-ended system that can be <i>appropriated</i> for diverse community content and activities
+ allows <i>development</i> of members interested in web development and Java programming, including opportunities suitable for varying levels of member expertise
– BUT the BRIDGE user interface for website access, interaction, and editing departs significantly from familiar platforms for content creation and social interaction
– BUT the tailoring or creation of new objects requires significant Java programming expertise

The claim articulated in Table 1 also hypothesizes the downsides of using BRIDGE as a platform. The user interface for editing BRIDGE objects (e.g., changing the content of a web page or adding a new type of object) was unfamiliar and complex, even for female undergraduates with a background in networks and databases. Particularly when compared to everyday use of platforms like Facebook or Google Docs, this first version of wConnect Online felt too foreign to promote regular and active use. As a result we were not able to build a critical mass of community members (i.e., beyond the core set who we had recruited personally). The research team had intended that wConnect members would begin by authoring content in BRIDGE objects and gradually learn the skills to tailor the interactive tools for the community's needs. However we underestimated the difficulty of learning to use this platform and how different the user experience would be relative to young women's normal social networking practices.

Phase 2: Reaching Out via Facebook

This second phase of wConnect Online was initiated by the community members, who proposed that the Facebook social networking site (<http://facebook.com>) already had some of the functionality needed by the wConnect community. A benefit would be that their friends and schoolmates already spend time using Facebook to interact and share interests. Thus a Facebook site might help them reach out to peers, building a critical mass of community members.

Orienting Design Goals

In response to the absence of community use observed for the website built using BRIDGE, the salient design goals for Phase 2 became member engagement and user interface transparency. System designers often face a cost-benefit challenge when designing a system whose use is discretionary – the effort required to use (or learn to use) the new artifact should be low enough to be balanced by the prospective user's interest or expectations of usefulness. From an organizational perspective, the Technology Acceptance Model (TAM) and its variations have identified both perceived usefulness and ease of use as critical determinants of adoption of new technologies (e.g., Venkatesh et al., 2003). From the perspective of individual behavior, Blackwell's (2002) Attention-Investment Model offers a similar analysis, positing that at any given point in time a person's willingness to invest effort (attention) to a new opportunity will depend on perception of both costs and benefits. Thus in this phase of wConnect Online, we were particularly oriented to design approaches that would be seen as attractive or fun to prospective members and at the same time relatively simple to use. The decision to explore Facebook as a platform was a move in this direction.

The wConnect Group in Facebook

In Phase 2, wConnect Online was realized as a private group in Facebook. This was a simple step easily accomplished by the undergraduate members; by making it a "closed" group, any Facebook user who might discover the group would need permission to join. At the same time it was easy to send out invitations to any other Facebook user to whom a member had a connection (i.e., a Friend link). Once the group was created the members configured it using standard Facebook components; for instance by adding a logo, a brief description of its mission, a wall for posts, a discussion forum, and so on (see Figure 4).

The Facebook group grew fairly quickly to 40+ members, including high school students, undergraduates and alumnae. In fact, the group would on occasion receive requests for joining the group in the middle of the high school workshops that members carried out as part of their developmental community activities. During this phase,

wConnect Online was able to use tools provided by Facebook to post announcements (i.e., as wall posts), share the growing list of members, schedule events, send notifications, and track responses. The members also located and started using a third-party “chat room” application, so that the group could hold online meetings. Two unfortunate consequences of this however were that commercial ads would appear in the midst of the chats, and the conversations were not protected by the closed status of the group itself and thus suffered from interlopers.

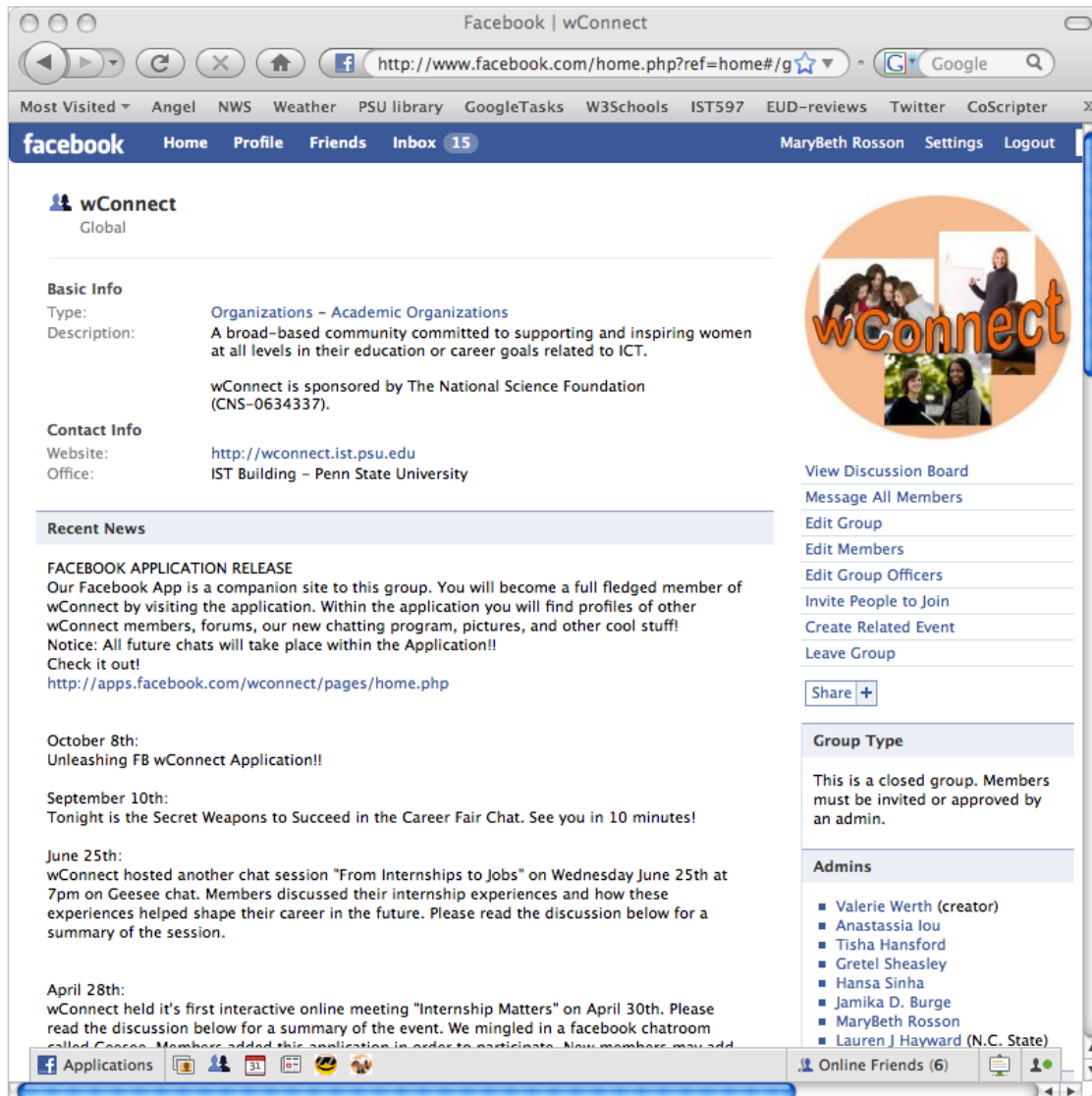


Figure 4: wConnect Online as a Facebook Group

Design Rationale

The rapid increase in online members was evidence that moving to Facebook had improved the cost-benefit analysis – the familiar user interface in combination with the general interest and engagement in Facebook as a place for online interaction seemed to have the desired effect (see Table 2). In addition, this phase brought into focus another design goal, that of privacy with respect to other people online. The closed group conveyed to outsiders that wConnect Online is a members-only group, while at the same time the occasional interloper in the group chats highlighted the annoyance of not being able to guarantee a private conversation.

Despite the increased interest and membership, the Facebook group concept had its own set of downsides. Perhaps the most disconcerting can be viewed as the inverse of our primary rationale for choosing to move to Facebook: the community found that some prospective members (e.g., those who were already in professional settings) preferred not to associate with Facebook, not even enough to obtain a user account and join the group. This was a relatively small proportion of individuals but it caused the community to start discussing the possibility of multiple online community sites (e.g., using LinkedIn, <http://linkedin.com>).

Table 2: Claims Analysis for Phase 2**A private group in Facebook that is configured and managed by the community...**

- + has user *interface transparency* for existing and prospective members who are Facebook users
- + leverages the general *engagement* that existing Facebook users may feel when online
- + conveys that *privacy* and membership management is a basic goal of the community site
- BUT some prospective members may prefer not to create a Facebook user account and thus will be unable to participate in the group
- BUT groups in Facebook are limited to the same social networking features that the platform provides to individual users
- BUT the Facebook platform is developed and managed by a commercial organization, with only indirect input from its users

Other downsides are related to the design goals that had been shifted into the background after Phase 1: member appropriation and development. While Facebook does provide a standard set of tools (e.g., for messaging, photo-sharing, etc.), and an active community of third-party developers provides plug-in applications (e.g., the chat tool), the Facebook group concept itself is quite primitive. There is no support for working together on activities or for representing oneself as a member of a group rather than an individual, and the platform itself is beyond the control of any individual or group. Other than locating and installing third-party applications, there are few if any opportunities for members to advance their technical skills in web development.

Phase 3: A Community Application

While the Facebook group helped the community to rapidly increase its membership, the standard tools offered little that could be aimed at community building. Information about members was limited to a user's Facebook profile, and the group was not able to operate as a *community* (except implicitly through posts or messages among members). As a result the research team began to explore the possibility of a custom application that would use the Facebook API (Rosson et al., 2009a). The initial process of understanding and using the Facebook API (at that time still a novel public interface) required considerable expertise and was carried out by programmers working with us on the project. However, as in the case of BRIDGE, we hoped that some community members would choose to maintain and extend the community application.

Orienting Design Goals

During Phase 3, the design effort was guided by two goals inherited from Phase 2 (user interface transparency and engagement), as well as a return to the goals of member appropriation and development that characterized Phase 1. We recognized that building an independent application that operated "off to the side" of Facebook was risky in terms of member participation, but hoped to design a system that had a better balance of transparency, engagement, appropriation and professional development.

wConnect Online as a Facebook Application

The user interface designers for the new Facebook application tried to create a look-and-feel that was similar to Facebook (e.g., in use of colors, fonts, and general layout) but also subtly different (e.g., with its own visual design theme; see Figure 5).

The application uses a tabbed user interface style similar to that found in Facebook, but the tabs lead to activities that are designed to appeal to the goals and actions of this developmental community. For instance, earlier focus groups had revealed an intense interest in summer internships among undergraduate members, and in particular a desire for alumnae to provide tips or pointers to relevant materials (Rosson et al., 2008). As a result the designers constructed an activity for posting and replying to such opportunities. The designers also provided a group chat and a "chat board" for archiving the records of previous chats. Finally, a central feature of the new wConnect Online application was the addition of member profiles that held information relevant to the community's developmental goals (e.g., developmental level, background, interests; see Figure 6). Members could browse the directory by developmental level and could use level and other member facets to generate group mailing lists.



Figure 5: wConnect Online as a Facebook Application

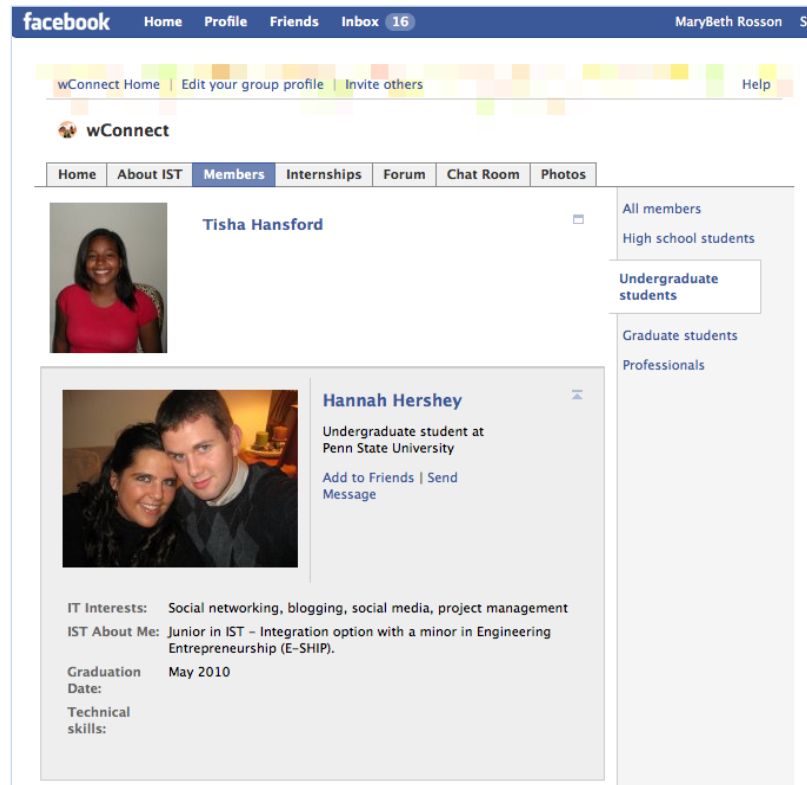


Figure 6. Profiles in the wConnect Facebook Application

Once the initial application was launched, many members in the Facebook Group added it to their Facebook pages, and attendance at the online meetings increased (e.g., alumnae who were off-site at times joined the chats, as did a high school student). There was general enthusiasm about having a distinct community place that felt like an extension of Facebook but had its own features, and many community members were excited to learn more about

programming with the Facebook API. However although the research team attempted to follow up on this interest and to provide technical support for members to design and build their own extensions (e.g., embedding or developing community games or other fun activities), we observed that only our research staff (a mix of graduate students and paid programmers) were able and willing to do the programming needed to extend the application (it requires the integration and debugging of technologies like SQL, PHP, Javascript, etc.).

Table 3: Claims Analysis for Phase 3

A private application built using the Facebook API...
+ can leverage familiarity with Facebook to create <i>transparency</i> in features and use while also having a separation from Facebook
+ can include community interactions that enrich the general <i>engagement</i> associated with Facebook as a social networking site
+ conveys that <i>privacy</i> and membership management is a basic goal of the community site
+ enables <i>appropriation</i> and <i>member development</i> through application extension and refinement
– BUT some prospective members may prefer not to create a Facebook user account and thus will be unable to participate in the group
– BUT the Facebook API is specified and managed by a commercial organization in service of its own needs, and developers must maintain their code accordingly
– BUT use of the Facebook API requires significant expertise in a variety of web technologies (e.g., SQL, JavaScript, PHP)
Community profiles that include information about members' developmental level...
+ suggests that members' <i>professional identity</i> in CIS is a core value in the system
+ enables level-specific community interactions and activities
– BUT members must input profile data to introduce themselves to the community
– BUT as members move through developmental levels their profiles must be maintained
– BUT overlap with Facebook profiles may lead to problems in identity management

Design Rationale

Not surprisingly, some of the claims analyzed for Phase 3 overlap with those hypothesized for the Facebook group (e.g., compare the initial set of claims in Table 3 to those in Table 2). As an application, this version of wConnect Online is less directly tied to the Facebook platform, but because it “extends” Facebook it can still leverage members’ existing social networking behaviors. Indeed the design team deliberately replicated some aspects of the Facebook user interface so as to enhance user interface transparency, while at the same time introducing subtle differences to remind members that this community space is not Facebook. Importantly, as an independent application, wConnect Online was now able to host activities specifically aimed at meeting its community-building and developmental goals. At the same time, reliance on the Facebook API also carried along downsides similar to those analyzed for Phase 2. Just like the group, this application requires a Facebook user account, so some prospective members will choose not to join. Although the application can be extended in arbitrary ways through creative programming, the underlying API (including some aspects of page layout) is controlled by the Facebook company; the wConnect Online developers thus have the task of monitoring and maintaining consistency with this API. Furthermore although the application approach makes it possible in principle for community members to appropriate and develop their own online activities, in reality the process was complex enough to require considerable programming expertise.

The development of a community database was an important design decision that complemented the freedom to build community-oriented activities. It creates a conceptual distinction between the individual’s Facebook profile (used for general social networking), and the wConnect profile presented to other members of the community. For example, although wConnect Online reuses Facebook profile information for name, birthday and hometown it adds information about developmental level and community interests.

As community members discussed and decided what to include as attributes in these profiles, we identified another emergent design goal – that of professional identity. Positioning oneself at a given developmental level (high school, undergraduate, graduate, professional) and summarizing one’s interests and community goals helps members to form and reinforce their current identity with respect to education and professional activities in CIS. A beneficial side-effect of these developmental variations is that other community activities can leverage the distinctions, for instance sending notifications of a summer internship posting only to the undergraduates who are most likely to be interested. At the same time, the reliance on an independent profile database creates a new responsibility for community members, both in terms of initially setting up their profiles and maintaining them to be consistent with their developmental progress.

Finally, an unexpected problem emerged as some community members began to find it difficult to manage their profiles in wConnect Online separately from those in Facebook. The community profiles reused Facebook's personal information; as a result when a few members chose to become more "invisible" in Facebook (e.g., removing their photos) they also became less visible in wConnect Online, even though that was not their intention. When we probed this in more detail we found a feeling among the more advanced undergraduate members that Facebook was beginning to be "overexposed," and that although it was a fun and convenient place to hang out with friends, it might not be the best place to pursue goals in professional development.

Phase 4: A Member-Built Community Application

Both of the Facebook systems were successful in that the community was able to enroll a wide variety of members who were already Facebook users and begin to explore community-oriented online activities. But working within the Facebook API was constraining even for the technically skilled graduate research assistants who built the original application. It was difficult to predict when and how the API would change and how to keep up with these changes. As we talked to advanced undergraduates and alumnae, we also became concerned about the pervasive focus on Facebook and its services. Connections to an established social networking site makes it easy to reach out to a large and diverse population, but at the cost of leaving out some individuals and perhaps confusing the community's professional development goals with the more general goals of social networking. One possibility is that Facebook (and LinkedIn, etc.) should be used for their primary benefit – outreach and new recruits – but that the community activities themselves should have a space that is more clearly distinct. This led us to investigate the Drupal platform, a popular open-source CMS (<http://drupal.org>), as an alternative to Facebook. We knew from other experience that Drupal has a rich and growing set of functionality that can be used to support a wide variety of web applications.

Orienting Design Goals

In Phase 4 we integrated many of the goals previously in focus: member appropriation, professional development, user interface transparency, engagement, personal privacy, and professional identity. The earlier phases had allowed us to explore these goals in different ways, and to articulate some of the tradeoffs that they implied, so that we were in a better position to consider them simultaneously.

wConnect Online in Drupal

One strength of Drupal that we discovered almost immediately was that it supports "programming" at many different levels, including for end users who have relatively little training in computer science. Using its large body of themes and modules, even moderately sophisticated users can build websites. Less sophisticated users can edit the content of pages or other content objects, just as they can using the BRIDGE toolkit but now with a simpler web-based user interface. More sophisticated users can locate and customize themes, research and install third-party modules, or even build new modules from scratch. As one consequence, during 2010-2011 a new version of wConnect Online was designed and built by members of the community itself, a changing group of about 8-10 women working at different skill levels, with occasional support from research programmers. The web programming for this site has been more extensive, involving not only the design and implementation of custom themes and objects, but also the discovery and embedding of external applications and the development of custom modules (the latter have been created by a mix of graduate assistant programmers and several more skilled community members). The welcome page of the application was shown earlier (on the left of Figure 1, which also showed one of the community blogs); a sample home page for a member after logging in is shown in Figure 7.

Members authenticate using university credentials; non-university members (e.g., high school students and teachers, or alumnae) are guided to first create a guest account that serves the same purpose. Like the Facebook application, the current system has a member directory (organized by developmental level), and includes typical social networking services such as discussion boards, photo sharing, and chat. However, in contrast to the previous prototyping efforts, the community members did not only build the initial website but also have been able to extend the software, typically by finding and customizing an existing Drupal module or service. The new community activities that have been created through these system extensions include:

- Blogging, including notifications about comments by other members
- A "virtual industry panel" hosted by alumnae, using external tool Adobe Connect
- A bi-monthly newsletter distributed to almost 150 subscribers
- Visualizations of members' hometowns, birth dates and other personal information
- Video interviews of professionals, with an index to questions asked and answered
- Community activity data, including participation "points" and related badges
- A growing set (N=19) of simple online games.

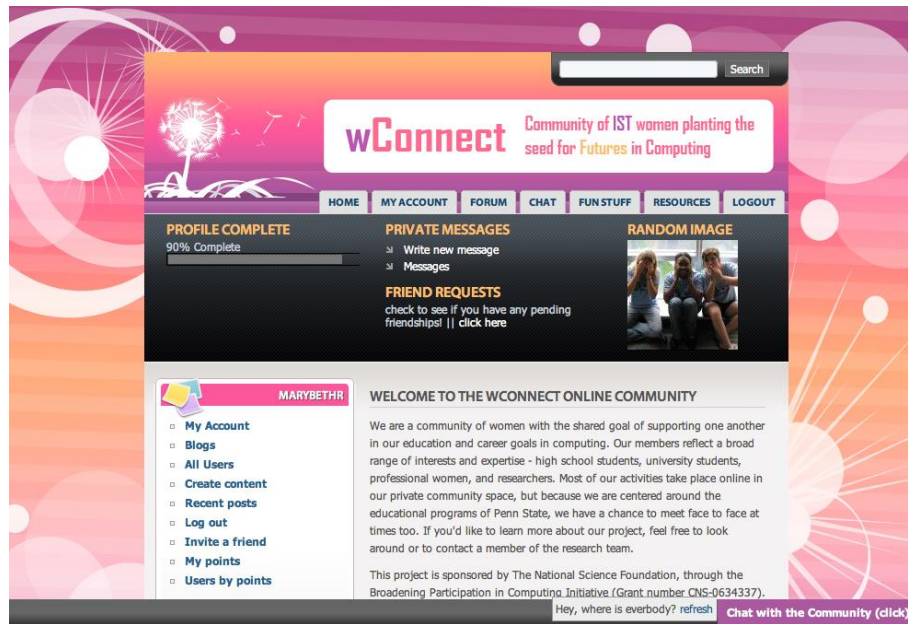


Figure 7: Member Page in Drupal Application

Now that the Drupal site is functioning and some of the members have developed the skills to add and refine functionality, new ways to engage members are beginning to emerge. For example, a few members organized videotaped interview sessions with two visiting alumnae. This led to an extensive design and editing process where the video creators decided how to share the resulting videos (as question-oriented clips), confirmed agreement with the interviewees, edited the raw video, and located and installed a Drupal module for video viewing. More recently another member has developed a scheme for managing these clips as a video gallery, complete with a hierarchical menu index; the entire process was documented so that other members could replicate it with other alumnae as desired. The result is a new activity related to professional learning (i.e., about recent alumnae's experiences and tips), as well as investigation and prototyping of additional Drupal functionality.

Design Rationale

Reflecting on the process of building wConnect Online, we can see that the current Drupal platform positioned us well with respect to the many tradeoffs among our design goals. At the start we focused on offering members a flexible and extensible tool set that they could use to pursue their own goals and activities. The lack of interest in the BRIDGE website caused us to take a large step toward familiarity and current practices in Facebook. In so doing, the community system became less flexible, and importantly still not extensible or even maintainable by wConnect members. In Drupal we have found an intermediate position between flexibility, member development, and engagement. We now delve more deeply into a discussion of these design lessons.

The Drupal platform matches well the design goals of appropriation and member development (Table 4). We have observed undergraduate members who learn to "code" in Drupal, even if they have only moderate expertise in HTML; some of them later transition from editing content to editing the CSS definitions for existing themes, and eventually to acquiring and installing new themes. As members acquire greater sophistication, they learn to research and install third-party modules, including edits of PHP or other code that lets them customize look and feel.

As community members have used and extended the Drupal system over the past two years, we have noted the emergence of a multi-leveled learning community within the core members, as more advanced women help to mentor those looking for ways to contribute. Furthermore the site has come to include tools and activities that offer ways to attract involvement by less-active members (e.g., participation via content sharing, discussion, and so on).

One unanticipated feature of the move to Drupal was that the community also designed and built a separate website for public outreach. They designed content customized to students at different developmental levels, or for mentors wanting to help young women at different levels. This was a relatively simple project, involving primarily graphical and information design and organization. But it used Drupal themes and modules as well as requiring articulation and communication of the community vision to diverse stakeholders. Thus the members who built the site expanded their web development skills and demonstrated commitment to the community vision. The only downside is that this is a static website; as other aspects of the community continue to evolve, content synchronization has become a concern.

Table 4: Claims Analysis for Phase 4**Tailoring of existing Drupal themes and modules to build an application...**

- + encourages *appropriation* and extension of existing software to meet community needs, ranging from content creation to programming of modules
- + offers a *professional development* activity for members who are interested in modern tools for content management on the web
- + enables prototyping of diverse modules for *engaging* different segments of the community
- + helps members to enhance their *professional identity* by interacting with a large and vibrant open source developer community
- BUT reusable Drupal components may not meet needs exactly and introduce complex errors or customization efforts
- BUT the Drupal CMS will evolve through the work of a large open-source community and may introduce changes that are inconsistent with the community site

Community profiles that include information about members' developmental level...

- + suggests that members' *professional identity* in CIS is a core value in the system
- + enables level-specific community interactions and activities
- BUT members must input profile data to introduce themselves to the community
- BUT as members move through developmental levels they must maintain their profiles

Reusing the university's user authentication protocol...

- + implies that the *privacy* of the online site is well-protected
- + adds a *user interface transparency* to authentication for university students or affiliates
- BUT requires an extra account for university outsiders
- BUT makes the community dependent on university tools and protocols

Adding "fun stuff" to the community website (e.g., hometown map, interests cloud, games, activity badges)...

- + offers a *professional development* activity for members interested in online games and graphics
- + may be *engaging* to junior members who are not ready to contribute to professional topics
- BUT may imply that the online site is for socializing and distract from more challenging professional topics

Note that in contrast to the process of creating extensions to the BRIDGE toolkit, much of the programming in Drupal relies on discovery, analysis, customization, and integration of modules built by third parties. A side effect of this reuse paradigm is that some community members have informally joined the community of Drupal developers, giving them another basis for their growing professional identities in CIS. Importantly, the community now has a cadre of "Drupal developers" who guide and mentor others wanting to develop new skills. Indeed, since the site was first designed and implemented in 2010, five additional members have helped to extend its functionality, making us optimistic that in the long run, the community will be able to sustain and evolve its own community system.

Of course the reuse of Drupal themes and modules has its own tradeoffs. Like for Facebook plug-ins, each module works as originally implemented and some are hard to customize for the community's needs (e.g., the standard Drupal profile module uses a set of pages and frames that seem unnecessarily complex for our members). The community developers' general approach has been to tailor as much as possible but then to simply accept the rest as a suboptimal solution, with the hope that alternate modules might become available in the future.

One feature added by a community member in the initial design was a module for newsletter subscription and broadcasting. After discussion with other community members, she made the newsletter public, so that anyone can subscribe (registered community members are automatically enrolled but can opt out). This created an interesting overlap between the private community system and the public outreach site and has been useful as a recruiting tool, or for staying in touch with members who become less active after graduating. The bi-monthly authoring and review of the newsletter is also a useful reflective tool for community members, highlighting important activities (e.g., high school outreach workshops) that underscore the developmental goals of the community.

The community database used by the Drupal website has similar upsides to the one created for the Facebook application – it has personal information as well as developmental status and interests and can be used to support level-specific community interactions. Unfortunately it also has the same downsides that we experienced in the prior application, namely members must make a conscious effort to complete and maintain their community profiles. Worse, some aspects of the Drupal support for profile creation are particularly awkward (e.g., uploading profile photos) and have made this process even more burdensome at times (recall that the Facebook application reused content already uploaded to the Facebook accounts). Viewing this downside in a more positive light, a few community members are now sophisticated enough with Drupal development that they are starting to investigate ways to simplify

and refine the profile creation and editing process. They are also considering notification schemes that might help members remember to view and update their profiles once or twice a year.

The Drupal platform has influenced our approach to privacy management, in that the designers were able to embed our university's module for account authentication. The result is that university students, faculty and some alumnae automatically have credentials (i.e., their university account), which short-circuits the first step in the enrollment process (for others, the university supports an affiliate system for "friends of the university" to create their own credentials). This approach has benefits similar to those obtained from reusing Facebook accounts, but puts the emphasis for security management on a single university rather than on a widely-used and for-profit social networking site. The reliance on university credentials may also remind members that the wConnect Online website is supporting education goals versus the purely social emphasis of Facebook. The downsides are that some interested females must take a separate step to create and invoke university credentials before joining the online community, and that any changes or concerns with university authentication will also be felt in wConnect Online.

An interesting trend that we have observed since the Drupal site was launched is that members continue to discuss and enhance the "fun stuff" section of the site – visualizations, games, videos, and so on – that the contributing members hope will engage new members who are exploring the system. There is a sense that these offerings may be particularly helpful for increasing participation among younger members. A recent addition is a "points counter"; members receive credit, in game-like fashion, for different kinds of contributions and eventually earn badges or even a t-shirt gift as their cumulative participation increases. The motivation for these initiatives is engagement and participation, but the members also recognize that if too many of these activities appear, the community site may come to be seen as a place for socializing, perhaps detracting from its more "serious" purpose of raising and discussing issues and education related to CIS careers. A persistent challenge for wConnect Online will be designing and hosting activities that are engaging to members with widely varying goals and expectations.

Table 5: Generalized Claims Analysis

An open-source content management system that is rich but extensible by individuals with varying levels of technical expertise...

- + offers a range of *professional development* activities for members, ranging from simple content creation or editing to coding new features
 - + encourages long-term *member appropriation* and extension of a shared community site
 - + enables exploration of many options for *engaging* community members at different levels
 - BUT programming tools that demand extensive skills to get started may disengage even motivated members from helping to build and extend the community site
-

Online profiles that encode and mediate community members' developmental roles...

- + emphasizes users' professional *identity* as members of this community
 - + invites community activities that have been specialized for different developmental levels
 - BUT creation and maintenance of profile data may be burdensome at times
-

Emulating the user interface presentations and interaction styles of common websites...

- + enhances *user interface transparency* so that benefits may outweigh costs of learning to use a new website
 - + suggests a mechanism for reaching out to prospective members already using the other sites
 - BUT a user interface that is identical or very similar to other websites may introduce confusion or overlap of the website's mission
-

Authenticated access to a developmental community website...

- + reinforces the expectation that the developmental community website will protect members' privacy while they are discussing personal concerns about education and careers
 - BUT if the authentication service is not seen as trustworthy by all members, feelings of privacy and comfort may be compromised
-

Activities that invite relaxation and recreation along with professional development...

- + suggests that members of the community should have fun along with pursuing their interests in education and careers
 - + offers activities that might be more *engaging* to new or young members who have not yet adopted personal developmental community roles or goals
 - BUT an overwhelming balance of recreational activities may obscure the core developmental mission of the community
-

TOWARD A DESIGN SPACE FOR DEVELOPMENTAL COMMUNITIES

We have described an ADR process that began with a problem grounded in research on women in computing and in online communities, but where the understanding of the problem and associated design approaches has evolved through four phases. We characterized each phase by a set of orienting design concerns that were addressed via prototyping, and subsequently analyzed and documented as design reflections. At this point we shift to a more general discussion of design lessons learned, synthesizing across the design rationale that we developed during the four phases (see Table 5). Our intention is to surface and share design concepts that seem to work well for engaging and supporting members of a developmental community online.

From the start of this research project, we were committed to participatory development of the community system. However, it took the designers several attempts to find an infrastructure that mapped well to community members' interests and skill base. As we have observed the members working with Drupal in recent years, we have also noted the benefits of a CMS that enables contributions at multiple levels of sophistication. In hindsight, this is an obvious analogue to the range of developmental phases that the community was intended to support. The net result has been that the current team of "community system developers" form a kind of microcosm that serves as a specialized developmental community, wherein the developmental activities consist of learning and refining Drupal CMS skills.

What gives a developmental community its developmental character? One answer is the implicit variation in interests and types of participation. But when each member's developmental level is explicit – even at the rough granularity of high school versus university student – the community can use this information not only to browse or identify members of a certain sort, but also to build community activities that are predicated on these levels. The simple process of writing about oneself "as a community member" contributes to one's self-perception (Bem, 1972) and serves as an initial step toward defining a personal identity within this community's discourse.

The design team explored multiple options for minimizing the cost of learning to use a new community website, from direct reuse of Facebook, to a more nuanced model in the Facebook group, to the more varied and general web application styles provided by Drupal. While Facebook appeared to be the simplest and most attractive style, it seemed to convey that the website was "about" Facebook, which in the end may not be desirable. Looking back, this is a design goal for which we suggest compromise as a strategy – the community website should feel familiar enough to not discourage new users but need not be totally transparent. On the other hand, recruiting a familiar user interface for outreach may be just the right thing to do.

From the beginning, community members have emphasized that their discussions of education and career issues might involve personal issues (e.g., financial or relationship goals; Rosson et al., 2008), making perceived privacy an important design concern. Thus each website had some protocol for user accounts and authentication. In the two Facebook websites, the step was transparent for existing Facebook users, whereas in the Drupal website it was transparent for university students and staff. The contrast is that when a trusted institution (we presume this is the case for the university) services the authentication, it carries a different weight than a commercial for-profit enterprise like Facebook. Thus our recommendation is to reuse existing institutional authentication protocols but to consider carefully the members' trustworthiness beliefs about the institution managing the process.

Finally, our design understanding of what can count as member engagement has broadened considerably over the ADR process. Initially we were very oriented toward the professional growth of members, for instance through CIS-related discussions or skill-enhancing web development. Ultimately, however, we have realized that one element of community building may be simply relaxing and having fun, and that what may be immediately engaging to a member at an advanced level of development may be foreign or even odd to a less advanced member.

CURRENT STATUS OF WCONNECT

As one would expect from its developmental orientation, wConnect Online has always attracted "members" at many levels of commitment and engagement. Some people enroll and visit the website, but never contribute; others participate in real-world activities (e.g., a workshop or panel) but do not register or join the wConnect Online activities. Others join the team of more active members who take on tasks that result in new online content or activities.

With respect to participation measures, levels of involvement are greater for the Drupal application than they were in Facebook or in BRIDGE, presumably due at least partly to the larger set of options it offers. After one year of the interactive Facebook application, there were 7 archived chats (typically held once every other month); one discussion topic with two replies; two wall posts; and about two dozen photos (all from group workshop events). In contrast, after the first year with the Drupal website there were 48 blog entries (from 8 different authors), 21 discussion topics with

12 replies, 28 images (including not only group events like workshops, but also personal milestones like moving, graduation, marriage); and 20 video clips (alumna interview segments; a middle school girl who "reviews" the iPad). In the new website, the community does not archive its online chats as part of the system, but instead summarizes and shares them in newsletters. When this paper was written in late 2011, we had 52 registered members in wConnect Online; we continue to gradually add new members. Interestingly the community's high school outreach efforts and related tools are beginning to serve a recruiting function: one of our newest members is an educator who none of the community members have met, but who is interested in sponsoring one of her own hands-on web programming workshops using the tools provided by wConnect. She has become involved in a new thread of outreach activities, offering hands-on workshops for even younger (middle school) girls.

Note that even though the community no longer maintains its Facebook application, we continue to maintain a Facebook presence as a group; the group is very useful for just-in-time recruiting of members and for advertising events to students or professionals who have not yet registered for the Drupal system. For example, when wConnect members conduct workshops for high school girls, they mention the Facebook group as a quick and easy way to affiliate with the community, then follow up to seek more active participation.

CONCLUSIONS AND FUTURE WORK

We have analyzed and discussed a set of design tradeoffs encountered in the exploratory design of an online community system aimed at creating and supporting a developmental learning community of women interested in CIS. We have characterized the process as an example of ADR that was motivated by the problem of attracting and retaining women to CIS and the opportunities inherent in establishing and leveraging social connections among women who vary in their interests and skills in CIS. We described the design goals that helped to focus our efforts at each of four phases and shared lessons learned in the form of design rationales.

Looking across phases and website designs, we have observed that personal and community growth (e.g., via development and appropriation) often trade off with familiarity and ease of use (e.g., transparency). Features that enable a community's members to learn about and create many options for activities tend to be complex to understand and learn. It also appears that central community goals like engagement and professional identity may best be seen as second-order goals that must first be enabled by building a critical mass of members who can contribute meaningful content and activities. Like transparency, privacy is quite constrained by the user interface and services of the underlying platform. For others seeking to build similar online communities, popular platforms like Facebook may well be helpful in building momentum and critical mass, but the more open (though less familiar) services of open source platforms like Drupal can engage members in active development of their own community.

Our discussion of design rationale has focused on tradeoffs considered in this particular set of prototypes, but more generally can be seen as a theoretical contribution in the domain of developmental communities. Other work has documented a broad range of arguments and examples of design rationale as theory, showing how a body of design rationale accumulated over related projects can provide theoretical account of a problem domain (Carroll and Rosson, 2003b). The analysis offered here provides an initial step in this direction for the design domain of online support of developmental communities, and we hope it will be extended by our continuing work and the work of other developmental community designers.

In the long run, the goal of wConnect is to build a community of enough women, at enough levels of development, that together they can help to address the problems of declining numbers of women in CIS. This goal is still in the future: Our focus thus far has been on the practical aspects of building the online community system and recruiting a critical mass of members. Because the community has been in existence since 2008, we have used it to maintain connections with former undergraduates and high school students who joined the community at one level but are now at another. For example, our undergraduate alumnae sometimes join us for the online chats, giving us the opportunity to see how they are doing in their new professional lives, as well as to catch up with one another on a more personal basis. As the number of members who move through such transitions increases, we expect to see concomitant increases in the developmental commitments and support available within the community.

Like others working on expansive concepts of participatory design (Costabile et al., 2006; Fischer and Ostwald, 2002, we believe that the end-user programming enabled by Drupal (where moderately sophisticated users can reuse and tailor modules and themes) is an important contributor to any group's ability to manage its own evolution. Although the recruitment and engagement of members via wConnect Online will always be underway, the progress that current members have made in envisioning and building their own community system is a promising indication of a rich and continuing evolutionary trajectory.

ACKNOWLEDGEMENTS

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REFERENCES

- American Association of University Women (2000) *Tech-Savvy: Educating Girls in the New Computer Age*. Washington, DC: American Association of University Women.
- Barker, L.J. and K. Garvin-Doxas (2004) "Making Visible the Behaviors that Influence Learning Environment: A Qualitative Exploration of Computer Science Classrooms," *Computer Science Education* (14) 2, pp. 119-145.
- Barker, L.J., C. McDowell, and K. Kalahar (2009) "Exploring Factors that Influence Computer Science Introductory Course Students to Persist in the Major," in *Proceedings of the 39th Technical Symposium on Computer Science Education* S. Rodger, J. Dougherty, M. Guzdial, S. Fitzgerald and E. Walker (Eds.), New York, NY: ACM Press, pp. 153–157. Portland, OR, March 12-15, 2008.
- Baskerville, R. L. (1996) "A Critical Perspective on Action Research as a Method for Information Systems Research," *Journal of Information Technology* (11) 3, pp. 235-246.
- Bem, D. (1972) *Self-Perception Theory*. New York, NY: Academic Press.
- Blackwell, A. F. (2002) "First Steps in Programming: A Rationale for Attention Investment Models," in *Proceedings of the IEEE 2002 Symposia on Human Centric Computing Languages and Environments* E. Glinert (Ed.), Los Alamitos, CA: IEEE Computer Society, pp. 2-10. Arlington, VA, September 3-6, 2002.
- Carroll, J. M. (2000) *Making Use: Scenario-Based Design of Human-Computer Interactions*. Cambridge, MA: MIT Press.
- Carroll, J. M. (2012) *The Neighborhood in the Internet: Design Research Projects in Community Informatics*. London, UK: Routledge.
- Carroll, J. M. and W. Kellogg (1989) "Artifact as Theory-Nexus: Hermeneutics Meets Theory-Based Design," in *Proceedings of CHI 89: Conference on Human Factors in Computing Systems* J. K. Bice and C. Lewis (Eds.), New York, NY: ACM Press, pp. 7-14. Austin, TX, April 30 – May 4, 1989.
- Carroll, J. M. and M.B. Rosson (2003a) "A Trajectory for Community Networks," *The Information Society* (19) 5, pp. 381-393.
- Carroll, J. M. and M.B. Rosson (2003b) "Design Rationale as Theory," in J.M. Carroll (Ed.), *HCI Models, Theories, and Frameworks: Toward an Interdisciplinary Science*. San Francisco, CA: Morgan Kaufmann, pp. 231-261.
- Cohoon, J. (2007) "An Introductory Course Format for Promoting Diversity and Retention," in *Proceedings of the 38th Technical Symposium on Computer Science Education* I. Russell, S. Haller, J. Dougherty, S. Rodger (Eds.), New York, NY: ACM Press, pp. 395-399. Covington, KY, March 7-11, 2007.
- Cohoon, J. and W. Aspray (Eds.) (2006) *Women and Information Technology: Research on Underrepresentation*. Cambridge, MA: MIT Press.
- Coleman, H. (2009) *The Personality Traits of Instrumentality and Expressiveness in Relation to Microcomputer Playfulness*. Ph.D. Dissertation, University of Texas.
- Costabile, M., A. Piccino, D. Foglio and A. Marcante (2006) "Supporting Interaction and Co-evolution of Users and Systems," in *Proceedings of the Working Conference on Advanced Visual Interfaces, AVI 2006 A*. Celentano (Ed.), New York: ACM Press, pp. 143-150. Venice, Italy, May 23-26, 2006.
- Fischer, G. (2003) "Meta-design: Beyond User-centered and Participatory Design," in J. Jacko (Ed.), *Human-Computer Interaction: Theory and Practice*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 88-92.
- Fischer, G. and J. Ostwald (2002) "Seeding, Evolutionary Growth, and Reseeding: Enriching Participatory Design with Informed Participation," in *Proceedings of the 7th Biennial Participatory Design Conference 2002* T. Binder, J. Gregory and I. Wagner (Eds.), Palo Alto: CPSR, pp. 135-143. Malmö, Sweden, June 23-25, 2002.
- Greenbaum, J. and M. Kyng (1991) *Design at Work: Cooperative Design of Computer Systems*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Guzdial, M. (2003) "A Media Computation Course for Mon-majors," in *Proceedings of the 34th Technical Symposium on Computer Science Education* S. Grissom, D. Knox, D. Joyce and W. Dann (Eds.), New York, NY: ACM Press, pp. 104-108. Reno, NV, February 19-23, 2003.
- Guzdial, M. and A. Tew (2006) "Imagineering Inauthentic Legitimate Peripheral Participation: An Instructional Design Approach for Motivating Computing Education," in *Proceedings of the 2nd International Workshop on Computing Education Research, ICER '06* R. Anderson, S. Fincher and M. Guzdial (Eds.), New York: ACM Press, pp. 51-58. Canterbury, UK, September 9-10, 2006.
- Hevner, A. R., S. March, J. Park and S. Ram (2004) "Design Science in Information Systems Research," *MIS Quarterly* (28) 1, pp. 75-105.

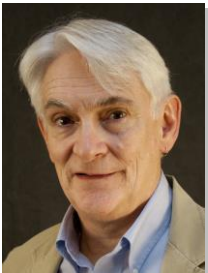
- Kafai, Y. B. (2010) "World of Whyville: An Introduction to Tween Virtual Life," *Games and Culture* (5) 1, pp. 3-22.
- Kavanaugh, A., J. Carroll, M. B. Rosson, D. Reese and T. Tzin (2005) "Participating in Civil Society: The Case of Networked Communities," *Interacting with Computers* (17) 1, pp. 9-33.
- Kelly, S., C. Sung and S. Farnham (2002) "Designing for Improved Social Responsibility, User Participation and Content in Online Communities," in *CHI 2002: Proceedings of Conference on Human Factors in Computing Systems* D. Wixon (Ed.), New York, NY: ACM Press, pp. 391-398. Minneapolis, MN, April 20-25, 2002.
- Kim, A.J. (2000) *Community Building on the Web: Secret Strategies for Successful Online Communities*. Berkeley, CA: Peachpit Press.
- Leonard, E. B. (2003) *Women, Technology, and the Myth of Progress*. New York, NY: Prentice Hall.
- Margolis, J. and A. Fisher (2002) *Unlocking the Clubhouse: Women in Computing*. Cambridge, MA: MIT Press.
- McDowell, C., L. Werner, H. Bullock and J. Fernald (2003) "The Impact of Pair Programming on Student Performance, Perception, and Persistence," in *Proceedings of ICSE 2003: The 25th International Conference on Software Engineering* L. Clarke, L. Dillon and W. Tichy (Eds.). Washington, D.C.: IEEE Computer Society, pp. 602-607. Portland, OR, May 3-10, 2003.
- Muller, M. J. (2003) "Participatory Design: The Third Space in HCI," in *The Human-Computer Interaction Handbook* J. Jacko and A. Sears (Eds.). Hillsdale, NJ: L. Erlbaum Associates, pp. 1051-1068.
- Preece, J. (2000) *Online Communities: Designing Usability, Supporting Sociability*. Chichester, UK: John Wiley & Sons.
- Preece, J. and D. Maloney-Krichmar (2005) "Online Communities: Design, Theory and Practice. Introduction to a Special Issue on Online Communities," *Journal of Computer-Mediated Communication* (10) 4, article 1.
- Rosson, M. B. and J. M. Carroll (2002) *Usability Engineering: Scenario-Based Development of Human-Computer Interaction*. San Francisco: Morgan Kaufmann.
- Rosson, M. B. and J. Carroll (2006) "Developmental Learning Communities," *Journal of Community Informatics* (2) 2, <http://ci-journal.net/index.php/ciej/article/view/354/255>.
- Rosson, M. B., J. M. Carroll, and H. Sinha (2011a) "Orientation of Undergraduates Toward Careers in the Computer and Information Sciences: Gender, Self-efficacy and Social Support," *ACM Transactions on Computing Education* (11) 3, Article 14.
- Rosson, M. B., J. M. Carroll, D. Zhao and T. Paone (2009a) "wConnect: A Facebook-based Developmental Learning Community to Support Women in Information Technology," in *Proceedings of Communities and Technology 2009*, New York: ACM, pp. 125-134. State College, PA, June 25-27, 2009.
- Rosson, M. B., D. Dunlap, P. Isenhour and J. M. Carroll (2007) "Teacher Bridge: Building a Community of Teacher Developers," in *Proceedings of HICSS 40: Hawaii International Conference on System Sciences* R. Sprague (Ed.), Washington, D.C.: IEEE Computer Society, 10 pages, CD-ROM. Waikoloa, Big Island, HI, January 3-7, 2007.
- Rosson, M.B., A. Ioujanina, T. Paone, G. Sheasley, H. Sinha, G. Ganoie, J. M. Carroll and J. Mahar (2009b) "A Scaffolded Introduction to Dynamic Website Development for Female High School Students," in *Proceedings of the 40th Technical Symposium on Computer Science Education* S. Fitzgerald, M. Guzdial, G. Lewandowski and S. Wolfman (Eds.), New York: ACM Press, pp. 226-230. Chattanooga, TN, March 4-7, 2009.
- Rosson, M. B., H. Sinha, T. Hansford and J. Mahar (2010a) "Offering Early Success Experiences in Software Construction: Experiences Teaching Dynamic Website Development to High School Girls," in *Proceedings of ICALT 2010, 10th International Conference on Advanced Learning Technologies* M. Jemni, Kinshuk, D. Sampson and J. Spector (Eds.), Washington, DC: IEEE Computer Society, pp. 458-460. Souse, Tunisia, July 5-7, 2010.
- Rosson, M. B., H. Sinha, D. Zhao and J. M. Carroll (2010b) "wConnect: A Developmental Community for Women in Computer and Information Science," in M.B. Rosson (Ed.), *Advances in Learning Processes*. New York: InTech, pp. 149-165.
- Rosson, M. B., H. Sinha, D. Zhao, J. M. Carroll, C. Ganoie and J. Mahar (2008) "Cultivating a Landscape of Online Places for a Developmental Learning Community," in *Proceedings of ICALT 2008, 8th International Conference on Advanced Learning Technologies* P. Diaz, Kinshuk, I. Aedo and E. Mora (Eds.), Washington, DC: IEEE Computer Society, pp. 311-315. Santander, Spain, July 1-5, 2008.
- Rosson, M. B., H. Sinha, D. Zhao, J. M. Carroll, C. Ganoie and J. Mahar (2009c) "wConnect: Cultivating a Landscape of Online Places for a Developmental Learning Community," *Educational Technology & Society* (12) 4, pp. 87-97.
- Rosson, M. B., E. Thiry, D. Zhao and J. M. Carroll (2011b) "Developing an Online Community for Women in Computer and Information Sciences: A Design Rationale Analysis," in *Proceedings of HICSS 44: Hawaii International Conference on System Sciences* R. Sprague (Ed.), Washington, D.C.: IEEE Computer Society, 10 pages, CD-ROM. Kauai, HI, January 4-7, 2011.
- Rosson, M. B., E. Thiry, D. Zhao and J. M. Carroll (2011c) "Teachers as Designers: Enabling Teachers to Specify Dynamic Web Programming Projects for Students," in *End User Development: Third International Symposium, IS-EUD 2011* M. Costabile, Y. Dittrich, G. Fischer and A. Piccinno (Eds.), Heidelberg, Germany: Springer Lecture Notes in Computer Science, pp. 233-238. Torre Canne, Italy, June 7-10, 2011.
- Sashaani, L. (1993) "Gender-based Differences in Attitudes Toward Computers," *Computers & Education* (20) 2, pp. 169-181.

- Schuler, D. (1994) "Community Networks: Building a New Participatory Medium," *Communications of the ACM* (37) 1, pp. 38-51.
- Sein, M. K., O. Henfridsson, S. Purao, M. Rossi and R. Lindgren (2011) "Action Design Research," *MIS Quarterly* (35) 1, pp. 37-56.
- Stevens, G., V. Pipek and V. Wulf (2009) "Appropriation Infrastructure: Supporting the Design of Usages," in *End User Development: Second International Symposium, IS-EUD 2009* V. de Ruyter, V. Pipek, M. Rosson and V. Wulf (Eds.), Heidelberg, Germany: Springer Lecture Notes in Computer Science, pp. 50-69. Siegen, Germany, March 2-4, 2009.
- Venkatesh, V., M. Morris, G. Davis, and F. Davis (2003) "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27) 3, pp. 425-478.
- Vygotsky, L.S. (1978) *Mind in Society: The Development of Higher Psychological Processes* Cambridge, MA: Harvard University Press.
- Wenger, E. (1998) *Communities of Practice: Learning, Meaning and Identity*. Cambridge, UK: Cambridge University Press.
- Wulf, V., V. Pipek and M. Won (2008) "Component-based Tailorability: Enabling Highly Flexible Software Applications," *International Journal of Human-Computer Studies* (66) 1, pp. 1-22.

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