Dramatic advances in information technology are disrupting and revolutionizing education. Online education improves the cost and accessibility of learning. As Andrew Calkins and Kristen Vogt have observed: “We are all privileged to be living in the moment when ‘next generation’ approaches to learning become so commonplace that they become understood as, simply, learning itself.”

Yet the transition from traditional models of education to digital tools is nuanced and often fraught with technical and practical issues. The allure of a vast array of technological options is quickly followed by the realization that these tools provide value only when deployed in ways that meet the needs of teachers and students. In short, information technology influences educational outcomes when it addresses the human context surrounding the learning activity.

So, how can online courses be best designed to enhance the quality of the learning that results? We answer this question by drawing on our experience as coordinators of the STEM Academy, a two-year project to create online high school and dual-enrollment Science, Technology, Engineering, and Math (STEM) courses for rural school districts in southwestern Pennsylvania.

Background

The STEM Academy was designed to reach the underserved students in three rural counties through a partnership between Intermediate Unit 1 (IU1), Carnegie Mellon University (CMU), and Penn State Fayette’s Eberly Campus. The goal was to build on the IU1 Cyber Solutions Initiative (CSI), an established online learning effort. By providing each participating district with the ability to offer the electives in an online format and sharing courses across a consortium of schools, the CSI provides students from very rural districts with access to STEM electives.

Twelve teachers were selected to participate in seven days of advanced professional development facilitated by CMU and IU1 faculty. During the sessions, teachers worked collaboratively to align objectives, write content, embed technology tools, and explore design-based learning. Additionally, the teachers attended three to four days of training on the learning management system used by IU1. Through this process, each of the teachers designed and developed online courses on topics ranging from astronomy to robotics to landscape architecture.

Identifying Collective Aspirations

Successful design projects involve understanding the constraints and limitations that frame the problem. The participatory design sessions began with a simple exercise called “I like, I wish,” a method that allows a group of individuals to express what works well and what doesn’t when reflecting on shared experiences. All of the teachers were asked to contribute at least five things they “like” and five things they “wish” about teaching their real-world courses and how they might extend those into the online space.

We then performed a large affinity diagram synthesis of the approximately 250 likes and wishes. The synthesis resulted in the following opportunity statements, forming a strategic backbone to drive the design:

- There is an opportunity to create and support a community of engaged students by celebrating each individual’s sense of pride, integrity, and community identity.
- There is an opportunity to encourage teachers and students to reflect on, share, and creatively express their interests and motivations to inspire learning.
- There is an opportunity to build a network that optimizes existing material and technology resources to energize and motivate teachers.
- There is an opportunity to inspire changes in education policy and assessment by leveraging 21st-century learning technologies.

Ideation

Next the participants, working in teams, reframed the opportunity statements into “how might we...?” questions. They brainstormed 50-plus concepts on each question, resulting in more than 300 rough concepts. Favorite concepts were voted on at the end of each session, and these concepts were further distilled onto more refined sheets containing a title, description, value proposition, and sketch (see Figure 1).
The 40 refined concepts were then clustered into 11 categories representing aspects of online learning systems. Collectively, these categories illustrated the system architecture for the proposed online STEM Academy.

Tailoring E-Learning Concepts to Individual Courses

Building on the opportunity areas identified above, teachers began developing online course content designed to meet educational goals. The process identified four principles that were used to ground the design of each course relative to the learning goals:

1. **Make learning fun:** enhance students’ enjoyment of learning experiences that are personally satisfying.
2. **Facilitate project-based learning:** emphasize the real-world application of course content so that students are able to focus on solving relevant and meaningful problems in their lives.
3. **Celebrate failure:** provide a safe space for taking risks and allowing things to go wrong.
4. **Provide opportunities for dialogue and peer-to-peer feedback:** allow students to give each other online feedback in the form of comments and critique, so that students can present their work and learn from the mistakes of others.

The teachers were asked to perform two activities designed to facilitate self-reflection on their course as it was being designed. First, they were given a page containing the four identified design principles and were asked to assess how well their course responded to each. They were also given a page containing all 40 of the refined course design concepts and were asked to identify those concepts that would best address the principles when implemented in their course. The intent was for the teachers to self-assess the instructional strategy of their course by comparing their strategy to previously established design principles. Second, as the design of their courses became increasingly detailed, teachers were given a large sheet of paper containing a 2x2 matrix and a stack of stickers containing the 40 favorite brainstormed ideas. The matrix contained the following axes:

- “This is easy to add to my course” vs. “This is hard to add to my course.”
- “This would help, and my course would be better” vs. “This wouldn’t help, and my course would be worse.”

The teachers were then asked to sort the 40 ideas into one of the four resulting quadrants to identify how best to enhance their educational approach. When totaled, the most popular concepts employed in the designed courses were, in descending order:

- Discussion Forums
- Virtual Field Trips
- Online Exhibitions
- A Self-Reflection Phase
- Electronic Portfolio Artifacts
- Virtual Demos

Discussion

The primary goal of education is the effective transfer of learning. Rather than beginning with content that is presumed to be useful and formatting it into an online template, our approach centered on real-world practices that teachers know to be effective. It identified specific learning destinations that students will work toward and the interactive mechanisms required to make sure they succeed. The question is: What should be taught, and how can it be taught in a way that will most likely lead to fluent, flexible, and lasting learning?

In our process, participatory design is key to fostering a shared sense of purpose and individual motivation. When communities of learners are empowered with open tools and guidance to further their collective aims and are supported by design principles that value the nature of their practice and their needs as individuals, the results are inspiring. Our approach demonstrates the power of democratic education as a transformative tool for digital systems design, one which information technologists would be wise to incorporate into their planning and development processes.

We also found that the teachers participating in our workshop were enthusiastic about open and participatory learning, as if mirroring the open nature of the courses that they were developing. In this regard, “open” access to a wide array of freely available online resources and digital tools enabled them to create and share content in ways that would be difficult to facilitate in a traditional classroom. Indeed, we believe that when the design of online learning is centered on universal human needs and values—such as the desire for personal expression and for the creative collaboration necessary to foster community pride—then the clearly defined hierarchies and organizational structures of teacher and learner begin to erode, revealing a network of enthusiastic, motivated, and caring mentors.

Notes

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