Cooperative Inquiry as a Community of Practice

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Abstract: In this paper, we demonstrate how direct student involvement in the design of curricular interventions and educational technologies not only produces meaningful and creative designs, but also allows students to question their own assumptions about learning and to develop a deeper understanding of content. We adhered to the perspective of Cooperative Inquiry; that is, students were treated as partners in the design process. Using interview methods, we describe the perceived experiences of four student partners regarding their participation in developing a guided inquiry technology-based curriculum. We outline three major themes (*learning outcomes*, *community* and *philanthropic outlet*) and their implications for future design research.

Introduction to Cooperative Inquiry

The enactment and development of pre-designed curricula is not a simple task. In traditional models of design, people in power develop materials and expect teachers to operationalize prescribed plans (Barnett & Hodson, 2001). However, these developments routinely fail to generate impact because they do not take into account the complex interactions and culture of the classroom (e.g., Squire, MaKinster, Barnett, Luehmann, & Barab, 2003). As a result, researchers are partnering with teachers in collaborative work-circles to develop learning activities that accompany educational technologies (e.g., Penuel, Fishman, Haugan Cheng, & Sabelli, 2011). Such partnerships allow for a common understanding of the goals, core ideas, and learning principles of the curriculum and can help address concerns and tensions within implementations. While collaborations between teachers and researchers are a step in the right direction, we argue that students have often been overlooked as participants in the design of new technologies for learning (e.g., Cook-Sather, 2002). More often than we wish, adults tend to underestimate the insights and perspectives of students, particularly when it comes to making decisions about student learning (Könings et al., 2010). Many design projects continue to involve students only as testers, despite growing evidence that they can act as design partners at all stages of development (e.g., Bland & Atweh, 2007).

Participatory Design (PD) provides a mechanism to attend to student perceptions and desires during the design process. Generally, PD is used to include any design activity with an end-user; such roles include *user*, *tester*, *informant*, and *design partner* (Druin, 2002). The most involved method of PD is the philosophy of Cooperative Inquiry (CI). In CI, the user becomes fully integrated in the design process in the early stages of development. CI recasts users as representatives in work circle development teams who actively participate in setting design goals, planning prototypes, and making decisions that ensure the final design meets the needs of future users. Design partners use their experiences to assess the current design and give opinions on its shortcomings. Researchers suggest that if students are given the chance to be directly involved in making decisions on their learning and the learning of others, they might be more inclined to learn more from both an academic and a democratic standpoint (e.g., Bland & Atweh, 2007; Cook-Sather, 2002). In the present study, we examine the ways in which student designers benefit directly from participating on a large-scale technology-infused chemistry curriculum development project. Our analysis demonstrates that the use of CI can foster increasingly positive attitudes towards learning, develop a sense of community, and fulfill philanthropic ideals.

Methods and Analysis

We asked students to participate in curriculum development by having them provide feedback on written materials and ideas for the design of new simulations for teaching high school chemistry. The curriculum, *The Connected Chemistry Curriculum*, utilizes simulations modeled in a user-controlled microworld to teach chemistry at the submicroscopic level (Stieff, 2011). The simulations are paired with a structured workbook to introduce vocabulary and concepts through guided inquiry. In the beginning stages of the design process, we asked students to make important user interface design choices for the simulations. In the later stages of development, students provided suggestions for presentation of that content. The participants in this exploratory study were four freshman female students who had completed one high school science course and were currently enrolled in preparatory college chemistry. Preparatory chemistry provides remedial instruction to students seeking to enroll in general chemistry. *Kim* loved science and eagerly participated in the project. *Sarah* was excited to participate and contributed readily, but worried that her content knowledge was lacking. *Amanda* was a self-professed 'non-scientist' who expressed disinterest in the activities and completed activities perfunctorily. *Beth* was a pre-medicine major who enjoyed developing materials to help students transfer ideas between units.

We obtained student feedback regarding the workbooks and simulations through six three-hour interviews with a single design researcher over the course of an academic year. We chose to use a one-on-one interview process to protect the anonymity of the participants and to allow students to be candid with their responses outside the larger team. In each session, students reviewed drafts of written materials and alpha versions of software. We asked them to complete each draft activity and provide critiques and ideas for future materials. Student design partner ideas regarding workbook format and software user interface were compiled and communicated to the entire team as recommendations for revisions. Team members revised the materials and created new drafts using these recommendations. The format of each interview was loosely structured to accommodate the student design partners: some interviews began with an explicit probe of their opinions about various components of the curriculum and some interviews began with students working directly with the materials with no prompting. At the end of the academic year, each student participated in a 1.5-hour exit interview. The exit interview was semi-structured to allow each participant to comment on her personal experience as a student design partner. The exit interviews were used for the present analysis. All exit interviews were videotaped for later analysis. Each video was analyzed using a constant comparative method (Strauss & Corbin, 1994). We analyzed the videos using an initial open coding scheme that yielded the following codes: *Positive Attitude Toward Science*, *Learned Something*, *Part of the Team*, *Test Subject*, *Don't Deserve Credit*, *Used Later*, *We Listen*, *Helping Others*, *Paid*, *Tutoring*, *Appreciation for Process*, *Appreciation for Teachers*, and *Conflict/Tensions*. Three themes emerged from axial coding. The **Learning Outcomes** theme captured changes in the participants' chemistry content learning that included changes in content knowledge, attitude toward science learning, and epistemology regarding science learning. The **Community** theme captured changes in the participants' identity as designers and their sense of belonging to a community of practice. Finally, the **Philanthropic Outlet** theme captured the participants' feelings of satisfaction that their ideas and efforts were contributing to a larger project that potentially might help other students in the world.

Three Themes in Cooperative Inquiry Participation

The first theme reflects the **learning outcomes** (*Theme 1*) of the students. The students each noted that they gained skills or knowledge by participating in the design of the curriculum. First, the students expressed that they were motivated to participate because they saw the design interviews as a tutoring experience and that reviewing curriculum materials improved their understanding of chemistry. Specifically, each student noted that working with computer simulations provided a deeper appreciation for molecular phenomena. Sarah and Kim indicated that they referenced the simulations outside of the design interviews and applied them to coursework to visualize concepts. Second, the students reported gaining communication and professional skills such as offering constructive criticism and use of vocabulary. Third, all four students expressed newfound appreciations for learning science. Importantly, this appreciation extended beyond content learning to include an appreciation for how learning occurs as well as an appreciation for science teachers and text authors. Beth and Sarah voiced changes in their own understandings of the learning process in science as an iterative process. Finally, working as a student design partner in the construction of curriculum materials helped Sarah and Beth change their views of science. Sarah left the project with additional content knowledge that led to the realization that scientific knowledge was more accessible. Because she felt that the content was easier to interpret, she found science more interesting; thus contributing to a more positive view of science for her. Throughout the design process, Beth found that the content was more applicable than she had previously thought and the content knowledge she learned has applications to other careers outside the laboratory.

The second theme reflected student beliefs about **community** (*Theme 2*). This includes their view of their own role within the project, how they felt they had a voice that was heard, and whether they deserved recognition for their participation. These themes indicate that the student design partners developed a sense of belonging to a project team and a larger community of practice (Lave & Wenger, 1991) populated by individuals with a commitment to educational materials development. All members of the project team including teachers, researchers, and software developers have voiced commitments to creating new technologies and curriculum activities to improve student learning in different ways. As the student design partners' participation continued, they too began to express such commitments and a sense of ownership that they discussed in the exit interview. Student utterances in this category varied in perceived impact or influence on materials development. These students viewed the design partnership as a positive experience in which they could share their ideas in a way that could have impact. Kim even noted the partnership generated a sense of responsibility that created feelings of stress because she was invested in the project to the extent she worried about the consequences of her design recommendations. Rather than thinking of herself as a simple user or informant, Kim expressed feelings common among all members of the design work circle and acknowledged ownership of her ideas and input. Although the student design partners acknowledged that other team members heard their input and valued their opinions, they also expressed doubts about whether they deserved any credit for their participation. Language from the participants indicated that at times they felt like designers and at other times like a 'test subject.' For example, Beth felt as though any student could fill her role, but noted her individual impact when she recognized a curriculum modification based on her recommendation. Amanda suggested that she would have felt more involved had she been provided with the edited materials regularly so that she could see her impact on development. Amanda and Sarah recommended that they would feel more part of the community of practice by attending regular work circle meetings. However, Beth and Kim preferred the anonymity of the one-on-one interview setting. Despite the one-on-one interview setting, the students all expressed sentiments that they did feel as though they were part of the community with some students feeling more open and comfortable than others with the individual interviews.

The final theme of **philanthropy** (*Theme 3*) captured all four students' expressions that the interview functioned as an outlet in which their contributions would help future students learn chemistry. When students are asked for their opinions on how to better their schools, often times they will want to engage in pro-social behaviors that benefit others in their communities and will gain a sense of empowerment as a result (Thomson, 2009). We found that when we asked our student design partners for their opinions on the curriculum, they wanted to help others. Kim noted her input "could help the younger generations." Even Amanda, a self-professed 'non-scientist,' stated, "I helped people…the thought of knowing that I helped other people I feel good about it." Kim and Sarah spoke to the fact that they were uniquely qualified as students themselves to help others in this role. The students felt as though they were making a contribution and the interview was an activity that helped serve their own personal desires of philanthropy.

Discussion & Concluding Remarks

Our analysis of the student reflections about participation in a CI design project suggests that CI design not only improves the quality of designed materials and educational technologies, but that the process can engender important changes in the students themselves. While we as researchers gained benefits from their insightful views, we saw that the students gained positive aspects from our partnership. First, as seen in *Theme 1*, CI can give student designer partners more opportunities to take responsibility for their learning. During this collaboration, what becomes important is the creation of an atmosphere in which students are aware they can negotiate through dialogue, exercise responsibility, and achieve goals that have personal meaning and motivation for them (Whitehead & Clough, 2004). CI design of learning activities can help student designers to take responsibility for their learning outside of the project. Here, each of the student designers noted that through participation they not only learned more, but they became more invested in their own science learning; for some participants this included an increased interest in pursuing a science career.

Equally important, the co-designers also gained a sense of belonging through their participation (*Theme 2*) and personal satisfaction from doing work that might help other students learn science (*Theme 3*). This sense of belonging to a larger community of designers was not uniform across the students. Each student expressed surprise that her ideas were seriously considered and that they had a direct impact on materials development. Their collective position on participation suggested that they came to the project with prior beliefs that their contributions had no merit or that their contributions would be dismissed or minimized by other project team members. In fact, some students expressed this belief until confronted directly with evidence that she had made an important contribution that was carried forward throughout the design process. We believe that regardless of the student's career aspirations, developing a sense of belonging in this way is an important benefit that may last outside the project.

Despite the perceived benefits to design, adult designers and students, working with student design partners can produce tensions we must recognize and balance. Grundy (1998) argues that collaboration between researchers and teachers is already difficult and complex enough. If teachers and research designers have these dilemmas, arguably working with students is even more complicated. The capacity to have students make design decisions in an equal democratic fashion like adults can be a challenge. Often, researchers, teachers, and students come into projects with different agendas (Atweh, 2003), and university sponsors are under ethical and legal obligations and constraints to protect students (e.g., Bland & Atweh, 2007). In our case, while we protected Amanda's identity, she would have preferred to be credited for her work on the materials in a public fashion.

Similarly, students' perspectives can easily be twisted to conform to existing school traditions or adults' preferences (Mannion, 2007). To prevent us from imparting our biases over the students, we took great care to inquire about their perspectives. We strived to avoid a scenario that allowed only for superficial involvement of students (e.g., Bland & Atweh, 2007) by visibly taking notes as a student spoke and asking for clarifications. From these notes, we made changes to the curriculum and the workbooks. If researchers work with student partners in design, we recommend that designers document and credit what changes were made through students' suggestions. Although students gave many suggestions, we could not implement every idea.

We believe it is critical to describe and make clear the role of student participants. In doing so, this will help students understand that when their ideas are not used it is not meant to belittle their contributions. In conclusion, as others have advocated (e.g., Druin, 2002) we have seen that such collaborations not only enrich the products of our design efforts, they have enriching and potentially lasting impacts on the student design partners themselves. We saw that students utilized the design interviews as a philanthropic outlet, realized a way to gain content knowledge through participation, and developed a sense of community. Although researchers suggest that communities of practice are developed through face-to-face interactions with an entire group (e.g., Lave & Wenger, 1991), we found that our student design partners engaged in a design community utilizing one-on-one interviews through maintaining a student empowering role in the project, creating a professional and welcoming atmosphere, and making clear to students that we were actively listening and integrating their opinions and ideas into the curriculum.

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