Scenario-based Design of Technology to Support Teaching in Inverted Classes

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Abstract
Literature has studied students learning in inverted (flipped) classes. However, little attention has been paid to another important set of stakeholders – the instructors. While past research indicates that the inverted paradigm is effective, there has been no analysis of preparing, creating and delivering this instruction model from an instructor's point of view. We argue that education technology designers must understand the socio-technical aspects of what instructors teaching in this paradigm need for course preparation and delivery. In this paper, we report a first step in this direction, reporting on scenario-based design work conducted in response to interviews with instructors of flipped courses. We construe this as an interactive system design problem; in that teachers must create and deliver technology-mediated content that will support their goals for student learning. We summarize our design process, comment on findings from scenario-based analysis and design interviews conducted to evaluate and refine our design concepts.
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1 Introduction

As technology continues to evolve, so do the options for creating and delivering education. Teachers at all levels are integrating games, software, and other technology into their instruction, primarily so as to increase student engagement and participation. Traditional lecture style classrooms are being left behind as instructors begin to appreciate the flexibility and attractiveness of new pedagogical approaches.

The inverted (or flipped) classroom (IC) is one such alternative teaching paradigm that provides an exciting way for instructors to reform their teaching (Bishop & Verleger, 2013). IC inverts the traditional activities of the classroom and encourages self-directed student learning (Lage, Platt, & Treglia, 2000): homework usually done outside the classroom is completed within the shared space, allowing instructors to help students with a direct, hands-on and customized response to questions. Lectures normally delivered in the classroom are recorded and viewed (or heard) outside of class, with students at home consuming content at their own pace (Bishop & Verleger, 2013). Research evaluating the inverted teaching model has documented some success, in terms of increasing student grades and elevating the classroom environment (Strayer, 2012; Gannod, Burge, & Helmick, 2008).

IC teachers rely on technology to create, manage, and deliver the out-of-class content and on-your-own activities. For example, one interview study showed that instructors used three to eight different pieces of technology to support their inverted courses (Peña & Rosson, 2014). Several complained that their content management system (CMS) fails to support even simple tasks: "*...[The CMS] is totally, it's dinosaur-ish. I have thought about using Yammer. I spend a lot of time in the summer with my kids, so if I'm sitting there and I got my phone and someone pings me a question in Yammer I can answer it. I can't do that through [The CMS], it's not intuitive.*" (*Ibid*., p. 7) As a result, instructors search for new technologies to aid in tasks ranging from creation of documents, websites, audio or video recordings; or smooth delivery of the resulting online content. At times this means paying for software out of pocket and learning a new user interface, a significant task that adds to the content development time. Instructors who use external tools to perform content development or delivery tasks must juggle these tools separately. One instructor reported taking two hundred hours or more to record and edit online lecture videos; in this case she needed six months to prepare for her course.

Experienced instructors who adopt an inverted teaching method for the first time must uproot well established teaching patterns and organizing structures (Peña & Rosson, 2014). For example, they must shift away from a view of students as autonomous learners; they must swap the traditional task of content delivery and explanation for facilitation and coaching. Importantly, the technical task of delivering content and external activities must be extremely smooth. The students must be able to access content modules online as easily as they would otherwise access the content by listening to a professor in class. At the same time, the professor must have support for accessing, reviewing and interacting with their students' activities while in the classroom.

For educational technology designers, one approach might be to create a comprehensive or monolithic teaching toolbox that incorporates all needed technology support into a single front-end, hopefully cutting down the time for looking for extra tools, learning to use new software, and other time consuming tasks. But how can we integrate these effectively? How can we minimize instructors' effort and make the processes of preparation before, during the class, and after, more efficient? What features best support the inverted classroom?

We are analyzing these questions using an exploratory lens. An important starting assumption is that many instructors building flipped courses have no programming expertise, and indeed may not even be "tech savvy"; nonetheless they often have specialized needs for novel technology-mediated content and activities for students to use prior to or during class. Other instructors may have the expertise to build their own content and tools, but may be forced to work across disparate software or institution-specific platforms, spending significant effort to integrate their class needs within their universities' teaching infrastructures. Some universities do not even provide specialized resources to instructors, preventing them from attempting new and innovative tools and teaching practices.

To address such course preparation issues for IC instructors, we conducted interviews with current instructors, using what we found to both understand their practices and to develop preliminary design ideas for technology support. We used a scenario-based design approach to create the design ideas and organized participatory analysis and design sessions with IC instructors to assess our ideas. In this paper we report the methods and outcomes of these sessions, which were guided by the following exploratory research question:

> *What technology features are most essential to development and delivery of flipped course designs and how should they be presented and used by instructors?*

To summarize, our goal is to consider specific opportunities for design of a system that could support teachers in their preparation for and delivery of inverted teaching. Using design-based research investigation, we seek to elicit design feedback for refinement or more radical transformation of our design concepts and to consider possible technology support approaches for instructors seeking to adopt an inverted teaching pedagogy.

2 Related Work

The current study is the second phase of a more extensive research project. In a first study, we interviewed IC instructors, to understand their teaching model and the technologies they use. After constructing a basic understanding of the inverted phenomenon and instructors' technical practices, we developed design responses that focused primarily on addressing problems raised by our interviewees. Broadly, instructors felt that current technologies are inefficient and unable to aid them effectively in their course tasks. For example, "*[The CMS] sucks! There's not that many other tools to use, I put a syllabus and readings and assignments and I use it because it's within the system."* (Peña & Rosson, 2014, p. 7). We used responses from the earlier study to develop themes that guided a scenario-based design process, focusing on the technologies needed by instructors of inverted courses, while also drawing from prior research on technology usage in the inverted classroom and other innovative teaching tools.

Similar studies have also focused on a 'teacher perspective', considering how technologies are or are not helping instructors to organize, prepare and teach their classes. For example, Rosson et al. (2007) describe Teacher Bridge, a suite of tools and an online community designed to share knowledge amongst a community of teachers. It was found that most teachers develop their skills and experiences over a period of time and because of traditional lecture classroom structures, most explore and practice skills alone without collaboration (Rosson, Dunlap, Isenhour, & Carroll, 2007). Teacher Bridge allowed a network of teachers with common interests and concerns share information but also build new content and materials for their students. The design process used in this work is similar to the current project, in that the researchers relied on participatory analysis and design as a way used to elicit feedback. One difference in the present work is its focus on IC as a specific teaching approach.

Likewise, Ainsworth and Fleming (2006) conducted a five-year study program where they evaluated their tool REDEEM in several different classrooms. This was designed as an authoring tool for teachers to create and select materials to build learning environments. The tool was conceived due to teachers' request to be more deeply involved in tool design and development (Ainsworth & Fleming, 2006). Most of the implementation and the usage involving REDEEM had a positive effect on teachers and students using the system, though they did find that even simple tools require complex thought processes and heavy authoring decisions which have tremendous consequences on time and usability (Ainsworth & Fleming, 2006). Further, they found results suggesting that teachers can become "instructional designers" by successfully creating tools (Ainsworth & Fleming, 2006). The main belief established is that teachers should have several technical choices at their disposal, even if REDEEM does not provide a sole comprehensive solution, it steers attention toward more research in this area.

Our emphasis and gap continues to be the design of tools for teachers and revealing their important perspectives. And how teachers can make contributions by creating and modifying technologies as opposed to being forced or dictated by certain technologies.

3 Method Overview

We used scenario-based design (SBD) to develop personas, problem scenarios and design prototypes (Carroll, 1995). The SBD materials were then the focus of a formative evaluation that took place through design walkthroughs and discussion; the participants were instructors who are proponents of innovative teaching practices and technology usage. The instructors' feedback is being used to refine the design ideas until a desirable design emerges from the iterative discussions. Eventually, a system will be built and implemented "in the wild" so that it can be evaluated through classroom studies. In this brief paper, we will produce some design recommendations and future steps.

Guided by our interview study, we first created a set of *personas* (examples of individuals from the target group who illustrate important distinctions, see also (Grudin & Pruitt, 2002)) and problem scenarios (depictions of current practices in developing flipped courses that illustrate important issues). We also developed initial design ideas about how to address the problem scenarios. Each set of design ideas was illustrated with a single paper-based sketch, leading to six pairings of one problem scenario and one design sketch.

For the participatory design sessions reported in this paper we recruited ten instructors who varied in their teaching expertise (HCI, information systems, health informatics, computer science). The only screening criteria were their use of the inverted classroom or variations of this inverted structure because it implies a familiarity with innovative teaching approaches and may indicate diverse technology usage. We identified participants by a snowball sampling method, which involved asking instructional design staff, educational workshop participants, and other related staff about which instructors use the inverted approach; we were also able to schedule four participants from our earlier study, with the aim of enhancing cohesion and consistency across the two phases of the project (Pena, 2015). This led us to a heavy STEM-based group of instructors. We documented each *individual* session with instructors by taking notes and recording the design session; audio recordings were manually transcribed. Primarily, we coded for two themes, technology/design related and the social/surrounding factors and other themes were seen as emergent. The sessions lasted from 60 to 120 minutes. In a later section, we provide a more detailed summary of the instructor's profiles. We conducted the following process for each participant:

1. Gather general background, including departmental affiliation, teaching area and background, and uses of technology.
2. Summarize the scenario-based feedback process we would be following.
3. Present three personas and gather reactions regarding believability and coverage of important characteristics.
4. Cycle through the six pairings of problem scenario and design sketch, gathering reactions to both the scenario narrative and whether and how the design addressed its important aspects.
5. Gather general reflections about the personas, scenarios and design sketches.

Our analysis and discussion of the personas, scenarios and sketches were lively and intense at times, and participants raised a number of alternative design concepts. During the process, we helped participants to feel comfortable sharing their thoughts and suggestions by giving them as much time as they needed to digest the materials we were presenting. Although we relied on the participants to drive the discussions (i.e., based on their own reactions and interests), we also used probes such as "*Does this set of scenarios cover the important issues? Does it seem to be consistent? Do you have problems understanding what each element does? Should one element be removed or placed elsewhere? Is there a different approach you would use?"* We repeated participants' comments back to them, to ensure we understood their intentions and assumptions. Hearing their own ideas repeated back to them often prompted elaboration from the participants. Lastly, after the sessions, we did a rough open coding analysis of comments to discover design ideas for refining the prototypes.

4 Scenario-based Design

Scenario-based design (SBD) is a set of techniques designed to envision the future use of a system early in the design process (Carroll, 1995). SBD supports rapid communication and feedback using the relatively simple process of scenario generation and discussion. This is because scenarios can quickly present problems and capture human activities and particular actions that correspond to technical functions (Carroll, 2000). Scenarios represent the usage context within which a system is intended to operate; a scenario consists of settings, actors, tasks, and goals (Carroll, 2000). For the purposes of our study, we used a subset of the activities that make up SBD that fit our needs for synthesizing descriptions of current practice, developing design concepts, and refining scenarios. Figure 1 depicts the aspects of SBD that we used in this project.

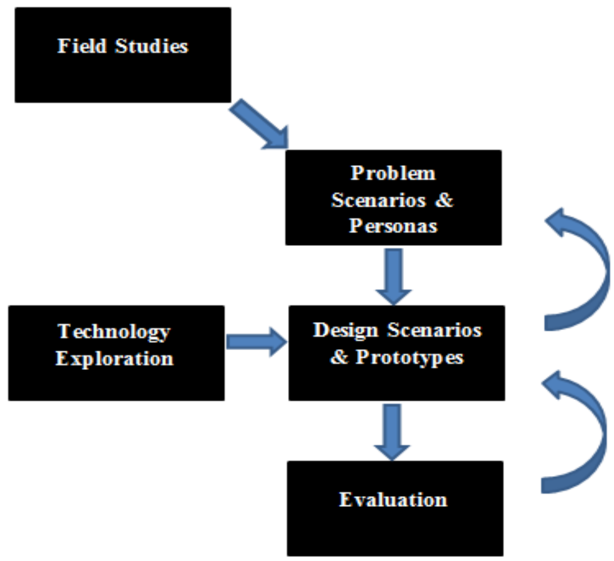


Figure 1. Scenario-based Design Process Used

Personas (characters synthesized to represent real world users) are created to serve as actors in a scenario. Personas depict an important segment of the target user population, documenting contrasting skills and experiences. These fictional profiles were used for validation from participants; we asked if they were authentic and believable, e.g. "*Do they accurately depict different types of individual's representative of the population?"* One of these is a "newbie" instructor who is new to teaching and who does not have the technical experience needed to build tools on her own though may be open to new technology and teaching practices. The "traditionalist" is resistant to change in the sense of new approaches and technology, while the "skillful" instructor has many skill sets and has the ability to build their own tools and learn new ones. These personas were derived from our interviews with instructors exploring flipped classrooms, as they discussed their own background with technology (or lack thereof) and how it had influenced their approach to use of technology, also emphasizing the challenges in integrating with the university class support infrastructure and finding sources of help for learning to use and integrating new tools and types of content into their teaching. Figure 2 illustrates how we depicted two of the three personas (the novice and the expert; we show only two because of space limitations but the third one can be found in see Pena, 2015 along with a full set of other materials developed and used in both phases of our exploratory study of IC teaching.).

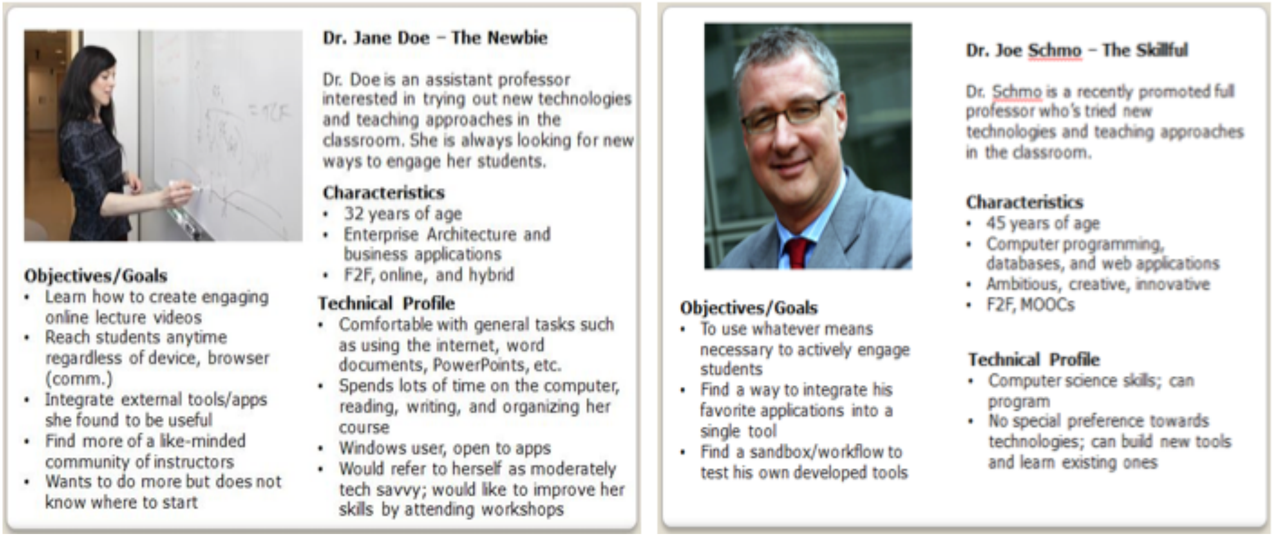


Figure 2. Two Sample Personas Shared with Participants

Problem scenarios demonstrate users in meaningful activities and communicates features of the current situation that have implications for use (i.e., the personas; Carroll, 2000). Thus the problem scenarios shown in Figures 3 and 4 depict issues in the current world of the instructors. The scenarios were created to evoke problematic narratives that instructors experienced as they were attempting to inject IC features into their teaching practices. We created six problem scenarios that stem from the first stage of this research project through interviews (Field Studies in Figure 1), each relating a hypothetical story about an instructor's design process that also suggests ideas for new features. To address the issues implied by the problem scenarios, we created design concepts conveyed though rough paper sketches (Figure 5). For instance, Jane pursues the same goals for creating a video but uses features implied by the paper prototype (during the participatory design session, we talked our participants through these sketches). This allows the user and designer to explore variations in system functionality; the incompleteness of the sketch conveys a freedom of opinion, encouraging participants to make substantive comments. Each sketch corresponds to a problem implied by a scenario, thus referring to the needs of an inverted classroom. For the purposes of space, we have illustrated only two of the six pairings of problem scenario and design sketch to illustrate of what participants encountered (all six pairings can be found in Pena, 2015).

Scenario 1 – Video

Jane is organizing her business analytics course which begins in the next few weeks. Jane recently attended a university-wide workshop and noticed an emerging trend of new teaching approaches and technologies being used in the classroom. Due to the success of other instructors, she has elected to use the inverted classroom structure as her teaching approach this semester. As there are lots of modules of content in this specific course, Jane is looking to upload video lectures of the core concepts in the course. Jane is extremely frustrated in that her current course management system does not provide editing tools to support her content creation endeavors. She believes that her university-based resource should provide this or should be able to integrate this feature into their system. As she is under a tight timeline, Jane ventures online to find an external tool to help her record and create her videos. The high quality tool she desires, requires payment, so she makes a payment out of pocket to start the process immediately. Unfortunately, the tool is much more complex than she had originally thought, regardless, she still manages to complete 3 videos.

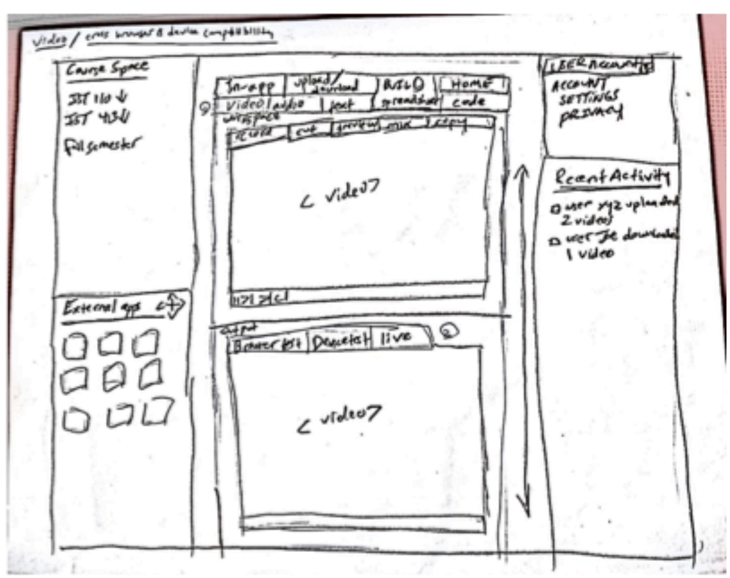
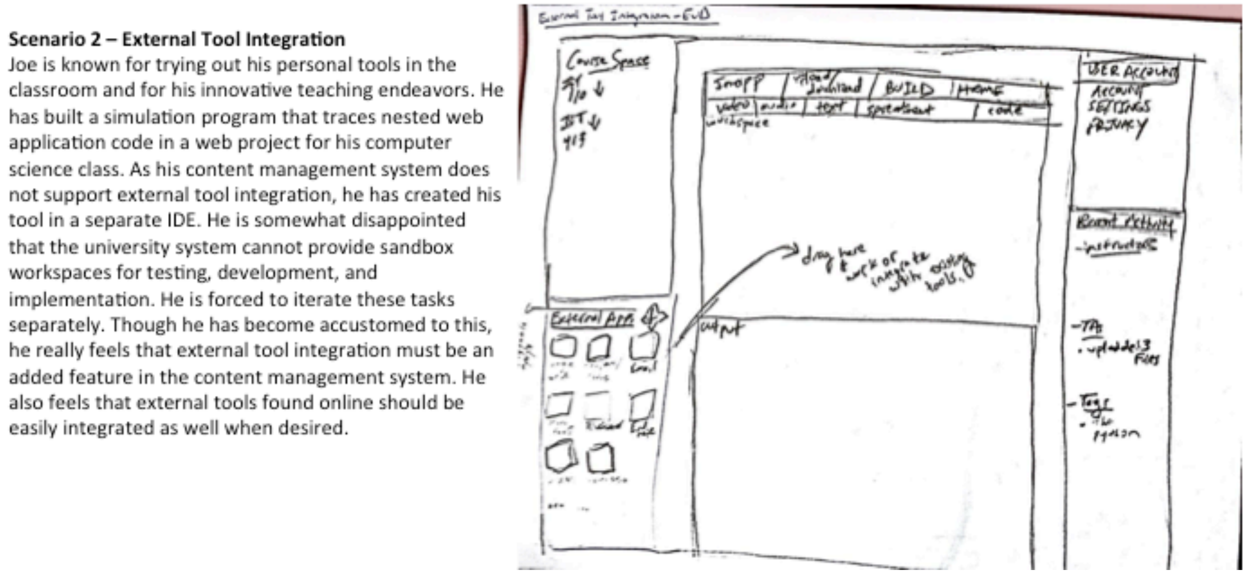


Figure 3. Video Problem Scenario and Corresponding Design Sketch



Scenario 2 – External Tool Integration
Joe is known for trying out his personal tools in the classroom and for his innovative teaching endeavors. He has built a simulation program that traces nested web application code in a web project for his computer science class. As his content management system does not support external tool integration, he has created his tool in a separate IDE. He is somewhat disappointed that the university system cannot provide sandbox workspaces for testing, development, and implementation. He is forced to iterate these tasks separately. Though he has become accustomed to this, he really feels that external tool integration must be an added feature in the content management system. He also feels that external tools found online should be easily integrated as well when desired.

Figure 4. External Tools Integration Problem Scenario and Corresponding Design Sketch

As is evident in the two example sets of materials and in the summary of all six scenario-sketch pairings in Table 1, the design of the technology concepts did not involve novel features in general. Rather the focus was much more on addressing the integration and support needs that we had learned about from our interviews. As is common in SBD, each problem scenario tended to have one or two themes, and the design concept reflected responses to these themes (Carroll, 2000).

Problem Scenario	**Design Sketch**
Jane video-records a lecture • Video content is essential to IC • Current environment provides no support	*Video workspace* • Both input and bottom output spaces for work; • Real-time video creation and debugging
Joe uses external tools • Has expertise to build his own custom tools • Must use separate IDE, no integration	*External Tool Integration* • Palette holds mobile app-like structures; • Opens and connects external applications
Michael wonders about other instructors • Curious about other instructors' experiences relating to his current goal; • Wishes for notifications or tags to learn more	*Awareness visualization* • Visualization of other users' activities; • Editable to create list of most useful ideas
Jane searches for resources • Department has little IT support structure; • Frustrated at lack of broader university support	*Teaching community index* • Dashboard of university-related resources; • Includes workshops, tutorials, technical help with potential for sharing
Joe worries about compatibility • Has created custom peer-grading tool; • Unable to test across all platforms, and worries it will not work for some students	*Cross-browser/device compatibility* • Built-in for testing, evaluation, and debugging; • Able to select a range of content (e.g. video; a custom tool) and platform (e.g., Android)
Michael loses files from last semester • Recreating a course based on previous; • A few files missing, unable to locate; • Wishes for structured cloud-based storage	*Cloud Storage System* • Virtual course space indexing multiple courses and associated materials; • Elements can be imported by dragging to a new and modified as needed

Table 1. Summary of the Six Scenario-Sketch Pairings

5 Findings

The participants offered valuable feedback. A few worried that too much detail had been depicted but most felt the narratives presented legitimate issues for IC. One felt that the designs did not address the problems thoroughly. However, all participants were intrigued by the general idea of incorporating many elements into one system. Below we first characterize the participants and then elaborate our findings; we refer to participants throughout with pseudonyms (note that the implied gender of each name does match the participant's gender). The findings are organized by the themes reflected in the scenarios and design sketches, as well as the more general comments provided at the end of the sessions.

5.1 Instructor's Expertise

Instructors' level of expertise varied greatly. Table 2 summarizes the instructors' advanced training discipline, how many times they have used an IC approach, and their general technology preferences. It is important to note that only a handful of instructors reported extensive expertise in IC teaching; three have been using IC or something similar for 4 or more years. Interestingly, Nicole has published several papers on her IC experiences and is quite invested in this approach. Of note is that our sample included no instructors from the humanities or liberal arts, who may have different perspectives on technology usage and innovative teaching practices.

Pseudonym	**Discipline**	**Inverted/Flipped Experience**	**Technology Usage Summary**
Michelle	Chemistry	1 year of flipped	Podcasting
Lisa	Mathematics	1 year of flipped	YouTube, Yammer
Nicole	Civil Engineering	4 years of flipped; published pedagogical research	Doceri, CMS, Personal Site, Wacom tablet
Ron	Computer Science/HCI	10 years of flipped variations	Q&A System, CMS
George	Information Systems	5 years of flipped variations	Prezi, FB group
Kara	Computer Science/HCI	2 years of flipped	Built Own IDE Tool
Sara	Information Systems	2 years of flipped variations	Piazza, CMS
Larry	Computer Security	1 year of flipped	Coursera, Khan Academy
Bill	Computer Science	2 years of flipped variations	YouTube, CMS, Github
Mary	Computer Science/HCI	3 years of flipped variations	CMS, Adobe Connect

Table 2. Instructor Profiles

5.2 Video Creation and Use

Online video lectures are important for inverted classes. Bill is a new instructor with only a few years of teaching experience. He understood the video idea but questioned its basic value:

> "*What is the difference between using this system and just getting a free template and hosting resources on a personal website that does all of the audio, video, etc.?" – Bill*

In addition, Bill understands the landscape within his community. He acknowledges the struggle that instructors have trying to incorporate new technologies in the classroom:

> "*This happens all too often when instructors are trying to utilize new technologies in their courses. The good thing is that most platforms offer some sort of trial period at no cost to the instructors these days. The issue is commonly that after I spent a considerable amount of time developing course materials for a specific platform, there's no way to transfer it to another novel platform that comes along later. Too often this creates scattered information for both the instructors and the students, and is extremely confusing for everyone." – Bill*

Bill's key point is the lack of a platform to host material and aggregate student information in a uniform fashion. This is a primary intention with our goal of designing a more supportive infrastructure, that is, hoping to minimize the juggling of external tools by allowing them to live in one place.

George is a participant who explores innovative teaching practices and technologies but has had negative experiences. He was critical of our concept, but offered important insights:

> *"For online courses and MOOCS and things like the flipped classroom, I can see the importance of novel tools. But it seems like there is a lot to learn and lots of different little things. Will this really cut down time or just add to it? I guess it will be worth a try. I mean if one is really motivated they can search for free things online but I understand how free trials and other limited access tools work. They never give you full access to the features so then you have to keep on searching." – George*

George has an in-depth understanding of the external tool ecosystem. However, he poses a valid question - will the system reduce time for course preparation or the opposite? This question cannot be answered until we have a working system that can be tested with users. We hope that another iteration of user feedback can remove unnecessary detail and reduce unintended consequences such as raised by George. However, his comment reminds us of the meta-concern designers must have for any new technology aimed at existing work practices, namely if the "unassisted" practice still works and is familiar, people may resist or be poorly motivated to try out the new offerings (Rogers, 1962).

5.3 External Tool Integration

Mary is an experienced teacher and researcher with expertise in interactive system design; she offered detailed suggestions about the design sketches. For instance, she felt that draggable external tools are an interesting idea but wondered whether this approach is feasible.

> *"What are the differences in dragging the tool while you are on the university campus as opposed to your local desktop. For example, you name some applications that may need licensing for this to occur? Or the university will have a partnership with these vendors for access on the university campus network. How about your home machine?" – Mary*

We had not considered the licensing point in detail until talking with Mary. We recognize now that we will need to work carefully with the university and their licensing agreements to provide the integration we are envisioning. This broadens our socio-technical design problem in an important way, namely that another key set of stakeholders (who we have not yet approached) will be information technology support staff of the university, who acquire and maintain software tools and infrastructures. In the next phase of our design work, we will interview and engage with representatives of this group as well as instructors.

Larry was the most experienced instructor we interviewed (and most like the Joe persona). He keeps up with technology and innovative teaching concepts, often participating in relevant workshops and conferences. He has programming expertise and is able to build his own tools at times. Below he stresses the importance of reducing the time for creating flipped classes:

> *"Some instructors like me, teach a bunch of different courses every semester. Some overlap in content but overall I feel they are very different. [The CMS] sometimes flakes out when importing or copying courses from previous semesters. Can I import my course tools and template from previous semesters? And enabling and disabling things as I need them?" – Larry*

Although many platforms offer "import-export" functions, these should be enhanced. Downloads can be time consuming and sometimes items or pointers are lost. We should enable integration of the desired tools within the template structure of a semester.

5.4 Awareness and Collaboration

Our third design sketch included a recent activity pane similar to what appears in social networking sites like Facebook, along with a tagging system for categorizing content. Our intent was to encourage instructors to reach out to other instructors interested in the same topics, or at the minimum to query and view what other instructors are doing. The imagined "digest" of notifications has settings to adjust or completely remove the viewing of different categories or authors of activities. This idea was understood to have both pros and cons – a good idea if it shows useful content, but with the provision that it should be optional or customizable about when and how it is displayed.

> *"How about awareness of students? Maybe having a way to see if they accessed content, viewed a video, or did some sort of action? Not sure that was the kind of awareness you have displayed here but that could be a thought…" – Kara*

"This might be really distracting with everything else going on in this system. As long as there is an option to not participate, it could be fine. However, you really don't want to discourage people from looking elsewhere for tools and ideas. But I see your vision in trying to encourage collaboration and some awareness here." – Mary

Though we agree to some extent that an activity feed may be a distraction, instructor preferences would be supported, allowing them to adjust the feed to their needs. However, we do want to consider other modifications to the feature to see whether its distraction character can be lessened. Kara seemed to have students in mind when considering the opportunities for promoting awareness, though it seems that this would be more useful during and after a specific course, not necessarily for teacher preparation and developing course materials specifically. At this point we are not clear whether the same technology features will be useful for both teacher preparation and course delivery. Furthermore we might want to make this an opt-in feature rather than a default.

5.5 Community

Participants were not very enthusiastic about supporting a university community of teachers, especially in relation to the awareness feature they had just seen. Nonetheless, they continued to offer suggestions about how such a system might enhance feelings of community and encourage more collaboration. More thought is definitely needed to sort out the sketches and perhaps the problem scenario itself, perhaps to expand it beyond the "community" of a single university.

"I think the question depends on if the instructor is willing to make the commitment to find resources to make it work? Providing a bunch of resources and external resources is tricky. Departments may have their own stances on this and the type of resources and support IT does. I think what you propose here has some overlap with the awareness piece; you should revisit both." – Nicole

"Honestly, I've taken up reading professor blogs. There are professors out there around the country who try out new things in the classroom and write journal entries of their experiences from day-to-day. I keep track of them as best I can to understand how other people do things and try to reach out to collaborators by commenting on their posts." – Lisa

5.6 Implementation Preferences

Toward the end of the feedback sessions, participants reflected on their own implementations of hybrid learning environments. This prompted a discussion about how the concept of IC is quite loosely defined, and a range of variations is common. There is no guide to follow; an instructor experiments little by little and relies greatly on trial and error. An important factor is the resources they have at their disposal and the content needed for the course. Some may make certain behaviors mandatory such as attendance or peer assessment while others may not; the IC structure is easy to tailor to specific needs of instructors, course content and outcomes. The responses below are consistent with the literature, which tells us that 1) there is a lack of consensus as to an IC definition; and 2) because IC is flexible and caters to many needs, there is no uniform way to implement it.

"I created my materials on a needs basis. For instance, as I was trying new activities, I developed things on the go and I thought that was how I should be testing things. I had a general outline and then changed my mind all the time. It was crazy but that is how I operate." – Ron

"I did this weird thing where my semester was split in half. For example, I tried the flipped method for the first half and switched back to traditional towards the last half. I wanted to just give students a taste of the approach and I wanted to lighten the load for myself. I figure if I can try it out for a few weeks that would be an indication of how it could pan out in the long run. It was pretty successful. It kept everyone on their toes. And I did not have to really create more materials and use other resources; I just transitioned to the traditional lecture." – Michelle

6 Variations of Technology and Structure in IC

We hoped to learn about useful tools that could aid IC practices, hopefully by reducing time spent on preliminary activities like searching for and learning to use tools. Though our starting concept was to integrate such technologies into features for a customizable system, we found that not all are necessary or desirable. Instead, we learned that we should avoid building a platform that is congested with too many tools and options. This has made us realize that a monolithic approach is probably not the best the solution, and that perhaps we should pursue a "lowest common denominator" approach.

We also found many different structures created for IC implementations. For instance, depending on their course demands, technology resources, and student reactions, instructors may implement inversion for a specific amount of time and purpose. Some of our participants said that they split their time over the semester in half, with half of the time used on the inverted approach and half on the traditional lecture approach. Some decided to implement a full semester without worrying about evaluation; others tried it out on occasion, i.e. as interested or possible. Instructors felt that catering content delivery to the students made a huge difference in how they interacted with and understood the course material; some instructors reported that their students were more engaged. In other cases, professors made specific activities mandatory while others did not which affected students' behavior. For example, attendance was required in George's class as part of the grading system while Nicole was very loose and advised students to attend whenever they wanted because she saw herself as a guide and facilitator as opposed to an authoritative figure. Most used their own online video lectures; some incorporated YouTube videos and audio podcasts. These variations underscore how IC practices are emerging as a process of individualized appropriation of the "flipping" concept and associated technologies.

7 Conclusion

The IC approach has great potential for student engagement. The rapid evolution of technology and teaching innovation is unparalleled; instructors must move forward to accommodate the ever-changing needs of the education realm. If and when instructors elect to use the IC pedagogy, the technologies unique to the inverted activities must be available to help them succeed at every level.

After our in-depth design sessions, we conclude that although an all-in-one system seems like a plausible technical solution, in reality, this is not the case. Instructors enact many different practices, routines, and skills, and do not want to feel "boxed in" by one technology. As an alternative we plan to focus on a few essential features (e.g., basic video editing) rather than a full feature set. We have also raised the priority of flexible selection and customization of what we will offer as a default workspace. Lastly, we are considering some dashboard or repository design to account for modular features.

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