

## What Features of a Flipped Course Improve Design Student Learning Experiences?

Peter Scupelli<sup>\*a</sup> & Judy Brooks<sup>b</sup>

a School of Design, Carnegie Mellon University.

b Eberly Center for Teaching Excellence and Innovation, Carnegie Mellon University.

*Design education is changing. In this case study, we describe how we used the flipped class format to teach a design studies course. The flipped course format allowed us to push the lecture portion of the class onto an online platform where students watched videos, answered questions, and received immediate correctness feedback. During in-class sessions we discussed homework questions and did hands-on design exercises. We describe features of the flipped class courses that were positively and negatively associated with student learning experiences. In this case study, we measured: student learning with pre- and post-course tests, course quality with faculty course evaluations, and student experience with early course focus groups and post course surveys. We saw significant improvements on average students' post-course test in both courses and faculty course evaluations. We describe changes made to the courses and provide key insights on applying flipped pedagogy to design courses. Classroom type, hands on activities, and online platforms play critical roles in the flipped pedagogy. Five key insights include: match physical classroom format to in-class hands on activities, streamline online learning environments, reduce online cognitive load, scaffold time critical activities, and require thinking fast and thinking slow. We describe pitfalls to avoid.*

**Keywords:** *Design Futures; Foresight; Flipped Classroom; Futures Thinking; Design Thinking; Futures Studies.*

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\* Corresponding author: [scupelli@cmu.edu](mailto:scupelli@cmu.edu)

## Introduction

The world is changing exponentially (Mau, 2005). Times are uncertain, and we are inevitably surprised by changes (Schwartz, 2004). Increasingly, designers are engaged in broader societal problems (e.g., Berman, 2009; Papanek, 1972), for example, humanitarian aid (Architecture for Humanity, 2006), environmental degradation (e.g., Ortbal, Lange, Carroll, & AIGA, 1996), organizational change (Brown & Katz, 2009), toxic chemicals (e.g., McDonough & Braungart, 2002), climate change (e.g., Steffen & Gore, 2008), voting rights (e.g., Lausen, 2007), and so forth. But while engaging more complex design problems, design researchers articulated the need for new design methods for the increased complexity of societal concerns (e.g., Archer, 1968; Weiner, 1969; Jones, 1992).

Changes to design curriculum and courses are difficult. Adding something within existing curricula or courses requires discernment on the best use of limited student time and attention. How should the new topic be taught (e.g., studio, lecture, seminar)? How large should classes be? In this paper, we focus on a design studies course taught as a flipped class when traditionally such courses are delivered as lecture courses. Next, we describe lecture-based seminars to situate the flipped class pedagogy.

### *Flipped Classroom Pedagogy for a Design Studies Course*

Lecture courses are often described as content or instructor-centered. The instructor controls the information flow. Students listen and take notes with limited discussion opportunities (e.g., Stewart-Wingfield & Black, 2005). One advantage of lectures is that many students can be exposed to basic principles. A limitation is that lecturer effectiveness varies. Students may hesitate to ask questions, discuss, and seek clarifications; thus, limiting opportunities to clarify misconceptions. Limited interaction in class with content and instructor may result in superficial understanding and not deep learning (e.g., Pellegrino & Hilton, 2012).

We chose the flipped classroom as an alternative to a lecture class. Flipped courses, shift new content exposure to pre-class work, preparing students for in-class hands-on application activities (Bergmann, & Sams 2012). This pre-class work included online readings, videos, and interactive questions with immediate feedback; and students can submit questions to the instructor online.

In class, the instructor responds to students' questions. The online platform we used, Open Learning Initiative (OLI)<sup>1</sup>, provides a dashboard with the top five incorrect questions so that instructors can clarify student misconceptions. In-class discussion prepares students to transition to actively engaging the application activities. During hands-on individual and group activities, the course instructor provides just-in-time guidance as students work. Likewise, in-class group activities and peer feedback also helps to guide and enhance student learning.

McCarthy (2016) lists six potential benefits and limitations to the flipped classroom model: (a) students can learn at their own pace, assuming all students have access to online resources at home; (b) introducing students "to self-directed, independent learning, as well as, collaborative, group-oriented learning" but, students may come unprepared to class or ignore class discussion and rely on team members who paid attention; (c) teachers may have more insights on student performance and learning challenges, but interactive in-class materials take significantly more time prepare; (d) students have 24/7 access to rich, customised, course materials but instructors need more time, skill, and effort to create such rich interactive course materials; (e) classroom time can be used more effectively with peer interaction but, the assumption is that all students are on task during class and not working on other coursework or browsing the internet (e.g., social media, online shopping); (f) students enjoy the new technologies used in the flipped classroom and find it motivating, except for students that prefer familiar teaching methods (McCarthy, 2016).

We believe three other potential benefits and limitations exist: (g) the flipped class format forces students to actively engage the course material, but daily active learning is more effortful than passively listening to a lecture and writing a term paper; (h) online homework can be automatically graded in a low stakes manner (e.g., done/not done), but students can click through the exercises without watching the videos or engaging with the online questions, or reasoning about the feedback received; (i) the many scaffolded in-class activities give students opportunities to practice and apply new knowledge learned during pre-class work, but the course instructor needs to provide feedback on in class assignments to foster learning opportunities.

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<sup>1</sup> <https://oli.cmu.edu/>

### *Description of Dexign Futures*

Sustainability challenges are often framed as long-term challenges for year 2050 (WBCSD, 2009). The Dexign Futures course described in this paper explicitly focused on aligning near-term design action with longer time horizons aimed at sustainable futures. In the course, students ask: how might a short-term preferred situation lead to a long-term preferred situation? We focus on *dexign*, an experimental form combining design thinking with futures thinking (Wasserman, Scupelli, & Brooks, 2015<sup>ab</sup>; Scupelli, Brooks, Wasserman, 2016; Scupelli, Wasserman, Brooks, 2016).

Design studies courses at the School of Design at Carnegie Mellon University focus on design research methods, explorations into design culture, and new topics (e.g., systems, placing, cultures, futures, persuasion<sup>2</sup>). The design studies courses are required of all undergraduate design students in one class (approximately 40-50 students) in 80-minute classes twice a week. Design studies classes are taught as lecture classes with hands-on activities to apply key concepts. Instead, required studio courses are taught in three different tracks (i.e., Products, Communications, Environments) with approximately 16-20 students with 3-hour sessions twice a week.

The Dexign Futures course was required of all third-year design students. The course covers different approaches to constructing and critiquing futures. There are four modules: Futures Narratives and People, Critiquing Alternative Futures Scenarios, Critiquing Normative Futures Scenarios, and Making Experiential Futures. The course has two main parts: (a) online pre-exposure to concepts that help students prepare for (b) in-class hands-on application activities. The class meets twice a week for 80-minute sessions. In this paper, we describe learning outcomes for the Dexign Futures courses taught in 2016 and 2017.

### *Flipped course evaluation measures and analysis*

We evaluated the 2016 and 2017 Dexign Futures courses using four measures: pre- and post-course knowledge tests, faculty course evaluations, early course student focus groups, and student experience surveys.

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<sup>2</sup> Curriculum overview: <https://design.cmu.edu/content/bachelor-design>  
Course descriptions:  
<http://coursecatalog.web.cmu.edu/collegeoffinearts/schoolofdesign/courses/>

### **Pre- and post-course questions**

The pre-post tests for both courses covered key ideas students were expected to learn. In 2016, the course instructor developed a true-false test. The true-false test format was very easy for the students. In 2017, we created a more difficult multiple-choice test. We conducted paired samples t-test to compare the pre-post test scores for each year.

### **Faculty Course Evaluation**

Carnegie Mellon University conducts a Faculty Course Evaluation (FCE) at the end of each course. The FCE consists of ten questions that provide information on students' perceptions of their engagement, learning outcomes, the instructor's behaviour and course activities (Table 1). Questions are rated on a five point Likert scale (1=Poor, 2=Below Average, 3=Average, 4= Above average, 5=Excellent).<sup>3</sup> We conducted an independent samples t-test to compare the ten FCE questions for the 2016 and 2017 courses.

*Table 1. Faculty Course Evaluation questions.*

1.	On average, how many hours per week have you spent on this class, including attending classes, doing readings, reviewing notes, writing papers and any other course related work?
2.	Does the faculty member display an interest in students' learning?
3.	Does the faculty member provide a clear explanation of the course requirements?
4.	Does the faculty member provide a clear explanation of the learning objectives or goals of the course?
5.	Does the faculty member provide feedback that helped students improve their performance?
6.	Does the faculty member demonstrate the importance and significance of the subject matter?
7.	Does the faculty member explain the subject matter of the course (e.g. concepts, skills, techniques, etc.)?
8.	Does the faculty member show respect for all students?
9.	Overall how would you rate this faculty's teaching?
10.	How would you rate the overall quality of the course?

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<sup>3</sup> <https://www.cmu.edu/es/fce/docs/fce-questions.pdf>

**Student-learning experience**

We measured the student learning experience in two ways: early-course focus groups and end-of-course online surveys.

*Early course focus groups* Students participated in two early course focus groups during week 4 of the 15-week courses in fall 2016 and fall 2017. The purpose of early course focus groups was to provide actionable insights to course instructor early in the course so adjustments could be made for the remainder of the course. The same consultants from the Eberly Center of Teaching Excellence conducted the focus groups both years. The course instructor and teaching assistants left the room so that students could speak frankly. Students responded to four questions (Table 2).

*Table 2. Early course focus group questions.*

1.	What are the strengths of this course that are helping you learn?
2.	What specific suggestions do you have for changes that could improve your learning?
3.	Evaluate your experience with the online homework. What is working well and/or helping you learn? What is not working well and/or detracting from your learning?
4.	Evaluate your experience with the in-class assignments and activities. What is working well and/or helping you learn? What is not working well and/or detracting from your learning?

Students were assigned to small groups. One person from each group noted students’ responses. As individual students suggested feedback, group members checked whether all of the students in the group agreed with each point raised. Students wrote down the points upon which they agreed. Dissenting views in each group were recorded. After 8 minutes of small group discussion, students provided the key points from each group, and – by a show of hands and further whole class discussion – determined whether each point had agreement. The teaching consultants wrote a memo representing majority student views. During the next class, the course instructor discussed suggested course adjustments with students.

The focus reports summarized key insights into the two courses taught. We used themes in the reports to compare the key findings across the 2016 and 2017 courses.

*Student learning experience survey* At the end of each course, the instructor asked students to respond to an online survey with three questions (Table 3).

Table 3. *Student learning experience online survey questions.*

1.	What activities in the Dexign Futures course do you feel contributed the most to your learning?
2.	What, are some concrete examples, of how you applied what you learned in Dexign Futures class to things you worked on outside of class (e.g., studio projects, independent projects, own life)?
3.	What suggestions do you have to improve the Dexign Futures course student experience for next year?

We coded student comments with grounded theory methodology (Strauss & Corbin, 1994). We iteratively developed codes for the open text responses iteratively for each survey question. Our goal was to quantify the different categories of codes for each of the three questions. For each question, we counted the total number of topics and calculated percentages.

## Results

We describe results in three sections: students' scores on the pre- and post-tests, faculty course evaluations, and student learning experience measures (i.e., early course focus group, post-course experience survey).

### *Pre- and post-course tests*

Overall, in the 2016 course, 48 students answered 20 true-false questions. On average on the pre-test, students answered 13.90 questions correctly (SD 1.82); and on the post-test, students answered 15.96 questions correctly (SD 3.08). This was a significant improvement by 10.30% on the post-test ( $t(48) = -4.49, p < .0001$ ).

In the 2017 course, 32 students answered 15 multiple-choice questions. The pre-test score was on average 6.60 questions correct (SD 2.26) and post-test score was 10.66 questions correct (SD 2.48). This is a significant improvement by 27% ( $t(32) = -9.85, p < .0001$ ).

### *Faculty Course Evaluation (FCE)*

In 2016, 43 of 48 students (89%) filled out the FCE and in 2017, 31 of 35 students (88%) filled it out. An independent-samples t-test was conducted to compare students' responses to the ten FCE questions in the 2016 and 2017 courses (Table 4). There were significant differences for five questions:

- Question 3, 'instructor explains course requirements' in 2016 (M=3.14, SD=1.19) and in 2017 (M=3.77 SD=0.92);  $t(72)=-2.48$ ,  $p < 0.05$  (Figure 1);
- Question 5, 'instructor provides feedback to improve performance' in 2016 (M=3.10, SD=1.23) and in 2017 (M=3.71 SD=1.16);  $t(71)=-2.17$ ,  $p < 0.05$  (Figure 2);
- Question 6, 'instructor explains importance and significance of subject' in 2016 (M=3.79, SD=1.07) and in 2017 (M=4.23 SD=0.80) (Figure 3);  $t(71)=-1.92$ ,  $p = 0.05$ ;
- Question 7, 'instructor explains subject matter' in 2016 (M=3.43, SD=1.15) and 2017 (M=3.94 SD=1.00) (Figure 4);  $t(71)=-1.97$ ,  $p=0.05$ ;
- Question 10, 'overall quality of the course' in 2016 (M=2.79, SD=1.01) and in 2017 (M=3.58 SD=0.76);  $t(72)=-3.65$ ,  $p < 0.001$  (Figure 5).

Two questions trended towards statistical significance.

Students said they spent less than the expected nine hours each week working on the course: in 2016, (M=6.86 hours, SD=1.19) and in 2017, (M=5.77 hours, SD=0.92);  $t(71)=1.58$ ,  $p = 0.11$ .

- Instructor 'Explains learning objectives or goals' rated in 2016 (M=3.33, SD=1.17) and in 2017 (M=3.81 SD=1.01);  $t(72)= 1.84$ ,  $p = 0.07$ .

The other three questions were rated at least higher than "average" and not significantly different in the two years the course was taught:

- Instructor's 'interest in student learning' ranked between *above average* and *excellent*.
- Instructor 'shows respect for all students' rated between *above average* and *excellent*.
- Instructor's 'teaching' rated between *average* and *above average* (Table 4).



Table 4. Faculty course evaluation questions for courses taught in 2016 and 2017. Averages calculated for five point Likert scale values (1=Poor, 2=Below Average, 3=Average, 4= Above average, 5=Excellent). \*  $p < .05$ ;  $t p < .15$ .

		2016	2017
1	Weekly hours spent on class	6.86 <sup>t</sup> (SD 2.96)	5.77 <sup>t</sup> (SD 2.79)
2	Interest in students' learning	4.30 (SD 0.83)	4.55 (SD 0.62)
3	<b>Explains course requirements</b>	<b>3.14</b> (SD 1.19)	<b>3.77</b> * (SD 0.92)
4	Explains learning objectives	3.33 <sup>t</sup> (SD 1.17)	3.81 <sup>t</sup> (SD 1.01)
5	<b>Feedback to improve performance</b>	<b>3.10</b> (SD 1.23)	<b>3.71</b> (SD 1.16)
6	<b>Importance of subject</b>	<b>3.79</b> * (SD 1.07)	<b>4.23</b> * (SD 0.80)
7	<b>Explains the subject matter</b>	<b>3.43</b> * (SD 1.15)	<b>3.94</b> * (SD 1.00)
8	Show respect for all students	4.50 (SD 0.83)	4.71 (SD 0.53)
9	Rate this faculty's teaching	3.53 (SD 1.03)	3.87 (SD 0.85)
10	<b>Rate quality of course</b>	<b>2.79</b> (SD 1.01)	<b>3.58</b> * (SD 0.76)

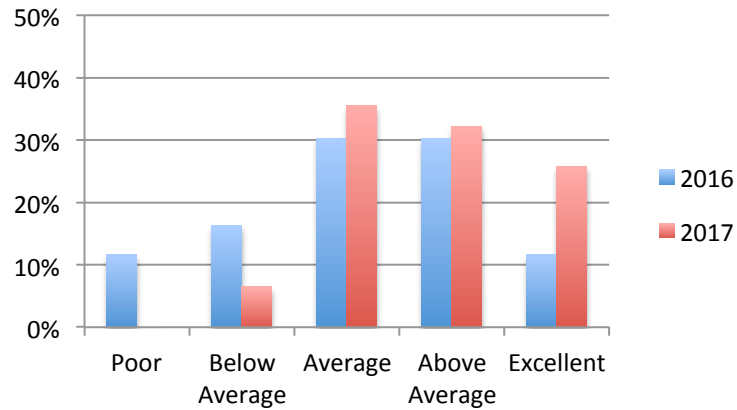


Figure 1. Student responses for the 2016 and 2017 Faculty Course Evaluations to the question "Does the faculty member provide a clear explanation of the course requirements?"

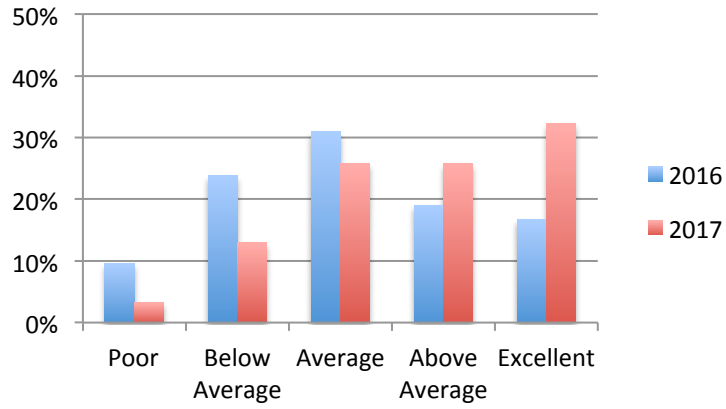


Figure 2. Student responses for the 2016 and 2017 Faculty Course Evaluations to the question "Does the faculty member provide feedback that helped students improve their performance?"

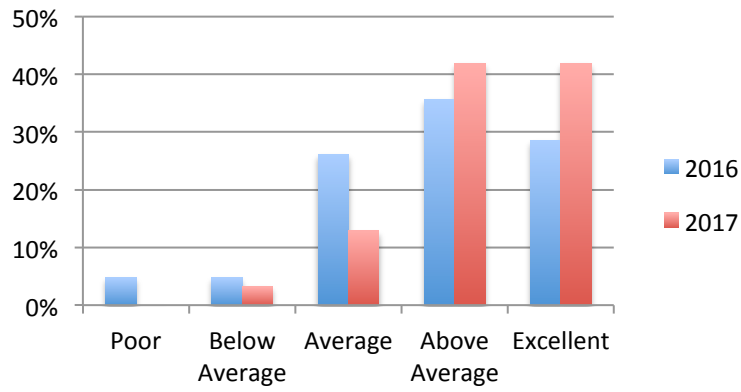


Figure 3. Student responses for the 2016 and 2017 Faculty Course Evaluations to the question "Does the faculty member demonstrate the importance and significance of the subject matter?"

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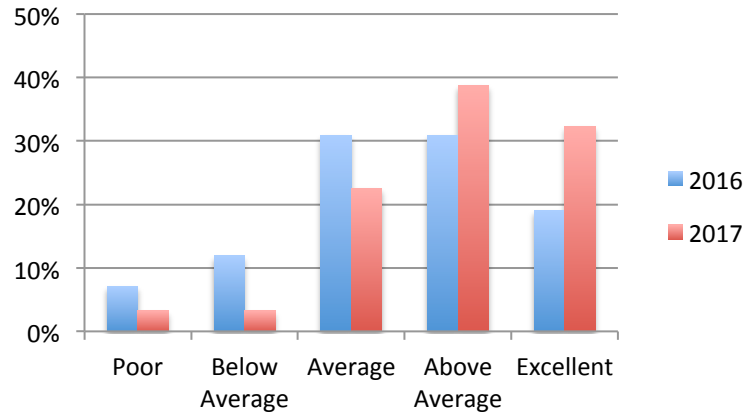


Figure 4. Student responses for the 2016 and 2017 Faculty Course Evaluations to the question “Does the faculty member explain the subject matter of the course (e.g. concepts, skills, techniques, etc.)?”

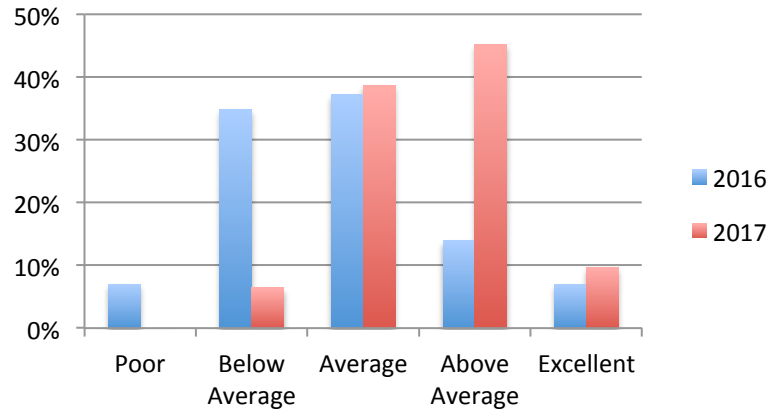


Figure 5. Student responses for the 2016 and 2017 Faculty Course Evaluations to the question “How would you rate the overall quality of the course?”

*Student learning experience in 2016 and 2017 courses*

Next, we describe the student learning experience in two sections: early course focus groups and end of course online survey.

### Early course focus groups in 2016 and 2017

In fall 2016, forty-two of forty-eight students participated in the focus group. In fall 2017, thirty-four of thirty-five students participated in the focus group. The learning consultants created two reports on the early course focus group summarized students' comments on what is helping their learning and suggestions for improvement. We report summaries from both the 2016 and 2017 reports in the following discussion section according to five themes: physical learning environments, online learning environments, hybrid challenges, in-class activities, and weekly reflections.

### Student learning experience online survey

To the open-ended question "What activities in the Dexign Futures course do you feel contributed the most to your learning?" in 2016, 44 students responded on average 32 words (SD 24.54). In 2017, 30 students responded on average 28.63 words (SD 29.99). Emergent topics included: Online Learning Initiative materials (OLI), in-class activities, discussion, experiential futures enactment assignment, futures methods, videos, and other. In total we coded 110 topics in 2016 and 74 topics in 2017. In 2016, on average, students listed 2.5 activities contributed most to their learning (SD 1.11). 2017 was similar, students listed 2.47 activities (SD 2).

Table 5 shows the six topics students said most supported their learning: (a) Online Learning Initiative (OLI) homework, (b) in-class activity, (c) in-class discussion, (d) enacting experiential futures activities, (e) futures methods, and (f) videos. Figure 6 shows the topics that students thought most supported their learning side-by-side for each year.

*Table 5: Top six topics coded from student comments in online survey on what aspects of the course helped their learning.*

	OLI	Activity	Discuss	Enact	Methods	Videos	Other
2016	25%	11%	17%	10%		12%	18%
2017	11%	27%	9%	19%	8%	8%	23%

To the open-ended question, "What suggestions do you have to improve the Dexign Futures course" in 2016, 44 of 48 students responded on average 49 words (SD 96.01). In 2017, 30 of 35 students of responded on average 49.70 words (SD 54.04). We coded in: 2016, 136 topics and in 2017, 76 topics. In 2016, on average, each student listed 3 improvement topics (SD 1.85). In 2017, students listed 2.53 improvement topics (SD 1.41).

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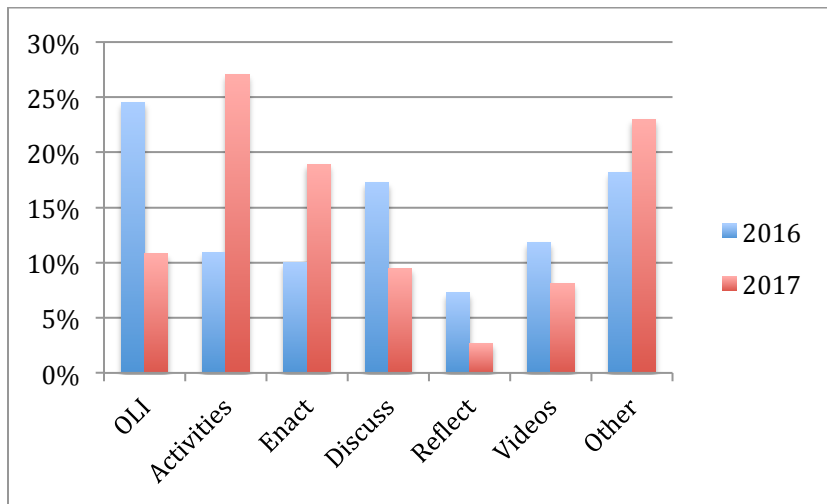


Figure 6. Top six topics for the 2016 and 2017 courses coded from student responses to question what aspects of the course helped their learning most.

There was little overlap in improvement topics over the two years. In 2016, students suggested: fewer online platforms (e.g., OLI, Blackboard, course blog, student blogs), discussion (e.g., create more opportunities for in-class discussion on the course topics), change classroom (e.g., lecture hall does not support in class activities), time management (e.g., not enough time to finish assignments in class), course structure (e.g., rethink the organization of course activities), Activities (e.g., provide more instructions to in-class activities), and lectures (e.g., some students wanted more lectures in class) (Figure 7).

In 2017, students mentioned wanting: discussion (e.g., more time for in-class discussion), assignments (e.g., broader range and opportunities to go more in-depth), pace / content (e.g., fast-paced course with lots of content, vary pace of activities), flipped format (e.g., prefer lecture style classes), facilitate (e.g., facilitate discussions to encourage participation), group work (e.g., provide individual accountability in group projects), questions (e.g., think of more engaging ways to answer student questions), motivation (e.g., link course material to real world problems), and reflections (Figure 8).

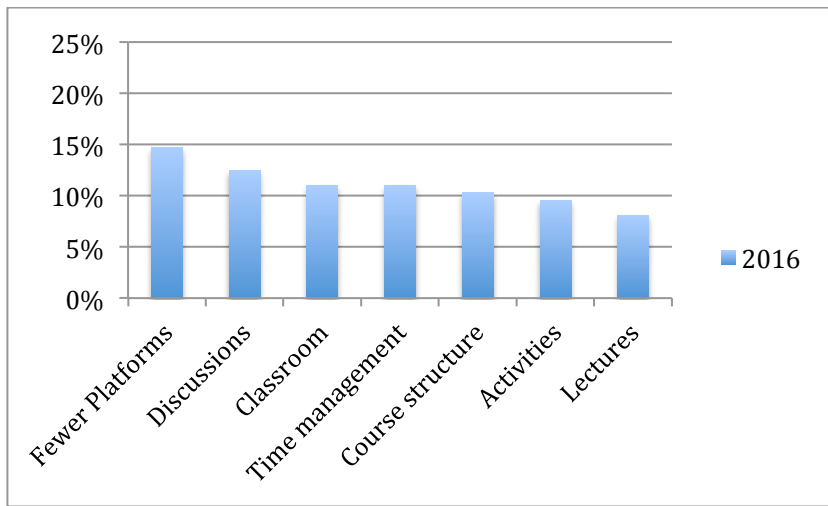


Figure 7. Topics for the 2016 course coded from student responses to the question what changes would improve the course.

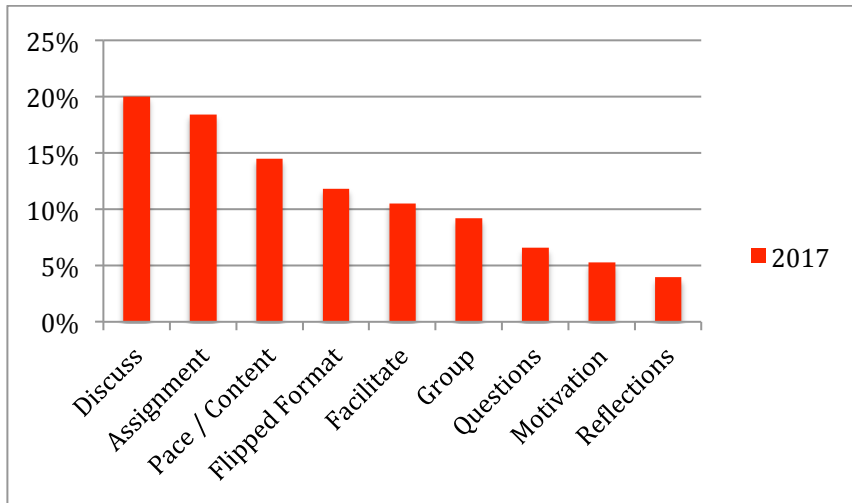


Figure 8. Topics for the 2017 course coded from student responses to the question what changes would improve the course.

## **Discussion**

In the previous sections, we described the data by type. To consolidate themes across data sources, we organize the discussion section according to five key insights: (a) physical learning environments, (b) online learning environments, (c) hybrid challenges, (d) in-class assignments and (e) weekly reflections. For each section, we use input, process, and outcomes models to illustrate and discuss our main insights. For each theme, we interpret the data supporting our interpretations.

### *Physical learning environments*

In 2016, the course was taught in a sloped lecture hall in a sub-basement. Over one third of the 2016 focus group students said the physical layout of the classroom undermined the ability of students to do group activities (Figure 9 left). The instructor leveraged the 2016 student complaints about the classroom to obtain a more appropriate classroom for the flipped classroom pedagogy (Figure 9 right). In 2017, to better support learning design classroom with student chair-desks on wheels and floor to ceiling whiteboards replaced the cavernous fixed-chair lecture theatre hall.



*Figure 10. (Left) In 2016, students in sloped lecture hall class were constrained to their chairs. (Right) In 2017, students in the design classroom were able to do group work easier. There were floor to ceiling whiteboards and desks on wheels that allowed easy transitions from class discussion to group work.*

Based on the 2016 focus group data and online survey (Figure 8), we posit that the physical layout of the lecture classroom made it far more difficult for students to collaborate on group activities in class. Furthermore, the physical layout made it more difficult for the instructor to move through the classroom and answer student questions during small group exercises. He was able to easily interact with students on the front of the class and along the edges; the students sitting in the middle of class were harder to reach and engage. Tables 6 and 7, illustrate our models for how the features for the classrooms impacted in-class processes and outcomes for the physical classroom for the classes taught both years.

*Table 6. Input, process, and outcomes model for the 2016 class taught in a sloped lecture hall.*

2016 Input	Processes	Outcomes
Fixed seating in a sloped lecture hall	More difficult for students to move around and do active group work in classroom.	(a) Less on-task small group discussion, (b) less student engagement with in-class assignments, (c) less participation in class discussion.
	Difficult for instructor to move around classroom and reach all students.	Students in the middle of the classroom receive less targeted feedback on in-class work. More off-task student behaviour in-class.

Instead in 2017, the new classroom made it much easier for students to transition from mini-lectures or class discussion to group work. The instructor was able to easily move from one group to the next answering questions and providing targeted feedback to all students.

Student comments in the post-course survey corroborate our interpretations of classroom dynamics. The Faculty Course Evaluations describe that there was significantly more feedback given to students in the 2017 course (Figure 2, Table 4) and explains subject matter e.g. concepts, skills, techniques, etc (Figure 4). The change of classroom from a sloped lecture hall to a design classroom allowed for students to engage in small group activities in class. The instructor was then able to provide feedback to students directly as they were working.



Table 7. Input, process, and outcomes model for the 2017 class taught in a flat design classroom with mobile chairs, wall sized whiteboards, and natural light.

2017 Input	Processes	Outcomes
Flat classroom, mobile seating, and large whiteboards.	Easier for students to do group projects.	Students more engaged in small group activities, groups actively working on whiteboards.
	Easier for instructor to walk around and meet with student groups.	Instructor provides students more just-in-time feedback.

One limitation of the models presented in Tables 6 and 7 is that they are based on observation and post-hoc reflection. In other words, there are no direct process measures (e.g., ease for students do group work, ease for instructor to provide students just in time feedback) and direct process outcomes (e.g., student on-task discussion, engagement, in-class discussion, targeted feedback received). Future work should test the validity of the proposed models by quantifying input variables, process measures, and outcome measures.

### *Hybrid learning challenges*

Using technology in learning environments for the flipped classroom brings challenges connected to merging the physical and online learning environments. We discuss two we encountered: bridging online homework into class activities, and open-laptop policy challenges.

#### **Bridging online homework to in-class activities**

The online homework was linked to the in-class activities with three strategies: go over student misconceptions, student homework questions, and overview mini-lectures.

Student misconceptions and homework questions from the pre-class work were discussed in class. Student misconceptions were surfaced by the online homework multiple-choice questions. The online homework provided the instructor with a learning dashboard that shows the five homework questions students made the most mistakes (Figure 10).

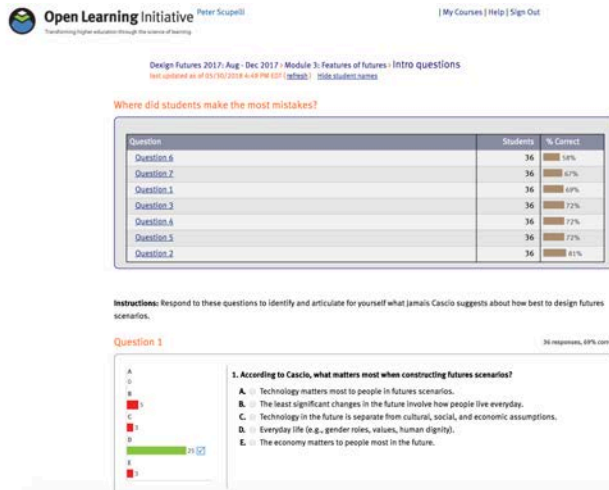


Figure 10. Open Learning Initiative teaching dashboard shows questions students struggled most with on homework.

At the end of each homework assignment, students could submit questions to the instructor (Figure 11). The instructor would then spend ten minutes at the beginning of class to discuss student questions. Not all students submitted questions. In 2017, to engage all the students with end of unit questions, in class students discussed in small groups and reported a one-minute summary to the class. To make the instructor perspective available, he posted his responses on YouTube video prior to class.



Figure 11. Open Learning Initiative dashboard shows course instructor questions students have from online homework.

Figure 12 shows the discussion board with an online post and two reply comments. Students made their posts and commented on their colleagues' posts but often failed to review the discussion board. In the 2017 focus

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group, students asked that the weekly online discussions be discussed in class. The instructor had students synthesize the online discussion in five person groups and give one-minute overview presentations to the class.

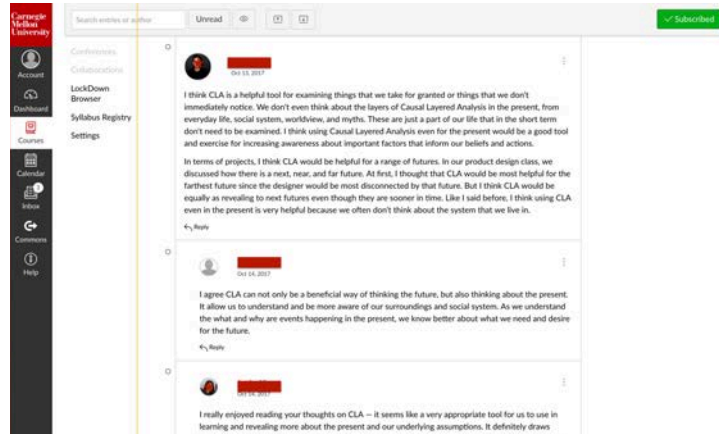


Figure 12. Discussion post with two comments on Canvas in 2017 course.

**Pitfalls of open-laptop policy**

The course instructor placed all course materials online each year (Blackboard in 2016 and Canvas in 2017). He instituted an open laptop policy so students could quickly access the course materials during class. Unfortunately, Figure 10 (left), clearly shows that in 2016 some students are deeply immersed in their laptops. To limit laptop distractions the instructor asked the students to close their laptops appropriately according to class activities. Table 9 and Table 10 show the input, process, and outcomes as they relate in the lecture hall classroom and design classroom.

Table 9. Input, process, and outcomes model for the 2016 class with regards to the open-laptop policy.

Input	Processes	Outcomes
Open laptop policy	Students tempted to do other work on laptop.	Students distracted during class time.
	Instructor asks students to close laptops.	Students distract themselves with mobile devices.

In 2017, the laptop distraction problem persisted in the new classroom. However, the instructor roaming in the classroom and commenting on off task behaviour coaxed students on task. Comments in the post-course survey both years corroborate that the laptop persistently distracted some students. Students that paid attention were annoyed during in-class group activities because they had to instruct the distracted students in their groups. Students suggested the instructor and teaching assistants more vigilantly enforce the closed laptop policy during class.

*Table 7. Input, process, and outcomes model for the 2017 class with regards to the open laptop policy.*

Input	Processes	Outcomes
Open laptop policy	Students tempted to do other work on laptop.	Students demotivated to learn during class.
	Instructor roams in class.	Students reduce off-task behaviour
	Instructor asks students to close laptops.	Students distracted by mobile devices.

### *Online learning environments*

The flipped classes described in this case used online platforms for three tasks: online homework, to manage the course materials, and to document student work. In this section we discuss two aspects: Streamline online platforms and reduce cognitive load on homework.

#### **Streamline online platforms**

In 2016, the course used four digital platforms: Blackboard<sup>4</sup> as a learning management system, the Open Learning Initiative (OLI) platform for homework, a class blog, and individual student blogs for weekly reflections. In particular, Blackboard presented many usability challenges for the instructor and students. More in general, students struggled finding things within Blackboard and having to navigate across four different platforms (i.e., Blackboard, OLI, course blog, student blogs).

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<sup>4</sup> <http://www.blackboard.com/>

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In 2017, the instructor took two steps. First, he halved the online platforms to: Canvas as a learning management system and OLI for homework. Second, he focused learning materials into the Canvas homepage so that students could find everything they needed from one place—OLI, daily agendas, discussion, and in class-activities (Figure 13).

We believe the student complaints with the online leaning environments disappeared with a switch from Blackboard to Canvas<sup>5</sup>. Students did not mention difficulties with using the new platforms. In short, for a flipped class, online technology choices can influence, for better or worse.

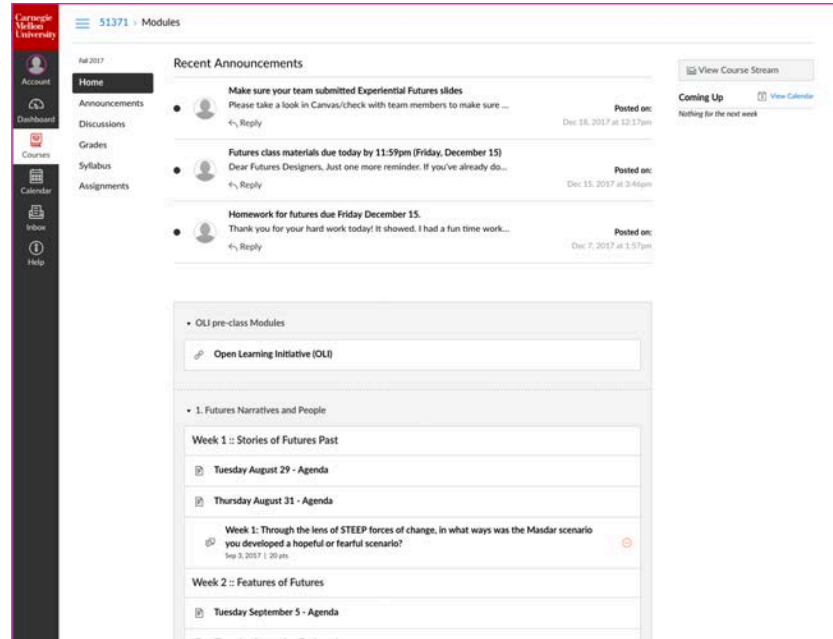


Figure 13. Screenshot of the Canvas homepage: announcements, OLI link, reflection and daily agendas are all in the same page.

<sup>5</sup> <https://www.canvaslms.com/>

### Reduce cognitive load on homework

The course was designed to have an estimated six hours of homework each week. It was split up into approximately four hours over the weekend and two hours between classes during the week. In the 2016 course, students wanted to know more detailed information about the online homework assignments. To help assess workload we added time estimates for each online video.

In 2016, students suggested that the online questions be reworded for clarity (Figure 8). Table 8 illustrates an input, process, and outcomes model for the online course materials with mostly “submit and compare” open text response questions.

*Table 8. Input, process, and outcomes model for the 2016 online course materials with mostly text based open-ended questions.*

Input	Processes	Outcomes
Online course materials mostly open ended text questions.	Students determine the answer and then need to write it in text form.	Students claim homework is tedious and time intensive.

For the 2017 course, most online questions were rewritten to facilitate student comprehension. Where possible, multiple-choice questions replaced “submit and compare” text open-ended questions to reduce time on task for comprehension checks. In 2017, students did not mention the online questions as an area for improvement (Figure 9; Table 9).

*Table 9. Input, process, and outcomes model for the 2017 online course materials with mostly multiple-choice questions.*

Input	Processes	Outcomes
Online course materials are mostly multiple-choice questions.	Students answer to the questions, and receive correctness feedback.	Students spend less time doing homework.

We believe the trend of spending one hour less on the course each week was associated with two factors: first, the redesign of the OLI homework questions from open ended text entry to multiple choice as more time efficient. Second, in 2017, the redesign of the in-class assignments and strict time management in-class allowed students to complete their work in class.

### In-class activities

We structured in-class activities to keep students on task. We noted three such structures: daily agenda, assignment scaffolding, and bridging homework to assignments.

#### Daily Agenda

During both years the classes were structured around a daily agenda. Figure 14 illustrates daily agenda implemented in Blackboard in 2016. It provided a sequence of activities and the instructions for each. A typical daily agenda included: (a) technology challenges, (b) homework misconceptions and questions, (c) in-class activity, and (d) homework. Table 10 illustrates the 2016 process model for the course agenda as an input, process, and outcomes model.

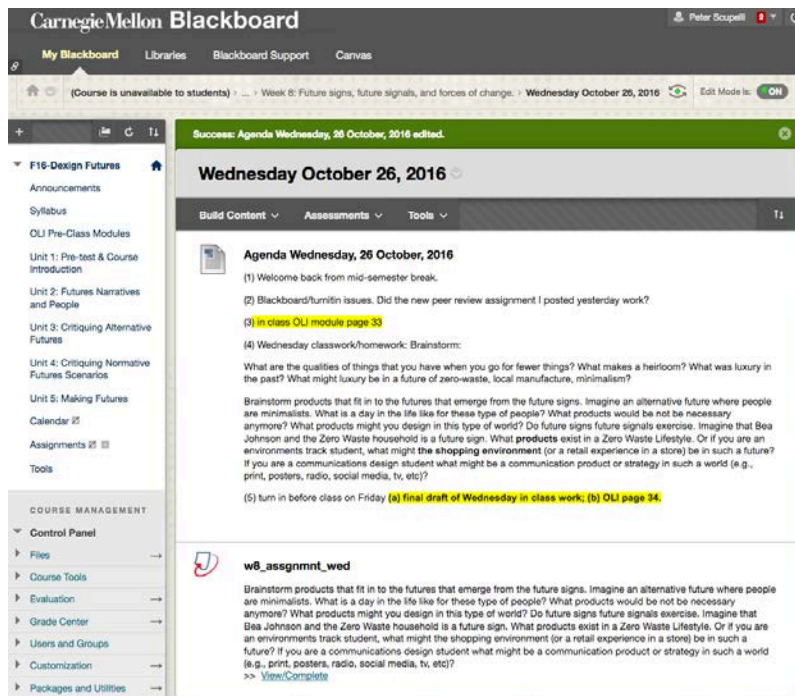


Figure 14. A screenshot of the daily agenda on the Blackboard in 2016.

*Table 10. Input, process, and outcomes model for the 2016 class using the Blackboard for the daily agenda and announcements.*

2016 Input	Processes	Outcomes
Daily agenda on Blackboard.	Instructor remembers all items to cover in class	Easy for instructor run out of time.
Announcements posted to Blackboard home page.	Students navigate agenda and announcements page.	Students feel scattered about assignments.

In the 2017 course, Blackboard was replaced with Canvas as the Learning Management System. Using Canvas, the instructor was able to reduce the total number of tools used thus significantly streamlining the course logistics for students. Notice that all links for students are in one place on the agenda page (Figure 15).

On the agenda, in-class activities are time blocked and streamlined. The first part of class was dedicated to student submitted questions that are discussed in small groups. The instructor posted his responses to the questions before class on YouTube along with supplementary links thus giving students access to mini-lectures but saving class time for hands on activities.

Table 11 illustrates the process model for the course agendas for 2017 as an input, process, and outcomes model.

*Table 11. Input, process, and outcomes model for the 2017 class using the Blackboard learning management system to show the daily agenda.*

2017 Input	Processes	Outcomes
Canvas displays the daily agenda, along with in-depth materials.	Students access all materials for class and homework in one place.	Students easily find course materials.
Daily agenda ordered according to class sequence, time block listed for each activity.	Instructor uses timer to keep class running on time.	Class activities are finished in class.



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Home  
Announcements  
Discussions  
Grades  
People  
Syllabus  
Assignments  
Attendance  
Zoom  
Modules  
Quizzes  
Files  
Pages  
Outcomes  
Conferences  
Collaborations  
Settings

Tuesday, October 17

11:30am-11:45am OLI questions

1) Between minimalism and consumerism, which concept people would more prefer in the future?  
N/A

2) Should the interpretations we make inform and inspire a call to action in tackling these emerging issues?  
this

3) How can we curtail the negative effects of economic growth in the first place?  
Student questions from online homework

4) How can we expect the issues with consumerism to change if we address them at an individual level and not the systemic level? What the minimalists are doing by rejecting consumerism makes sense to me, but individuals don't perpetuate consumerism. Our economic system does and is fundamentally based on consumerism continuing and growing, therefore, large businesses and the wealthy people that run them perpetuate consumerism. How do we address those audiences?

YouTube link

Instructor's Answers on YouTube

References: Thomas Piketty Capital [https://www.ted.com/talks/thomas\\_piketty\\_new\\_thoughts\\_on\\_capital\\_in\\_the\\_twenty\\_first\\_century](https://www.ted.com/talks/thomas_piketty_new_thoughts_on_capital_in_the_twenty_first_century)  
<https://books.google.com/books?id=TRJsa+X&ved=0ahUJKEwIT7P3-fWAhUJFN>  
Online resources: [thomas+piketty+capital+in+the+twenty-first+century&hl=en&sa=X&ved=0ahUJKEwIT7P3-fWAhUJFN](https://www.youtube.com/watch?v=thomas%20piketty%20capital%20in%20the%20twenty-first%20century&list=PL)  
[thomas+piketty%20capital%20in%20the%20twenty-first%20century&list=PL](https://www.youtube.com/watch?v=thomas%20piketty%20capital%20in%20the%20twenty-first%20century&list=PL)

11:45am-12:00pm Discussion Week 7: Personal futures

In-class discussion

You've explored alternative futures based on two critical uncertainties this week focused on career choice and other related uncertainty (e.g. research/practice, corporate/freelance, government/NGO). For one such future scenario, you conducted a Causal Layered Analysis to describe the four layers (i.e., litany, social system & structure, worldview, and myths & metaphors). CLA is a structured analysis tool. What did you learn from conducting such an exercise? On what kind of projects might you use CLA type analysis as a designer?

12:00pm - 12:10pm discuss future signs & go over instructions.

Future signs exercise ([google slide](#)). Download the slide and rename it.

12:15-12:20pm Steps 1-2. What is the signal? and what is the issue?  
Clear steps & timeline

12:20-12:30pm Step 3. What is your interpretation?

12:30-12:45pm Step 4. What is the design opportunity?  
Please submit your revised slide to Canvas [here](#)

12:45 pm Recap: We had a look at future signs today. You practiced discussing what the three parts of a future sign are: the signal, the issue, and the interpretation. Future signs are important to notice and interpret because it helps you understand clues in the present of what the future might be like. In the previous sections, we've discussed alternative futures scenarios. Future signs link the present to a future scenario.

Homework: Please do OLI page 30.  
Recap & Homework

Figure 15. Screenshot of the 2017 Canvas daily agenda lists class activities (a) student submitted OLI questions with instructors YouTube response and supplementary online links; (b) interactive class discussion of week 7 reflection theme; (c) in-class lecture on future signs that transitions directly into the in-class activity with timeline and submission instructions; (d) recap and homework.

### Assignment scaffolding

In 2016, the in-class activities were explained briefly in the class agenda (Figure 14). The limited instructions to the in-class assignments often challenged the students. The instructor answered student questions and demonstrated how to do the assignment on the blackboard. While the students were appreciative of the in-class explanations, such class

discussions took away time from doing the in-class activities. Students often finished their in-class assignments as homework.

The in-class assignments were overhauled for the 2017 course. Each assignment had step-by-step instructions, learning objectives, outcome measures, and a grading rubric. The clarity in new the assignments made it easier for students to work on the assignments.

In the early course focus group, students suggested that the assignment rubrics were too strict compared to the amount of work that was reasonable to do in the time allotted in class. Consequently the course instructor adjusted the granularity of the rubrics to better match the time constraints. Students commented that they were not used to having to work so quickly. However, as the semester progressed, students were finishing the tasks on time or before class was over. This would suggest that with clearer assignments and practice working quickly paid off.

### **Bridging homework to assignments**

The instructor noticed that many students struggled to connect the online homework with the in-class assignments. To make the connections more clear, the instructor developed mini-lectures to link homework content to in-class assignments.

In 2017, the course instructor created in-class assignments embedded into the mini-lecture slide decks. Students downloaded the slides directly from the in-class daily agenda and made a copy. The lectures in Google slides allowed students to transition directly into the in-class activity with timeline and submission instructions (Figure 16).

In the beginning of the 2017, students struggled to work quickly. Comments in the early course focus group prompted the instructor to provide time estimates for each step. Instructions were provided in the lecture notes of the slide deck. The course instructor used a countdown timer to keep students motivated and on task (Figure 17). Students did their assignment inside the presentation slide deck and submitted it to be graded online through Canvas (Figure 18).

The rapid pace of individual in-class assignments was intimidating for some students. The course instructor shifted to group assignments because small group discussion seemed to help students get unstuck. However, group work introduces the problem of uneven student contributions. The risk of freeloading increases especially when the task is ill defined and individual contributions are not measured (George, 1992).

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To keep students engaged with the group assignments the instructor introduced individual tasks within the group assignments (Figure 18). Students were required to submit individual tasks within the group project. The individual portion of the group assignment rendered students accountable.

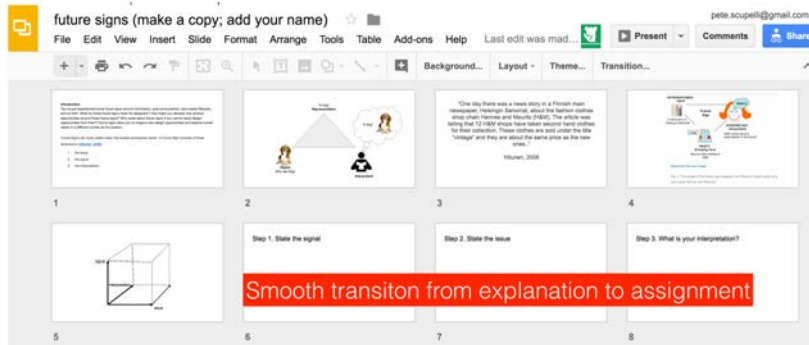


Figure 16. Google Slide mini-lecture that connects OLI homework with in-class assignment. Students make a copy of the slide deck, do their assignment, and submit the deck online for grading on Canvas.

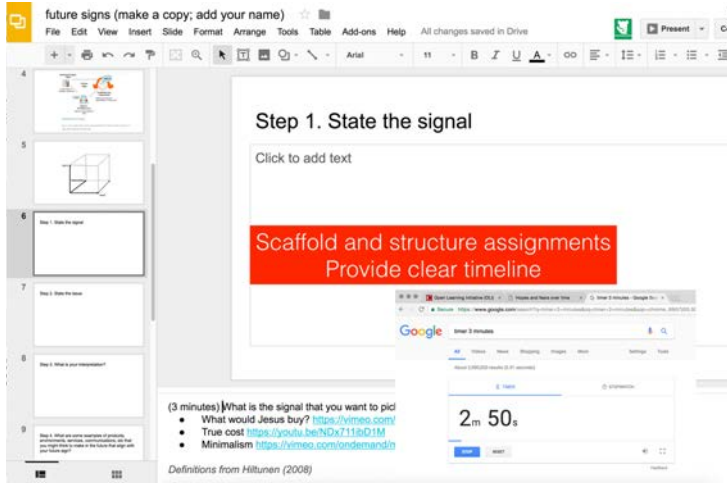


Figure 17. Detailed view of the Futures Signal assignment with clear steps, timeline, and countdown timer running during class.

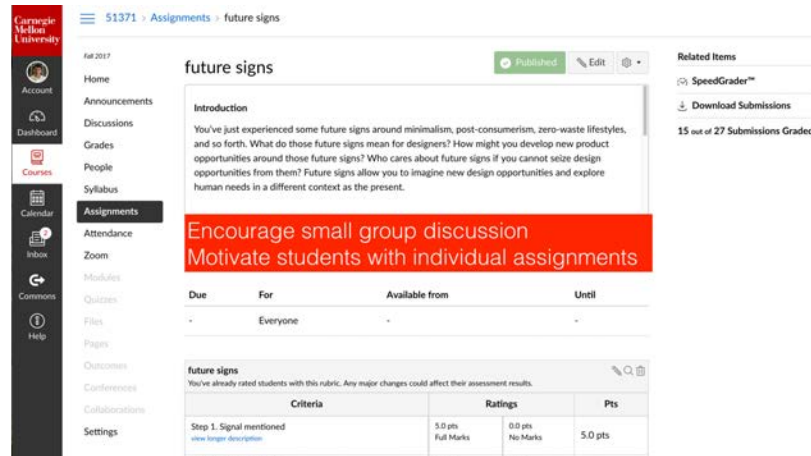


Figure 18. The Canvas future signs assignment page where students upload their assignment. The teaching assistants use a grading rubric that is visible to the students prior to submitting their assignments.

In Table 12, we hypothesize an input, process, and outcomes model for the redesigned in-class activities and scaffolded assignments. We argue that the changes describe previously are linked to three significant improvements in outcomes measured in the faculty course evaluation: explaining course requirements, increased understanding of “importance and significance of course”, and “explains the subject matter”.

Table 12. Input, process, and outcomes model for the 2017 redesigned.

2017 Input	Processes	Outcomes
Mini-lectures, misconceptions addressed, and homework questions discussed.	Students are re-engaged with the homework content to prepare for in-class assignment.	Students better understand the subject matter and can apply it to design challenges.
Scaffolded assignments provide clear steps, a timeline to follow, and clear expectations.	Students engage in bite-sized tasks, stay on task, and are timely.	Students make progress on activities, understand requirements, and feel confident.

The significant gain in “explaining course requirements” in 2017 (Figure 1) is likely linked to the changes made to the in-class assignments by adding

learning objectives for each, grading rubrics, and more clear instructions. The reduction of number of online platforms likely made it easier for students to keep track of assignments due (e.g., OLI homework, in-class activities, weekly reflections).

The increased student understanding of “the importance and significance of course” in 2017 (Figure 3) can likely be associated with in-class mini lectures that prepared students to transition to hands on in-class activities and changes made to the in-class assignments. The instructor redesigned the course assignments to closely link futures thinking methods to application to design problems. The new classroom afforded easier group discussion and interaction with the instructor making it easier to understand the significance of the course.

The significant improvement in “explains the subject matter” in 2017 (Figure 4) is likely due to mini-lectures linked to assignments and the discussion of student questions on homework in the beginning of class and the feedback in class to students’ in-class assignments.

### *Weekly reflections*

In 2016, to promote reflective practice (Schön, 1990), students were required to post and comment on two of their colleagues’ weekly reflections. The weekly reflections were based on three questions: (a) what did you learn this week? (b) how might you apply what you learned to a design project? (c) how might you change your design practice to incorporate what you learned this week? The questions sought to encourage students to consider how futures thinking methods related to their on-going design projects and design practice. Students wanted more variety of types of reflection. Students complained the weekly reflection and peer-review process was too complicated due to the multiple online platforms (e.g., reflections on Blog and peer reviews on Blackboard).

In 2017, the weekly reflections were changed from blog posts to a weekly 150-word post on a discussion board. They were asked to comment on two classmates posts. The shorter post format and having all reflections in one place, made access to other student reflections easier. More variety was added by asking specific questions each week that linked to the weekly content. Students seemed more engaged with the weekly reflections. In the 2017 focus group, students asked that the online weekly reflections be brought back into the classroom. To accommodate this, students were

asked to discuss in small groups their posts and the comments they received. Students reported back to the whole class key emergent points. Students seemed to enjoy the added brief group discussion.

## **Summary and future work**

The Dexist Futures course described here, sought to address two types of challenges regarding: futures thinking content and limitations of lecture class pedagogy for design studies topics. We used flipped class pedagogy to teach new design studies topics, such as futures, with twice the number of students in half the time of a traditional design studio course. We pushed the lecture portion of the class onto an online platform where students watch videos, respond to questions, and receive immediate correctness feedback. We assessed student experience with an early course focus group and a post-course survey. In 2016, we evaluated student learning with a pre-post course test; on average students' post-course test was 10% higher than the pre-test. In 2017, with a new more difficult pre-post test, student's learning on post-test was 27% higher than the pre-test.

The two courses differed in type of classroom, number of online platforms, and amount of scaffolding for in-class activities.

In 2016, the sloped lecture hall classroom with fixed furniture limited the student interactions during in-class activities. In 2017, the design classroom with wall-to-wall whiteboards and movable furniture better supported in-class activities. Students did not mention the classroom as problematic in 2017.

In 2016, the many online platforms created undue stress for students. The online homework was a major source of learning for students. In 2017, we reduced the number of online platforms to OLI for homework and Canvas for in-class assignments and weekly reflections. Students did not complain about online platforms in 2017.

In 2016, the limited scaffolding of the in-class activities created the need for more discussion around the in-class activities. The in-class discussion reduced time for hands on activities and in-class activities were finished as homework. In 2017, the more scaffolded activities allowed students to finish assignments during class time.

The in-class activities played a larger role in supporting student learning and taught students futures methods more deeply. However, the fast pace

left students wishing for time to work on assignments outside of class and for more time spent in class for discussion.

In future versions of the class, we intend to develop assignments to mix fast paced in-class activities with slow paced homework, and add in-class discussion of finished assignments.

In both years, the final group project required an experiential futures scenario enactment (Candy, 2010; Candy & Dunagan, 2016). This project resonated more with students in 2017. We speculate that multiple factors likely contributed such as: the design classroom was more conducive to group work, and the more scaffolded in-class activities allowed deeper understanding of the course materials. In future courses, we plan to incorporate a final course debrief for this experiential futures enactment assignment.

We described changes made to the 2016 course and provide key insights from the 2017 early course focus group. Key lessons learned include: use a classroom that supports the flipped classroom pedagogy, focus learning activities on as few online platforms as possible, scaffold hands on activities, support the transition from online learning activities into interactive active learning in-class activities, and require thinking fast and thinking slow. In summary, our data suggests that the flipped class pedagogy succeeded in teaching a design studies course, but the details of how the flipped class was implemented were associated with significant differences.

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