Building Educational Technology Partnerships through Participatory Design

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INTRODUCTION

Educational technology provides many examples of how efficient software development and deployment is not enough. Teachers work in a complex and dynamic context in which measurable objectives and underlying values collide on a daily basis. Traditionally, teachers work in isolation from their peers; individual teachers have well-established personal practices and philosophies of education. Teachers have enormous discretion with respect to what goes on in their classrooms, yet are also routinely interrogated by supervisors, by parents and other community members, and by educational bureaucracies. This has led to an abiding tension in the culture of schools: Teachers' innovative practices are often not adequately acknowledged or valued, and at the same time, teachers often passively resist school reforms that are imposed top-down.

Technology is a particularly problematic element in the culture of schools. The isolation and discretion of the teacher's work environment requires that technology for classroom use be highly appropriate and reliable. Yet it is generally assumed that teachers are to be *trained* on new technologies, not asked to *define* what those technologies should be. From the teacher's standpoint, classroom technology often is itself the problem, not the solution. This culture of technologydevelopment in the schools has been singularly ineffective—film and radio in the 1920s, television in the 1950s, and computer-assisted instruction in the 1980s, among others, have been notable failures (Tyack & Cuban, 1995).

An alternative to merely efficient technology development is *participatory design*, the inclusion of users within a development team such that they actively help in setting design goals and planning prototypes. This approach was pioneered, and has been widely employed, in Europe since the 1970s, and now consists of a well-articulated and differentiated set of engineering methods in use worldwide (Carroll, 2000; Clement & Van den Besselaar, 1993; Muller, 2003; Muller, Haslwanter, & Dayton, 1997; Rosson & Carroll, 2002).

In 1994, a design collaboration was formed between Virginia Tech and the public schools of Montgomery County, Virginia. The objective was to develop and investigate a high-quality communications infrastructure to support collaborative science learning. Montgomery County is located in the rural Appalachian region of southwestern Virginia. In March 2000, one of its high schools was listed among the top 100 in the US by *Newsweek* magazine. However, in others, physics is only offered every other year and to classes of only three to five students. The initial vision was to give students in this diverse and dispersed school district access to peers through networked collaboration.

We felt it was critical for the teachers to contribute as collaborators in design analysis, implementation, deployment, testing, and refinement, and as leaders in the development of courseware and classroom activities that would exploit the software. For a classroom-technology partnership to succeed, the university researchers must eventually fade and leave the teachers to maintain and develop its achievements. In the end, the technology-development goals of this project were achieved, though this is not the topic of this paper (Isenhour, Carroll, Neale, Rosson, & Dunlap, 2000).

BACKGROUND

We analyzed our participatory engagement with the teachers as "developmental" in the sense of Piaget and Inhelder (1969) and Vygotsky (1978). We believe the teachers developed qualitatively different roles through the course of our collaboration. In some cases, these roles were suggested to them; in other cases, they defined and claimed new roles. But in all cases, these transitions exemplified the defining characteristics of *developmental change*: active resolution of manifest conflicts in one's activity, taking more responsibility, and assuming a greater scope of action. Each successive stage can be seen as a relatively stable organization of knowledge, skills, and attitudes that resolves the instigating conflict.

During the six years of this project, we distinguished four stages in our collaboration with the teachers. At first, the teachers were *practitioner-informants*; we observed their classroom practices and we interviewed them. Subsequently, the teachers became directly and actively involved in the requirements-development process as *analysts*. Later, the teachers assumed responsibility as *designers* for key aspects of the project. Finally, the teachers became *coaches* to their own colleagues within the public school system.

In a classic Piagetian example, a child in the preoperational stage perceives single dimensions of quantity. This produces conflicts: A given quantity of liquid poured from a short, wide container into a tall, thin container appears suddenly to be more, but of course cannot be more. These conflicts eventually precipitate a cognitive reorganization called the concrete operational stage, in which constant quantities are perceived as constant regardless of varying shapes and arrangements.

Developmental change in adults is of course more complex. The stages we describe are not singular competencies, but relatively complex ensembles of collaboration, social norms, tool manipulation, domain-specific goals and heuristics, problem solving, and reflection in action. They are social constructions achieved through enculturation, constituted by the appropriation of the artifacts and practices of a community (Vygotsky, 1978).

In the Piagetian notion of stages in child development, successive stages build upon the cognitive structures and enabled activity of prior stages, but ultimately replace those structures. A child who enters the concrete operational stage can no longer function at the preoperational stage. Adult growth, however, is not static achievement, but continual elaboration. The teachers are still practitioners whose classroom practices we regularly observe and whose classroom expertise we still interrogate; they seem to us and to themselves to be representative practitioner-informants. However, they are now *also* analysts and designers, and often coaches. Indeed, effective design coaches probably must be experienced designers, successful designers must be skilled analysts, and analysts must have attained significant domain knowledge (Carroll, Chin, Rosson, & Neale, 2000).

MAIN THRUST OF THE CHAPTER

Developmental theory explains transitions between stages as resolutions of conflict. Thus, the preoperational child's conflicting perceptions of quantity based on single dimensions, such as height and width, are resolved in the abstraction of quantity as an invariant in the concrete operational stage. For development to take place, the child must have attained the requisite competencies to experience the triggering conflict, and then be able to reconceptualize the situation in such a way that the conflict dissolves.

This analytical schema seems to fit the transitions between the stages of cooperation we identified. The general mechanism appears to be that successive increases in knowledge, skill, and confidence empowered the teachers to resolve conflicts by assuming successively greater scope of action and responsibility in the project. Early on, the teachers faced the conflict that their pedagogical concerns and perspectives would be adequately represented and fully considered by the group only if they themselves championed those concerns. This went beyond the practitioner-informant role they had played in the project up to then. But they were both motivated and competent to resolve this conflict by assuming the analyst role in the project.

Once the teachers were functioning as analysts in the project team, further conflicts and resolutions arose. The teachers experienced a conflict between their own analyses of system requirements and the current state of our project software and development plans. They resolved these conflicts by formulating their own design proposals, ultimately a radical reorientation of the project's vision of classroom activity. They became designers. Subsequently, the teachers recognized that they were the best qualified project members to train new teachers and to pursue specific curricular extensions of the project. They became coaches.

The teachers' behavior also reflects development *within* the four general stages we have described. For example, cognitive scaffolding (via examples, reflective prompts) was needed to engage the teachers in the novel and relatively abstract activity of design analysis. But as the project progressed, teachers spontaneously identified and presented design trade-offs to the group as a way to articulate personal positions. This is consonant with the general notion of learning as movement through a zone of proximal development (Vygotsky, 1978).

The designer stage also reflects several different levels of development. Initially, the teachers were able to collaborate with a research assistant in focused design sessions, cowriting scenarios of technology-mediated activities for their classroom. Later they banded together as a subgroup, pooling their goals and expertise to develop a scenario that specified a new vision of collaborative learning activities. Ultimately, each learned to function as an independent designer, envisioning and specifying activities optimized for their own teaching styles, objectives, and classroom environments. In their coach role, the teachers also worked first as a group, but subsequently recruited and mentored colleagues in a one-to-one fashion.

In sum, it appears that the transitions among stages were triggered by conflicts with respect to the teachers' role in the project. In each case, a series of scaffolded activities enabled them to attain the knowledge, skill, and confidence that led them to expand their role (Carroll et al., 2000).

FUTURE TRENDS

We originally committed to a long-term participatory-design method because we conjectured that such an approach would be crucial for success in this educational technology setting. We believe we could not have succeeded to the extent we have had we not made this commitment. Working from the