Informing Design Research: Examining the Ways That Teachers Design Social Infrastructure

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Most of the K-12 educational studies carried out as Design Research have focused on contexts where the design researchers have been the agents overseeing the local adaptation of an intervention into local classroom practices. However, those adapting the intervention to the local classroom contexts can differ from the design researchers, as when an intervention is being "scaled up," or is offered commercially --- where instead teachers play the central role in overseeing the classroom implementation. Investigating the design decisions that teachers make in implementing interventions in classrooms with regard to the interplay between the developers intentions and the teachers intentions provides a valuable, but as yet under-utilized, source of data for informing the work of design researchers. In the present paper, the Social Infrastructure Framework (Bielaczyc, 2006) is used to analyze the design of classroom social structures by a particular team of teachers who integrated Knowledge Forum (Scardamalia, 2004) into their classroom over the course of several years.

Design researchers study interventions in practice, with the dual goal of progressively refining the design of the intervention itself and the theories of learning and teaching that inform the design (e.g., Barab, 2004; Brown, 1992; Collins, 1992; Kelly, 2003; Sandoval & Bell, 2004). Through analysis and theorizing, design researchers work to determine the critical elements of an intervention and how their combinations make for effective learning environments. Most of the K-12 educational studies carried out as Design Research have focused on contexts where the design researchers have been the agents overseeing the local adaptation of an intervention into local classroom practices. However, those adapting the intervention to the local classroom contexts can differ from the design researchers, as when an intervention is being "scaled up," or is offered commercially --- where instead teachers play the central role in overseeing the classroom implementation. We might frame such a context as actually consisting of two layers of design: the design as conceived by the developers and the design as conceived by teachers adapting the tool to the local context of use. The central claim of the present paper is that investigating the design decisions that teachers make in implementing interventions in classrooms with regard to the interplay between the layers in this double-layer of design provides a valuable, but as yet under-utilized, source of data for informing the work of design researchers.

LEARNING FROM TEACHERS' DESIGNS

In the present paper a case study of teachers integrating technology into their classrooms is used in order to better understand what can be learned from such negotiations. The case study focuses on the design of the social infrastructure of a given classroom, and is guided by the use of a particular analytic tool, the *Social Infrastructure Framework* (Bielaczyc, 2006). The Social Infrastructure Framework highlights four dimensions of classroom social structures that impact the type of learning environment created with technology-based tools, specifically:

1. The *Cultural Beliefs Dimension* refers to the mindset that shapes the way of life of the classroom.
2. The *Practices Dimension* concerns the ways in which teachers and students engage in both online and offline learning activities relating to the technology-based tool.
3. The *Socio-Techno-Spatial Relations Dimension* refers to the organization of physical space and cyberspace as they relate to the teacher and student interactions with technology-based tools.
4. The *Interaction with the "Outside World" Dimension* refers to the ways in which students interact, online and offline, with people outside of their immediate classroom context.

Although treated separately, these dimensions of social infrastructure are interdependent. Table 1 (from Bielaczyc, 2006) provides a summary of the Social Infrastructure Framework.

Design Research is intended as a way to characterize, test out, and optimize specific elements of a design. The Social Infrastructure Framework centers on one set of variables that design researchers should analyze in carrying out progressive refinements of a design. The framework is not meant as a rigid checklist, but rather a guide as to critical design variables to be considered in creating the relevant social structures for a given technology-based tool.

Case Study of an Implementation of Knowledge Forum

One way to develop a deeper understanding of the ways in which teachers design social infrastructure and the lessons that design researchers can learn in examining such designs is to focus on an example case. Here the Social Infrastructure Framework is used to analyze the design of classroom social structures by a particular team of teachers who integrated Knowledge Forum (Scardamalia, 2002, 2004; Scardamalia & Bereiter, 1991, 1994) into their classroom over the course of several years.

Given the long and rich history of classroom implementations of Knowledge Forum (e.g., Bereiter & Scardamalia, 1992; Bielaczyc, 2001; Caswell & Bielaczyc, 2002; Chan, Lee & vanAalst, 2005; Hewitt, 2002; Ow, Low & Tan, 2004; Reeve & Lamon, 1998), it was assumed that the design work would be quite rich – both for the developers and the many teachers that have worked with Knowledge Forum over the years. However, neither the developers nor the teachers have been explicitly guided by the Social Infrastructure Framework. What do we learn if we use it as an analytic lens? In the case study, the Social Infrastructure Framework is used to reverse-engineer the design decisions concerning social infrastructure. In examining this particular Knowledge Forum case through the lens of the Social Infrastructure Framework, we are able to see the power of making such design decisions explicit.

The Whitman Team

The data for the case study comes from a larger set of projects focusing on teacher and student reflections on creating classroom learning communities (e.g., Bielaczyc, 2006; Bielaczyc & Blake, 2006; Bielaczyc & Collins, 2006; Caswell & Bielaczyc, 2002; Ow & Bielaczyc, 2007). The developer data is drawn from the Knowledge Forum literature, interviews, participation in annual Knowledge Forum Summer Institutes, and the author's post-doctoral affiliation with the Knowledge Forum project. The teacher data is drawn from a 6th-7th Grade Team who integrated

Knowledge Forum into the daily rhythm of their classrooms. Research in the Whitman Team classrooms was conducted over the course of one and a half academic years. Beginning in the Spring of the 6th grade year and continuing until the end of the 7th grade, classroom visits were made roughly every 6 weeks for a period of 5 days. Data collection included classroom observations, student and teacher interviews, surveys and written data, along with online data from the Knowledge Forum databases. For the present paper, I draw specifically on teacher data collected from phone and face-to-face interviews over the course of the 6th and 7th grade school years (approximately 30 hours of interviews), four Saturday morning reflection meetings held over the course of the 7th grade school year (approximately 16 hours of interaction), field notes taken while attending team planning meetings during the weeks I was visiting the schools, and teacher comments on earlier manuscripts.

Investigating the Alignment Between Developer's and Teacher's Designs

Because I believe that the Cultural Beliefs Dimension is one of the most important but least understood of the dimensions of the Social Infrastructure Framework, I focus here on the examination of alignment between the Knowledge Forum developers' and Whitman teachers' designs on this dimension[1]. The *Cultural Beliefs Dimension* refers to the ways that teachers and students conceive of learning and working with a technology-based learning tool. Here we consider two types of cultural beliefs from the Social Infrastructure Framework: (1) how learning and knowledge are conceptualized, and (2) how a student's social identity is understood.

Whitman Team Conceptualization of Learning and Knowledge

The teachers on the Whitman Team had certain beliefs about learning and knowledge in which they wanted students to share. These beliefs were not written down, nor given as a comprehensive list, but they were articulated consistently by all four teachers in the discourse of their classrooms, interviews, team meetings, and Knowledge Forum Summer Institute sessions. The Whitman Team's beliefs emphasized:

- Learning needs to build from existing knowledge.
- Knowledge differs from information.
- Knowledge is always improvable.
- It is "okay" not to know.
- Knowledge building requires time and reflection.

For example the belief that *it is "okay" not to know* was meant to set a common understanding in the classroom that one doesn't always have the answer for everything, that even as one develops expertise in an area, there will be things that are outside of one's current understanding. This belief focuses on students' feelings of self-worth in relation to knowledge building. The teachers want to underscore that *not knowing* is natural, not a problem or stigma.

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[1] In Bielaczyc (2006), I discuss how it might seem odd to conceive of cultural beliefs as something that is "designed." "Cultivated" may perhaps be an easier way to conceive of this dimension. Either way, the dimension serves to highlight that in order for a tool to be successful in the classroom, it may be necessary to develop new ways of thinking about learning and working with the tool.

This is particularly important in using a tool such as Knowledge Forum where one's work and developing understanding is so public.

> It's just the way that things are run. And one is that it's OK to ask questions. And I think that was in place with our team, like I said, with some of our experiences that we'd had. But we certainly didn't allow for it as much as once we started on this [using Knowledge Forum]. It's OK to ask for help. That is very hard for kids to do. It's very hard for them to admit that there might be something that they don't know. If it's OK to ask questions then obviously some of the things you're asking questions about are things that you don't know. But that is not often admitted. Kids go to school for years and find a place in the room where they can shrink up and not be seen and not be heard but as far as they're convinced it is not OK to ask questions. That is a very scary thing to do…And that's OK, we all have misconceptions but people go about their lives like in this role that I'm clear on everything, I understand everything but misconceptions are part of learning and part of unraveling them, what that misconception is. So it's OK to have those. And if you change your mind about something that's actually a badge of honor. It's like I used to think this but now I have learned and I understand this.

The teachers point out that developing the belief that *it is "okay" not to know* is difficult, particularly since it represents a shift from beliefs and behaviors that students have acquired over years of schooling. Asking questions, and thus admitting that you don't know things, can be a "very scary thing to do." And yet the Whitman teachers want students to come to see not only that "misconceptions are a part of learning," but also that changing one's mind publicly, and thereby recognizing an advance in one's understanding, can be cause for pride.

Whitman Team's Conceptualization of Students' Social Identity

The *conceptualization of a student's social identity* refers to how students view themselves as learners and how they perceive the role that other students in the class (and others in their social network) play with regard to their own learning. The Whitman teachers describe their main educational objective as creating a "learning club," where members learn how to learn. Becoming a member of the learning club was seen as involving two complementary areas of student growth: development of (a) confidence in oneself as a learner who can advance one's own understanding and who has something to contribute to the community's understanding and (b) a sense of being part of a team, where others are valued as learning resources, allowing one to go beyond what is possible alone.

For example, one of the teachers emphasized that he wanted learners to experience the joy of discovering "Gee, I didn't know I could do that." He viewed such experiences as critical in shifting students' perspectives that "going to school and learning is not just something being done to them" toward realizing "I have something to contribute":

> Bielaczyc: Why is that important?…That they get that sense of themselves?

> Mr. B.: Well, I think it makes you a more productive person. What we want in this world are people who are confident in their ability to put together ideas and to contribute, and if you are always going through life thinking that somebody is going to be doing this for you and raising the critical questions, we're not going to have a productive society. But once you begin to realize that I have something to contribute, that I have contributed, that I can learn, that I can see what the issues are, along with someone else, that I'm not just have to wait for somebody to tell me, I think we're going to be better off.

Hence, a student's social identity involves a sense of autonomy and confidence in one's ability to learn and to make valuable contributions. Further, the teachers feel that one's identity needs to also extend beyond the self, to feel a part of a larger whole:

> There has to be a very strong feeling of collaborative learning that exists and of the whole idea of team. That has to be fostered over and over and over again if anything like that is going to work, that this person

sitting next to me is an important part of my learning... There has to be a measure, a great measure of respect that each one of the kids has for the other kids on the team. They have to look at each other as partners. They have to see each other as researchers, and they have to respect what each of them has to say and what each of them has to contribute to whatever the learning happens to be.

It is also important that one's social identity be relevant beyond the school setting:

I suppose it's the word community. It seems like wherever you go and whatever job you do and whatever discipline it may be in, you have to rely on other people to build the communities just like on our team.

The teachers felt that in working as a knowledge building community, their students gained a sense of pride and purpose. That students were given a voice and were heard not only by their peers and teachers, but by other adults as well:

I mean, it was just like you had pinned a badge on them...It had been somebody referred to something they said or somebody picked up on their idea, or somebody asked them a question… But it's just like your inside is ballooning when you become aware of something. It's a wonderful feeling. And there are kids in our classrooms, and they can go through their entire school and indeed their entire life and they've never been blown up by learning. And it happens more here and for more kids because there's more opportunity to be heard. Other teachers listening. There are other adults who are listening.

It was important to the Whitman teachers that students see themselves as active, contributing participants in their classroom community. This involved feeling part of a team, respecting the ideas of others, and listening to others as well as being listened to. The hope was to not only create the confidence and ability to communicate and collaborate in the classroom, but also as they go out and become workers in the world beyond school.

DISCUSSION

What do we notice in looking at the desired conceptualizations of the Whitman teachers? There is a consistency between the Whitman Team's belief that *knowledge is always improvable* and the Knowledge Forum developers emphasis on *improvable ideas*, where "All ideas are treated as improvable. Participants work continuously to improve the quality, coherence, and utility of ideas" (Scardamalia, 2002, p. 9). Further, Scardamalia (2002) points out that "For such work to prosper, the culture must be one of psychological safety, so that people feel safe in taking risks --- revealing ignorance, voicing half-baked notions, giving and receiving criticism." The Whitman teachers' beliefs about knowledge and learning are intertwined with a deep concern for student motivation and validation: *it is okay not to know* and *knowledge building is work and requires time and reflection*. The Whitman teachers concern themselves with students' feelings of self-worth and frustration: "That is a very scary thing to do… And that's OK, we all have misconceptions." Further, "Not be afraid to say what they know for fear that someone's going to say something to them. To begin to see that they do understand, that they do have something to say. And there's a forum for them to engage in. So, no one will have to be afraid to open their mouths in the classroom." The teachers recognize that typical school conceptualizations present learning as a relatively straightforward process of taking in and reproducing information, involving "busy work." Integrating Knowledge Forum shifts such conceptualizations and requires students to take on new roles that may be "scary" and make them "afraid to open their mouths." The teachers feel that providing students with guidance and legitimatization is critical in making such a shift.

The Whitman teachers center their conceptualization of student social identity on being part of a "learning club" where students take responsibility for improving their ideas and the ideas of other members. The goal is for students to see themselves and others as powerful

contributors to the world of ideas. The teachers also emphasize that this approach to knowledge and learning is not confined to the school context, but is about making the school context consistent with knowledge work in the real world. These conceptualizations are geared toward helping students to develop meta-knowledge: this is how people work with ideas—not just in school, but also in life.

Such a conceptualization of social identity appears to be consistent with the conceptualizations put forward by the Knowledge Forum developers. On the surface, both the Knowledge Forum developers and the Whitman teachers emphasize that students should understand their social identity as being part of something greater than themselves. In addition, both the developers and the teachers want student work with knowledge to be similar to knowledge work in the world outside of the classroom walls. However, a closer analysis reveals that the central notion for the Knowledge Forum developers is that the social identity is a *person-to-enterprise relationship*: we are here to build a collective understanding, to advance what we know as a community. Students are meant to see themselves and each other as working toward this common enterprise. For the Whitman teachers, a student's social identity is expressed as a *person-to-person relationship*: we are here to help each other to learn. The emphasis is on students viewing themselves and each other as resources for their individual investigations. Further, the Whitman team's conceptualizations place emphasis on individual knowledge, rather than on collective knowledge. Cultivating a student sense of an entity of *collective knowledge* was not as clearly emphasized as the entity of *one's own knowledge*.

Although the ways in which knowledge, learning, and student social identity are conceptualized by the Whitman Team and the Knowledge Forum developers may seem more closely aligned than not, it is instructive to investigate the points of misalignment and question why inconsistencies might exist. One reason might be that the Whitman teachers do not have a good grasp of communal knowledge as an entity and what it means to be involved in the enterprise of advancing collective understanding. In fact, in one of my group interview sessions with the teachers, I raised the distinction between "Helping others' individual inquiry" and "Building a communal understanding." In discussing this distinction, the four teachers agreed that the concept of "communal knowledge" was difficult to fully grasp, even after eight years:

> And I think as long as we have worked with CSILE and Knowledge Forum, the first is fairly easy to comprehend and fairly easy to see students doing this readily. You know, how does that student help that student. And for years we've seen that happen. But this whole understanding of the communal database is so nebulous and so large that I think it's what I feel is a big challenge still in seeing how that happens and how we can make attempts to facilitate that. It's a biggie.

This is not to say that the teachers' design of social infrastructure offered *no* support for communal knowledge building, but rather that because the concept posed a challenge, it may have limited their ability to effect communal knowledge building through their design decisions.

The difficulty the Whitman teachers experienced in developing a good feel for the meaning of "communal knowledge" or "collective understanding" is not surprising, according to the literature on group processes in schools (e.g., Senge, Cambron-McCabe, Lucas, Smith, Dutton & Kleiner, 2000; Webb & Palincsar, 1996) and team learning and organizational learning in the workplace (e.g., Brooks, 1994; Donnellon, 1995; Hackman, 1990; Senge, 1990; Argyris & Schon, 1996). For example, Brooks (1994) points out "…the shift to working in teams in many U.S. work organizations represents not just a structural change in how work is done, but a significant historical and cultural shift that affects the way many individuals identify themselves

and attempt to establish their social worth" (p. 231). Thus, the Whitman team's struggle with the concept may be representative of a difficulty faced by members in the wider society.

Another challenge to building a communal understanding described by the teachers is that: "Because we work with 100 kids, this is very difficult for us. If I was teaching fifth grade and I had my homeroom and I worked with four or five groups every day, I think that would be a lot easier to keep your finger on." The knowledge building community that the Whitman teachers worked to cultivate was quite large, which posed challenges to keeping track of "what we know" as a collective. In designing participant structures for each unit, the teachers created small team structures in an attempt to make communal knowledge building more manageable.

Another reason why points of misalignment might exist between the ways in which knowledge and student social identity are conceptualized by the Whitman Team and the Knowledge Forum developers has less to do with limited understanding, and more to do with intentional design decisions on the part of the Whitman Team. That is, areas of misalignment between developers' and teachers' designs of social infrastructure need not be viewed as "lethal mutations" (Brown, 1992) on the part of the teachers. Instead, such misalignments may reveal aspects of the implementation context not taken into account by the tool developers – the teachers may be "closer to the ground," more aware of the needs of particular learners or school contexts. Or, it might be that the developers' design represents an idealized end state, but the teachers are faced with determining design decisions that shift their classroom social structures from an initial state toward this desired state. In such cases, misalignment might indicate that the teachers have identified a critical intermediate design stage in the trajectory from initial to desired social infrastructure (i.e., critical stages in the "implementation path" (Bielaczyc, 2006; Bielaczyc & Collins, 2006)).

The construct of implementation paths may be particularly relevant to Whitman Team classrooms since the teachers frequently stressed the challenge of developing a knowledge building community among students who had already come through six years of traditional schooling and were of middle school age:

> They have to see each other as researchers, and they have to respect what each of them has to say and what each of them has to contribute to whatever the learning happens to be. And having said that, if you reflect on that, that is a big order when you're putting it into the environment of a middle school where kids have an awful time respecting each other, feeling as if they belong together, where you have cliques and all that kind of stuff. … You are working in, sometimes in an environment that does not lend itself to that kind of behavior. If you have a very small group, yes, perhaps that might work. But if you don't have a small group, if you're working with large, collective groups of people, you really have to work hard at that.

The Whitman Team was faced with the issue *how can you get kids to construct communal knowledge if they don't view themselves as a community?* Put simply, just sharing work in a common database does not make a class a "community." The Whitman Team's efforts were focused on ways to help students in becoming familiar with each other's ideas and to establish a sense of helping each other to reach their goals. The focus on building *person-to-person relationships* might be seen as a transitional step in the implementation path toward the type of *person-to-enterprise relationships* needed in a knowledge-building classroom.

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