

Reflections on the Use of HCI Methods for the Design of Learning Spaces

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INTRODUCTION

The topic of learning spaces and their design has become increasingly popular in education. Whether it is the development of physical spaces in higher education settings [5, 9] or K-12 settings [7], more attention is being paid to the design of physical spaces in educational contexts and how those spaces can be designed to support learning and other educational activity. The issue of architecture and its impact on learning is also being discussed in educational research. For example, Shulman [13] describes the notion of *signature pedagogies*—teaching that organizes the fundamental ways in which future practitioners are educated to think, act, and perform in their new profession—and how these pedagogies can serve to help inform and determine the architectural design of educational spaces in ways that support those pedagogies.

While my primary work is in human-computer interaction (HCI) and the design of learning technologies, I have become increasingly involved in the development of physical learning spaces as part of the team planning and enacting renovations at our School of Education (SOE) building at the University of Michigan. That work on physical space design has involved consulting with architectural teams plus SOE faculty, staff, and students to develop specifications and a master plan for future renovations of the entire school building. However, there has also been some recent work on the creation of a specific new space in the building called the *Brandon Center for the Study of Education Practice*¹. At a general level, the Brandon Center is a new study and meeting space for students and faculty. But more specifically, it aims to support video-centric educational activity focused around the study of teaching and education practice (e.g., the creation, contribution, access, and analysis of video teaching records). The Brandon Center was conceived as a “21st-century library” that was intended to house digital video archives of teaching practice and support the work of students, faculty, and researchers exploring contemporary issues in teacher education and other educational research.

Our SOE Technology Advisory Committee, which I chair, was tasked with working on the Brandon Center design along with architectural and interior design teams, SOE facilities management, and members of the SOE community. This activity involved working on the design of the center’s interior spaces and making decisions about the technology (and non-technology) resources for the center, furnishings, etc., all aimed at supporting the educational activity and study envisioned for the center.

While an architectural team developed the blueprints for the interior spaces of the center, our work essentially involved designing those spaces. At that point, a main question for us involved the processes and methods we could use for this design task. As someone with a design/HCI background, but not necessarily a significant architecture background (aside from growing up in the construction business and having that prior experience with architects and construction crews), a reasonable step to move forward and design this physical space was to refer to the HCI work and design methods I have used and developed. As our work continued, I was struck by and continue to be interested in the overlap between HCI, design methods (both general design methods and those focused on supporting educational activity), and architectural design.

HCI AND THE DESIGN OF PHYSICAL SPACES

As we began our work developing the various Brandon Center interior spaces, I thought about HCI and how we might use HCI methods and processes to inform that work. My HCI work has revolved around the notion of designing learning technologies using a *learner-centered design* (LCD) perspective [11, 14]. In LCD, we consider educational activity and the audience of learners (i.e., novices in this activity) trying to engage in that activity. The design task involves developing supportive technologies that support those novice learners so that they can mindfully engage in the activity key to their learning.

Thus the notion of *activity* is crucial. My specific work is situated in science education contexts where our learner audience is middle school students and the educational activity involves science inquiry. Thus I have worked to design technologies that help these middle school students engage in multi-faceted and complex science investigations.

¹ <http://brandoncenter.soe.umich.edu>

When we began the Brandon Center design, we thought about how we could design the physical spaces to support our learner audience (i.e., college students, educational researchers, etc.) for the activity of studying and analyzing the practice of education. Our design decisions would thus be based on different aspects of that activity.

As HCI researchers and designers, our job is to understand and describe activity, along with the context in which that activity is situated and the audiences engaging in that activity. We then develop tools and interfaces for those audiences to support that activity. So in thinking about how we could envision and describe the educational activity that would take place in the Brandon Center, we thought about the different HCI approaches that are used for describing activity. Different approaches have certainly emerged over the years to describe activity in HCI, from activity theory (e.g., [8]) to contextual inquiry [4]. Another idea that I explored in previous work was the notion of *process spaces*, which was put forth by Fitzpatrick and Welsh [3] as a conceptual space in which activity takes place. A process space includes the following components:

- **Roles:** The responsibilities undertaken by the participants of some work process.
- **Activities:** The components of the work process that are undertaken by the roles, include a task or a set of tasks that may be complex enough to themselves constitute a process space
- **Services:** Tools that are used to perform the activities
- **Artifacts:** Objects that the activities produce or objects that mediate the completion of other activities
- **Information Objects:** Pieces of information in the work environment that are used to complete activities

In previous HCI work, I extended the process space idea into a *process space analysis* approach to analyze and describe the larger activity that would be supported by the software we were creating [12]. For example, in order to design software to help students engage in scientific inquiry, we used the process space analysis approach to describe the full set of roles, activities, artifacts, information objects, and services that comprise scientific inquiry to help define the content of our software and the support our students would need to do their science work.

Thus for the Brandon Center design, we thought an approach like a process space analysis would be a good starting point to describe the educational activity that would need to be supported by the spaces in the center. Since a process space defines a conceptual activity space, we felt this would allow us to describe the conceptual spaces for different learning activities to take place in the center (e.g., the activity involved in recording, analyzing, critiquing, and describing education practice) and then map that to the physical space. The other design methods named above share similarities with this approach, but are more complex

and can be difficult to apply to new design tasks. The process space approach served as a straightforward and useful conceptual organizer that our team could use to think about the different facets of activity that needed to be supported in the center's physical spaces and the way those spaces could be designed to support that work. Note that there is newer work in learning technology research, such as recent work by Luckin [6], who is developing the *Ecology of Resources Design Framework* to inform the design of technology-enhanced learning contexts (whether physical contexts, curricular contexts, a combination, etc.). It would be interesting to consider how such a framework that is specifically focused on designing learning *contexts* could be applied to the design of learning *spaces*.

As we then defined different aspects of the learning activity for the Brandon Center spaces and started to articulate different visions of what those spaces could be, we needed to describe these visions in ways that would not only be useful to the design team, but also to other stakeholders in our building, such as administrators, other designers involved in the project, students and faculty, etc. This is a straightforward idea, but here we also turned to other HCI ideas, such as scenario-based design [2] and other recent work that is emphasizing the importance of storytelling when designing the user experience [10].

In particular, we reviewed some of the educational activity descriptions that we developed with the process space characterization and then described how the center's potential users (e.g., students, researchers, etc.) might currently engage in that activity inside or outside of our building. We wrote up these existing scenarios, which included the problems, complexities, and successes that arose for students in the current spaces. We then developed another set of scenarios that described how students *might* engage in the same kind of activity in the new spaces we were designing, which forced us to think about how we could create the new spaces to address the problems and issues in the existing scenarios without losing some of the favorable aspects. Thus we created a set of *current scenarios* that describe how students work in the current building spaces, and *future scenarios* that describe how students could work in the new Brandon Center spaces we were designing. These sets of scenarios, or "journey maps" have been similarly used in other design projects and helped us to not only clarify the design of our new spaces, but to also tell a set of stories about the emerging Brandon Center vision to the other stakeholders in the building.

OPEN QUESTIONS, RESEARCH DIRECTIONS, AND CONCLUDING REMARKS

The Brandon Center opened in September 2011, and we are now observing how students and researchers are using the spaces in the center, especially looking to see where their use is as we expected, but also at some of the unexpected uses. We will be continuing with these observations over this first year to see what kind of revisions, additions, etc.

need to be made to the space. Ultimately, this design experience has been interesting from multiple perspectives. From an academic perspective, it was interesting to think about design issues and the overlaps between HCI, user interface/experience design, and architectural design. For us, it was also interesting to think about how the design of physical space might impact learning. From a more practical perspective, it was also a learning experience for many of us to participate in a “real world” design project, complete with budgets and timelines that had to be met, and the prioritization decisions that come with such a project.

In some respects, it is the “learning space” aspect of this project where we still have questions and things to think about in terms of the ways that we did or did not fully support different kinds of learning activities in the center. One lingering question focuses on how we can truly make physical spaces congruent to the type of learning activity that we wish to support. Our use of the process space template was useful for informing the different kinds of spaces were needed within the Brandon Center and the different resources needed for those spaces. For example, some spaces in the center are set up for collaborative work with multi-screen, multi-user work tables (e.g., Steelcase media:scape tables) and technology connections in closed, private rooms, while some spaces are semi-formal, casual meeting spaces without technology connections. However, it is not clear yet that we fully identified and addressed all our target educational issues in the design of the center. In other words, reflecting on our process space model, we think we successfully identified the services and artifacts needed for the different spaces, but it is not clear that we identified all the information objects students may need to engage in the given educational activity, and thus we may not necessarily have included educational supports in the physical space. While we outlined the services and artifacts to include in the spaces (e.g., furniture, technology, technology connections, etc.), we did not think about ways to augment the different spaces with information objects—whether they be in the form of signage, external resources, technology-based help—that provide cognitive guidance for how to engage in the educational activity of the center.

This also leads to a question about the incorporation of educational *scaffolding* into a physical space. By “scaffolding”, we mean cognitive support provided by some more knowledgeable agent (human or technology-based) to a novice learner to help them engage in a given task that is just beyond their reach [16]. Much of my HCI research has focused on describing ways that technology can scaffold learners. But in designing the Brandon Center, the question was how to provide or embed cognitive scaffolding within the physical space itself—in other words, how can a physical space scaffold learners? The notion of scaffolding is always centered on some learning task, and here we realized we could think about scaffolding in two ways. On the one hand, we could think of the learning task as “learning to use the physical space”. Here, scaffolding

could be, for example, signage on how to use the center’s facilities, (e.g., how to use the media:scape stations, etc.). But on the other hand, if the learning task is “analyzing education practice”, there is a question about how we embed scaffolding (i.e., information objects) within the center’s spaces to support that activity. It is a subtle difference, but one that arose in our thinking as we began to differentiate between supporting people to use the space itself versus supporting people to engage in the activity being supported by the space.

Finally, other questions emerged from this design experience about how the notion of traditional learning spaces is changing because of technology, and what this means for the design of such spaces. For example, I mentioned earlier that the Brandon Center was initially envisioned as a “21st-century library” that would house an archive of education practice information, including videos of teaching. However, as time passed, it became clear that such a digital video archive did not necessarily have to reside in the Brandon Center, nor would someone have to actually be in the center to access the video archive. This led to a philosophical issue of sorts: with mobile and ubiquitous technology and the advent of cloud-based technologies, what exactly will the purpose of libraries be in the future? If libraries have traditionally housed information and people have had to go to libraries to access that information, what are the implications for libraries when that information can now reside outside of the library? What are the new roles and the purposes of a library? What learning activities should physical spaces in libraries now support and how do this potential new activities and roles impact their design? These questions have arisen in recent library projects (e.g., the construction of the new Seattle Public Library [15]) and pose some interesting issues for the design of learning spaces. As technology becomes more ubiquitous, are there now more linkages between, for example, the design of digital library user interfaces and the design of the learning spaces where people will use their mobile technology to access those (now digital) libraries?

Finally, this leads to another design question that arises in the context of mobile and ubiquitous technologies. Specifically, how do you connect the design of these technologies with the design of the learning spaces where those technologies are being used, especially if the two are supposed to work in concert to support a certain kind of educational activity? This idea has emerged in my recent Zydeco research project [1] where we are exploring the use of mobile technologies (smartphones and tablets) as science inquiry tools so students can engage in science investigations that can span formal classroom environments and informal science environments, such as science museums, nature parks, etc. Here, we are looking at how technology can essentially help conceptually morph two learning contexts (e.g., classrooms and museum) into a single, larger learning context. With mobile and cloud

technologies, learners can now have classroom discussions, take aspects of those discussions with them to museums, capture relevant aspects of the museums, and use the cloud to essentially access those museum representations back in the classroom. When we can use technology to conceptually combine multiple learning contexts that will now work together to support certain learning activities, how might this impact the future design of these spaces? How might classrooms be designed to facilitate work around digital artifacts and information that are collected in other contexts and how might museums be designed to also support the kind of work going on in classrooms when the work in those contexts revolve around a common set of learning activities and goals?

As new plans continue for other projects in our building, what emerged from the Brandon Center project was a view into the commonalities and distinctions between different kinds of design tasks. While there has been much recent buzz about the notion of “design thinking” and its possible utility in other professional contexts not typically seen as involving design, there certainly was an appreciation for ways in which HCI methods and architectural methods might usefully cross pollinate. Indeed, while we now use the term “user experience” with increasing frequency in HCI, we realized that the term resonates in architectural contexts because in designing a physical space, we are also having to support and worry about “user experience”. It is exciting and timely to have a CHI workshop on this topic, and I look forward to the opportunity to discuss these issues with others who are thinking about the potential synergies between these fields.

REFERENCES

1. Cahill, C., Kuhn, A., Schmoll, S., Pompe, A., & Quintana, C. Zydeco: Using mobile and web technologies to support seamless inquiry between museum and school contexts. In *Proc. Interaction Design and Children 2010*, ACM Press (2010).
2. Carroll, J.M. (Ed.) *Scenario-Based Design: Envisioning Work and Technology in System Development*. Wiley, Hoboken, NJ, USA, 1995.
3. Fitzpatrick, G. & Welsh, J. Process support: Inflexible imposition or chaotic composition. *Interacting with Computers* 7, 2 (1995).
4. Holtzblatt, K. & Beyer, H. *Contextual Design: Defining Customer-Centered Systems*. Morgan Kaufmann, San Francisco, CA, USA, 1998.
5. JISC. *Designing Spaces for Effective Learning: A Guide to 21st Century Learning Space Design*. HEFCE, Bristol, UK, 2006.
6. Luckin, R. *Re-Designing Learning Contexts: Technology-Rich, Learner-Centred Ecologies*. Routledge, Milton Park, UK, 2010.
7. Nair, P., Fielding, R., & Lackney, J. *The Language of School Design: Design Patterns for 21st Century Schools*. DesignShare, 2009.
8. Nardi, B.A. (Ed.) *Context and Consciousness: Activity Theory and Human-Computer Interaction*. MIT Press, Cambridge, MA, USA, 1996.
9. Oblinger, D.G. (Ed.) *Learning Spaces*. EDUCAUSE, 2006.
10. Quesenbery, W. & Brooks, K. *Storytelling for User Experience: Crafting Stories for Better Design*. Rosenfeld Media, New York, USA, 2010.
11. Quintana, C., Soloway, E., & Krajcik, J. Issues and approaches for developing learner-centered technology. *Advances in Computers*, 57, 2003.
12. Quintana, C., Eng, J., Carra, A., Wu, H., & Soloway, E. Symphony: A case study in extending learner-centered design through process space analysis. *Proc. CHI 99*, ACM Press (1999).
13. Shulman, L.S. Signature pedagogies in the professions. *Daedalus* 134, 3 (2005).
14. Soloway, E., Guzdial, M., & Hay, K. Learner-centered design: The challenge for HCI in the 21st century. *Interactions* 1, 2 (1994).
15. Steen, K. The making of a library. *Metropolis*, October (2004).
16. Wood, D., Bruner, J.S., & Ross, G. The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, 17 (1975)