TEACHING IN THE CLOUD: LEVERAGING ONLINE COLLABORATION TOOLS TO ENHANCE STUDENT ENGAGEMENT

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The rapid proliferation of technology can have profound effects on the evolution of teaching, learning, scholarship, and governance in higher education (Katz, 2008). However, instructors report that simply "keeping up" with new instructional technologies, let alone integrating them productively into one's teaching, can be a significant challenge (Sorcinelli, Austin, Eddy, & Beach, 2006; Zhu, Kaplan, & Dershimer, 2011). This Occasional Paper describes how instructors at the University of Michigan are currently using online collaboration tools (hereafter OCTs) in a variety of disciplines and teaching contexts to enhance student engagement and course management. Based on these cases and faculty interviews, we also outline recommendations for implementing OCTs effectively and efficiently in teaching.

Why Student Collaboration? Why Online?

In a meta-analysis of over 150 studies representing diverse disciplines and class sizes, Johnson, Johnson, and Smith (1998) found that students demonstrated significantly greater learning gains, in terms of recall of basic knowledge and critical thinking, when collaborating than when working independently. Students also reported greater motivation and persistence regarding problem-solving tasks when working collaboratively. More recent studies of large lecture-based courses have found that peer instruction, an active learning strategy in which pairs or small groups of students practice applying concepts or solving problems, leads to higher mastery of course content (Deslauriers, Schelew, & Wieman, 2011; Smith et al., 2009; Crouch & Mazur, 2001). Although research clearly suggests the virtues of collaborative learning, it is worth noting that these impacts depend upon how instructors implement and manage collaborative activities. Key considerations include, but are not limited to, task design, group formation, team management, and the establishment of both individual and group accountability (Finelli, Bergom, & Mesa, 2011; Michaelson, Fink, & Knight, 1997; Oakley, Felder, Brent, & Elhajj, 2004).

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The appropriate use of instructional technology can also significantly enhance student collaboration and learning (Zhu & Kaplan, 2011). For example, OCTs create opportunities for student-student or instructor-student interactions before, during, and after face-to-face class meetings that would be impossible or logistically difficult to achieve otherwise. As a result, instructors can facilitate greater student engagement with course content, as well as more frequent implementation of active learning, low stakes student practice, and formative feedback on student learning—all of which align with research findings on ways to promote student learning (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010; Brandsford, Brown, & Cocking, 2000). Furthermore, OCTs often record and archive the artifacts of learning activities, so that students may revisit and study the core aspects of activities or discussions that may otherwise be ephemeral. Additionally, although many students increasingly use technology such as social networking applications and mobile devices in their daily lives (EDUCAUSE, 2011), they may not be sufficiently skilled in the use of OCTs required by future employers. Consequently, instructors who leverage OCTs to achieve course goals may simultaneously prepare students for a workforce that increasingly depends on OCTs for productivity and collaboration.

How Do U-M Instructors Use Online Collaboration Tools to Enhance Teaching?

In 2011, the University of Michigan selected Google as the primary provider of OCTs for all faculty, staff, and students on the Ann Arbor campus. To explore potential applications of these and other OCTs for teaching and course management, CRLT partnered with U-M's office of Information and Technology Services to sponsor a faculty learning community. We recruited 23 faculty instructors from 14 schools and colleges, representing a wide array of disciplines, teaching contexts, and levels of OCT experience ranging from novices to "power users." The learning community met monthly for seven months. Sessions featured hands-on exploratory activities, demonstrations by early adopters, brainstorming sessions, and dialogues to design and debrief pilot projects enacted by learning community participants. Seventeen faculty pursued pilot projects in their courses or clinical teaching, and CRLT conducted interviews with them to document their approaches. Below, and in Table 1 (p. 11), we describe applications of OCTs for teaching developed by learning community members and other U-M instructors interviewed by CRLT. These examples are not intended to be exhaustive. However, they illustrate a variety of innovative solutions to common pedagogical challenges that are transferable or adaptable across disciplines and teaching contexts.

Facilitating collaborative authorship, editing, or peer review

When students receive feedback on their writing (whether from peers or experts) and act on it, not only does the quality of their work improve, but their writing and editing skills may also improve significantly (Cho & MacArthur, 2010; MacArthur, 2007; Nelson & Shunn, 2009). By providing feedback to peers on their writing, students may also positively improve their own writing performance (Cho & MacArthur, 2011; Lundstrom & Baker, 2009). The examples below illustrate how OCTs can facilitate collaborative writing and timely, frequent, low-stakes peer feedback.

- **Brandon Respress**, *Nursing*. Respress instructs upper-level undergraduates in the writing of grant proposals in preparation for independent research projects with faculty mentors. Each week, students draft or revise a section of a standard NIH grant proposal, refining the designs of their individual research projects, as well as their scientific inquiry and disciplinary writing skills. Respress creates a Google Doc collection for each weekly assignment, "chunking" portions of the proposal that require different skill sets and degrees of conceptual mastery. As students post drafts to each collection, the entire class automatically receives viewing and commenting privileges. Respress and students then use the Google Doc commenting feature to leave substantive, conceptual feedback on each other's drafts. Respress carefully models and discusses effective feedback practices during the first few weeks of the course online, while continuing to provide weekly feedback during classroom sessions. The revision history feature in Google Docs can be used to gauge the extent of changes in students' writing in response to peer feedback. Respress found that students showed increased confidence in their ability to apply research skills and develop proposals. More importantly, this approach affected student confidence about their work and their beliefs, the questions they would ask, and, most importantly, their practice as nurses.

- **George Hoffmann**, *Romance Languages and Literatures*. One of Hoffmann's courses explores the controversial literature on the Algerian War. Thirty-two undergraduate students are each required to deliver a PowerPoint presentation on a capstone analytical project. In-class presentations are dynamic, but ephemeral, and their engaging material is lost to students in following course iterations. Therefore, Hoffmann uses Google Sites to create a collaborative course website to document and extend the highly visual capstone projects across courses. Based on his or her PowerPoint presentation, each student creates a media-rich web page, exclusively in French, without having to learn HTML. Hoffmann pairs students to peer review web pages using the commenting feature in Google Sites. Students' grades reflect both the content of their own web page, and the quality of their peer critiques. Through the combined use of PowerPoint and Google Sites, students not only learn valuable communication skills, but also practice disciplinary skills of close reading and critical evaluation.

- **Anne McNeil**, *Chemistry*. McNeil leverages a wiki in her graduate-level chemistry courses to improve students' scientific communication skills. Small groups of students are challenged to collaborate on creating or revising public Wikipedia pages that will clearly communicate challenging concepts to both laypersons and experts. Students with different academic backgrounds are grouped to maximize available skill sets and resources within teams and to foster meaningful interdisciplinary exchanges that would otherwise be absent from the course. Groups nominate topics, and instructors select a subset based on course objectives. At key milestones during wiki page creation, both students and instructors provide critical feedback through the wiki, iteratively vetting content before the final drafts go public on Wikipedia. The public nature of final wiki pages raises student motivation, as well as the overall quality of the work.

Improving teamwork during group projects

Instructional technology can enhance the ability of student teams to collaborate effectively, increasing access and efficiency by reducing spatial and temporal barriers to teamwork. Similarly, OCTs provide novel, efficient, and effective means for instructors to monitor and provide feedback on group projects. The following examples demonstrate how OCTs can improve teamwork and course management of group projects.

- **Robin Fowler**, *Technical Communication, Engineering*. Fowler co-teaches Introduction to Engineering, a course in which student teams design, build, and test products for professional scenarios (e.g., Company X needs a remote-operated vehicle to investigate subglacial life at the Ross Ice Shelf in Antarctica). Teams need to apply course concepts to evaluate competing designs relative to client-generated objectives and constraints. However, teams often pursue suboptimal designs due to poor group process. To enable more equitable and conceptually sound design decisions, Fowler shifted team meetings from face-to-face discussions to synchronous, text-based online discussions, during which team members are geographically dispersed. Fowler creates a Google Doc for each team, including each student's individual project idea and a decision-making matrix to be completed as a team. Students simultaneously access these materials and negotiate decisions at preordained times using the commenting and chat features in Google Docs. Preliminary analyses of chat transcripts and student surveys suggest that this approach increases student engagement and participation in design decisions, particularly for students easily marginalized in such courses (e.g., non-native English speakers, women, and historically underrepresented minorities). Because Google Docs allowed Fowler to monitor group dynamics remotely, she was able to respond to misconceptions and intervene constructively in ways that were not logistically possible when the teams met face-to-face.

- **Melissa Gross**, *Kinesiology*. Gross's students use 3D animation and motion capture technologies to study the biomechanics of human movement in a studio course. Students' group projects are presented as narrated movies and include animations to illustrate their research findings (e.g., differences between a healthy knee and a reconstructed knee climbing stairs). One major logistical hurdle is the need for students and the instructor to manage, share, and collaborate on many large video files. To overcome this challenge, Gross uses Box.net, a cloud-based file storage and sharing service explicitly designed for collaboration. In addition to solving storage capacity and organization issues, Box.net allows students and instructors to attach comments, tags (to facilitate easy file searches), and editable task lists in the file directory. These features provide easy mechanisms for students to manage and coordinate workflow within teams. Instructors can also use task lists and commenting features to provide feedback or directions to teams and then to monitor what has been implemented or not. Box.net can also generate a single e-mail digest per day to the instructor (site owner), summarizing all activity on the site and facilitating efficient oversight of student projects and instructor-student interactions.

Crowdsourcing learning activities

Crowdsourcing refers to the public outsourcing of specific tasks to an undefined, generally large, and geographically distributed group of people, often online (Howe, 2006). In educational environments, crowdsourcing leverages the skills and resources of an *entire* class of students to complete discrete learning activities collaboratively. The following examples illustrate crowdsourcing via OCTs.

- **Margherita Fontana** and **Carlos González-Cabezas**, *Dentistry*. In intensive clinical courses, dentistry students frequently request study guides to organize and digest the deluge of content. Fontana and González-Cabezas crowdsource this task via Google Docs as a learning activity to prepare students for exams. They assign groups of 10-15 students to each of ten major content areas. Groups create their own Google Docs and work together to write the best possible exam questions (two per student) aligned with the learning objectives in the syllabus. To earn credit, questions must go beyond regurgitation of facts and require the evidence-based application of key concepts. The instructors provide a few questions as models. Groups share Google Docs with instructors, who provide feedback. After students revise their questions, instructors compile them in a new Google Doc that is shared with the entire class. To motivate students, if questions meet the desired criteria, Fontana and González-Cabezas promise to create the majority of the exam from this pool (or slightly edited versions of the questions). However, if the learning objectives are not covered by the students' submissions, they promise to create their own challenging exam questions on those topics. Overall, this approach fosters higher-order learning while also leading to the creation of a pool of potential exam questions for both current and future courses.

- **Chad Hershock** and **Rachel Niemer**, *Center for Research on Learning and Teaching*. Instructors in lab courses often find it difficult to simulate and discuss all phases of scientific inquiry during a single class period. For instance, individual lab groups may not be able to replicate experimental trials sufficiently in the time allotted, requiring instructors to compile data sets across lab groups before students can properly analyze and interpret results. Google Spreadsheets can circumvent this logistical barrier by allowing instructors to crowdsource the data aggregation and "cleaning" during class. For example, Hershock and Niemer teach a short-course for postdocs on college teaching in science and engineering (http://www.crlt.umich.edu/programs/psc). During a unit on converting traditional, "cookbook" lab exercises into inquiry-based activities, postdocs work in pairs to complete a sample lab protocol. All the pairs then enter their data into a single Google Spreadsheet, so that the class compiles a robust class data set in real time, without any cutting and pasting across files. Instructors simply monitor the data as it accumulates, responding to problems as needed. In the same class meeting, each group can analyze the entire data set to test student-generated hypotheses and predictions brainstormed during a brief pre-lab discussion. Students then share and discuss visual representations of their findings within the Google Spreadsheet, connect results to underlying fundamental concepts, and reflect on their inquiry processes. This approach integrates more of the scientific method into a single classroom experience, rather than leaving the analysis and interpretation for students to complete in isolation after class.

- **Trisha Wittkopp**, *Ecology and Evolutionary Biology*. Wittkopp teaches genetics to hundreds of students in a large lecture. She uses personal response systems (clickers) to increase interactivity, assess student learning, and address student confusion during class. Nevertheless, between classes, questions remain, and many students have similar questions. To avoid responding individually to each student, Wittkopp employs Piazza, a discussion forum designed to crowdsource answers to students' questions. Instead of sending individual e-mails, students post their questions on Piazza, where they can be answered by one of their peers, a graduate student instructor (GSI), or Wittkopp herself. This reduces the number of redundant questions and shortens response time. Students collaboratively edit answers to questions as they would on a wiki, eliminating the need to read through long, threaded discussions or chat transcripts to find the correct answer. Wittkopp can answer questions directly in a separate field, edit the collaborative student response, or, with a click, simply confirm that the student-generated answer is reliable. Tagging contributions with labels such as "lecture," "homework," "quiz," or exam number aids searching and organization. Additionally, Piazza can generate a report of student activity, facilitating relatively easy grading of participation.

Blogging to promote student reflection and critical thinking

The literature critiquing higher education in the U.S. suggests that more effective approaches to teaching critical thinking skills should be among the highest priorities for undergraduate education (Arum & Roksa, 2011; Bok, 2006). Developing students' metacognition, the ability to reflect on one's thinking and learning processes, is also an increasingly important component of the literature on teaching (Ambrose et al., 2010; Dunlosky & Metcalfe, 2009). The examples below show how OCTs can provide opportunities for students to practice and receive feedback on their use of these important skills in various disciplinary contexts.

- **Mary Ruffolo**, *Social Work*. Ruffolo coordinates an advanced course on clinical practice in which 20 graduate students are concurrently placed in field internships. The class meets face-to-face only once per week, so she uses a blog to facilitate continuous learning and exchange among students. For example, students sign up for a number of weeks to post reflections on challenging clinical experiences as they relate to the weekly course readings. Students also exchange and reflect on the resources and tools used in their fieldwork. Due to the blog, students report increased engagement and improved dialogues with peers during their fieldwork and class meetings compared to writing traditional reflection papers. The blog enhances Ruffolo's classroom teaching because she draws from the material to prepare lectures and discussion activities. The blog also facilitates her oversight of the integration of classroom and field internship learning by enhancing student-instructor interactions.

- **Scott Moore**, *Business*. In Moore's course, Business Thought & Action, 55 sophomores are challenged to apply the analytical tools they learn in class to business news articles via a class blog. Students' blog posts include, but are not limited to, analyses of corporate mergers, new business models and practices, and new markets for products and services. Students are required to post once per month and to read and reflect substantively (comment) on the writings of other students at least twice per month, helping the entire class learn about current events in business while practicing the application of key concepts and skills. Moore comments on students' posts, reinforcing desired behaviors, and he also provides guidance on how to write provocative posts that invite comments and responses. The class blog is public to the world, and the fact that some posts receive thousands of visits substantially raises student engagement. To manage course blogging efficiently, Moore sets up the blog to send him an e-mail any time a student posts or comments. He then creates an e-mail filter, so that these blog notifications automatically move to a designated folder, rather than cluttering his inbox. At convenient times in his schedule, Moore checks this blogging folder, accessing, reviewing, and grading blog activity through links in the e-mail notifications.

- **Melanie Yergeau**, *English*. Yergeau teaches in computer labs to help integrate technology into her teaching. The twenty-five students in her disability studies course participate in blogging and commenting activities, both in and out of class, supporting student dialogue and critical engagement with course content. Blog posts contain reading responses composed across a variety of media. For example, during one class, groups of students use digital cameras to create short, impromptu YouTube videos about disability, normalcy, and the built environment on campus and then integrate them into blog posts that are compliant with web accessibility requirements. In another assignment, students synthesize their learning through "carnival" blogging: blog posts that synthesize and link to other blog posts on controversial course topics. Using students' carnival blog entries as a starting point, Yergeau invites authors of external blogs to interact with her students on the class blog, creating a dialogue not possible in the context of the traditional classroom.

Increasing engagement and interactivity in large courses

Although lectures are an effective way to disseminate content efficiently to large numbers of students, to present cutting-edge material not available elsewhere, and to model expert thinking, students can easily become passive, disengaged learners in a traditional lecture setting (Bligh, 2000; Cashin, 1985). And there is increasing evidence that the use of well-structured active-learning approaches results in increased student learning (Deslauriers et al., 2011; Prince, 2004). Consequently, instructors often wish to infuse active learning into their teaching, but find that doing so in large lectures can be logistically challenging. The use of peer instruction and instructional technologies, such as clickers, to overcome these difficulties is well documented (e.g., Bruff, 2009; Smith et al., 2009; Zhu, 2007). Here, we describe how several U-M instructors have used OCTs to increase student interactions and engagement with course content in large lecture courses.

- **Mika LaVaque-Manty**, *Political Science*. LaVaque-Manty teaches lecture courses with 100-300 students and several GSIs. He has used Google Docs to foster and monitor small group discussions during class. Students are divided into groups that are either pre-assigned or based simply on where they happen to sit. Depending on the number of groups and the purpose of the assignment, they may work on a single Google Document or generate one for each group. In either case, only one student in a group serves as a "scribe," although other students may view the shared document. This way, a student's lack of a laptop is not a problem, and the number of documents remains manageable. In cases where the entire class works on a single document, the instructors create it, share it with the students, and divide it into sections so that a manageable number of groups (3-5) works on each section. They can then project the collectively produced document so that the class can debrief it together. At other times, LaVaque-Manty asks each group to create its own Google Document and share it with the instructors. He uses this strategy for brainstorming or for answering specific questions. In addition to standard text-based documents, LaVaque-Manty has used Google Drawings to encourage students to engage in visual brainstorming and concept mapping during class. Instructors can read, comment on, and even grade documents and drawings after class.

- **Robin Queen**, *Linguistics*. Queen lectures to about 150 students in a 300-level linguistics and anthropology course on language and social conflict. To increase student interactions with peers and internet content related to the course, she instituted a blog for each discussion section of 25 students. Queen and her graduate student instructors provided a weekly discussion prompt and seeded blogs with initial posts, to model ways of meeting the desired criteria. Students were randomly assigned two dates when they had to post. Students could either use the prompt to frame their post, or they could post on a topic of their choosing. To earn a "B" grade for blogging, students also had to comment on peers' posts twice a week. More extensive weekly commenting could earn an "A." GSIs monitored and graded blog posts and comments based on content, instead of assigning conventional essays. Like other instructors CRLT interviewed, Queen's GSIs reported that the effort of grading blogs was comparable to grading conventional essays, but that the degree of student interaction and exchange increased dramatically.

GSIs also used blog discussion threads as primers for their weekly discussion section activities.

Efficiently managing courses

Faculty research, teaching, and service workloads can be large and challenging to manage. On average, U-M faculty report working over 58 hours per week, spending over 25 hours per week on teaching alone (Wright, 2011). As described in the examples below, OCTs not only enhance teaching, but can also facilitate effective course management.

- **Joe Bull**, *Biomedical Engineering*. Bull teaches an "old-school, chalk and blackboard" lecture course, introducing biomechanics to 95 sophomores. The course emphasizes quantitative problem-solving techniques to help students learn to think like biomedical engineers. Many students use office hours as a critical support mechanism. During a term with demanding travel obligations, Bull did not want to decrease his accessibility to students or the quality of student-instructor interactions. Thus, on several occasions, he used Google+ Hangouts to hold virtual office hours from another continent. First, Bull added his students to a Google+ "circle," a private group within this social networking application. Circle members can share documents and create and join hangouts of up to ten participants. A Hangout enables video and audio web conferencing, as well as text-based chat, and it also allows participants to share screens and files. Consequently, Bull could create a Hangout and hold office hours at the usual times with any students who wished to join online. As in his traditional office hours, Bull displayed and discussed a copy of the current assignment, answered questions, provided supplemental explanations and resources, and mentored students on problem-solving strategies. The screen-sharing functions were particularly well suited to troubleshooting segments of computer code from students' assignments. Similarly, students could share and discuss documents containing their attempts to solve quantitative problems. Bull also used a drawing application on his iPad to model problem-solving techniques during Hangouts. After handwriting solutions on his iPad, he would e-mail them to himself and then share the .pdf file with students in the Hangout, so that he could illustrate his explanations. Thus, Google+ Hangouts provided an effective means to increase accessibility to students without significantly increasing instructor workload or sacrificing the quality of small group or individual instruction. Links to a Google+ Hangout can also be embedded in the events in one's Google Calendar.

- **James Morrow**, *Political Science*. Morrow teaches a large introductory lecture course that employs a team of GSIs who lead weekly discussion sessions of 20-30 students on assigned readings and lecture content. Training GSIs and coordinating teaching across sections can be challenging in large courses. Likewise, maintaining and sharing institutional memory of successful and unsuccessful teaching practices is difficult, especially given rapid turnover of GSIs across terms. Consequently, Morrow used the wiki within CTools to collect and archive effective instructional materials and lesson plans for GSI discussion sections. Weekly course meetings with GSIs can include group reflections on instructional practices and updates of wiki content. GSIs in physics have used a similar approach to document and share common student problems and effective teaching practices within and across terms in gateway lab courses.

Recommendations for Effectively Implementing Online Collaboration Tools in Teaching

Learning about new technologies can help instructors innovate. Technology can positively impact teaching by: (1) automating or increasing the efficiency of course management activities, and (2) providing opportunities for learning that were otherwise impossible or logistically difficult (Zhu & Kaplan, 2011). If a tool will not tangibly add value to your teaching in at least one of these ways, then it may not make sense to use it. When implementing new instructional technologies, the faculty we interviewed identified the following key considerations.

Carefully select specific instructional technologies

U-M's adoption of the Google suite of applications and other cloud-based tools (e.g., Box and Piazza) has made a large set of OCTs free to instructors and students. Often, multiple OCTs provide ways to achieve the same goal, each with its own advantages and disadvantages. Ultimately, any choice of instructional technology should be closely aligned with and motivated by one's teaching and learning goals. Nevertheless, when selecting among options, the following aspects are also important.

Start-up costs. Instructors should consider how difficult it is for them (as well as their students) to set up and learn any given tool. For example, if an instructor wishes to make a tool available to an entire course (e.g., grant students permissions as authors on a blog), it may be preferable to use a tool for which U-M provides grade roster import/export options. It can be time-consuming to enter dozens of students as authors on a blog or give an entire course access to a storage site manually, so the ability to share permissions with class rosters significantly reduces start-up times. Currently, such course groups can be created in MCommunity for most Google Apps (for instructions, please see http://www.itcs.umich.edu/itcsdocs/s4390/). For exceptions (e.g., Blogger) one can use the "export memberships" link under the course groups tab in MCommunity to open a spreadsheet with a column of student e-mail addresses that can be copied and pasted to set permissions in OCTs. (Class roster e-mail lists may also be exported from U-M's Wolverine Access.)

In general, most of the current OCTs are very easy to use, but it is always a good idea to test drive a tool, especially from a student's perspective, before making it a part of one's instruction. For example, it takes merely minutes to set up a blog or a Google Sites website, even for a novice, but it may take longer to make one that is easy to navigate. Furthermore, using an OCT's basic functions may be intuitive (e.g., posting text to a blog), but advanced functions critical to particular learning activities may be more difficult to learn or use (e.g., posting and captioning videos on blogs).

IT support. What technical support is available to students and instructors? Before using an OCT that is not supported by U-M or the IT staff in one's academic unit, instructors should carefully consider their comfort level, willingness, and availability to serve in the role of tech support and training. Similarly, it is important to consider whether your classroom has the appropriate infrastructure to support the desired technology use (e.g., power outlets for students' devices, wireless internet with sufficient bandwidth).

Tool overload. Students can be overwhelmed by the diversity of instructional technologies in several ways. First, they may become frustrated if they have to learn how to use many different tools to complete similar tasks across courses. Using common, U-M supported tools may help keep the focus on learning course content, rather than learning how to use a new technology.

Second, managing accounts and passwords for different OCTs can be challenging. Fortunately, U-M supported OCTs, such as Google Apps, Box, and Piazza, allow students to log in using their U-M uniqname and password. To use apps not supported by U-M, students may need to create new accounts and passwords for each tool. The number of accounts and passwords within and across courses can rapidly become unmanageable for students.

Third, leveraging U-M's learning management system (CTools), can ease students' navigation of course materials and multiple online tools. Access to most OCTs can be linked to CTools via the Web Content and/or Resources tools, providing "one-stop shopping" and a common look and feel for students as they engage with courses.

Accessibility. Is the technology accessible to students with disabilities? For example, Google Docs are accessible to some users with disabilities, primarily via keyboard shortcuts, but are not accessible to visually or dexterity impaired users who depend on screen reader or speech input technologies. If instructors select technologies that are not accessible, they should consider employing an additional strategy. For instance, in addition to sharing a Google Doc with students, instructors could upload a .doc version to Resources in CTools, which is accessible to visually impaired students. For more information on the accessibility of OCTs, please see http://www.itcs.umich.edu/atcs/news/google-apps-accessibility.php. For questions or assistance, please contact the Knox Center Adaptive Technology Computing Site (http://www.itcs.umich.edu/atcs/computing-site.php).

Protect students and their privacy

One of the virtues of OCTs is that sharing content is easy. Instructors should, however, think about how widely information from a course or a tool will be shared. A blog or a course-generated website or wiki, for example, might be a meaningful project for students exactly *because* it is accessible to the public at large: students may feel empowered as knowledge producers or be excited to interact with the public, including experts external to U-M, as part of the learning experience. Students can be *required* to produce publicly available content, if this activity is central to the learning goals of the course. However, this expectation should be clearly stated in one's syllabus. Additionally, to protect students' identities and ensure their safety, instructors *must* provide the option for students to participate anonymously or to use an alias, when content is public.

Public sharing isn't, however, always the best approach or even feasible, for example, in medical settings when sensitive material is being discussed. Even if public access to content is granted, decisions still need to be made about allowing viewing, commenting, and/or editing. An instructor should decide on a policy before using a tool in a course. One's policy depends partly on the nature of the content created and partly on student privacy considerations. Instructors should carefully manage the privacy settings within a tool: it is often easy to make a mistake, particularly because default settings vary across tools.

Whether a student produces content under his or her real name or not, he or she retains the right to be identified as the work's author, and instructors must ask for students' consent to use their content for any purpose beyond the scope of the course. A discussion about intellectual property, copyrights, and other intellectual property regimes (e.g., Creative Commons licensing) may be helpful in a course that produces public content.

Resist the myth of "the tech-savvy student"

This recommendation is slightly counterintuitive given students' increasing use of technology in their lives (EDUCAUSE, 2011). It nevertheless is a mistake to assume that all of our students are extremely sophisticated users of contemporary technologies. Most demonstrate facility with technologies that may be unfamiliar to faculty. However, these applications may be irrelevant to academic work, or students may have only a surface-level familiarity with them. As with academic background and preparation for college, students also vary significantly in technological proficiency. It is therefore not a good idea to expect one's students to be familiar with any given OCT. At the same time, faculty report that current undergraduates are willing to learn, and in many cases it may be enough to encourage them to play with a tool and, where appropriate, allow individuals to share their knowledge with others, including the instructor.

Members of CRLT's faculty learning community recommended several effective strategies to support the successful use of OCTs by students. Some faculty dedicate time during the first class to teaching students both how to use the tools and how to troubleshoot technical problems. Demonstrations often included a hands-on introductory activity for students (e.g., creating and sharing a Google Doc, commenting on a blog post). Other faculty enlist IT support staff to provide a workshop to train students in the use of a particular OCT. Alternatively, some faculty create video tutorials using screencasting software like Camtasia or Jing that allow students to learn how to use the tools at their own pace, as needed.

Develop guidelines for equitable and inclusive participation

As with all group work, instructors should consider using strategies to foster equitable participation and accountability (see Finelli et al., 2011; Oakley et al., 2004). Faculty also found it helpful to develop guidelines for appropriate etiquette just as they do for in-class discussions. For instance, when online, students might make inappropriate or unprofessional comments, especially from a position of anonymity, that they would not say to someone face to face. Consequently, faculty often invited students to help develop guidelines, building consensus and student ownership around acceptable practices. These practices can help promote respectful, inclusive dialogue (e.g., see http://www.crlt.umich.edu/publinks/discussionguidelines).

Actively foster and sustain desired student engagement

Getting students to use an OCT and then keeping up with what gets produced can be a challenge. Simply making a tool available for students doesn't mean that it will get used; students may need some incentive to use it. For example, a purely voluntary blog is unlikely to get contributions or readers. On the other hand, some incentives may make it difficult for instructors to keep up with student-produced content. When considering an OCT, asking yourself the following questions can be helpful:

- *How large is my class, and how many students will use this tool?* For example, 300 regular contributors on a blog is too many. A class of 15, on the other hand, will need strong incentives to keep a blog active. Will each section have its own blog/wiki/website, or will it be course-wide?
- *To what extent should I incentivize participation?* Faculty reported learning tremendous amounts from reading students' required contributions to OCTs, but getting students to engage voluntarily and extensively with peers' contributions was difficult. Without compelling incentives, students strategically allocated their limited time to other course activities.
- *Who will keep up with this tool, and how carefully?* The instructor? The GSIs? Will all work be commented on carefully, or will it simply be checked? Will this tool add to the course workload for students and instructors, or will it replace something else?
- *Whom should I credit?* If students are allowed to contribute anonymously or with pseudonyms or avatars, what mechanism will allow the instructor to identify them? How does one disaggregate different students' contributions to, for example, a single essay?
- *How will I optimally sequence activities to promote engagement?* What are the critical milestones, and are they realistic? Is there sufficient time for students to post content and then critically engage with peers? Is there sufficient time for instructors to participate in the online interactions or provide feedback?
- *What are the criteria for successful performance?* The most successful learning community projects clearly delimited expectations regarding the number and timing of contributions and comments. These instructors also explicitly communicated evaluation criteria, "seeded" their OCTs with exemplary contributions or comments, and/or facilitated classroom discussions of what constitutes an effective contribution and how to foster sustained peer engagement (e.g., asking provocative questions of others, linking to other people's content, including multimedia elements).
- *Are there opportunities to integrate student-generated OCT content into face-to-face sessions?* Student-generated content from OCTs can be used to stimulate or deepen face-to-face dialogues, to provide rich examples illustrating fundamental course concepts, or to diagnose and address common misconceptions. Linking online, asynchronous engagement to face-to-face instruction helps to deepen the meaningful integration of technology into a course and minimizes students' perceptions of online activities as tangential or busy work.

None of these concerns are reasons not to use OCTs, nor is there a single correct answer to any of them. Rather, we recommend that an instructor think about them in advance.

Have realistic expectations

This paper highlights a variety of approaches by which OCTs can significantly enhance teaching and learning. Unfortunately, technology can fail mechanically. Therefore, it is always a good idea to have a contingency plan in place, especially if your learning activity depends heavily on a particular technology. Based on faculty experiences, we also recommend starting small. Select one OCT to pilot in one course. Our learning community members were unanimously glad they took a risk on a new pedagogy, but agreed that one may need to be persistent to reap the benefits of one's investment. Implementation did not always go flawlessly, but faculty usually identified minor tweaks that would optimize efficiency or efficacy. Finally, we recommend that instructors avoid operating in isolation. Talking to colleagues, IT support staff, and CRLT instructional consultants can minimize instances of reinventing the wheel and facilitate successful integration of instructional technologies into one's teaching.

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Table 1. Selected Online Collaboration Tools and Applications for Teaching and Learning

Google Apps	**Selected Interesting Features**	**Sample Applications for Teaching**
Blogger	• post text, images, audio, video • respond to posts • private or public	• postings of course notes, materials • forum for student writing and reflection/analysis • space for student dialogue
Calendar	• manage multiple calendars • subscribe to existing calendars • "smart" scheduling by querying availability	• schedule GSI meetings, student team meetings • students sign up for office hour appointments • students subscribe to supplemental events
Docs (Documents, Drawings, Forms, Presentations, Spreadsheets)	• synchronous/asynchronous collaborative authoring/editing • commenting (threaded discussion) • synchronous text chat while editing • document sharing • version control • organized by "collections" for easy search and retrieval (multiple identifying tags possible)	• collaborative authoring by students/instructors • interactive feedback on student work via comments in margins • easy surveys, classroom assessments, scheduling of make-up exams, etc. • collaborative concept mapping or image annotation • collaborative collection and analysis of lab data
Google+ Hangouts	• video conferencing with multiple participants • social networking	• remote collaboration by student teams • interaction with guest lecturers/panelists • remote office hours • workshopping student writing
Moderator	• create backchannels during lectures, seminars, and presentations • audience may submit and vote on questions or ideas	• collect, prioritize, and respond to student questions during a lecture, in real time or during planned intervals, rather than calling on hands • vote on and prioritize ideas or questions submitted by students in response to instructor prompts • use as a "clicker" system to respond to questions/answers
Sites	• collaborative website creation • private or public	• creation of student project websites • documentation of student work • creation of course/curricular materials
Other Online Collaboration Tools Integrated With CTools		
Box	• store, organize, and share large files • tag and search files • comment on files • create editable task lists at the level of files	• students collaborate on video production projects involving many iterations • instructors provide feedback and mentorship on group projects
Piazza	• wiki-style discussion forum to ask and answer questions • instructor can endorse an answer • editor supports equations • tag and search posts • generate report of site activity	• mechanism for crowdsourcing Q&A with students in large courses and reducing course-related e-mail traffic

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