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Community-based Learning: Design Patterns and Frameworks

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Abstract. Information technology adoption and literacy are typically not first-order goals for community-based volunteer organizations. Nonetheless, information technology is vital to such groups for member recruiting and management, communication and visibility to the community, as well as primary group activities. However, volunteer organizations are often not able to make effective use of Internet-based technologies and content. They lack resources of all sorts (money, skills, telecommunications infrastructure) as well as organizational structures, protocols, and continuity to effectively cope with the rate of change in Internet technology. We describe a *design pattern*, a standard solution schema for a recurring problem, that proposes a self-sustained process in which volunteer organizations identify and analyze their technology needs, and then learn about information technology through active engagement in solving their own problems. The pattern, called Community-based Learning, is grounded in our fieldwork experience in several community computing projects. We discuss patterns and pattern frameworks as a research approach to community computing.

Introduction

Personal computing and the World-Wide Web (WWW) have made information technology (IT) far more accessible and versatile. More people interact collaboratively with IT than ever before, and for many the key tool and environment is their Web browser. However, most users of the WWW are

consumers and relatively passive observers, rather than producers and active participants. The WWW is a highly effective delivery channel for government and commercial information and medium for form-filling transactions, but it does not as effectively afford opportunities for creative and active end-user participation, such as designing Web sites and publishing of Web content.

Yet there has never been a time when it is more critical for everyone to relate to and to participate in IT actively and creatively. Many recreational, learning, and work activities require at least some IT skill, and this is becoming more pervasive. People who do not have these skills or who cannot acquire these skills may become marginalized in the society of the future.

The point of departure for our project is the observation that community-based volunteer organizations, like church groups, service organizations, arts and cultural groups, clubs and recreational groups, are paradoxically both more important and less well-supported than in the past. They are more important because they are bastions against the decline of community described by Bellah, Madsen, Sullivan, Swindler and Tipton (1986) and by Putnam (2000) among others, and because this sector of organizational activity is growing rapidly. In the state of Pennsylvania, for example, there are now 700,000 non-profit organizations, compared to only 12,500 in 1940. Moreover, non-profit organizations, which are largely community-based and rely heavily on volunteer labor, now account for about 10% of total employment in the state (Grobman, 2002).

(Nota Bene that many of our literature sources and analyses are deliberately restricted to American society, and more specifically to the states of Pennsylvania and Virginia. This is reflects the locations of our primary study sites. As far as we can tell from visits and discussions with European colleagues, the larger situation characteristics are not dramatically different in at least some other western societies. We simply do not know how our sources, observations, and analyses might generalize to other, especially non-western, societies.)

But community volunteer organizations are less well supported with respect to IT than in the past. No longer can an organization function with a typewriter and a telephone. Maintaining PCs, networks, and software, perhaps even servers, and obtaining or otherwise organizing training and other personnel support is an order of magnitude more expensive, financially and with respect to organizational structures.

Our premise is that the learning of key technology skills and the motivation for applying those skills are increased when people are empowered to become creators rather than consumers of technology. This premise derives from diverse research in psychology showing that *perceived control* is critical to effective engagement, learning and human development, and to the achievement of autonomous and sustained performance (Carroll, 1998; Deci and Ryan, 1985; Knowles, 1973; Ryan and Deci, 2000; Vygotsky, 1978).

This paper, in part, describes a “pattern”, that is, a solution-schema, called “Community-based Learning”. We draw upon discussions of design patterns in other disciplines such as architecture (Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, and Angel, 1977) and software (Gamma, Helm, Johnson, and Vlissides, 1994). Patterns generally include a problem, a description of the problem’s context, an analysis of relevant forces, that is, resources and trends that enable or constrain possible solutions to the problem, a statement of our solution to the problem, a discussion of how the resulting context, that is, how the problem context might be changed by adoption of our solution, and examples of the solution, pointers to instantiations of the pattern in our on-going work.

Patterns provide a common language to be shared among domain experts for codifying and developing design knowledge. For example, among Alexander's patterns is the Street Café pattern. The problem this pattern addresses is the need to enhance feelings of openness and access to people and activity in city spaces. The context is tightly packed, tall buildings and narrow streets, with many people anonymously hurrying along. The forces are construction and operation costs, the hassles of getting municipal approvals to open a café onto the sidewalk, the personal approach-avoidances of making eye contact and meeting others in public, and so forth. And so on. Documenting and analyzing the pattern provides a resource to designers and other design stakeholders for sharing and improving solutions.

In the balance of the paper, we first characterize the problem that our pattern, Community-based Learning, addresses, namely, that community volunteer organizations often cannot make effective use of Internet technologies and content. They have little control over their own IT and seldom participate actively in IT related activities. They need to use the Internet for member recruiting and management, communication and visibility to the community, as well as primary group activities. But they often lack relevant resources, including skills and equipment.

We then examine aspects of contemporary societal context bearing on this problem. IT is increasingly pervasive, and important to community organizations, but they and their members relate to it and participate in it in limited and fairly passive ways. Such passive interactions do lead to enhanced technology literacy and skills, but they also keep people from playing a more active and creative role in using technology (e.g., by becoming publishers of web content).

Thereafter, we present our solution to the problem. We advocate an active and collective process of problematizing technology, in which organizations recognize and analyze their technology practices and needs, and then learn about IT through contining engagement in solving their own problems. In the balance of the paper, we analyze how the original problematic context might be changed and improved by adoption of this solution, including aspects that go beyond the

original problem statement. We exemplify how this solution pattern was implemented in real community settings.

More broadly, our concern, and the larger contribution of this paper, is to illustrate a research approach to codifying design knowledge in community computing through patterns and pattern frameworks. In community computing, where most technical interaction is deeply participatory and all about empowering people where they live, it is critical to be able to share design solutions. This is highly consistent with the developing methodological vision of pattern languages in CSCW and community computing (Erickson, 2000; Schuler, 2002).

Problem: Lack of Control over IT

Not so many years ago, it was a radical proposition to assert that community organizations could maintain information and manage activities through the Internet. Through the 1980s, community groups used the Internet to facilitate information dissemination, discussion, and joint activity pertaining to municipal government, public schools, civic groups, local events, community issues and concerns, and regional economic development and social services. Some of these projects have become touchstones of Internet activism—jobs, housing, and veterans' issues in the Berkeley Community Memory (Farrington and Pine, 1997), community health in the Cleveland Free Net (Beamish, 1995), problems of the homeless in the Santa Monica Public Electronic Network (Rogers, Collins-Jarvis and Schmitz, 1994), and public education and Native American culture in the Big Sky Telegraph (Uncapher, 1999).

In their decade, these projects were the leading edge of community networking. But in fact they were implemented on relatively simple networking software platforms—the file transfer protocol (ftp). People were inspired to be able to use this new medium to exchange civic information and perspectives with fellow citizens. But of course the broader context was that most civic and community-based organizations, and indeed most commercial and governmental organizations as well, were still operating in a world of typewriters and telephones.

Today, baseline expectations throughout western society about communication are different. One expects to be able to identify and access an organization's url (universal resource locator). One expects to be able to send or receive an email announcing a meeting. The pervasive adoption of email and the WWW present opportunities and challenges to community-based volunteer organizations. The opportunities are obvious. Organizations can get their message out for "free". Web communication may result in more time-efficient management of work, and so on.

The challenges are less obvious. The Web is easy and accessible to all, if accessibility means browsing. But when a community organization wants to post

and serve current information about activities and new programs, it faces a host of issues—Who will design and create the Web site, the various pages, and the content in the pages? Who will maintain the site and contents, run the Web server, and update software? It is likely that no one in the organization has these skills. If so, it is unlikely that anyone wants to invest much time and effort into acquiring these skills.

The problem we are addressing is that community-based volunteer organizations experience a lack of control over their own IT. What makes the problem worse is that these organizations can have so little in-house expertise that they are not even able to recognize the extent to which they lack control, or to diagnose how they might begin to remedy the situation. An example from our own fieldwork was an environmental group who felt they were participating in IT activities over which they had control, because they had hired a commercial vendor to produce their web site. Indeed, when they wished to change the Web site design, they discovered that this outsourcing had deprived them of control. The vendor had all the knowledge, all the content, and all the code (Farooq, Merkel, Nash, Rosson, Carroll, and Xiao, 2005). Hence, part of the problematic lack of control over IT is not realizing that this problem exists in the first place.

Context: American Society and the Internet

A key context for the challenges that community-based organizations face with respect to control of their own IT is the rapid and pervasive growth of computing and the Internet during the past two decades. The WWW began as a way for elite military and academic groups to exchange information but has evolved rapidly into a powerful information source for ordinary citizens.

Our empirical work takes place in North America, chiefly in Pennsylvania and Virginia in the United States. Sixty three percent of American adults now use the Internet. Since 2000, the distribution of Internet users across gender, income, and race is surprisingly regular. Use of the Internet has become normal in daily life. On a typical day in 2004, 70 million adult Americans logged on to the Internet (about 35%), up from about 50 million in 2000. Fifty-eight million used email; 35 million got news; 24 million did job-related research; 24 million looked for political information. Ninety-four million Americans have used the Internet to find or to share health-related information; 97 million Americans have used government Web sites. Sixty-five percent of American Internet users believe that the Internet has helped their relationships with friends; 56% believe it has helped their relationships with their own family members. Sixty million American homes now have broadband Internet access, compared with 6 million in 2000. (All data are from Rainie and Horrigan, 2005).

These facts and trends contrasts interestingly with trends relating to the ability and interests of Americans in preparing for more active roles with respect to IT.

For example, undergraduate enrollments in computer science fell about 25% between 2000 and 2003 (Computer Research Association, 2003).

Moreover, as the Web has evolved, browsing, searching, and carrying out purchases has become easier and more accessible, while creating dynamic, interactive Web content has become increasingly more difficult, requiring server-based mechanisms (e.g., servers that support web-based discussion forums), embedded components written in other programming languages (e.g., Java applets, ActiveX controls, Flash, or JavaScript), or plug-ins that augment the user's browser and allow it to receive data in closed, proprietary formats. These advances create richer experiences for the passive information consumer on the Web, but they add technical obstacles for users interested in constructing novel, interactive functionality to their own creations.

Forces

Two of the key forces shaping the solution to the problem in this pattern are the lack of resources among volunteer community-based groups and the important role such groups play in social capital formation.

Lack of Resources

Community volunteer organizations generally lack financial resources, telecommunications infrastructure (high bandwidth connectivity), equipment, skills, and access to training. They lack almost every relevant resource to support an IT strategy. In our studies, we have found that it is typical for community organizations to have no budget line item for technology. In one case, a community organization we worked with only had Internet access via the home connections of its members; the organization as such had no connectivity other than its own phone line. Lack of resources is a force—it affects how community volunteer organizations will address the problem of having less control of their IT.

Lack of relevant resources is exacerbated by the fact that IT is generally *not* a core concern of these organizations. Not surprisingly, a local historical society is chiefly concerned with preservation of sites and artifacts, informal education programs, and interactions with school and community groups. Even though an outside consultant might conclude that IT is a key to addressing their primary concerns in an efficient and effective manner, they do not necessarily see it that way.

Social capital

Social capital is the generalized trust, social interaction, and mutual reciprocity throughout a group, a community, or a society (Coleman, 1990). Because community volunteer organizations depend upon intrinsic motivation and personal commitment, rather than material rewards, social capital formation and preservation is especially critical to their survival and growth (King, 2004). And the social capital produced through participation in these organizations is critical to the whole society (Putnam, 2000).

Indeed, many studies of contemporary American society have concluded that traditional mechanisms of social capital formation in American communities are in decline (e.g., Bellah, Madsen, Sullivan, Swindler, and Tipton, 1986; Putnam, 2000). For example, between the 1960s and the 1990s, participation rates in a variety of civic activities declined: Red Cross volunteering declined by 60 percent; participation in parent-teacher organizations declined by nearly half, membership in the League of Women Voters and in the Jaycees both declined by 40 percent; the number of people reporting that they attended a public meeting on town or school affairs in the past year has declined by more than a third; volunteering of Boy Scout troop leaders declined by a quarter; voter turnout in national elections declined by nearly a quarter; churchgoing and church-related activities declined by a sixth; the proportion of Americans who socialize with neighbors more than once a year declined by nearly a sixth.

In this societal context, the formation and preservation of social capital through participation in community groups has become of greater importance to the larger society.

Solution: Community-based Learning

An important alternative to formal pedagogy is learning *informally*. Informal learning refers to learning that occurs outside of classrooms, schools, and other formal instructional environments and activities, and it includes incidental, self-directed, and lifelong learning. People with existing and active commitments to their communities may find it more meaningful to learn about Web programming, for example, by helping to create a Web application for a community service organization, than by attending an intensive programming class. What we know about adult learners suggests that this would indeed be the case (e.g., Knowles, 1973).

In fact, informal learning represents an important part of the common culture of the Internet and its democratic and community roots (Rheingold, 1993). Informal learning of Web technologies often involves "learning by doing", for example, learning in the course of downloading and exploring new software, posting on newsgroups, getting product technical support, or copying and editing

useful or appealing Web pages. Such activities are often situated in "authentic" tasks, providing solutions to real, concrete problems that the learner faces either as an individual or as part of a group or community.

One solution to the problem of lack of control over IT is a self-sustained process of informal learning, in which organizations identify and analyze their technology needs, and then learn about IT through continuing engagement in solving their own problems. We describe this solution as comprising three facets: *reflection*, *analysis*, and *enactment* (see Figure 1). Reflection is a self-assessment on part of the community organization of its relationship to its own IT. It is more effective to come to the realization that there is a lack of control on one's own, than to be told there is a problem by another. Technology self-assessments and discussions of critical incidents within the organization are good approaches for this reflection. In the example, we discussed above, when the environmental group wanted to change their Web site and found that this would be a long and difficult process, they realized that they were not in control to the extent they wanted to be and needed to be.

Organizational competition with peer groups may also prompt reflection, such as multiple environmental organizations in a proximate community competing for project or operations funding from one government source.

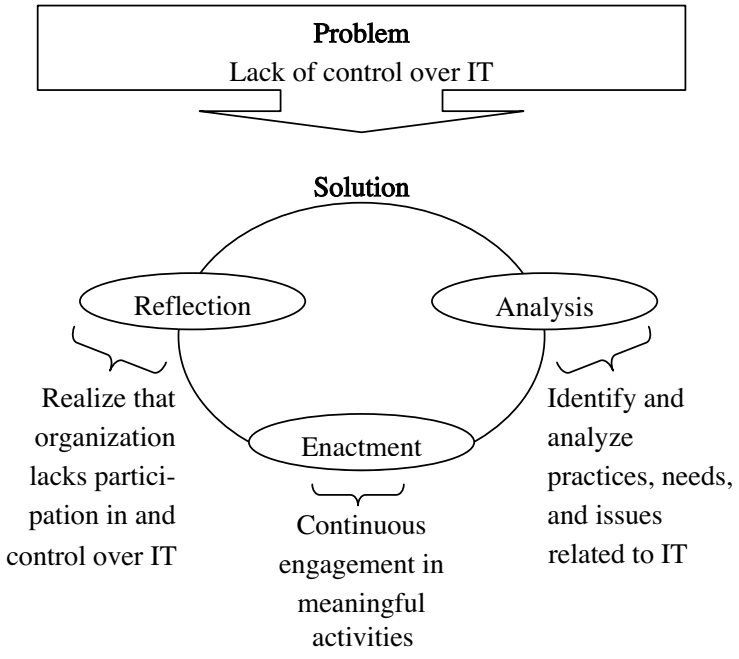

Figure 1. Solution schema for Community-based Learning.

The second facet is identification and analysis of organizational practices, needs, and issues related to IT. Community-based volunteer organizations are unique in that their work activities may be loosely coupled and minimally coordinated (Carroll, 2001) they depend primarily on volunteerism, they face a lack of financial and temporal resources, and so forth, which makes them unique. Technology needs and issues must be identified and analyzed in context of these unique structural features of community-based volunteer organizations. While technology provides many opportunities for these organizations to achieve their civic-oriented goals, community-based volunteer organizations still face formidable challenges in sustaining the use of technology (Merkel, Farooq, Xiao, Clitherow, Carroll, and Rosson, 2005). Part of the reason is that the adoption and use of technology is not aligned with their unique structure. Hence, these organizations must identify and analyze their organizational practices to see how IT can become a part of their organizational day-to-day activities. One way to achieve this is to develop technology plans by assessing the current status of work practices and technology-related activities in the organization (e.g., Techsoup, 2005).

The third facet of our pattern solution is enactment. The solution must be assimilated into everyday practices of the organization. In other words, learning about IT is an on-going facet of everyday activity, in the sense that Dewey (1916) described traditional models for situated learning as integrated into community activities, and in the sense that Lave and Wenger (1991) describe learning as the process of becoming a full participant in a socio-cultural practice. Enactment makes the solution sustainable (e.g., Merkel, Farooq, Xiao, Clitherow, Carroll, and Rosson, 2005).

The three facets are not stages. They are three aspects of the solution that can be discussed independently. Reflection, analysis, and enactment are all key to achieving more control over IT because they are interdependent. A community organization could be engaged in meaningful activities but may not realize that they are not in control of IT, or vice versa. The integration of these facets leveraged through the social mechanisms of the community allows community organizations to inspire and assist one another in learning about, utilizing, and developing skills for advanced IT tools and resources.

Resulting Context

It is difficult to project all the effects of any socio-technical innovation. Several likely consequences of Community-based Learning are the following:

(1) This pattern would help in achieving sustainable learning related to IT. IT is critical for community-based volunteer organizations to achieve their goals for many reasons: it increases their outreach to the larger geographical community, workload may be lightened by email and web-

based communication, and it may provide more convenience for interested stakeholders through features like online donations. However, with the fast-paced change in IT, these organizations have to continuously learn. Our pattern assigns sustainability a key role in the solution by emphasizing the need for *continuous* engagement in meaningful activities *over time*.

(2) This pattern would enhance organizational preservation of technical expertise. For community-based volunteer organizations, technical experts just like other volunteers are temporally volatile. They come, do an IT-related project(s), and go. Since these organizations cannot afford a continual supply of technical experts round the clock, it is natural for these organizations to consider preservation of technical *expertise* rather than *experts*. Our pattern solution, in effect, allows community organizations to develop IT-related knowledge management within the organization. Since community organizations would breed their own technical expertise, and would continuously learn and develop their IT skills over time, a culture of eliciting and packaging organizational memory emerges.

(3) This pattern would help to recast organizational practices related to IT. In our pattern solution, community-based volunteer organizations are cognizant of the fact that sustainable use of technology is key to their long-term success. Decision makers in such organizations make decisions by following a reflexive and proactive process of thinking about how particular technology-related decisions will affect the organizational goals and use of that technology in the near and far future. Part of this process involves perceiving how technology learning will be managed in their organization over time (e.g., Who will update the site when you are on vacation? Who will maintain the site if you, your technology person, or a volunteer leaves the organization?) and how will a long-term technology plan be incorporated as organizational practice (e.g., What will happen to the site when the grant runs out? Who is going to add content to these more dynamic features of the site?).

These consequences are some of the major ones that result from following our pattern solution. They all converge toward greater control over IT for community-based volunteer organizations. We now discuss our pattern solution with two examples in the next section that also illustrate some of the resulting context.

Examples

The Community-based Learning pattern can be illustrated in many community-oriented participatory action research (PAR) projects. Spring Creek Watershed Community (SCWC, http://www.springcreekwatershed.org) is a sustainable development, volunteer organization committed to regional environmental and economic planning, specifically, planning by watershed area rather that by

individual municipalities. The organization works to explain this vision to the larger community, and to show how watersheds have an impact on quality of life and the local economy. We have been working with this organization during the past 18 months (Merkel, Xiao, Farooq, Ganoe, Lee, Carroll, and Rosson, 2004).

A major technology issue that SCWC faced was to redesign their web site. Before our involvement with the organization, SCWC hired a commercial vendor to develop and maintain their web site. SCWC was dissatisfied with the web site because it did not reflect their mission, overall goals, or the fact that they were a local organization concerned with environmental and economic planning. For example, whereas the goal of SCWC was local economic planning, influencing decision makers, and encouraging quality of life through watersheds, the web site depicted them as a generic tree-hugger group. Moreover, the vendor resisted any major restructuring of the web site and often times used his/her sole control over the community organization's technology to avoid changes. Critical incidents such as this forced SCWC to realize the problem. By delegating their web site design and maintenance to a commercial vendor, SCWC lacked control of IT because they were not active participants in web site related activities.

To address this problem, key stakeholders in SCWC first analyzed the situation. This was achieved by holding a kickoff meeting in which many volunteers from SCWC's social network were involved. The result of this meeting was that SCWC would itself redesign their web site so that they retain control over its management. The volunteers who attended this first meeting formed, by default, an informal technology committee that would deliberate over subsequent meetings to see SCWC's vision through.

During the web site redesign process, committee members had different perspectives on "design" that created tension between technical requirements and the need to organize information on the web site effectively. One of the more technical volunteers wanted to follow a rapid prototype approach by proposing several new designs for the web site, whereas another volunteer who had been working previously with SCWC suggested that content design should be done first. The latter proposal meant that layout design would be done afterwards—this would allow SCWC to focus on the organizational message they want to convey through their web site. Key stakeholders in SCWC agreed to the latter idea by being active participants in this negotiation process, trying to tease out the pros and cons of the different proposals put forward. This resulted in the creation of an expert-novice zone of proximal development that concretely led to achieving common ground and understanding through hierarchical modes of learning (Farooq, Merkel, Nash, Rosson, Carroll, and Xiao, 2005).

One way that key stakeholders from SCWC became active participants in the social context of the web site redesign process was through the use of scenarios as conceptual tools (Farooq, Merkel, Nash, Rosson, Carroll, and Xiao, 2005). Key stakeholders used scenarios to convey their input into the design process. Active

engagement through scenarios had a direct effect in eliciting design, communicating design rationale, and resolving design conflicts. It also had an indirect effect by resulting in increased learning on part of the key stakeholders as they were now transitioning from legitimate peripheral participants to more core actors in the redesign process (Lave and Wenger, 1991).

The solutions adopted by SCWC had both short- and long-term implications. In the short-term, the current stakeholders in SCWC's web site have become more technology literate. For example, one of the key stakeholders before did not even know what HTML denoted, and now, after having engaged meaningfully in technology-related activities, is heavily involved in technical discussion forums and basic HTML coding. In the long-term, this solution will result in more autonomy over time, where learning is being captured and transformed into organizational expertise. Some evidence of this is currently being seen. For example, SCWC has incorporated technology-related knowledge management practices within the organization and has thus reduced the dependence on outside technical experts. SCWC now keeps a documented record of all their web site management activities, so that newer volunteers can come in and learn about how web site maintenance and update is done.

Another example of our Community-based Learning pattern comes from a project involving middle and high school science teachers in Giles and Montgomery counties (Virginia, USA) and researchers from Virginia Tech and the Pennsylvania State University (Carroll, Rosson, Dunlap, and Isenhour, 2003). This 5-year participatory action research project sought to facilitate resource and knowledge sharing among communities of teachers. This community included about 60 teachers, many of whom were intrinsically interested in sharing resources and knowledge with colleagues, and all of whom understood that they are under a sort of mandate to more effectively leverage one another. A special challenge for teachers is that they work all day in isolation from their professional colleagues. Moreover, the information technology in their classrooms is oriented to uses within the classroom, and not to supporting teacher collaboration.

A major focus of the project was helping teachers to articulate their frustrations with this situation and their interests and ambitions in collaborating more effectively within their community. This involved teacher-initiated identification of opportunities to share and exchange resources within their own teaching practices, and to recognize and analyze the ways in which IT did and did not support such practices.

A second focus of this project was the initial development and successive refinement of a web-accessible collaborative environment called Teacher Bridge (http://teacherbridge.org) to better support sharing and reusing a range of pedagogical artifacts, including lists of URLs, evolving lesson plans, and interactive activities. We tried to help the teachers to collectively establish new collaborative practices using the Teacher Bridge infrastructure.

For accessibility and familiarity, Teacher Bridge looks and behaves like a typical web site, with all content rendered as HTML and images. A key difference is that users can directly edit Web page content in the browser: Each page has an "Edit" link which supports editing and new page creation using a shorthand notation that requires no external authoring tools or knowledge of HTML. This design is intended to facilitate the kind of easy transition from browsing to authoring, and from authoring to collaborative authoring, that is supported in Swiki and similar wiki-based systems (Guzdial, Rick, and Kerimbaev, 2000).

Each page also has a "Full Editor" link that launches an interactive Java-based client. The Java client supports interactive authoring functionality that is not possible or practical using HTML-based forms. In our current implementation, this includes tools for drawing, creating data tables and charts, uploading files, and creating interactive maps. These data objects can have either static (text- or image-based) or interactive web representations and can be embedded in web pages created in the system.

The interactive client also supports synchronous collaboration. A user list displays the set of users currently logged into the system, and chat facilities provide a simple communication mechanism. All authoring tools also support synchronous interaction, so that users working together on the same object will see each other's changes as they are made. Our belief is that the integration of simple authoring tools, awareness features, and collaboration tools will encourage the kind of content reuse and skill sharing that was perhaps more common in the early days of the Web.

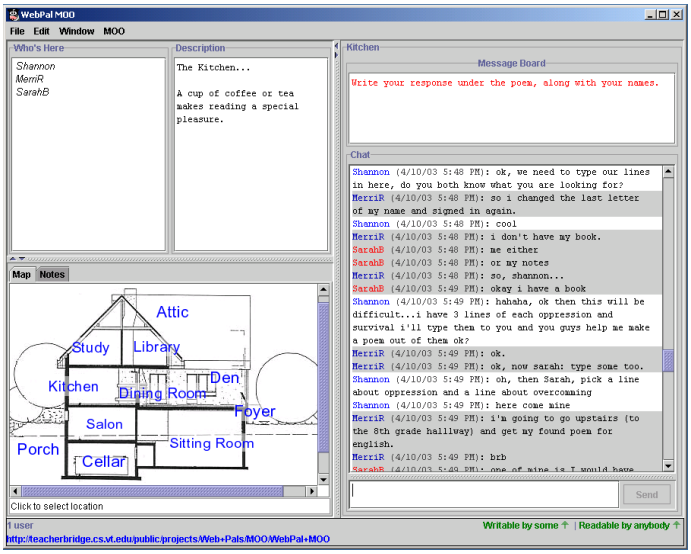

Figure 2. WebPals activity in Teacher Bridge.

An example teacher-designed project is WebPals (Figure 2), a reading and discussion activity for middle school students. The activity was originally created using a text-based multi-user domain (MUD). We developed a collection of Bridge objects for a graphical MUD, a set of "rooms" each with a user list, navigation map, message board, chat area for each, room description, and an optional object to swap with the map using a tab. The objects could be configured and copied easily to create new MUDs or, since each object has a web rendering and corresponding URL, each object could be accessed in a web browser. Adoption of this activity spread rapidly to other teachers; it seemed critical that the technology was demonstrated by peers, and could be quickly appropriated and repurposed.

Teacher Bridge was initially used by a handful of teachers and administrators. However, as part of a process involving the design of a new school website, the school administration decided to host a workshop to introduce Teacher Bridge to the entire staff. The workshop sessions, run by the teachers and administrators, walked groups of teachers through the process of setting up their own sites. In most cases, these were sites for individual teachers' classroom management, but in some cases, they were sites for groups of teachers, teams, or departments. As a result, many Teacher Bridge components were shared and reused among teachers (e.g., authentication privileges of web sites). The diversity of skills among the teachers actually helped strengthen the social network by distributing the burden of training. Using Teacher Bridge, no one teacher had to know everything, and no one teacher had to train everyone else.

Frameworks and Patterns as a Research Approach

Community-based Learning is a design pattern that is a specific solution to the recurring problem of lack of control over IT in community volunteer organizations. We believe that patterns, and related abstractions, offer a research approach that usefully couples codification and application of design knowledge. This is a highly desirable property in practical design domains like CSCW where many kinds of scientific knowledge necessarily converge and interact (see Carroll and Rosson, 2003, for general discussion). In the balance of this discussion, we describe how our approach recruits the notion of *frameworks* from software design to codify knowledge for design.

A framework is a reusable design of all or part of a system that is the skeleton of an application customizable by a software developer (Gamma, Helm, Johnson, and Vlissides, 1994). Frameworks are expressed in a programming language—they are code. A single framework usually contains several to many patterns, and in this sense patterns are narrower than frameworks (Johnson, 1997). Patterns are embodied in and illustrated through their roles in frameworks. Patterns are more abstract, and can be viewed as micro-architectural elements of frameworks. A

well-known example in software engineering is the role of the observer, composite, and strategy patterns in the model-view-controller framework (Gamma, Helm, Johnson, and Vlissides, 1994).

In the CSCW domain of community computing, frameworks are the various types of community networks, community portals, and community organization Web sites. For example, Spring Creek Web site (section 7) instantiates a design framework: It consists of a shallow information hierarchy navigated by a permanently-displayed dynamic menu that foregrounds a statement of the organization's mission, a rationale, and a newsletter archive. The primary graphical content is a set of images depicting typical landmarks throughout the Spring Creek Watershed. This Web site is literally code, but more specifically it is a code base over which the Spring Creek organization now exerts substantial control. It exemplifies an application skeleton that could be immediately repurposed with a few cut-and-paste operations.

As described earlier, the *Community-based Learning* design pattern is an architectural element of this framework. The framework embodies and illustrates the pattern, but it also shows how the knowledge codified in the pattern interacts in design implementation with other patterns. For example, another recurring problem for community organizations is that of *preparing and disseminating newsletters* (Merkel, Xiao, Farooq, Ganoe, Lee, Carroll, and Rosson, 2004). This pattern is also evident in the Web site framework; the current newsletter and the newsletter archive are one click away from the homepage display of the organization's mission and strategic goals. This pattern (which we have not yet analyzed in the same detail as *Community-based Learning*) highlights the need to organize members to contribute content and editorial assistance, and to streamline the formatting of newsletter content into email, Web pages, and other formats (e.g., *pdf* file). It suggests, for example, solution approaches like Wiki-based interface through which organizational stakeholders can add newsletter content without worrying about the details of formatting tags, and possibly press a button to generate the newsletter as a *pdf* file styled according to a pre-defined template.

Another community-oriented design pattern could address the problem of *managing different volunteers* who have a variety of technical skills and vested interests. Within the web site framework, this pattern implies the problem of who does what on the web site while keeping organizational goals in mind. In our fieldwork, we have observed that community organizations want to micro-manage volunteers in relation to specific Web site tasks. In our work with Spring Creek, it was noted that they did not want all volunteers to be able to update the entire web site because it may be detrimental to the organization (volunteers' interest may not match organizational mission, volunteers may involuntarily delete vital content, etc). One possible solution that was discussed was to grant access rights to specific volunteers so they could change web site content only for the sections they had privileges to.

The *preparing newsletters* and *managing different volunteers* are two related patterns to *community-based learning*. We discussed these patterns in context of the *Web site* framework.

Linking patterns explicitly to pattern frameworks is a critical step in developing patterns as a medium for effectively codifying design knowledge. For example, Schuler's (2002) impressive pattern language collection has had limited utility and impact. This collection is organized as a searchable list. It does not link patterns to frameworks, either in the sense of providing concrete exemplification (i.e., code) or in the sense of illustrating how multiple patterns can work together. Thus, it does not provide enough support for bridging from knowledge to design.

First, using the notion of frameworks in community computing gives us an analytic lens to *concretely* study recurring problems in this domain. Patterns themselves are abstract constructs that have little meaning and implication without context. Frameworks add this context by tangibly illustrating the use of patterns. Community-based learning, for example, would be demonstrably weak as a pattern if it were not applied to the Web site framework.

Second, frameworks enable researchers and practitioners to apply multiple patterns *interdependently*. Without frameworks, patterns would exist in isolation with loosely conjectured relations amongst themselves. Frameworks strengthen these loose relations by evoking synergies and tradeoffs between multiple patterns. In the Web site framework example, granting access rights to different volunteers in the *managing different volunteers* pattern may conflict with learning through engagement in the *Community-based Learning* pattern. This is because the former means more time needs to be expended to manage different volunteers, which leaves less time to actively engage in meaningful activities, therefore implying decreased learning.

In community computing, organizations such as community-based volunteer organizations are needy for practical solutions they encounter everyday because of the multivalent challenges they face. In addition to practical solutions, the need for developing abstractions is clear in community computing if we want to inculcate a culture of developing coherent and reusable scientific knowledge in this inter-disciplinary domain. Community-based learning, as a design pattern, and our integrated approach, comprising frameworks and patterns, set a research trajectory to develop such practical *and* abstract models in community computing.

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References

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I., and Angel, S. (1977): *A Pattern Language: Towns, Buildings, Construction*, Oxford University Press, NY, USA.

Beamish, A. (1995): *Communities On-Line: Community-Based Computer Networks*, Masters Thesis, Department of Urban Studies and Planning, MIT.

Bellah, R., Madsen, R., Sullivan, W., Swindler, A. and Tipton, S. (1986): *Habits of the heart: Individualism and commitment in American life*, University of California Press, CA, USA.

Carroll, J. M. (1998): *Minimalism beyond the Nurnberg Funnel,* The MIT Press, Cambridge, MA, USA.

Carroll, J. M. (2001): 'Community computing as human-computer interaction', *Behaviour and Information Technology*, vol. 20, no. 5, pp. 307-314.

Carroll, J. M., Chin, G., Rosson, M. B. and Neale, D. C. (2000): 'The development of cooperation: Five years of participatory design in the virtual school', *Proceedings of ACM Symposium on Designing Interactive Systems: DIS'2000* (Brooklyn, New York, August 17-19 2000), ACM, New York, pp. 239-251.

Carroll, J. M. and Rosson, M. B. (2003): 'Design rationale as theory', in J.M. Carroll (ed.): *HCI models, theories and frameworks: Toward a multidisciplinary science*, Morgan-Kaufmann, San Francisco, CA, USA, 2003, pp. 431-461.

Carroll, J. M., Rosson, M. B. Dunlap, D. R. and Isenhour, P. L. (2003): 'Frameworks for Sharing Knowledge: Toward a Professional Language for Teaching Practices', *Proceedings of the 36th Hawaii International Conference on System Sciences: HICSS-36* (Kona, Hawaii, January 6-9 2003), IEEE Computer Society, Washington DC, USA.

Coleman, J. S. (1990): *The foundations of social theory*, Harvard University Press, Cambridge, MA, USA.

Computer Research Association. (2003): 'Taulbee Survey', accessed at http://www.cra.org/ on March 1, 2005.

Deci, E. L., and Ryan, R. M. (1985): *Intrinsic motivation and self-determination in human behavior*. Plenum, New York.

Dewey, J. (1916): *Democracy in Education*, Macmillan, New York.

Dunlap, D. R., Neale, D. C. and Carroll, J. M. (2000): 'Teacher collaboration in a networked community', *Educational Technology and Society,* vol. 3, no. 3, pp. 442-454.

Erickson, T. (2000): 'Lingua francas for design: Sacred places and pattern languages', *Proceedings of ACM Symposium on Designing Interactive Systems: DIS'2000* (Brooklyn, New York, August 17-19 2000), ACM, New York, pp. 357-368.

Farooq, U., Merkel, C., Nash, H., Rosson, M. B., Carroll, J. M. and Xiao, M. (2005): 'Participatory design as apprenticeship: Sustainable watershed management as a community computing application', *Proceedings of the 38th Hawaii International Conference on System Sciences: HICSS-38* (January 3-6, 2005, Big Island, Hawaii), IEEE Computer Society, Washington DC, USA.

Farrington. C. and Pine, E. (1997): 'Community memory: A case study in community communication', in P. Agre and D. Schuler (eds.), *Reinventing technology, rediscovering community: Critical explorations of computing as a social practice*, Albex, Greenwich, CT, USA, 1997, pp. 219-228.

Gamma, E., Helm, R., Johnson, R., and Vlissides, J. (1994): *Design Patterns: elements of reusable object-oriented software*, Addison-Wesley, Reading, MA, USA.

Grobman, G. M. (2002): *Pennsylvania Nonprofit Handbook: Everything You Need to Know to Start and Run Your NonProfit Organization*, White Hat Communications.

Guzdial, M., Rick, J., and Kerimbaev, B. (2000):' Recognizing and Supporting Roles in CSCW', *Proceedings of the Conference on Computer Supported Cooperative Work* (Philadelphia, Pennsylvania, December 2-6 2000), ACM Press, NY, pp. 261-268.

Johnson, R. E. (1997): 'Frameworks = (Components and Patterns)', *Communications of the ACM*, vol. 40, no. 10, pp. 39-42.

King, N. K. (2004): 'Social Capital and Nonprofit Leaders', *Nonprofit Management & Leadership*, vol. 14, no. 4, pp. 471-486.

Knowles, M. S. (1973): *The adult learner: A neglected species*, Gulf Publishing Company, American Society for Training and Development, Houston, TX, USA.

Lave, J., and Wenger, E. (1991): *Situated learning: Legitimate peripheral participation*, Cambridge University Press, New York.

Merkel, C. B., Xiao, L., Farooq, U., Ganoe, C. H., Lee, R., Carroll, J. M. and Rosson, M. B. (2004): 'Participatory design in community computing contexts: tales from the field', *Proceedings of the 8th Conference on Participatory Design: Artful Integration: Interweaving Media, Materials and Practices* (Toronto, Ontario, Canada, July 27-31 2004), ACM Press, New York, pp. 1-10.

Merkel, C. B., Clitherow, M., Farooq, U., Xiao, L., Ganoe, G. H., Carroll, J. M. and Rosson, M. B. (2005): 'Sustaining computer use and learning in community computing contexts: Making technology part of "who they are and what they do"', *The Journal of Community Informatics* [Online], vol. 1, no. 2, 134-150.
URL: http://ci-journal.net/viewarticle.php?id=53&layout=html.

Putnam, R. (2000): *Bowling Alone: The Collapse and Revival of American Community*, Simon & Schuster: New York.

Rainie, L. and Horrigan, J. (January, 25, 2005): 'A decade of adoption: How the Internet has woven itself into American life', *Trends 2005*, Pew Research Center, accessed at http://pewresearch.org/ on March 1, 2005.

Rheingold, H. (1993): *The Virtual Community: Homesteading on the Electronic Frontier*, Addison-Wesley, Reading, MA, USA.

Rogers, E. M., Collins-Jarvis, L. and Schmitz, J. (1994): 'The PEN Project in Santa Monica: Interactive communication, equality, and political action', *Journal of the American Society for Information Science*, vol. 45, no. 6, pp. 401-410.

Ryan, R. M., and Deci, E. L. (2000): 'Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being', *American Psychologist*, vol. 55, pp. 68-78.

Schuler, D. (2002): 'A pattern language for living communication', *Proceedings of the 6th Conference on Participatory Design* (Malmo, Sweden, June 23-25 2002), CPSR, Palo Alto, CA, USA, pp. 434-436.

Techsoup. (2005): 'Technology Planning', accessed at http://www.techsoup.com/howto/articles.cfm?topicid=11&topic=Technology%20Planning on March 2, 2005.

Uncapher, W. (1999): 'Electronic homesteading on the rural frontier: Big Sky Telegraph and its community', in M. Smith and P. Kollock (eds.), *Communities in Cyberspace*, Routledge, 1999, pp. 264-289.

Vygotsky, L. S. (1978): *Mind and society: The development of higher mental processes*, Harvard University Press, Cambridge, MA, USA.

Wellman, B. (1982): 'Studying personal communities', in P. Marsden and N. Lin (eds.), *Social Networks and Social Structure*, Sage, Beverly Hills, CA, USA, 1982, pp. 61-80.