Beyond Access: Informed Participation and Empowerment

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Abstract: This paper is based on the fundamental claim that one of the major roles of new media is not to deliver predigested information to individuals, but to provide the opportunity and resources for social debate and discussion. For most design problems (ranging from urban design to graphics design and software design) that we have studied over many years, the knowledge to understand, frame, and solve these problems does not exist, but is constructed and evolved during the process of solving them, exploiting the power of the "symmetry of ignorance" and "breakdowns." From this perspective, **access** to existing information and knowledge (often seen as the major advance of new media) is a very limiting concept. Many social and technological innovations are limited to provide primarily better access, leading to "consumer" cultures. Our approach focuses and creates support for lifelong learning activities grounded in informed participation and empowerment, allowing learners to incrementally acquire ownership in problems and contribute actively to their solution.

To illustrate our approach, we present the Envisionment and Discovery Collaboratory (EDC), an integrated physical and computational environment supporting informed participation through new forms of knowledge creation, integration, and dissemination. The EDC empowers users to act as designers in situated learning and collaborative problem-solving activities. It addresses the integration of the userís consumer and designer roles, not by translating them into an "either-or" type of support, but rather by providing users with the flexibility to move along this spectrum according to needs, opportunities, and personal interest and engagement in particular learning situations.

Keywords: integrated physical and computational spaces, shared knowledge, active participation, distributed cognition, participatory design, CSCL in community and informal settings

Introduction

Many social and technological innovations are focused upon providing better access to resources, leading to "consumer" mindsets (Fischer, 1998a). Our approach creates and expands support for lifelong learning activities grounded in **informed participation** (Brown et al., 1994) and empowerment (Engelbart, 1995; Norman, 1993), allowing learners to incrementally acquire ownership in and to actively contribute to the resolution of problems (Arias, 1996).

Cultures are substantially defined by their media and their tools for thinking, working, learning, and collaborating. A large number of the new media are designed to see humans only as consumers. Television is the most obvious medium that promotes this mindset and behavior (Postman, 1985). Unfortunately, a consumer mindset does not remain limited to television, but in many cases extends to other activities and domains in our culture. For example, in our educational institutions learners are often treated as consumers of information and instruction, creating that mindset for the rest of their lives. As citizens they often feel left out in policy-making decisions, denying them opportunities to take an active role.

Unfortunately, most current computational environments do not allow users to act as active contributors and designers. Yet, computational media have the unique potential to assist people in becoming incrementally more actively involved. To move beyond "gift-wrapping" (Fischer, 1996), we need to rethink our learning environments (for school, work, home, community) in ways that support learning and designing by facilitating the integration of the userís consumer and designer roles. This integration should provide users with the flexibility to move along the consumer-to-designer spectrum. This implies environments in which self-directed as well as peer-to-peer collaborative learning is supported; in which the teacher/expert acts as a "guide on the side" rather than as a "sage on the stage" (Guzdial & Weingarten, 1995), in which we learn through **breakdowns** (Fischer, 1994), and in which learning activities such as courses are considered as seeds rather than finished products (Fischer, 1997). Such models of learning and education will require innovative computational support that will share many of the requirements and challenges articulated here.

Access AloneóA Limiting Mindset

In today's workplace, people need to know how to access information. This need is represented by the M1 model in Figure 1, in which a class of experts controls the production of information and individuals act as consumers whose only need is that of access. Although there is value in such a model, its focus is incomplete. For example, in the Presidentís Information Technology Advisory Committee report (PITAC, 1999), there is a call for ubiquitous information access. This call for accessibility needs to be

extended to include the understanding that the key to the future lies not only in greater access to information, but in greater support for knowledge construction (Scardamalia & Bereiter, 1994)
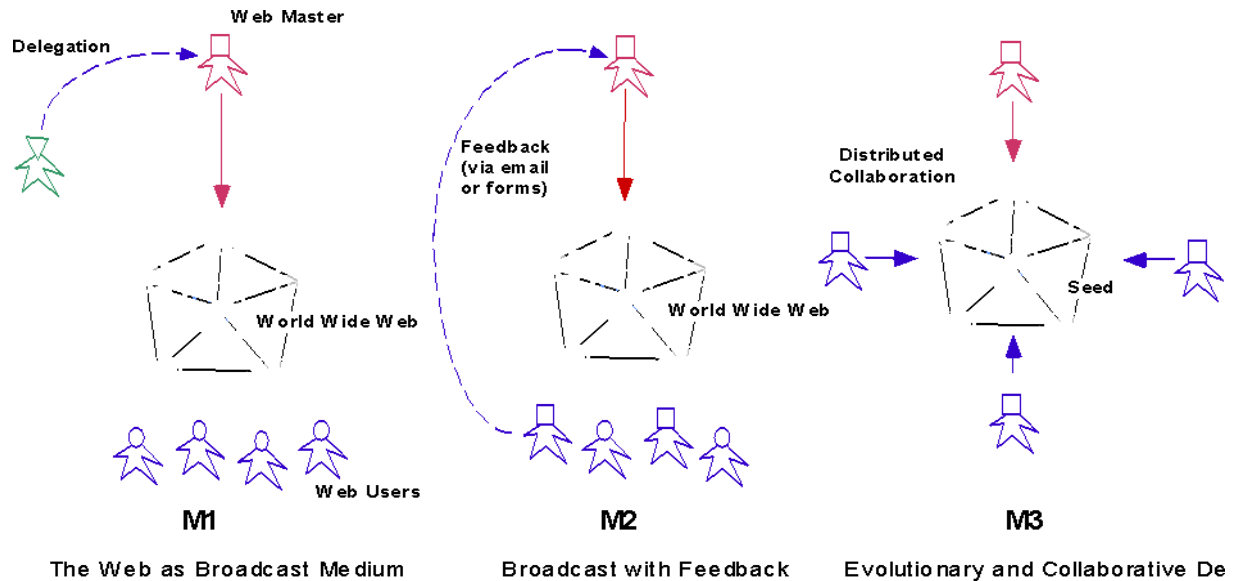
Figure 1: Supporting the continuum from consumer to designer

The next step in the information age is to move toward models that support not only the consumption of information, but also the construction and integration of knowledge as afforded by the M2 and M3 models in Figure 1. For example, we have asked the question, "Why is it that city planners do not use SimCity as a design tool?" Our research points to the observation that systems that users cannot extend to incorporate new knowledge are limited (at best) in solving real-world problems because these problems are by nature open-ended (Fischer, 1998b). Complex collaborative design problems, such as those found in real-world settings, cannot be supported by a closed, M1-like system, because collaborators need to fully participate in the construction and use of knowledge. In the M2 model, a Webmaster is still a custodian and the user is still primarily a consumer; however, the use of email or feedback forms allows users to react and contribute to the information in a limited way. The M3 model, typified by tools such as discussion groups or chat rooms, works toward providing the level of openness need for collaborative design problems.

We do not propose a binary choice between accessibility and informed participation. Each has its place and value. However, we argue that the "access-only" mindset is limiting because although access to information and technology is necessary, it is not sufficient, because it does not always support the goal that consumers can and should support to be active contributors. Therefore a focus on access alone may lead to a

consumer culture that wrongly assumes that the knowledge it seeks already exists, and that knowledge can always be accessed by those who need it.

This emphasis on access results in part from the impoverished conception of education "where omniscient teachers tell or show unknowing learners something" (Bruner, 1996). This mindset is deeply engrained into our educational culture. As learners in this system, we are trained to passively absorb information rather than engage in self-directed and collaborative learning, focusing on mutual dialogs and joint knowledge construction enhanced by the creation, discussion, and evolution of artifacts (Koschmann, 1996). Therefore, as the teacherís role changes, so too must the media supporting education. For example, teachers facilitating self-directed learning must be supported with computational systems and other educational resources suitable for the distributed self-directed process. Interactive systems for self-directed learning such as simulation and modeling environments (Roschelle et al., 1999) will provide students with new ways to formulate and reason about problems. Dynamic resources such as group memories and dynamic Web sites (Guzdial, 1999; Ostwald, 1999) will provide frameworks supporting individual and collaborative efforts.

Given our view of learning as a dynamic activity shaped by the situation, we do not take "either-or" positions regarding the three models aboveóeach has its place and value for different learning situations. This view, in turn, challenges us to design frameworks and tools that go beyond access to allow for the flexible support along the consumer-designer continuum, depending on the learning activity and setting. Therefore, these constraints and concerns from an **access-only** view have led our research to focus on the construction of theories and the design of systems that go beyond "accessibility of technology and information" to support "informed participation" and the "empowerment of users" in designing the future.

Beyond Access: Informed Participation and Empowerment

> How can more than 261 million individual Americans define and reconcile their needs and aspirations with community values and the needs of the future? Our most important finding is the potential power of and growing desire for decision processes that promote direct and meaningful interaction involving people in decisions that affect them. Americans want to take control of their lives (PCSD, 1996, p.7).

This finding of the President's Council on Sustainable Development (PCSD) warrants the claim that something **more** is needed than access alone. Creating new forms of civic discourse rooted in informed participation and shared understanding will support the goals articulated in the above quote by providing citizens with greater ownership and control over their futures (Arias, 1989; Arias, 1996; Illich, 1973). Therefore, an important challenge for future information technology is in the empowerment of citizens through the support of informed participation (Brown et al., 1994).

To make informed participation a reality, we need support for new forms of knowledge creation, integration, and dissemination. Humans seldom (if ever) explore large information spaces in the abstract (Fischer et al., 1996; Moran & Carroll, 1996). Instead, information is typically sought in response to **breakdowns** encountered during meaningful, real-life activities (Fischer, 1994; Popper, 1965). By overcoming such breakdowns, new knowledge is created, which then must be integrated with any knowledge that may have been generated during prior breakdowns. This cycle leads to the creation and evolution of rich information spaces that can empower interested community members as they "take control of their lives."

Knowledge Creation. One aspect of supporting organizations and social groups in creating knowledge is the externalization of an individualís **tacit** knowledge (Polanyi, 1966). This knowledge includes attitudes, values, and perspectives, which are difficult to formalize. Providing a means for capturing this knowledge is important for three reasons: (1) doing so causes us to begin to move from vague mental conceptualizations of an idea to a more concrete representation of it; (2) the externalization provides a means for others to interact with, react to, negotiate around, and build upon the externalized idea; and (3) the externalization provides an opportunity to create a common language of understanding around a particular problem (Resnick et al., 1991). Such a setting is governed by a **symmetry of ignorance** (Rittel, 1984) in which all stakeholders are aware that even though they each possess relevant knowledge, none of them has all the relevant knowledge; each of them must act as a reflective practitioner rather than as an all-knowing expert (Schön, 1983).

Knowledge Integration. A challenge for supporting informed participation is in providing a mechanism that allows various participants to integrate their perspectives (Stahl, 1993) in a meaningful way. To do so, it is important to support the process of reflection-in-action (Schön, 1983): As participants act upon a problem, breakdowns occur due to incomplete understanding of the underlying problem, conflicts among perspectives, or the absence of shared understanding. By supporting the process of reflection within this shared context, opportunities arise for building upon these breakdowns in ways that integrate the various perspectives and expertise while enhancing shared understanding. Supporting informed participation requires processes that integrate the individual and the group knowledge through collaborative constructions (Arias, 1996). Information spaces need to be constructed collaboratively Scardamalia & Bereiter, 1994) and integrated into the work and social practices of the community (Lave, 1988; Rogoff et al., 1998). These collaborative constructions result in work products that are enriched by the multiple perspectives emerging through community discourse.

Knowledge Dissemination. The knowledge created and integrated during collaborative design sessions needs to be made available for **on-demand learning** (Fischer, 1991) and **on-demand use** (Fischer, 1991) during subsequent sessions. Because humans have limited cognitive resources, they need less decontextualized information, but they do need resources and assistance to make information relevant to the task at hand. By integrating the processes of working and learning as collaborative practices, **learning**

webs (Illich, 1971) are created that support the availability of and access to knowledge that is needed.

Our Perspectives on These Processes. Our research is focused on complex, real-world problems in which the knowledge for resolving these problems does not exist *a priori*, but is generated though collaboration among stakeholders. We have found, specifically in our work with physical games, that the use of external representations (such as game pieces) and processes (such as game rules) serve to focus discussions upon relevant aspects of the framing and understanding of the problem being studied (Arias, 1996; Brown, 1997). This derives from the concept that designers engage in a "conversation with the material" (Schön, 1992), they interact with the problem at hand, and the situation talks back to them.

Requirements for Systems Supporting Informed Participation and Empowerment

Effectively supporting informed participation and empowerment is a socio-technical problem in which the social support and the technical infrastructure for open-ended problems go hand in hand.

At the technical level, providing access to information cannot imply allowing users to simply select from preexisting information. Passive technologies (television, closed systems) offer some selective power, but they are fundamentally limited by the inherent model of the system: they can not be extended in ways that the designers of the systems did not already foresee. In **closed systems**, the essential functionality is anticipated when the system is created. Important activities and changes that were not anticipated by designers are not only lacking from the closed systems, there is no way for non-designers to accomplish these activities. Closed systems force individuals into consumer roles because of their implicit constraints.

In contrast, open systems provide opportunities for significant changes to a system at all levels of complexity. Creating the opportunities to shape the system allows the owners of the problems (not just the system designers) to be involved in changes that are essential in using a system to address real problems. Our experiences in applying some of our systems in real contexts (Brown, 1997; Fischer, 1998b) have helped us support a number of principles for designing open systems. First, software systems must be able to evolve. Because problems are inherently open and software developers cannot fully anticipate every context in which software will be used, all software must be able to change as new situations and demands arise. Second, software must be able to evolve at the hands of the users. Giving the owners of problems in charge the opportunity to effect changes creates a situation in which users can take part in addressing the problems that they encounter. Finally, software systems must be designed for evolution (Fischer, 1998b).

By providing the opportunity for people to change systems, we encourage users to become owners of problems. Of course, not all users want to be intimately involved in all phases of a problem-solving activity. Fostering communities in which individuals can spontaneously find appropriate roles and responsibilities is important (Nardi, 1993).,

People are not going to accept responsibility without understanding what costs, benefits, and other motivating factors they will encounter. People are motivated to participate if a problem affects them and if they see a benefit to participating (Grudin, 1994). Supporting authentic problems in which people have a personal stake is an essential part of motivating a community. There must also be a reward for investing time and effort to becoming knowledgeable enough to act as designers. The nature of these rewards may range from a feeling of control over the problem, to being able to solve or contribute to the solution, a passion to master tools in greater depth, an ego-satisfying contribution to a group, or a sense of good citizenship in a community (Raymond, 1998). While we understand that systems should provide these affordances for informed participation and empowerment, we also realize that its use rests on the predisposition (e.g., needs and motivation) and competencies (e.g., intellectual, physiological, educational, or economic) of the individual in each learning context (Arias, 1989; Gans, 1968).

The Envisionment and Discovery Collaboratory (EDC)

To move beyond frameworks that provide more than access to existing information, we are developing the **Envisionment and Discovery Collaboratory (EDC)**, which addresses the goals of informed participation, empowerment, and the social and technical challenges that these goals present. The central theoretical vision of the EDC is to provide contextualized support for **reflection-in-action** (Schön, 1983) within collaborative design activities. Figure 2 shows the current realization of the EDC environment. Using the horizontal electronic whiteboard, participants work "around the table" to incrementally create a shared model of the problem. They interact with computer simulations in the **action space** by manipulating three-dimensional, physical objects, which constitute a language for the domain. The position and movement of these physical objects are recognized by means of the touch-sensitive projection surface. In the figure, users are constructing a neighborhood through the use of a physical language appropriate for the problem by placing objects representing houses, cars, traffic lights, and so on. This construction then becomes the object through which the stakeholders can collaboratively evaluate and prescribe changes in their efforts to frame and resolve a problem. In the upper half of Figure 2 is a second electronic whiteboard that serves as the **reflection space**, where information related to the problem-at-hand can be presented, explored, and reframed. In the figure a user is filling out a survey constructed from the model presented in the action space. The results of this survey are stored in the reflection space (for future exploration) and are also fed to the action space, where the ramifications of the decisions specified in the survey can be explored.
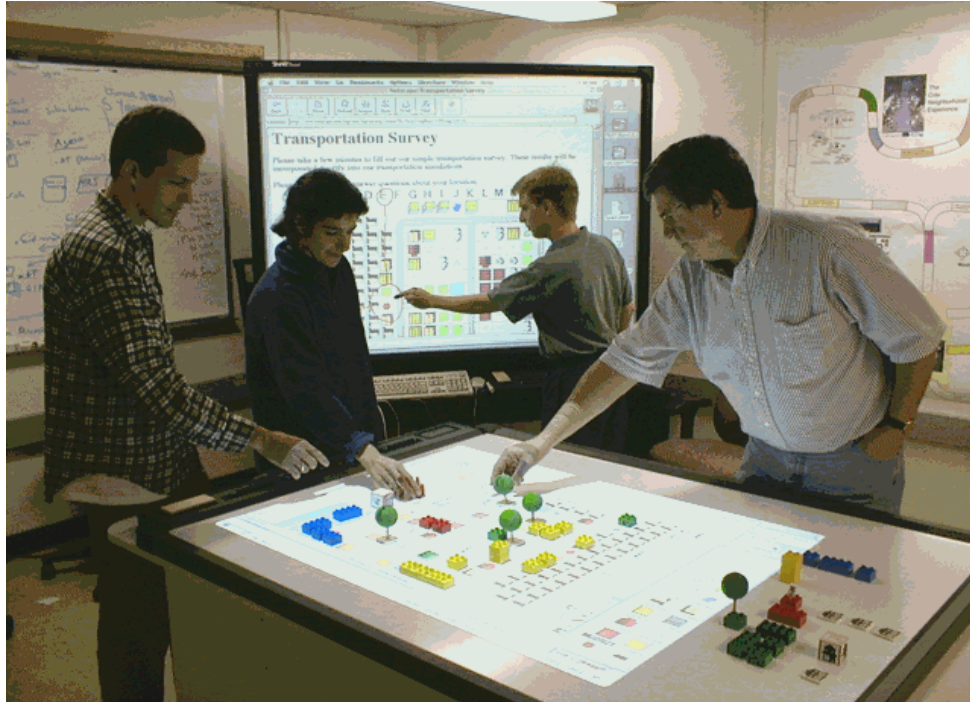
Figure 2: The EDC Environment

Utilizing novel computational and physical tools is a critical part of supporting this dynamic face-to-face interaction. Languages of physical objects provide affordances for the construction of shared, tangible representations that are used to frame problems in a collaborative manner (Alexander et al., 1977; Arias et al., 1997). In both the action and reflection spaces, creating an open seed (Fischer, 1998b) that can evolve through use is an essential element. The computational model is driven by AgentSheets, an open, user-extensible simulation environment (Repenning & Sumner, 1995). The reflection space is built using DynaSites, a substrate for evolving and maintaining dynamic Web-based information spaces (Ostwald, 1999). The action and reflection spaces are independent computational entities that utilize the Web as a communication medium. The EDC focuses on face-to-face collaboration when possible, but provides opportunity for distributed collaboration by allowing people to participate at a distance and by providing a persistent representation of what takes place at individual meetings.

Using the EDC to Move beyond Access

The vision behind the EDC is to shift the focus of future developments away from the computer toward an increased understanding of the human, social, and cultural system that defines the context in which systems are used. The EDC instantiates the conceptual frameworks and requirements outlined earlier and serves to create an **immersive** social context in which a community of stakeholders can create, integrate, and disseminate information relevant to their lives and the problems they face.

The EDC supports stakeholders in **creating knowledge** in a form that other people can understand. The use of a shared physical context is one of the important ways to help people articulate their knowledge and communicate with others. Integrated physical and computational systems are interesting because of their power to elicit tacit communication (Arias et al., 1997; Eisenberg & Makay, 1996; Kato et al., 1997). In the EDC, the physical representation serves as an external object through which users can express their views. It allows a group of neighbors to create an explicit understanding of what lies within their neighborhood. Through the common physical representation, users can utilize the language of objects to collaboratively determine what features are parts of their neighborhood.

Computational mechanisms support the **integration** of knowledge by analyzing the physical construction and pointing out things on behalf of participants who are not **around the table**. For example, if we are worried about bus-stop placement, neighbors who cannot be at a public meeting might create a "virtual stakeholder" that represents their point of view, checks to see if a bus stop has been created near their homes, and flags a problem if the bus stop is placed in a detrimental location. The creation of virtual stakeholders is one example of the integration of existing knowledge (created by the neighbor), and new knowledge (created around the table.) Another example is the survey shown in Figure 2. When neighbors fill out a survey, the simulation gets updated with new information. This new information changes the situation, and the corresponding computational model changes. However, this might have unexpected consequences. For example, if neighbors say they are willing to wait a certain amount of time to take the bus and the bus does not come by that frequently, then they may go back and use their cars.

The EDC supports knowledge **dissemination** by providing contextualized access to information. The failure of a bus to circulate often enough triggers the dynamic creation of information (in the action space) that synthesizes an explanation of the problem, shown in Figure 3. This explanation combines a description of the issues, some contextualized information about the ramifications of the issue, and a collection of local information about the issue. These pieces of information were contributed or constructed over time and are presented in a contextualized manner, thus facilitating the growth of information over time and the use of this information when appropriate.
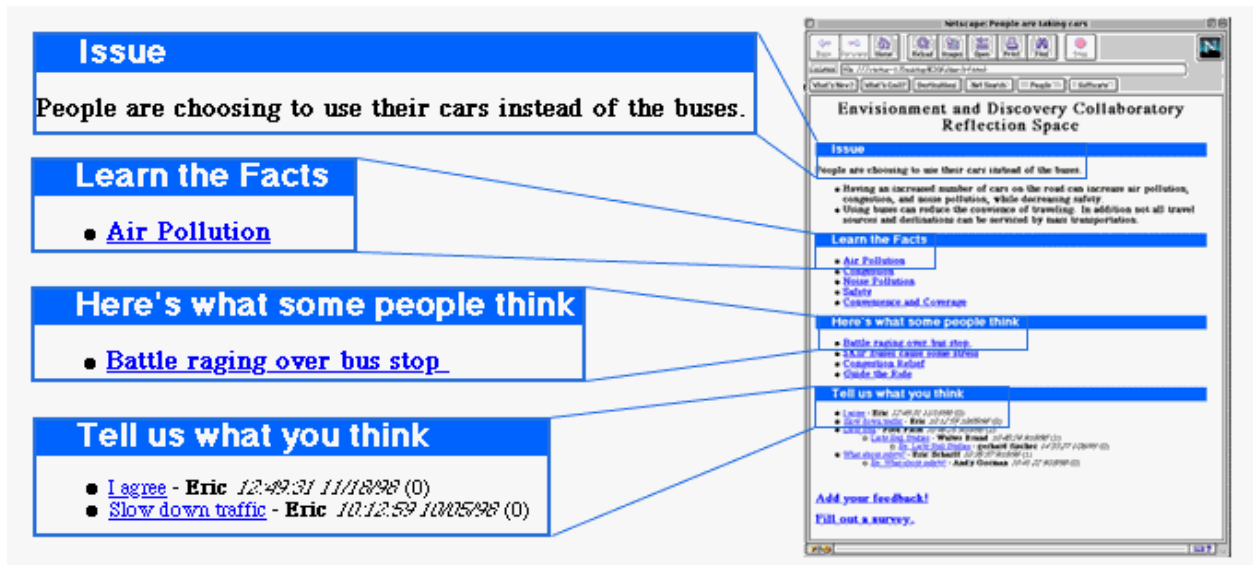
Figure 3: Dynamically Triggered, Contextualized Information

Rather than dissemination being the end of the process, the evolvable nature of the EDC supports a synergy between the dissemination of information and the creation of new knowledge. For example, the information presented in response to this situation can grow over time by allowing users to add their comments, new factual information, or related Web links associated with the issue. These capabilities of the EDC (as summarized in Figure 4) create a range of support for users to engage in informed participation.

EDC Support	Description	Challenges Addressed
physical languages	tangible physical representations that are manipulated by groups of users	encourages face-to-face collaboration, providing a common language for people to express themselves
computational simulations	models that capture constructions, analyze situations, and display ramifications	allows for users to engage in "what-if" games, provides interactive ways to capture and visualize information
dynamic web sites	evolving Web sites that display relevant information and capture feedback	captures knowledge and helps make tacit knowledge explicit
integrated physical / virtual interaction	tight coupling between physical construction and reflective information	creates an engaging forum, motivates participation, helps deliver information in a timely contextualized manner
virtual stakeholders	tools that help problem stakeholders define critics, problem constraints interesting to them	gives problem owners a voice in framing problems, integrates new knowledge with existing knowledge
open evolvable tools (including end-user modifiability)	making modification a "first-class design activity", being able to capture changes and evolve systems when new situations arise	captures important information not anticipated at system design time, encourages a culture of participation, addresses the open-ended nature of problems

Figure 4: Summary of Support Provided by the EDC for Informed Participation

Implications and Challenges

Empowering users by creating open environments has proved to be an important and rewarding experience. In his discussion about Open Source Software, Raymond describes how communities of developers work together to create software that addresses their unique needs. The success of Web sites such as Gamelan (Gamelan, 1999), the Educational Object Economy (EOE, 1999), and Educational Software Components of Tomorrow (ESCOT, 1999; Roschelle et al., 1999) shows that interested users may be motivated to share when there is a perceived benefit. However, even these systems often create a model of control that separates producers and consumers. In Gamelan, resources are contributed by the community, but only the small number of Web site administrators have the ability to accept, categorize, and evaluate new submissions. In contrast, systems such as the Behavior Exchange (a collaborative forum in which developers can share components for use in AgentSheets simulations (Repenning et al., 1998), the role of the "gatekeeper" is kept to a minimum, relying instead on members of the community (Fischer, 1998b).

There are a number of challenges when attempting to both empower users and create a forum where they are informed through their participation. In some situations, the goals of empowerment and providing useful information seem to be in direct conflict. If anyone can contribute, how can we guarantee that the information contributed is valuable or reliable? Although this is a problem, this issue is not unique to open computer environments. In some situations, creating a public forum and encouraging group participation acts as a filter for contributions (Terveen et al., 1997). As the group encounters information, people reflect and determine how much of this information is relevant to them. Although the physical representations used in the EDC have been used extensively in authentic real-world planning situations (Arias, 1996), the tools involving integrated physical and computational support are relatively new and, with the amount of work needed to make tools useful for the community, are beginning to reach the level necessary for supporting intense collaborative work. In one project, we have begun to use and evolve the EDC with the Boulder County Healthy Communities Initiative (BCHCI) to help citizens understand and collaborate around indicators that shape the city (BCHCI, 1998; Gorman, 1999b). By using these community indicators (such as crime statistics, water use, pollution, and so on) we are exploring the idea of "citizenís corners," locations around the city where citizens can interact with the EDC to learn about problems as well as provide their own input to these community-wide issues. In another application of the EDC, we support the construction of a new academic building, the Discovery Learning Center at CU Boulder (Gorman, 1999a). In the construction of this building, architects, academic tenants, administrators, and students will collaborate in the design of a new space for teaching and learning. Critical elements of this design will involve designing the building to evolve over time and creating an academic environment that features discovery learning (Brown & Campione, 1994).

Conclusions

Supporting existing models that dichotomize consumers and active contributors encourages a mindset that learning is essentially a one way street. Providing access is an important contribution of new technologies, but it is limited to cover the full range of human activities. Without acknowledging needs such as empowerment and informed participation, we will not address the challenges faced by authentic real-world learning situations. The EDC provides a first step to move beyond providing access toward creating a forum that empowers users and enhances informed participation around the table and beyond.

Acknowledgments

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