Chapter 3
Technology in the Flipped Classroom

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Abstract Digital technologies can play an integral role in the success of the flipped classroom: from the capacity to support and engage students, to understanding how students learn through learning and assessment analytics. The increasing ubiquity of enabling technologies allows for an array of opportunities for educators to augment teaching and learning strategies for the flipped classroom (Chap. 1). However, technology continues to be an ongoing challenge for educators. Bergman (2013) identifies technology as the "second hurdle" to implementing a flipped classroom. Part of this challenge is that while technology can be integral to the flipped classroom, the specific technologies and how they are used need to be deeply connected to the context in which the classroom is offered. This chapter focuses on the function and role of technology in supporting effective flipped classroom design. While we do not wish to dismiss or diminish the role of technology, this chapter looks at why design takes precedence over technology, as well as the challenges and benefits of using technology in the classroom. We propose frameworks for using technology within your design context, and the types of questions to be considered to guide the design process as well as providing some examples of technology to help you.

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3.1 Introduction

3.1.1 The Flipped Classroom and Technology

Flipped classrooms manifest themselves in many and varied ways depending on a wide range of contextual factors, such as discipline, class size, year level, demographic, learning spaces, resources, and institutional support. However, the common theme of any flipped classroom is the move from passive to active learning that "involves students in doing things and thinking about the things they are doing" (Bonwell and Eison (1991, p. 2). This move signals fundamental shifts in culture and expectations for both educators and learners, such as:

- requiring learners to take more responsibility for their learning;
- providing opportunities for students to negotiate and co-construct meaning with peers (Baxter Magolda 2012);
- challenging students through activities such as problem- or project-based work and enquiry-based learning methods;
- providing opportunities for personalised feedback;
- providing opportunities to adjust teaching based on student responses;
- using facilitation techniques to engage students; and
- increasing opportunities for formative assessment and feedback (Nicol and Miiligan 2006).

Technology can serve an integral role to augment or enhance the above features of a flipped classroom through administrative and pedagogical affordances. The administrative affordances enable efficiencies in areas such as information dissemination and class management (Chap. 2). The pedagogical affordances of technology can foster "a new means of intellectual expression and creativity" (Laurillard 2009, p. 289) and create opportunities for learning "previously inconceivable" (Puentedura 2006).

Technologies can range from expensive and sophisticated virtual environments to free Internet applications that support collaboration, connectivism, and community (Bosman and Zagenczyk 2011). Regardless of the choice of technology, there is a need for seamless integration into the curriculum and this is where learning design is critical. In a recent study by Keppell et al. (2015), learning design is recommended as a best practice methodology to make "pedagogically informed decisions and effective use of appropriate resources and technologies" (Canole 2013).

Indeed, the experiences shared in this book, particularly in the case study chapters, demonstrate that being guided by the learning design and flipped classroom

delivery model you intend for your course will enable you to adopt technology that is fit for purpose.

3.1.2 Technology as a Means to an End

Technology presents both affordances and challenges to teaching and learning, and both require due consideration in the design phase.

For example, the mindful use of technology can provide:

- new ways to:
  - interact in and out of class (e.g. discussion forums, chat rooms, polls);
  - collaborate, share, and create (e.g. wikis, social bookmarking, collaborative documents);
  - showcase, feedback, and peer review (e.g. e-portfolios, online rubrics); and
  - reflect and plan (e.g. journals, shared calendars);
- increased flexibility in time, place, and pace of study as recorded lectures and other online study resources allow students to access resources at their convenience and to suit their pace of learning;
- extended opportunities for discovery (e.g. 3D immersive environments, interactive role-plays);
- better monitoring of student learning and engagement together with increased ability to identify students "at risk"; and
- increased efficiencies in sourcing, producing, and distributing content.

However, there are potential downsides in the use of technology that need further discussion. We begin by debunking the myth that students will naturally make the best use of technology because they grew up with it. In our experience and that of other researchers (Goossens et al. 2008; Kennedy et al. 2010), while the majority of students are "digital natives" there will be a small percentage that struggle and that may not have had the necessary experience to be able to navigate your system with ease. You will therefore need to ensure that there are comprehensive instructions, and readily available IT assistance. Other caveats include:

- technology can (and will) fail. Heavy reliance on technology is risky without a backup plan; for example what is your Plan B if the wireless drops out during a polling session. (Note that we have found students to be very forgiving about technology lapses as long as we took their concerns seriously and explained the underlying reasoning and constraints.);
- technology is not automatically productive. The amount of work required to familiarise yourself and your students with a tool, troubleshoot, or provide technical support can outweigh the desired effect;
- technology can change rapidly and/or go out of date very quickly; and
- the cost of technology acquisition, deployment, and maintenance can outweigh the benefits.

3.2 Selecting Technology

3.2.1 A Learning Design Framework

Conole (2015) claims that technology is not extensively used and that teachers do not make effective use of Open Educational Resources (OER) due to *lack of necessary digital literacy skills,* insufficient time *to experiment with technologies*, and lack of support. What Conole proposes is a strategy that follows a design-based process and moves away from belief-based approaches. Her 7C learning design framework model is aimed at: "*helping teachers and designers make design decisions that are pedagogically effective and make appropriate use of digital technologies"* (Dalziel 2016, Chap. 6, p. 1).

Essentially, the framework moves through four phases: (i) Vision: initiating the design process (Step 1 Conceptualise), (ii) Activities: creating content and delivery mechanisms (Step 2 Create), deciding on communication channels (Step 3 Communicate), brainstorming with others (Step 4 Collaborate), considering how/if tools can be used to promote reflection and assessment (Step 5 Consider), (iii) Synthesis: synthesising what we have found (Step 6 Combine), and (iv) Implementation: taking things forward (Step 7 Consolidate). It's a useful model in that it encourages us to break down the process of deciding on technology, bring in others, and to look at what we can reuse rather than reinvent.

In terms of the flipped classroom, we believe that the model needs to incorporate the learning goals: what are students to learn (Chap. 2), and what do students have to do in order to demonstrate that they have achieved the learning. Therefore, we retrace the seven steps assuming the question of what students are to learn is well considered and shift our perspective to the practical considerations for a flipped classroom.

1. **Conceptualise**—We agree this is a very important first step to take when considering the change to a flipped classroom approach and the associated requirement for technology as it enables the learning design process and your potentially reconsidered learning outcomes to be viewed from different perspectives. At this stage, you should fully outline your context especially in relation to students' access to technology, students' prior experiences, and your institution's support systems.
2. **Create**—Before you begin to develop novel resources, it is important to be aware of the vast array of already constructed resources. Most often, we find that the task is about integration or adaptation: taking the core of things that others have developed and contextualising them in the framework of the class you have to teach. Set aside some time each week to explore the field of e-learning.

   Then, as discussed above, for the flipped classroom an understanding of what it is that will enable students to best develop the learning outcome(s) should drive selection of technology associated with content and activities. This requires

constant referral to what it is that you intend students to learn. We also recommend that you consider what a student needs to do in order to demonstrate evidence of learning. It is critical to align outcomes to activities and have these activities paired with assessments designed to distinguish how well an individual student understands the material, ideas, and procedures.

3. **Communicate**—Enabling fast, frequent, and effective communication is important on two fronts. Firstly, a flipped classroom may not have a lecture to make announcements about what and how to study and succeed in the course and therefore there must be another channel for this information to be accessed. Secondly, flipped classrooms require a shared understanding be established between the students and the facilitator(s). Both fronts will require us to understand the nature of the communication (e.g. are students reflecting, challenging, summarising, or critiquing) and to utilise tools that will enhance learning outcomes.
4. **Collaborate**—It is our experience that flipped classrooms require a team of people to design and implement, and hence, it is important that all are involved from the outset. The requisite knowledge of pedagogy, domain expertise, and ability to use technology usually comes in the shape of two to three people. Bringing in a variety of e-learning designers, librarians, and developers can bring new perspectives to the table, and their knowledge of existing systems can be very helpful in Step 2.
5. **Consider**—Take a step back and look at all the technology that you have chosen and ask what happens if it fails, what happens if it goes out of date, and what resources will be required to support it in terms of the learner. Having agreed once more that you have made the best selection, it's necessary to consider how you will evaluate if the tool is effective or if it requires improvement or replacement.
6. **Combine**—Don't underestimate the thought and effort required to bring all the elements together. You should be aware that you are in effect designing a system.
7. **Consolidate**—Considering what worked, can be systematised and shared, we'd like to say that if you've been thoughtful and rigorous in the proceeding steps, you should have all you need to publish, disseminate, and embed. Think about collaboration with different disciplines and other institutions as this can provide extra insight and endorsement.

3.2.2 Questions You Should Ask

Throughout the process of finding, adapting, or creating technology to fit your flipped classroom, there are a number of questions that will be context specific and that might aid the process. Again, we're using the 7C learning design framework to provide some structure to the questions (Fig. 3.1).

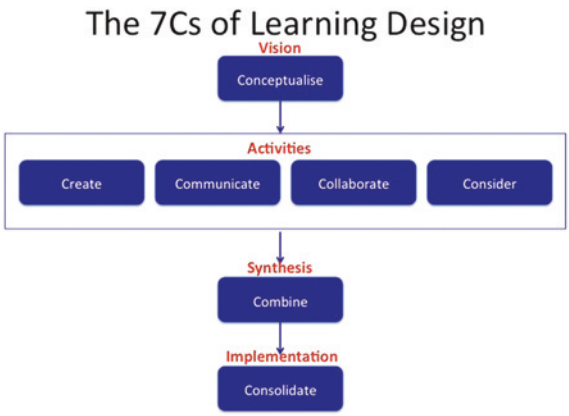

Fig. 3.1 The 7Cs of learning design

1. Conceptualise:
    a. What are you trying to achieve with your flipped classroom?
    b. What is your budget?
    c. How much time do you have?
    d. What support for technology-enhanced learning (educational and technical expertise) is available to you and your students?
    e. How technology savvy are your students? What are their expectations for the use of technology for learning? What is their capacity for learning new tools?
    f. Are there any technology constraints (e.g. bandwidth, operating systems)?
    g. Are there standards, policies, or access limitations that need consideration?
    h. What experience do your students have of a flipped classroom and study in your institution and discipline?
    i. What are students/staff already using (e.g. Facebook, Twitter, Instagram)?
2. Create (beginning with looking at what already exists):
    a. What do you have, what can you borrow, what can you create?
    b. What can you use from other flipped classrooms, MOOCs, and Open Educational Resources?
    c. What support can you find for your students in using technology?
    d. Will this work in our context; does it need adaptation?
    e. Will it make a difference? Is there existing evidence?
    f. What would help expedite the process?
    g. What technology can complement the space to achieve the desired goals?
    h. What is the simplest solution?
    i. Can student skills and understandings in the use of technology be leveraged?
    j. Can technology be used to redefine teaching spaces (e.g. mobile devices, virtual meetings, online resources) and facilitate both on- and off-campus activity?

3. Communicate:
    a. How will you communicate with students?
    b. How will students communicate with you?
    c. How will students or student teams communicate with each other?
    d. When do you need to communicate: before, after, or during an activity? Why?
4. Collaborate:
    a. What are your strengths? What are you comfortable with?
    b. Do you have the right expertise in your team?
    c. Who has done this before? Who can you learn from/with? What do they need to be able to join you?
    d. Are there students/tutors who can help? Can students mentor and support each other (and you?) to use technology?
5. Consider:
    a. How will we know that we've made the right choice?
    b. What measurements do we need to embed in the system?
    c. Are there any risks or implications associated with the privacy, security, or reliability of collected data?
    d. How important is control of your data?
    e. How much work is it to use/support the selected technology?
6. Combine
    a. Have all the necessary elements been addressed? Here you can begin with people, places, hardware, and software. Then perhaps drill down to items such as assessment, information transfer, support.
    b. What will your teaching team and/or support staff need to be aware of all the elements and processes involved in your flipped classroom?
    c. In what way will you communicate to students all the elements of the system?
7. Consolidate:
    a. What evidence is needed to convince potential adopters, collaborators, or journal article readers?
    b. Who will be interested in what you have achieved?
    c. How can you make the next offering of your course better?
    d. Can you share what you've learned and developed to help other teachers flip their classrooms?

The following section outlines a salient case in point of how the use of Conole's 7C model would have been beneficial in the implementation phase of a large-scale engineering course.

3.2.3 An Example of Continuous Improvement

As mentioned earlier, the flipped classroom model will render differently according to context, but also various iterations of the same flipped classroom will often change based on a review of what did and did not work (Consolidate). This process is a natural part of the design cycle, and important lessons can be passed on to others. The following is an analysis of how the use of an existing tool within our large-scale engineering course would have benefited from Conole's 7C model in the initial implementation.

In this flipped classroom instance, 1200 students are introduced to engineering materials, design, and modelling through a project-based course with large (n = 600) collaborative workshops, practical classes, and a suite of online resources and tools. Chapter 9 has more details of this case study. The tool in question is called MOOCchat; it was devised by The University of Berkeley and modified to fit within our course. MOOCchat provides an online forum for students to work collaboratively on a difficult concept set by the instructor; essentially, it is a peer-assisted learning tool that captures data from the chat rooms.

Firstly, we had in our minds that there was a gap that we needed to fill somehow at some time to help students learn *materials* concepts better. We understood that we couldn't use face-to-face time for this purpose as it would have been too expensive, and we were already planning to fully use what face-to-face time we did have in the collaborative workshops for other purposes. The materials mentors within our teaching team reinforced this need for concept checking on the basis of their experience of a previous iteration of the course. So it was something that needed to be addressed and we needed to find some way to do it online.

One of the authors (Reidsema) is part of a global network of experts in e-learning tools, and at the time, they were trialing MOOCchat as a tool for facilitating participant collaborative learning within MOOCs (Massive Online Open Courseware). Its capability to capture chat data was of interest to the network as they had been exploring semantic analysis of student discussions for a while. Reidsema could see how this might solve the problem within our flipped classroom. It wasn't that important that students not collude as long as they got the chance to practice applying a tricky concept.

So we adapted the technology to fit within our institutional learning management system and initially ran MOOCchat as a bonus activity (i.e. there were marks associated with participation, but participation was optional) and evaluated its success by looking at our students' understanding of concepts. We found that it made a significant difference in their understanding and so used it in the next course iteration, but this time we built it into the course assessment schema (i.e. it was no longer optional). In order to do this, we needed to modify the software further so that it could be properly assessed and accessed by the entire cohort.

The modifications were done on a shoestring budget and so there were many bugs inherent in the system. Once again, evaluation showed the value of the tool in terms of student learning, but the bugs in the system meant that students were

scathing in their own assessment of the system. (As an aside, we have managed to secure funding to upgrade the software and will bring back an improved version in the next course iteration.)

If we now relate this back to the 7C model, we can see that we:

1. failed to initially Conceptualise the need for this depth of discussion among students in our first flipped classroom offering and may not have achieved deeper learning of some of the trickier concepts, but we recognise that design is an iterative process and there is a need to continually re-conceptualise each offering of a course;
2. through happenstance managed to find what was already available but feel that the Create aspect is still not complete although we get closer with each iteration;
3. have been successful in terms of the Communicate element as MOOCchat enables everyone to have a voice and for shared meaning to be developed;
4. Collaborate(d) with another institution, developers, and materials concept experts;
5. perhaps have not been so successful in terms of the Consider element, and this is probably due to our need to get moving with something without thinking about what failure may mean;
6. have had a modicum of success in terms of Combine in that the system works well within our institutional learning management system, is embedded in the course assessment, and enhances learning within the course; and
7. are currently thinking about how best to Consolidate, which includes this work and exploring how we share MOOCchat with others.

3.3 Overview of Technology

3.3.1 Introductory Thoughts

The purpose of this section is to provide some examples of resources to help you select technologies fit for purpose. We recognise that technology is evolving at a fast pace, and therefore, we focus on resource toolkits that support academics to identify what already exists and could be used. The details provided in this section are not comprehensive. Instead, we have tried to provide some insight into what has worked for us, and also links to the more common resource collections.

We highly recommend that you talk to your colleagues, and search the web as there are some very detailed, practical, user-driven sites that may help and tools can rapidly become outdated or redundant. To begin, there are many other flipped classroom teachers who have shared the resources that they found valuable. Some examples are:

- Bergman (2013). The second hurdle to flipping your class: http://edtechreview.in/trends-insights/insights/1030-the-second-hurdle-to-flipping-your-class

- Centre for Teaching Excellence, The University of Waterloo (nd). Educational technologies: https://uwaterloo.ca/centre-for-teaching-excellence/resources/educational-technologies
- Western Teaching Support Centre (nd). e-learning tools: https://www.uwo.ca/tsc/e-learning/tools.html
- University of Southern Denmark (2015). Teaching for active learning using e-learning tools: http://sduup.sdu.dk/en
- Centre for Teaching and Learning, The University of Washington (2016). Teaching with technology: http://www.washington.edu/teaching/teaching-resources/engaging-students-in-learning/teaching-with-technology-2/
- Centre for Learning and Performance Technologies (2016). Top 100 Tools for e-learning: http://c4lpt.co.uk/directory/top-100-tools/

A final thought is to do with student access to the smart devices necessary for these tools and systems. In our experience, we have found very few students who don't have their own device. Our institution is careful not to specify that students must have their own device and so last year, with a cohort of around 1100, when we wanted to use online tools in class, we asked students who did not have a smart device to contact us. The plan was that we would loan them a device for their session. In all, we had three students who availed themselves of a loaned device.

3.3.2 Producing and Distributing Content

> …while Khan Academy's prominence engenders fear of standardization and deprofessionalization among some critics, Bergmann, Sams, and Smith see instructional videos as powerful tools for teachers to create content, share resources, and improve practice (Stannard 2012).

Video production can be time-consuming and expensive. We recommend that you be realistic, plan well, and remember that it is not necessarily the content that matters, but how students are expected to engage with it. Work with templates that can easily be reviewed, updated, and modified as and when necessary.

Initially, we dreamed of polished multimedia productions for our videos. In the end, we settled for narrated PowerPoint slides and invested the time we saved into the development of challenging quiz questions and better systems for feedback. We found production and distribution alone were not enough to engage our students and that developing activities that challenge students to understand and integrate content are essential. Our students were quite happy, as long as videos helped them understand difficult concepts. Although many claim it is necessary to have high fidelity resources to retain engagement (Lasater 2007), the success of Minecraft (Short 2012), with its pixelated graphics, suggests otherwise. And this resonates with our experience.

Remember too that you may not need to start from scratch as there exist published and open educational resources that are freely available. Also consider the options of getting students involved in creating resources as partners (Healey et al.

2014). If you decide that you do need to create your own online content, then there are a number of tools that can help (Table 3.1). The websites for these tools are included as footnotes to the table.

If you're a first-time user of an application, there are many instructive resources on the web: from videos (e.g. http://www.wikihow.com/Make-a-YouTube-Video) to papers (e.g. Ruffini 2012), to TED-Ed lessons (http://ed.ted.com/), to complete infokits like the JISC resources http://www.jiscdigitalmedia.ac.uk/infokit/models-of-learning/creating-video.

3.3.3 Supporting Communication

One of our first attempts at establishing a communication channel was a discussion board thread called "Things that make me want to scream". Whereas the discussion board, which was part of our institutional learning management system, as a tool did not work well at the scale of our class (1200 students), the conversations did, thus reinforcing the need for communication channels that are appropriate to the learning outcomes and students within the flipped classroom.

In our initial implementation, we were insistent that students use this discussion board. But in later iterations, we decided to use a Facebook group managed through our institution as we noted that nearly every student had a Facebook account. About 80% of the students decided to join, and we found that often students helped each other with general information or to solve problems and hence we have retained this system in all subsequent course iterations. Tutors and lecturers are present in this space to make sure the information is correct, but the notion that peers can help each other first is rewarding.

Online communication tools are some of the most mature and diverse tools available. Kaplan and Haenlein (2010) developed a model to explore different dimensions of online communication (Fig. 3.2) that is helpful for academics trying to decide which communication tool is the most applicable.

The allocation of "high" and "low" presence in the figure does not imply a high or low value but instead a consideration for appropriateness to context and task. For example, activities asking students for high self-disclosure may create discomfort when exposing weakness or uncertainty; however, high self-disclosure is important for creating effective communities. Taking these concepts into consideration helps to select tools that ensure students are engaged and productive in their activities.

3.3.4 Providing a Narrative

Our first-year engineering course uses complex authentic tasks, and we found it necessary to scaffold students' learning with a narrative of how the activities and

Table 3.1 Tools that help content production and distribution

Focus	Examples	Advantages	Useful resources
Screen capture and webcam recording	Screencast-O-matic, Snagit, Jing, Prezi, Explain Everything, Videoscribe, Camtasia, Dahu	Device-independent solutions that play on any device	Educause: Screencasting to engage learning[a] JISC infokit:screencasting[b] Kathy Schrock's Guide to Screencasting and Screen Recording in the Classroom[c]
Video recordings from mobile devices	Phone, iPad, GoPro	Journalists are increasingly using smart devices	JISC infokit: Video Production[d] BBC Academy. Smartphone journalism: Video[e]
Open Educational Resources		Freely accessible, openly licensed resources can save time and effort	OER Commons Search[f] JISC Open Educational Resource Guide[g] National Copyright Unit: Smartcopying website[h]

[a]http://er.educause.edu/articles/2012/11/screencasting-to-engage-learning
[b]http://www.jiscdigitalmedia.ac.uk/infokit/screencasting/screencasting-home
[c]http://www.schrockguide.net/screencasting.html
[d]http://www.jiscdigitalmedia.ac.uk/infokit/video-creation/video-creation-home
[e]http://www.bbc.co.uk/academy/journalism/article/art20130702112133395
[f]https://www.oercommons.org/
[g]https://jisc.ac.uk/guides/open-educational-resources
[h]http://www.smartcopying.edu.au/open-education/open-education-resources

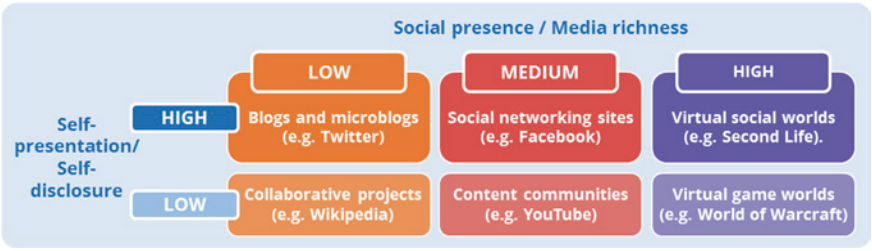

Fig. 3.2 Clarifying goals for social media. Reprinted from Kaplan and Haenlein 2010 with permission from Elsevier

Fig. 3.3 The Learning Pathway

assessment are aligned. For example, the engineering design process provides a storyline that relates back to authentic context in our courses. We could not find an existing tool that filled this function, so we developed what we now call "The Learning Pathway" (Fig. 3.3). This tool reduces confusion by signposting a "path to success" through the course.

The Learning Pathway runs like a thread through the course and breaks complex learning and sequences (e.g. podcast, online formative quiz, on-campus laboratory workshop then online summative quiz) down into manageable steps. It visualises the narrative in the form of a clickable pathway that guides users to relevant course materials and activities while showing the overall course intention. The interface connects learning activities in a blended environment to provide students with a clear outline of what they "Need to know" and "Need to do" each week to stay on track.

Since the first iteration of the Learning Pathway in 2012, the system has been successfully embraced by a variety of small and large classes (1200+ students) at

Table 3.2 Tools that help communication

Tool	Description	Advantages	Disadvantages
Discussion board (e.g. Blackboard[a])	A threaded discussion that allows ideas, Q&A, etc., to be shared	Asynchronous use Extends discussion outside of class	Can be clunky following threads Limited search and tagging function
Virtual room (e.g. Adobe Connect[b], Google Hangouts[c])	An online portal for communication	User choice of place Integration of video, screen sharing, resources and text	May require specific software
Casper Q&A[d]	A Q&A forum styled on Reddit and Stack that allows reputation points to be earned	Questions can be tagged/upvoted Editable email settings	No file upload Not suitable for conversational dialogue
YouTube[e]	A video-sharing platform	Easy upload/sharing Videos can be 11 h Scheduled uploads Analytics of usage	Videos public; access difficult to restrict Only Google + users can leave comments
Facebook Groups[f]	A social platform for text, photographs, or documents sharing	Editable post settings Users can comment/reply to posts Administrators can police posts	All posts have same privacy level Content structured by date/popularity Requests to join need administrators
Piazza[g]	A student-driven, instructor-controlled Q&A forum that supports questions, announcements, polls	Instructors can endorse Q&A Posts to class or instructor Folders used Statistics on activity	Free Integrated Learning Management System Maths (LaTeX) editor Not suitable for conversation
TodaysMeet, Braincloud, Top Hat	Communications tools enabling students to respond and discuss on mass in class including creating a backchannel discussion	Enables all students to respond and discuss Supports analytics of student activity	Requires students to have devices in class which may have some equity issues and require excellent networks
Slack[h]	A messaging app for team collaboration. Chat rooms organised by topic	Suitable for chat Public or private Users can be tagged Notifications based on keywords	Free use limited to 10,000 messages Messages can get lost in discussion No LTI integration

[a]https://en-us.help.blackboard.com/Learn/9.1_2014_04/Instructor/080_Collaboration/010_Discussions/010_About_Forums_Threads
[b]http://www.adobe.com/au/products/adobeconnect.html
[c]https://hangouts.google.com/
[d]https://www.eait.uq.edu.au/teaching-learning-projects
[e]https://support.google.com/youtube#topic=4355266
[f]https://www.facebook.com/help/162866443847527/
[g]https://piazza.com/
[h]https://slack.com/

different levels across faculties and institutions. Interested readers can explore the tool in our demo CourseSite, and you are more than welcome to use it—we have made it freely available.

3.3.5 Facilitating Collaboration

Collaboration, where students have to negotiate meaning and tasks, is another key feature of the flipped classroom. Most of our courses use project-based learning and hence require students to work in teams. Much of what we do to facilitate collaboration does not require technology:

- we design on-campus tasks to encourage learning in a team environment that requires students to support each other;
- assessment tasks are designed to develop the ability to independently judge the work and capacities of others; and
- physical spaces are provided for students to collaborate on campus (e.g. large flat floor spaces where students work assisted by a teaching team circulating the room, rooms where students can sit in pods to collaborate, and outdoor spaces where students can build prototypes).

But we also use online technology:

- modules to challenge students to reflect on personal strengths and preferences;
- chat rooms to allow students to discuss difficult concepts;
- systems to allocate students to teams based on a team skills inventory and/or prior knowledge of student attributes; and
- peer evaluation to measure the work of the individual in a team, and to identify teams that require targeted mentoring (Kavanagh et al. 2011).

Table 3.3 shows the comparison of the readily available tools for collaboration.

3.3.6 Assessment

The flipped classroom is characterised by increased opportunities for formative assessment and feedback that allow students and educators to evaluate whether key content is being understood as the course progresses, rather than at the end when it is too late. For example, online quizzes before class can be a diagnostic tool and allow the facilitator to adjust the lecture and calibrate in-class activities to suit students' needs (Novak et al. 1999). In much the same way, "clickstream" data (i.e. how many students watched a podcast, and how many watched it to the end) can be used to measure class engagement.

If the clickstream data are showing low engagement, then frequent low stakes assessment can be used to help motivate and guide student towards key

Table 3.3 Tools that help Collaboration

Tool	Description	Advantages	Disadvantages
WebPA[a]	Peer assessment of team work/input	Automatically calculates peer assessment factors Assists students/mentors review team functionality	Students can skew results; instructor moderation essential Does not work with groups of 2
iCAS[b] (Interactive Chemistry Assessment System)	Team collaboration and peer marking of submissions	Easy to monitor/control Central platform for assignment submissions/peer evaluation	Tailored specifically for chemistry assignments Can be difficult to set up
Dropbox[c]	File share service that allows multiple people to share files	Easy to set up Easy to access and use	Document version control is difficult Synchronous editing not available
Google Docs[d]	A service for writing collaborative documents	Easy to set up and use Allows multiple people to work on a document simultaneously	Not suitable for complex or large documents Difficult to monitor and control usage
Facebook[f]	A way to share files and comment on group work	Ubiquitous use Provides notifications of updates	Poor version control for documents Difficult to monitor

[a]http://webpa.ac.uk/
[b]https://espace.library.uq.edu.au/view/UQ:243051/ISIT_Final_Report.pdf
[c]https://www.dropbox.com/
[d]https://www.google.com.au/docs/about/
[e]https://www.facebook.com/

goals. Exploring your institutional learning management system (LMS, e.g. Blackboard, Moodle) will usually reveal that there are many assessment tools that support submission, marking, and grade management of assignments available to you for which you have institutional support and that students are familiar with.

Technologies also provide opportunities to explore innovative assessment tasks with students developing portfolios, videos, and virtual and real products. We recommend the Transforming Assessment website (http://transformingassessment.com/) and the Office for Learning and Teaching (http://www.olt.gov.au) for a great collection of resources and cases in technology enhanced learning and assessment.

Between your institution's LMS and the above websites, you may need to look no further but in case you are interested Table 3.4 shows the comparison of other common tools used for assessment.

Table 3.4 Tools that help assessment

Tool	Description	Advantages	Disadvantages
Semant[a]	Rapid identification of problematic concepts through semantic analysis of short-answer questions	Student responses can be used in class to focus discussion Used in LMS	Currently runs only in Blackboard
Google Sheets[b]	Collaborative online spreadsheet tool which can be used to manage marking with rubrics and mark collation	Enables a full history of changes to marking Collaborative marking—data can be entered simultaneously	Requires Google account Customisation can be time intensive and difficult
Turnitin[c]	Plagiarism detection software with built-in online grading tools for annotation and criterion-based marking	Accepts variety of document types Discourages plagiarism Marker can comment Templates/frequently used comments	Not suitable for diagrams, computer code, etc. Proprietary system
Electronic management of assessment[d]	Electronic submission of assignments, as well as marking and feedback	Increased flexibility Traceable assessment records New opportunities for peer review	Problematic submission of equations, drawings, and music Potential technical issues/disruptions

[a]https://www.elipse.uq.edu.au/projects
[b]https://www.google.com.au/sheets/about/
[c]http://turnitin.com/
[d]https://www.jisc.ac.uk/guides/transforming-assessment-and-feedback

3.3.7 Understanding What Students Are Doing in Your Flipped Classroom

Through the use of Learning Analytics, flipped classrooms provide many opportunities for you to assess student understanding and gather data to help you understand what's going on. We have already covered some tools that will help you understand what your students are doing, for example:

- assessment tools can identify key concepts that students are struggling with (e.g. Semant), individual contributions to team work (e.g. WebPA);
- communication tools enable students to tell you what they are doing; and
- social media tools can help you keep a finger on the pulse of the course.

Other tools that may help you evaluate your flipped classroom are detailed in Table 3.5.

Table 3.5 Tools that help course evaluation

Tool	Description	Advantages	Disadvantages
LMS Dashboard	Institutional LMS have associated dashboards that can show student engagement	Part of the institutional system Students familiar with system	Can be difficult to tailor/customise
Survey Monkey[a]	A proprietary system (with free trial) used to create, implement, and evaluate online surveys	Easy to set up All question types supported	An individual can take a survey multiple times Not free
Brightspace[b]	Advanced analytics to monitor and predict student performance	Can highlight problem areas	Experience needed Not free
Social media surveys/polls (e.g. Facebook, Twitter[c])	If you already use social media in your class, polls can help elicit student feedback and comments	Polls spark conversation and showcase results Backchannels enable real-time comments in class Build community	Student identity management Potential unprofessional interactions

[a] https://www.surveymonkey.com
[b] http://www.brightspace.com/solutions/higher-education/advanced-analytics/
[c] https://twitter.com

3.4 Conclusion

This chapter has explored both the affordances and challenges that technology brings to implementing a flipped classroom, peppered with examples from our engineering course. Technology has removed, and continues to remove, constraints from teaching and learning enabling exciting innovations. It can serve to alleviate the administrative burden of managing classes, especially large classes, and also to enhance and augment intended learning outcomes by fostering collaborative learning and allowing innovative assessment.

But technology must be purposefully linked to technology for intended learning outcomes, active learning, and engagement. Therefore, much like an architect or engineer conceptualises a vision and then sets out to turn it into reality, flipped classroom development should follow a design process and the selection of technology is one small part of this. We've focused on Conole's 7C framework in this chapter as we found it to be a very useful method for ensuring that technology is purposefully integrated with the design.

In choosing technology for your flipped classroom, consideration must be given to available resources and support. Some technologies are expensive to purchase and maintain, while others are freely available on the Internet. We've given you a range of tools to consider (Tables 3.1, 3.2, 3.3, 3.4, 3.5), but it may be that you

find other learning design models more appropriate, and/or a different suite of tools especially given rapid obsoletism and development cycles. The key message here is to design the learning experience with students in mind and implement purposeful integration of technologies to suit intended learning outcomes and activities.

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