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Teaching Futures: Trade-offs Between Flipped Classroom and Design Studio Course Pedagogies.

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Change is exponential. Products and services are developed faster, hold a shorter shelf-life disrupted by new offerings, and exist in the wider environment with global challenges emerging such as climate change and sustainability. Thus, design for the 21st century requires different skills; design educators are challenged to adapt. In this paper, we compare two versions of a futures studies course developed for design students: one uses a flipped classroom pedagogy (with interactive online pre-work and in-class workshop activities, meeting for two 80-minute sessions per week); and the other uses a hybrid studio approach (making more use of in-class lectures followed by hands on-studio activities, meeting for 170 minutes once per week) focused on experiential futures practices of tangible artifact and immersive scenario creation. We use four measures: learning activity inventory, course quality with faculty course evaluations, student experience with a post-course survey, and time and feedback on final projects. We discuss design trade-offs for learning: format of reflections is linked to transfer activities, time on learning activities shapes perceptions, less (interference) is more, more (scaffolding, feedback, links to practice, active learning) is better, and timing is everything.

Keywords: design thinking; futures thinking; flipped classroom; studio education; learning science.

1 Introduction

Changes to design curriculum and courses are difficult. Adding something new (topics, approaches, methods) calls for discernment on the best use of limited student time and attention. How should the new topic be taught: studio, lecture, seminar? How should classes be structured: size, duration, frequency? How should effort be paced and allocated in class vs outside? Enlightened course design relies on three pillars: applying the research on what works best for learning, data-informed iteration, and engagement with real-world problems (e.g., Ambrose, et al. 2010). Design educators are examining (and changing) their teaching pedagogies to engage with global challenges such as climate change and sustainability (e.g., Scupelli, 2019).

In this paper, we focus on two case studies and their respective pedagogies: *Dexign Futures*, a design studies course taught as a flipped class; and *Futures*, a redesigned

version of the course with a hybrid design studio model emphasising co-creation and experiential learning.

1.1 Four pedagogies frequently used in design education

Design education broadly relies on four pedagogies, each with its own strengths and limitations: studio, laboratory, lecture, and seminar (Lyon, 2012; Tovey, 2015; Boling et al. 2015; Farías & Wilkie, 2016; Davis, 2017). Studio and laboratory courses focus on applied making, while core concepts are often taught through lecture and seminars (e.g., Lawson & Dorst, 2015). In this paper, we discuss a flipped class and a hybrid studio.

1.2 Design studies courses at Carnegie Mellon University

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; Cultures; Persuasion). Design studies classes are typically lecture-based, with hands-on application activities. Studio courses complement these and focus on three different tracks (Products, Communications, and Environments).

1.3 Futures Studies within the design studies track

A futures studies class was introduced in the design studies spine as part of a new undergraduate curriculum launched in 2014. Futures studies (or simply "futures") is a transdisciplinary field of inquiry concerned with the investigation of diverse possible, probable and preferred futures (Bell, 2003; Gidley, 2017), and it has been taught in a range of university departments in the United States and around the world since the 1960s (Dator, 2002). This addition to core curriculum here was spurred by a recognition that emerging designers will, in their lifetimes, confront pervasive challenges such as sustainability and climate change, and that they should therefore be capable of contextualizing and embedding practical short-term design action within long-term thinking (Brand, 1999; Mau et al., 2004; Candy, 2010).

The futures class at Carnegie Mellon University, required for all third-year design students, was introduced to help prepare them for these grand challenges. Design educators addressing such larger-scale concerns confront an inherent tension between covering traditional artifact-centered approaches and the systems perspectives addressing societal level concerns (Irwin et al. 2015; Kossoff, 2011; Scupelli, et al. 2016[ab]; Scupelli, et al. 2017; Scupelli, et al. 2018). Case studies describe ways to bridge such tensions (Scupelli, 2019).

In the first three years, futures was taught in two ways: *Dexign Futures* (2016, 2017) as a flipped class meeting twice a week for 80-minute sessions; and *Futures* (2018) as a studio course meeting once a week for a 170-minute session. Three key challenges were faced in both versions are linked to the broader context of a new curriculum rollout.

First, managing student motivation was difficult. For many students, having to shift perspectives and meaningfully embed a "futures" worldview in their third year was different from the pattern established in their previous two years of study: learning to think about and apply design to immediate or near-term problem spaces for four semesters, then suddenly switching in the fifth to address much longer time horizons.

Second, futures thinking requires students to entertain an unfamiliar epistemology of time: there are no future facts, but multiple possibilities, the very consideration of which may affect what unfolds (Gidley, 2017). Radical differences between typical short-run perspectives on design as a technology-driven foray into the adjacent possible, and the embrace of philosophical pluralism, uncertainty and openness consonant with a longer view, appeared to make some students uncomfortable, avoidant, or dismissive.

Third, promotion of learning transfer from design studies courses, including the futures course, to studio projects, was lacking. Although framed and structured as core competencies, the concepts, methods and skills taught in design studies courses were not always explicitly referenced or reinforced in the briefs and instruction for studio courses, leaving students to make the connections. Consequently, some struggled to integrate futures methods into their developing design practice. Next we describe differences in structure, activities, and learning outcomes between the two versions of the futures course.

1.4 Case Study 1: *Dexign Futures*[1]

Sustainability is often framed in terms of long-range challenges unfolding over periods of a generation or more, for example looking to a specified multi-decadal time horizon like the year 2050 (WBCSD, 2009). *Dexign Futures* explicitly focused on aligning near-term design action with sustainable futures. The "X" in Dexign was originated by Wasserman to signify an experimental form of design and design education combining design thinking with futures thinking to align near term design action with long range vision goals – while navigating uncertainty and accelerating innovation toward desired futures (Wasserman, Scupelli, & Brooks 2015[ab]; Scupelli, Wasserman, Brooks, 2016; Scupelli, Brooks,Wasserman, 2016).

In 2016 and 2017, *Dexign Futures* was taught with the flipped classroom pedagogy as an alternative to the traditional lecture approach (Scupelli & Brooks, 2018). "Flipped" courses shift new-content exposure to pre-class work and use class time for hands-on application activities (Bergmann & Sams, 2012). Pre-class work included online readings, videos, and interactive questionnaires providing immediate feedback; as well as a mechanism for students to submit questions to the instructor ahead of each session. Weekly reflections asked students to explain how they might integrate futures methods into design practice.

The online platform, Open Learning Initiative (OLI), included an information dashboard highlighting the top five questions that students had answered incorrectly in the pre-work, so that the instructor could address student misconceptions. Discussion then paved the way to active engagement with hands-on individual and group activities, during which the instructor provided just-in-time guidance.

McCarthy (2016) lists potential six benefits and limitations to the flipped classroom model. Scupelli and Brooks (2018) suggest three further potential benefits and limitations. The *Dexign Futures* course was based on the premise that students need a broad introduction to futures, the goal being to help them bring these methods of longer-term, pluralistic thinking into applied contexts. As noted above, several challenges impeded this knowledge transfer to other courses. In the next section, we describe revisions in its third year, 2018.

1.5 Case Study 2: *Futures*

In fall 2017, the School of Design hired Stuart Candy, an internationally renowned academic and professional futurist, to embed futures studies (also known as "foresight") approaches throughout the curriculum. Taking existing undergraduate courses as a starting point, the integration strategy developed in collaboration with other design faculty was to weave a "Foresight Thread" through existing design studies courses. The "threaded" structure was devised as a way of distributing unfamiliar — and as we have noted, paradigmatically challenging — perspectives over a four-year degree arc. Instead of a single burst, starting

[1] *Dexign Futures* grew out of a course titled *Dexign the Future* originated in 2013 by Arnold Wasserman as Nierenberg Chair Visiting Professor. The course was co-taught by Wasserman via remote telepresence and Prof. Peter Scupelli on-site. https://dexignthefuture.com/

and ending in the space of one semester in the third year, the pedagogical architecture now underway embeds multiple exposures to futures methodologies and practices in smaller doses, starting in the first semester, with a view to them being used and reinforced in concurrent design studio courses in the Products, Communications, and Environments tracks of second and third year students, and culminating in an applied futures research component of the fourth-year (senior) studio.

The inception of the Foresight Thread allowed Scupelli and Candy to create a new *Futures* course for fall 2018. In line with the distributed "drip-feed" strategy of multiple exposures over years, one important parameter and goal for this specific run of the course was to reduce the number of topics from those covered in the course's first two iterations, to enable more in-depth practice with certain methods. A second goal was to help students take a deep dive into both futures and design via "experiential futures", a fast-developing genus of practice (Candy, 2010; Candy & Dunagan, 2017; Candy, 2018; Candy & Kornet, 2019), involving the use of design skills and other idioms such as performance, gameplay, and media production to mediate future scenarios as if they were real in the present.

The experiential futures approaches incubated in futures/foresight have been interwoven with, and in some key respects anticipated and preceded, the ascent over the past decade of futures-oriented methods in design education, such as design fiction and speculative and critical design (Durfee & Zeiger, 2017 including Candy, 2017; Dunne & Raby, 2013). The key difference is that when one starts with the aim of increasing the quality and depth of thinking about the future, all manner of media and approaches in support of that are considered fair game; whereas when one starts with a certain medium or practice and uses it to try to think about the future, the usual boundaries of that practice may unintentionally circumscribe the range of possible thought (Candy, 2017; Candy, 2018).

A way of framing the great challenge — and opportunity — of using experiential futures approaches is to bridge the "experiential gulf"; to shift from high-level, abstract ideas about possible futures down to 1:1 scale fragments that help make a hypothetical world feel real (Candy, 2010, p. 61). Based on Candy's research and teaching, and building also on the first two runs of *Dexign Futures*, in the *Futures* course students were scaffolded and supported through designing three experiential scenarios framed by two major projects.

The course was structured as follows. It began with a three-week introduction to key ideas and concepts in the field (for a broad-strokes sense of these foundational elements, see Candy, 2011). Over the following four weeks, students were guided through an investigation based on Ethnographic Experiential Futures (EXF) (Candy & Kornet, 2019), creating two "artifacts from the future"; the first instantiating a preferred personal future for themselves (i.e. a representative object "from" the world and the life that they would hope to find themselves in 20 years from now); and the second responding to and forming a coherent part of the preferred future of a classmate. These were individual projects, but completed in dyads, with the partner being the key interlocutor and "client of one". These activities in the first seven weeks comprised the first half of semester. The latter half revolved around experiential futures projects co-created in small groups, each producing a "Time Machine," an immersive scenario at the scale of a room, whereby a group of visitors is invited to visit a future scenario for fifteen minutes, and spends the period immediately afterward unpacking and exploring that experience (Candy, 2013; Candy, 2014). The three-hour weekly studio format was adopted for the *Futures* incarnation of the course with a view to supporting deeper peer-to-peer and group-based design exploration. In the next section, we describe methods and measures used to examine the three courses.

2 Methods

We evaluated the 2016 and 2017 *Dexign Futures* courses and 2018 *Futures* course using four measures: inventory of learning activities, faculty course evaluations, student experience surveys (Scupelli, Brooks, 2018), and a culminating assignment in experiential futures called “The Time Machine” (Candy, 2013).

2.1 Inventory of learning activities

For each course, we counted the learning activities listed in the course syllabus, course calendar, and class meeting agendas, taking stock of these as well as the graded assignments, and estimating the time dedicated to each activity. The goal of such an inventory is to compare and contrast students’ activities in each iteration.

2.2 Online student learning experience survey.

When the course concluded, we asked students to complete a three-question survey online (Table 1). We coded comments with grounded theory methods (Strauss & Corbin, 1994).

Table 1. Student learning experience online questions for Dexign Futures (DF) and Futures (F).

1.	What activities in the [DF, F] course do you feel contributed the most to your learning?
2.	What are some concrete examples of how you applied what you learned in the [DF, F] course 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 [DF, F] course student experience for next year?

2.3 Faculty Course Evaluations

Carnegie Mellon University conducts a Faculty Course Evaluation (FCE) at the end of each course, consisting of ten questions on students' perceptions of their engagement, learning outcomes, instructor behaviors and course activities (Table 2). Questions are rated on a five-point Likert scale (1=Poor, 2=Below Average, 3=Average, 4= Above average, 5=Excellent). We conducted an independent samples ANOVA to compare the ten FCE questions for 2016, 2018, and 2018 courses. In this paper we focus on five of these questions (see Table 2).

Table 2. Faculty Course Evaluation focal 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 provide feedback that helped students improve their performance?
3. Does the faculty member demonstrate the importance and significance of the subject matter?
4. Does the faculty member explain the subject matter of the course (e.g. concepts, skills, techniques, etc.)?
5. How would you rate the overall quality of the course?

2.4 Experiential futures project: The Time Machine

Each year student teams were given a (previously published) future scenario to inspire their “Time Machine” assignment. The purpose of the assignment is to create a live, immersive, and interactive experiential scenario of a possible future (see Candy, 2013). Figures 1, 2,

and 3 show selected student projects, illustrating some key differences between these assignments from year to year.

Figure 1. Dexign Futures *(2016) Time Machine performances focused on the future of education set in the year 2050. Student performances were on average five minutes long and often had the resolution of a campfire skit.*

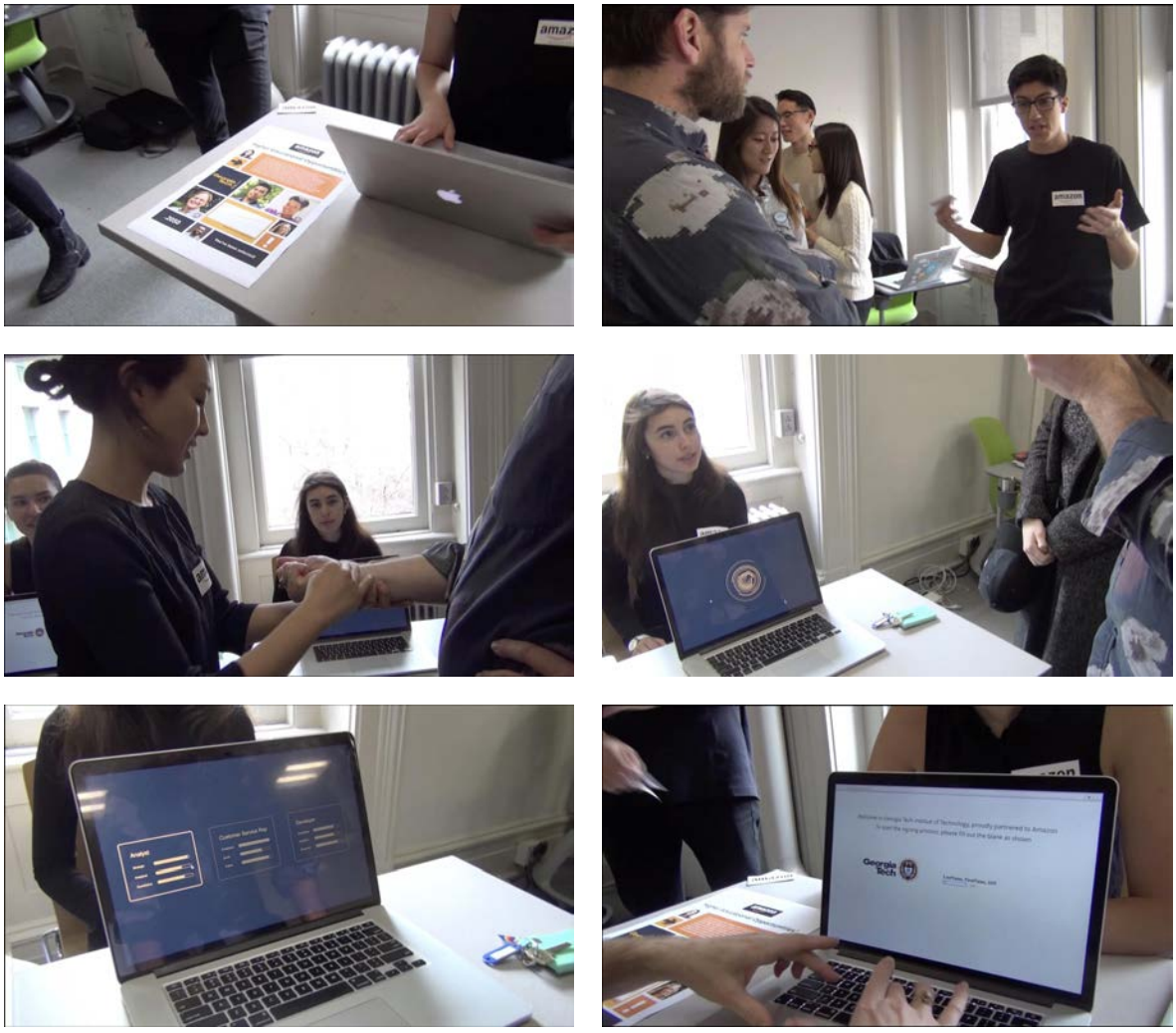

Figure 2. Dexign Futures *(2017) Time Machines again focused on the future of education set in the year 2050. There were two variants: five-minute theatrical performances, and fifteen-minute poster session performances. The project pictured dramatized a scenario where higher education is free because of a university-wide partnership with corporate entities that recruit students to train for specific jobs.*

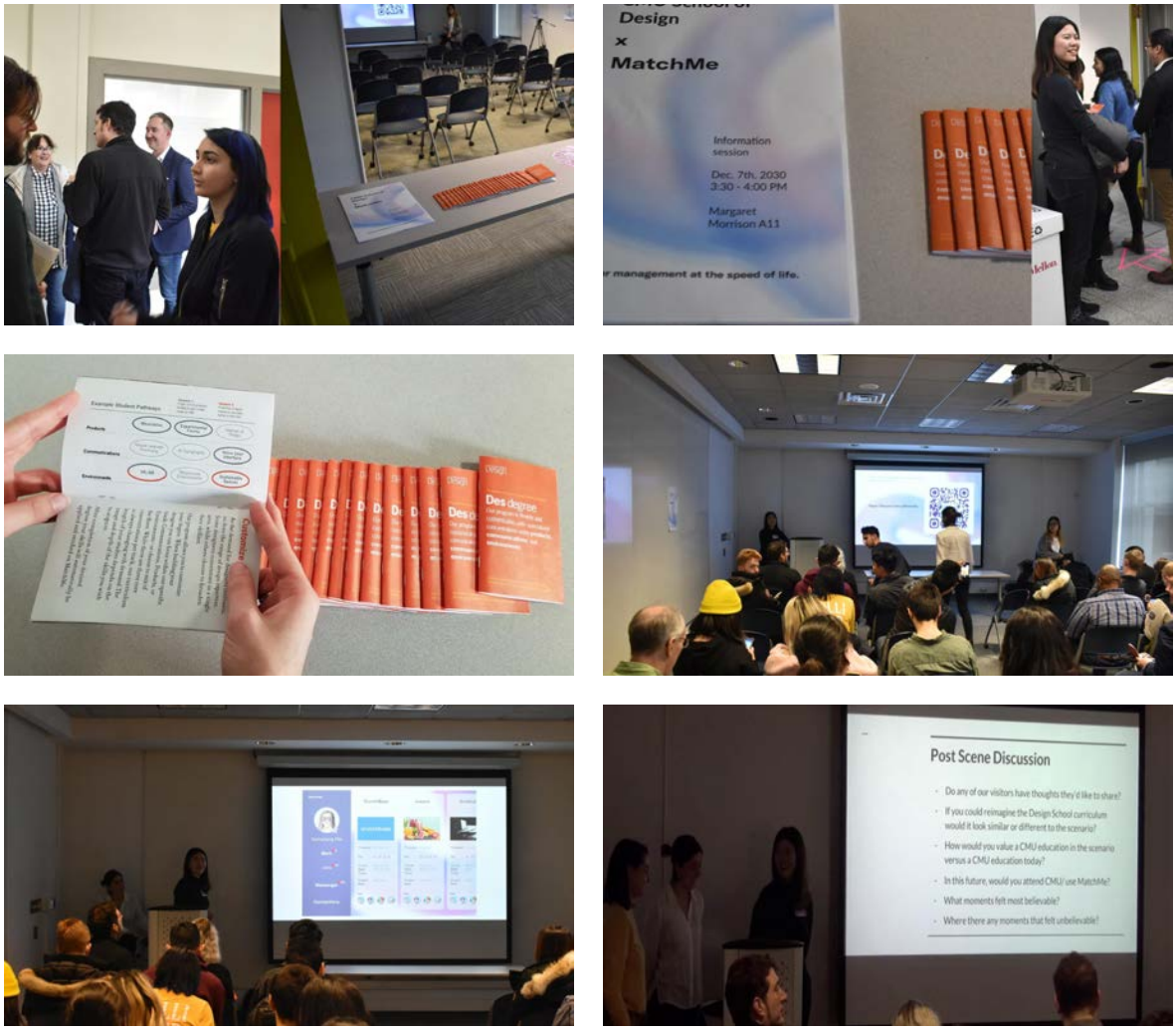

Figure 3. Futures *(2018) Time Machines were immersive scenarios lasting 15 minutes, followed by a 15-minute discussion with participants about the experience and ideas behind it. In a final class debrief , teams presented and reflected both on what worked and on what could have been designed more effectively.*

3 Results

Below we discuss the results in four sections, corresponding to the different measures used: inventory of learning activities, activities perceived by students as contributing to learning, faculty course evaluations, and time machine evaluations.

3.1 Inventory of learning activities

Table 4 lists the learning activities as they appeared in class agendas, and graded homework assignments for each year of the course. The time spent on each activity was estimated by the course instructors for both in-class activity and homework assignments (e.g., OLI pre-work; reading; reflection questions). Figure 4 illustrates an estimate of how much time students spent on graded assignments for the three instances of the course.

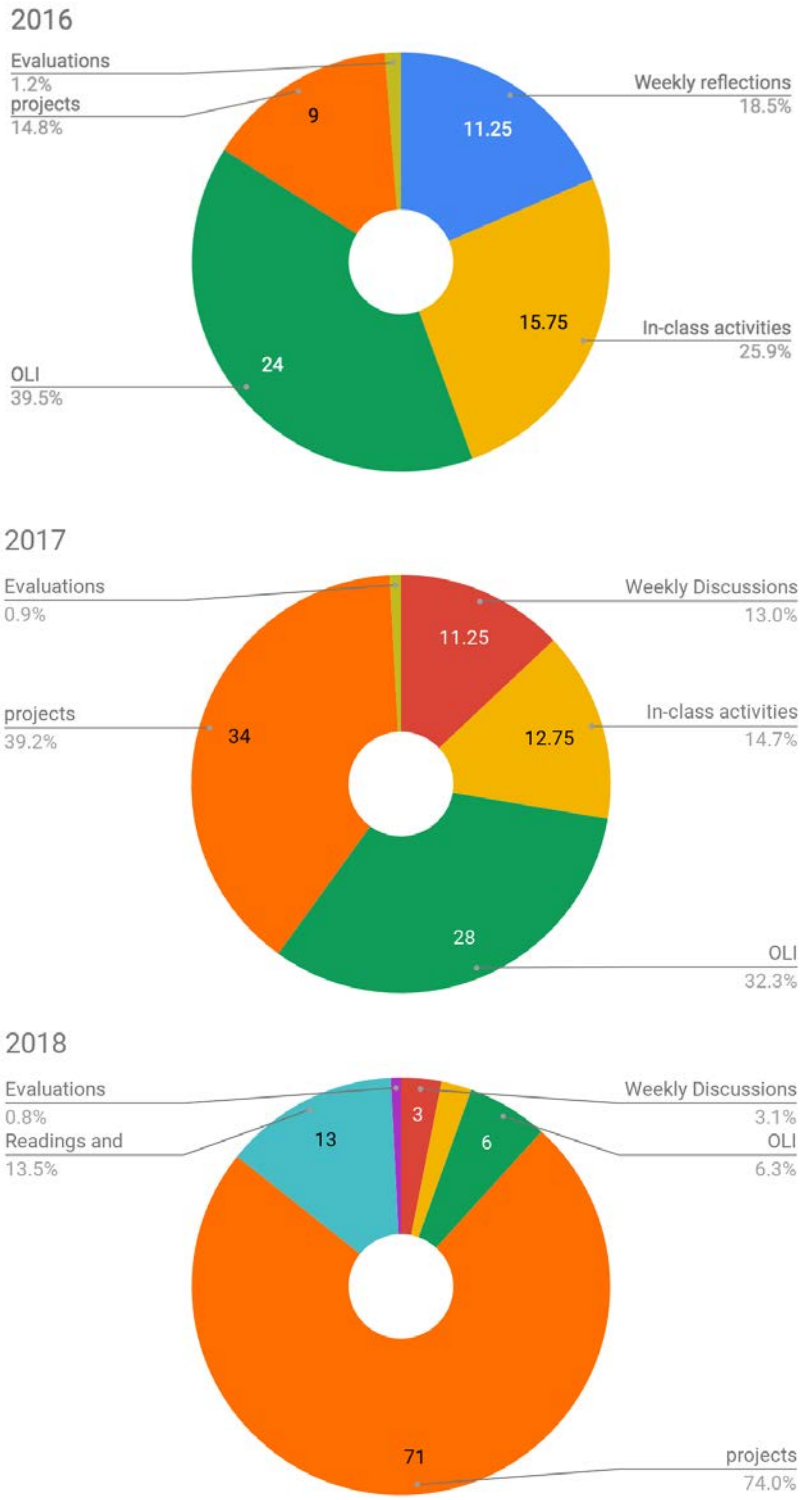

Figure 4. Graded assignments and estimates of in-class and out-of-class time spent expressed in hours spent on each activity. Dexign Futures *2016 (Top);* Dexign Futures *2017 (Middle);* Futures *2018 (Bottom). The circular chart expresses the total percent of hours per graded assignments. Table 4 contains detailed calculations.*

Table 3. Learning activity inventory based on graded work (9 credit course; times are estimates).

	2016	2017	2018
Weekly reflections	15 reflections (45 minutes writing and peer review) 11.25 hours total	15 weekly reflections (30 minutes writing each) (15 minute in-class discussion) 11.25 hours total	6 reflections (30 minutes each) 3 hours total
In-class activities	21 assignments (45 minutes each) 15.75 hours total	17 assignments (45 minutes each) 12.75 hours total	3 assignments (45 minutes each) 2.25 hours total
OLI	12 modules (4 hours each) 48 hours total	14 modules (4 hours each) 56 hours total	3 modules (2 hours each) 6 hours total
projects	1 project (4 hours in class) 9 hours total	1 project (9 hours in class) 34 hours total	3 projects (28 hours in class) 71 hours total
Homework	-	-	12 (15 minutes) 3 hours total
Readings	-	-	10 (1 hour) 10 hours total
Evaluations	3 surveys (15 minutes each) 45 minutes total	3 surveys (15 minutes each) 45 minutes total	3 surveys (15 minutes each) 45 minutes total

3.2 Post-course student survey results

Students answered three open-ended questions at the end of the course (Table 1). Responses were coded iteratively for content using a bottom up approach; identifying themes that could work across all three courses so that comparisons could be made. Below we discuss each question. 3.2.1 Activities perceived by students as contributing to learning The first question was: "What activities in the [*Dexign Futures, 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). In 2018, 33 students responded on average 34.42 words (SD 27.85). Emergent topics included: Open Learning Initiative materials (OLI), in-class activities, discussion, videos, reflections, experiential futures (i.e., personal artifacts from the future, Time Machines) groups, instructor, lecture, readings, methods, and other (Figure 5).

In total, we coded 110 topics in 2016, 74 topics in 2017, and 45 topics in 2018. In 2016, on average, students listed 2.5 activities contributing most to their learning (SD 1.11); 2017 was similar, with students listing 2.47 activities (SD 2). In 2018, in total, we coded 45 topics students responded on average 1.36 activities (SD 0.55). Table 4 distills students' evaluation of course activities' contribution to their learning; Figure 5 shows the same information in a bar graph format.

Table 4. "What activities in the [Dexign Futures, Futures] course do you feel contributed the most to your learning?"

	OLI	Class Activity	Discuss	Videos	Reflect	Time Machine	Artifact	Group	Instructor explains	Read-ings	Method	Other
2016	25%	11%	17%	12%	7%	10%	0%	9%	9%	0%	0%	0%
2017	11%	27%	9%	8%	3%	20%	0%	12%	3%	0%	8%	0%
2018	0%	0%	13%	0%	0%	38%	29%	0%	4%	4%	7%	4%

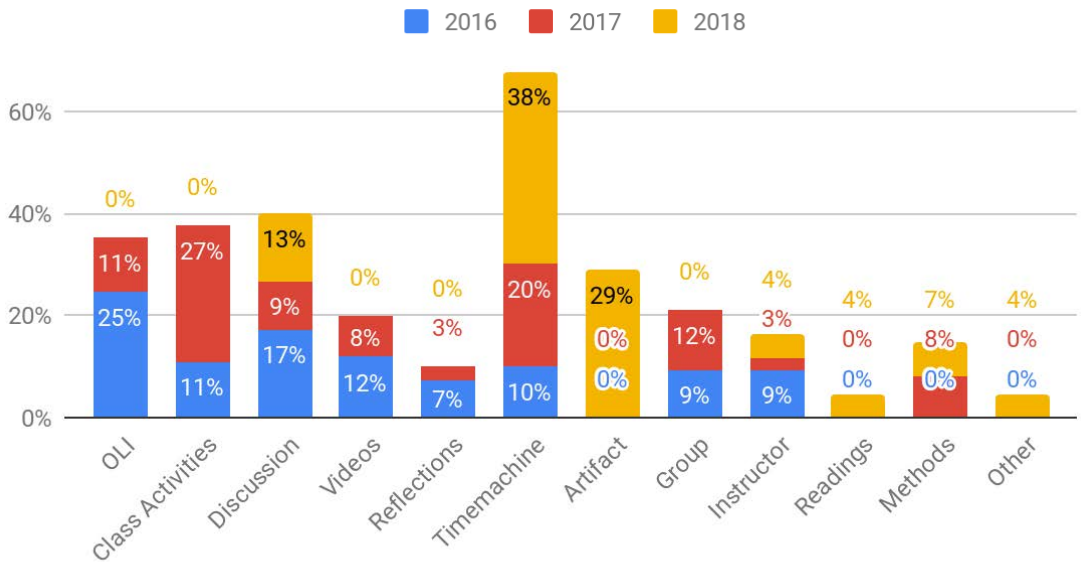

Figure 5. "What activities in the Futures course do you feel contributed the most to your learning?"

3.2.2 Activities perceived to transfer beyond course

The second question was: "What are some concrete examples of how you applied what you learned in the [*Dexign Futures, Futures*] class to things you worked on outside of class (e.g., studio projects, independent projects, own life)?"

In 2016, 44 of 48 students responded on average 74.41 words (SD 71.12). In 2017, 30 of 35 students of responded on average 38.47 words (SD 33.06). In 2018, 30 of 35 students of responded on average 45.70 words (SD 31.50).

We coded in: 2016, 56 topics; in 2017, 34 topics; and in 2018, 34 topics. In 2016, on average, each student listed 1.27 concrete examples (SD 0.54). In 2017, students listed on average 1.13 concrete examples (SD 0.35). In 2018, students listed on average 1.03 concrete examples (SD 0.17). Figure 6 illustrates the key aspects of where students believed they were transferring what they learned in the futures courses to outside activities.

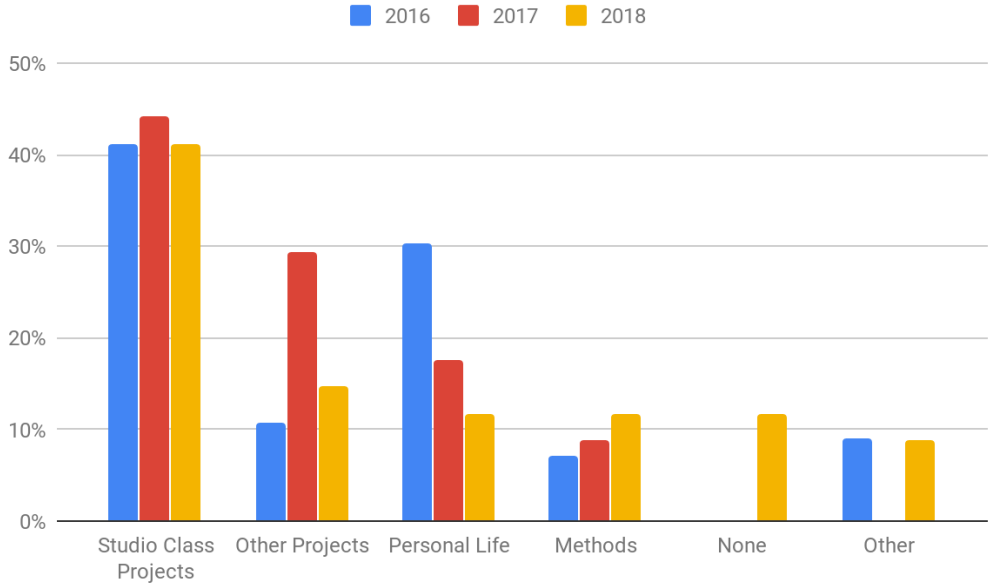

Figure 6. "What are some concrete examples of how you applied what you learned in [Dexign Futures, Futures] *class to things you worked on outside of class (e.g., studio projects, independent projects, own life)?" Student responses as a percent of total comments per year.*

3.2.3 Student suggestions to improve student learning experience
The third question was: "What suggestions do you have to improve the [*Dexign Futures, Futures*] course?" In 2016, 44 of 48 students responded on average 44.5 words (SD 96.01). In 2017, 30 of 35 students responded on average 49.70 words (SD 54.04). In 2018, 30 of 35 students of responded on average 72.09 words (SD 85.99).

We coded: in 2016, 136 topics; in 2017, 76 topics; and in 2018, 79 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); in 2018, students listed 2.39 improvement topics (SD 1.65). Figure 7 illustrates the percentage of student suggestions for improvement topics by year.

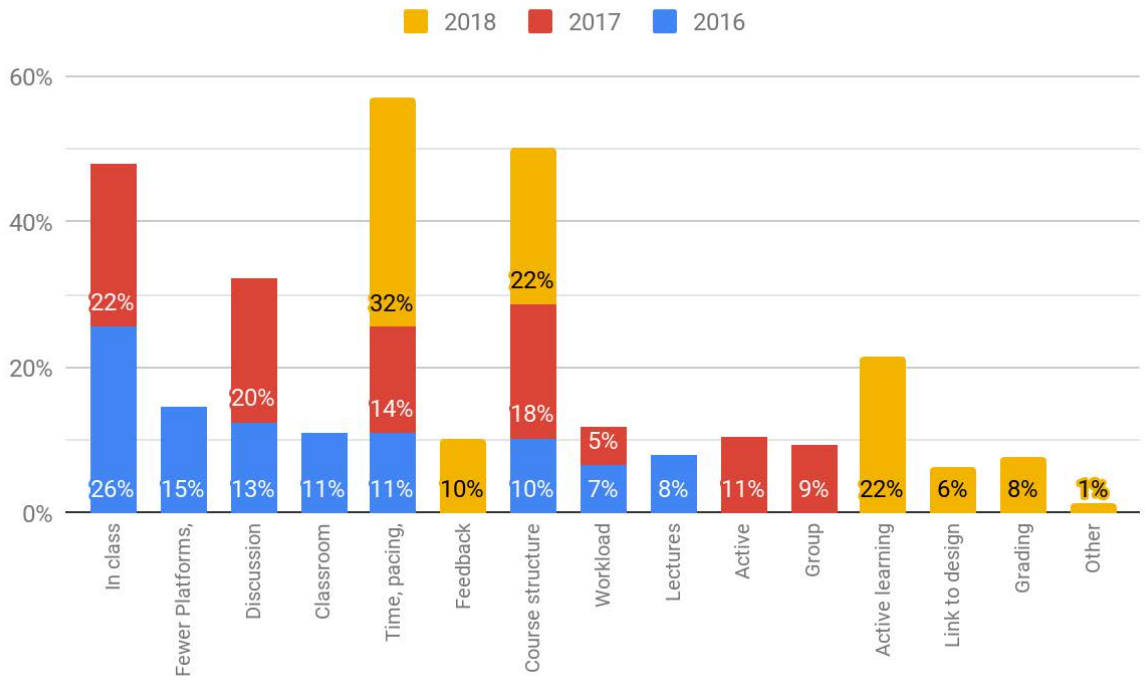

Figure 7. "What suggestions do you have to improve the [Dexign Futures, Futures] *course student experience for next year?" Student responses as a percent of total comments per year.*

3.3 Faculty Course Evaluation (FCE) Results

In 2016, 43 of 48 students (89%) filled out the FCE; in 2017, 31 of 35 students (88%) filled it out; and in 2018, 29 out of 38 students (76%) filled out the FCE. An ANOVA analysis was conducted to compare students' responses to the ten FCE questions in the 2016, 2017, and 2018 courses (Table 5). We report on five questions analyzed below (Figures 8 - 12).

*Table 5. Faculty course evaluation questions for Scupelli, courses taught in 2016, 2017, and 2018. 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. In italics are the questions discussed in this paper.*

	2016	2017	2018
1. Weekly hours spent on class	*6.86^{at} (SD 2.96)*	*5.77^{at} (SD 2.79)*	*6.55 (SD 2.96)*
*2. Feedback to improve performance **	*3.10^{a*} (SD 1.23)*	*3.71^{a*b*} (SD 1.16)*	*2.90^{b*} (SD 1.08)*
*3. Importance of subject **	*3.79^{a*} (SD 1.07)*	*4.23^{a*b*} (SD 0.80)*	*3.2^{b*} (SD 1.10)*
*4. Explains the subject matter **	*3.43^{a*} (SD 1.15)*	*3.94^{a*b*} (SD 1.00)*	*3.03^{b*} (SD 1.09)*
*5. Rate quality of course **	*2.79^{a*} (SD 1.01)*	*3.58^{a*b*} (SD 0.76)*	*2.72^{b*} (SD1.22)*

- There were no significant differences for weekly hours spent on the class (Figure 8).
- There was a significant effect of year for Question 5, ‘instructor provides feedback to improve performance’ at the p<.05 level for the three conditions [F(2, 100) = 4.14, p < .02] (Figure 9). A post hoc Tukey test showed that more feedback was provided in 2017 compared to 2018 (p < .02).
- There was a significant effect of year for Question 6, ‘instructor explains importance and significance of subject’ at the p<.005 level for the three conditions [F(2, 100) = 6.57, p < .002] (Figure 10). A post hoc Tukey test indicated significantly more ‘explanation of importance and significance of subject matter’ was provided in 2017 compared to 2018 (p < .001).
- There was a significant effect of year for Question 7, ‘instructor explains subject matter’ at the p<.01 level for the three conditions [F(2, 100) = 6.08, p < .007] (Figure 11). A post hoc Tukey test showed that students perceived more ‘explanation of subject matter’ in 2017 compared to 2018 (p < .005).
- There was a significant effect of year on Question 10, ‘overall quality of the course’ at the p<.005 level for the three conditions [F(2, 97) = 6.96, p < .002] (Figure 12). A post hoc Tukey test showed that the quality of the 2016 course was rated significantly lower than in the 2017 course (p < .005); and the 2017 course was rated significantly higher than the 2018 course (p < .005).

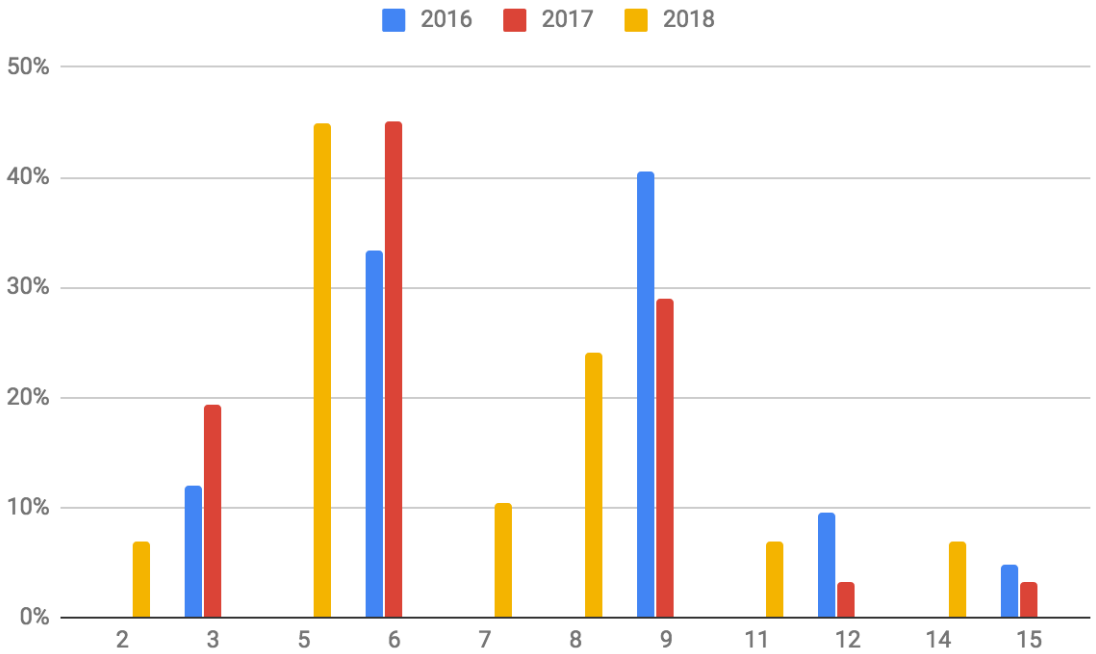

Figure 8. “On average, how many hours per week have you spent on this class, including attending classes, doing readings, reviewing notes, writing papers and any other course-related work?”

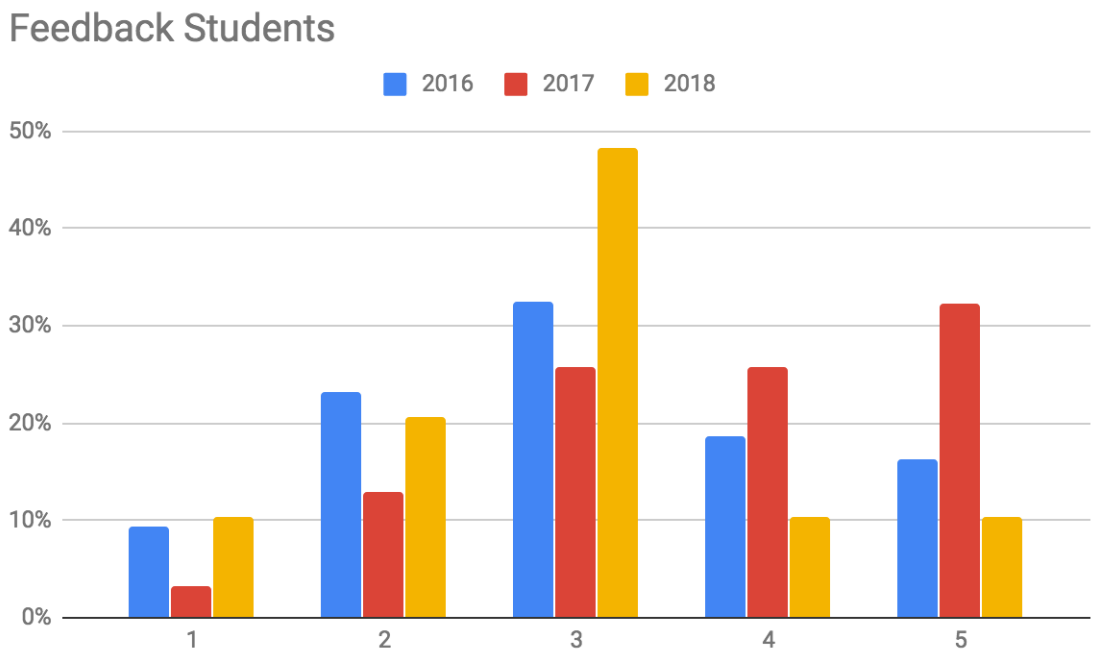

Figure 9. "Does the faculty member provide feedback that helped students improve their performance?" (1=Poor, 2=Below Average, 3=Average, 4= Above average, 5=Excellent).

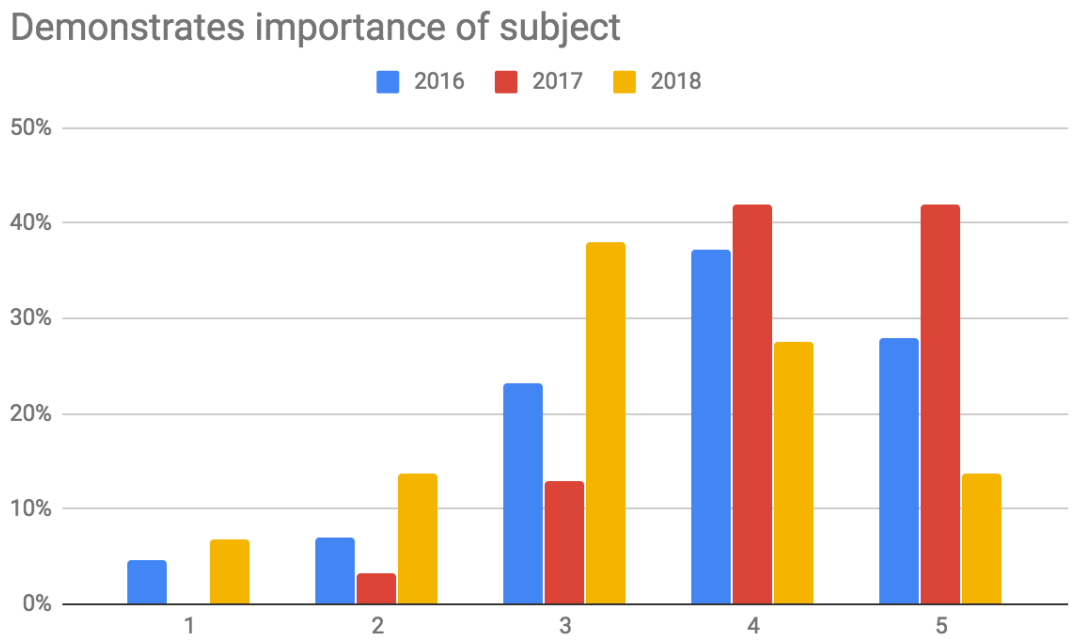

Figure 10. "Does the faculty member demonstrate the importance and significance of the subject matter?" (1=Poor, 2=Below Average, 3=Average, 4= Above average, 5=Excellent).

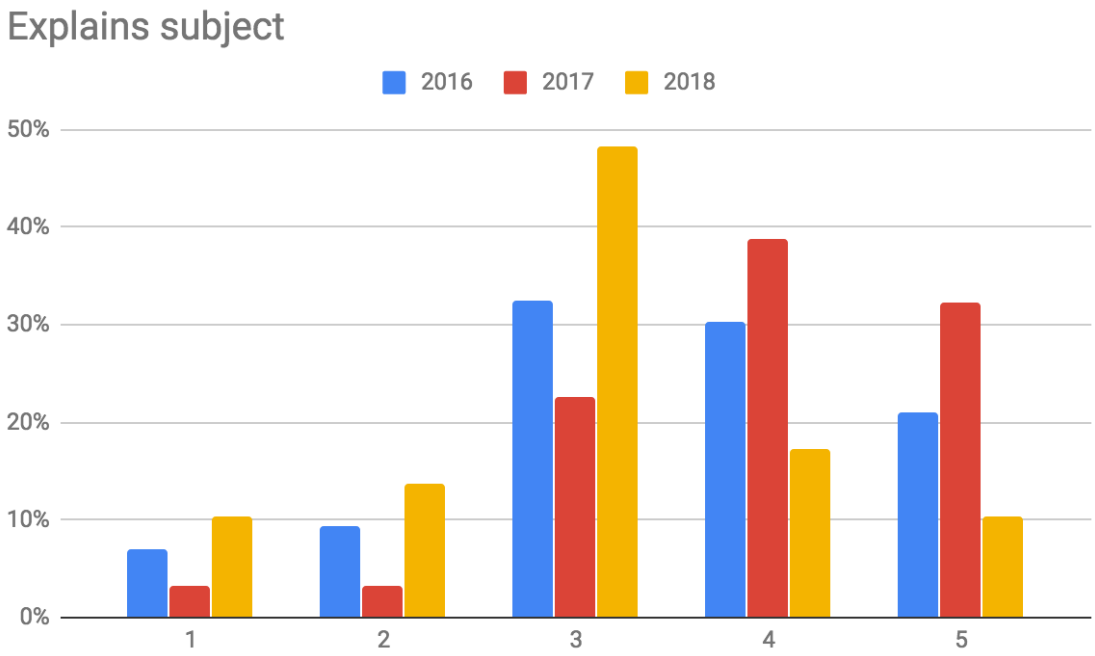

Figure 11. "Does the faculty member explain the subject matter of the course (e.g. concepts, skills, techniques, etc.)?" (1=Poor, 2=Below Average, 3=Average, 4= Above average, 5=Excellent).

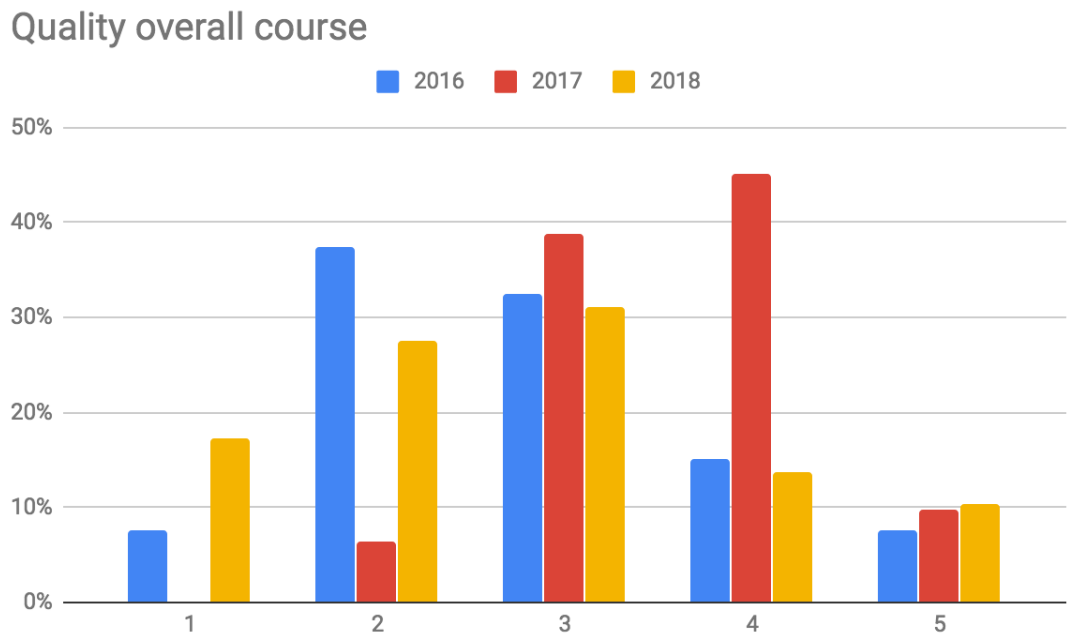

Figure 12. "How would you rate the overall quality of the course?" (1=Poor, 2=Below Average, 3=Average, 4= Above average, 5=Excellent).

3.4 Time Machine results

Time spent on the experiential scenarios assignments, and instances of feedback provided along the way, were calculated for each year (Table 6).

Table 6. Time spent on the experiential futures assignments, and instances of feedback

	Time on assignment	Number of classes	Contact time	Expected homework time	Feedback given
2016	1 Week	3 x 80 minutes	4 hours	6 hours	1
2017	4 Weeks	7 x 80 minutes	9 hours	25 hours	3
2018	6 Weeks	6 x 170 minutes	17 hours	37 hours	5

4. Discussion and future work

Next we discuss the findings according to multiple cross-cutting themes for the four data collected (i.e., learning activity inventory, online student learning experience survey, faculty course evaluations, immersive scenarios). Five insights emerge between the 2016-2017 *Dexign Futures* courses[2] in relationship to the 2018 *Futures* course: (a) reflection format shapes knowledge transfer, (b) time on learning tasks shapes perceptions of learning, (c) less is more (for learning), (d) more is better (for learning), and (e) timing is everything (for learning).

4.1 Reflection format associated with knowledge transfer

We interpret Figure 6 to mean that students transferred differently what they learned in each course based on the course's features each year (Figure 4; Table 3). Given the nature of these case studies, we can only speculate about the causation of such associations. We frame our interpretations with a view to enabling future field experiments to empirically test these hypotheses.

Studio course transfer. In all three courses, over 40% of the students claimed that they applied lessons from the futures class to their studio courses.

We notice three interesting spikes in Figure 6 regarding transferring what was learned in the *Dexign Futures* courses for "personal life" in 2016, "other projects" in 2017, and for *Futures* "none" in 2018. What might explain such differences? We suspect two factors in particular: differences in the format of the weekly reflections between 2016-2017, and differences in the total number of reflections assigned (15 in 2016-2017 vs. 6 in 2018).

We interpret with caution here given a single open-ended question, subject to self-presentation bias in student responses; future work should more robustly assess knowledge transfer to studio courses with the use of multiple measures. For example, how effectively do they incorporate futures methodologies in studio projects?

Personal life transfer. In 2016 we see a spike in students reporting learning being applied to their "personal life" (Figure 6). Different reflection prompts were provided in each course. In 2016, they wrote weekly reflections on a personal blog, and were required to review peer contributions. Each time they answered three questions: What did you learn this week? How might you apply what you learned to other projects you are working on (e.g., in studio course, other projects, personal life)? How might your design practice change to accommodate what you learned? Scupelli made this course design choice to promote students' transfer of *Dexign Futures* learning to other contexts/projects/life. In 2016, some

[2] For detailed discussion on the 2016-2017 Dexign Futures courses see Scupelli & Brooks 2018. Five key points were identified: 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.

students questioned the value of answering the same questions each week and described the peer-review component tedious.

Other projects transfer. In 2017, Scupelli overhauled the weekly reflections by prompting students to reflect on specific topics covered each week. In an online discussion board, students were required to write a reflection and comment on the posts of two other classmates. In class, small groups then discussed comments received and one person reported any patterns noted to the whole cohort. We hypothesize that the spike in "other projects" for 2017 in Figure 6 may be linked to this format, although further empirical work is needed to test what type of reflection questions, format, and timing promote better learning transfer.

No transfer. In 2018, the *Futures* course was designed to operate more like a studio course with an emphasis on learning by making. Three making projects were central (personal future artifact; future artifact for a classmate; Time Machine). Given the increase in making outside of class, we reduced the total number of weekly reflections to six, assigning three in the first three weeks of the course to follow the introduction of key concepts; and the other three to coincide with key readings and stages in the assignments. Unlike in 2017, the online reflections were not reincorporated into the classroom for collective discussion. We speculate that the total number of reflections, and lack of in-class discussion on the student reflections is linked to the 10% of students that professed to find no clear connections between the course and their external activities.

Other data sources confirm the trend; in the 2018 FCE, students rated the 'importance of subject matter' (Figure 10) and 'instructor explains subject' significantly lower than in 2017 (Figure 11). More empirical work is needed to understand how reflections and discussions have worked for learning in the various course contexts. One possible future research direction would be to code the content of reflections across multiple years to look for deeper patterns.

Limitations. The observed differences in student comments on transfer activities could be due to external factors such as current events, or possible differences among the three cohorts (Figure 6). An example of a potentially confounding external event is the 2016 United States presidential election of Donald J. Trump.[3] In particular, foreign students, minorities, women, and GLBTQ students worried about future discrimination. Future work could probe links between political climate and students' views on their personal futures, and further content analysis would be needed to uncover the deeper differences each year.

We found no significant differences among cohorts. Each was mostly composed of third year design students (with 2-3 non-design majors each year). The university admissions process for design students was the same for the three years. Furthermore, we see no significant differences in the distribution of gender, countries of origin, or age. Though theoretically possible, it seems unlikely that cohort differences are driving the results.

4.2 Time on task shapes perceived learning

There are many different ways to teach futures. Figure 4 illustrates the differences of time spent on learning activities by course year. Figure 5 shows the activities that students said contributed most to their learning each year. Previously, Scupelli and Brooks (2018) noted

[3] Donald J. Trump was elected as US president, the Senate, and House of Representatives all had Republican majorities. Some students expressed dismay and strong emotions after the election (e.g., concern about the impact on their lives and career plans; agency/ability to design positive futures). It is plausible that international students on with a student visa, racial minorities, and GLBTQ students may have feared personal impacts on their future plans and thus reflected more about their personal futures.

that the features of the OLI and in-class activities in 2016 and 2017 were salient to students (Figure 5). Looking across all three courses, it appears that students' focus on learning activities correspond to time spent on them (Figure 4; Table 3).

The learning activities are the vehicle to teach futures studies, not the destination. The question: "What activities in the [*Dexign Futures, Futures*] course do you feel contributed the most to your learning?" likely biased students toward describing more superficial aspects of the learning activities, rather than the deeper perspectival shifts that we hope students may cultivate. Future work should ask directly about key ideas learned for each learning activity and the course, and explore the content of reflections to link the articulation of the core ideas to the different learning activity inventories for each year.

4.3 Less is more (for learning)

In 2016 students wanted less: (a) lecture hall and more of a design classroom to match the teaching style of the flipped classroom; (b) fewer online platforms, (i.e., wordpress course, Blackboard™, Peermark™ for reviews, student online journals); (c) shorter assignments that could be finished in class.

In 2017, students wanted fewer fast-paced in-class assignments and more slow-paced homework assignments. Consequently, projects in the 2018 course were designed so that in-class assignments would have homework components. The 2018 course differed with students wanting less time spent on the in-class parts of artifact-based assignments, running past the end of class, and less complex instructions in scaffolded assignments. It is unclear if the student desires is driven by the type of exercise, the class duration (3 hours), or both factors together. These insights are informing the redesign of the 2019 edition.

4.4. More is better (for learning)

Four factors from 2018 could be seen as pointing to the principle that "More is better": scaffolding, feedback, links to professional practice, and active learning.

Scaffolded in-class activities. The learning science literature describes the nuanced yet positive role of scaffolding (e.g., Hogan & Pressley, 1997). In 2016, limited scaffolding of in-class activities created a need for more discussion around them (Figure 13). This reduced time available for hands-on activities, which were therefore often finished as homework.

Figure 13. Dexign Futures *instructor scaffolding student questions on in-class activities in real time during class. This reduced the time available for these activities so that students had to finish them outside class.*

In 2017, more scaffolded activities allowed students to finish assignments during class time. The in-class activities were explicitly mapped to new material learned in OLI beforehand,

and through 5-minute mini-lectures in class. Each activity listed learning objectives and provided step-wise instruction (Figure 14). The instructor time-boxed each activity and circulated to answer students' questions, surfacing common questions to the full class. Each class ended with a recap discussion complemented with an online sum up of key take-aways. Students commented that they were able to work quickly through these activities within the 80-minute class time allotted, but lamented that they wanted time outside to work and think more slowly and reflect about the ideas.

In 2017, the in-class activities played a larger role in supporting learning, with the intent to help students to integrate futures methods more deeply (Figure 5). However, the fast pace left some wanting more time to work on assignments outside of class, and more time in class for discussion. In 2018, we developed assignments that mixed fast-paced in-class activities with slower-paced project-based homework, and added in-class discussion of finished assignments.

In 2018, the two "Ethnographic Experiential Futures" (see Candy & Kornet, 2019) artifact-centred projects used detailed stepwise scaffolding in class, combined with homework tasks to accommodate multiple speeds of thinking. With the class meeting once weekly for 170 minutes, some students said the scaffolded in-class activities were tedious and repetitive; others described them as engaging and intense.

The scaffolded activities in 2018 instructed students on what to do, but may have benefited from closer and repeated reference to learning objectives, and explicit theoretical framing linking in-class activities to prior readings.

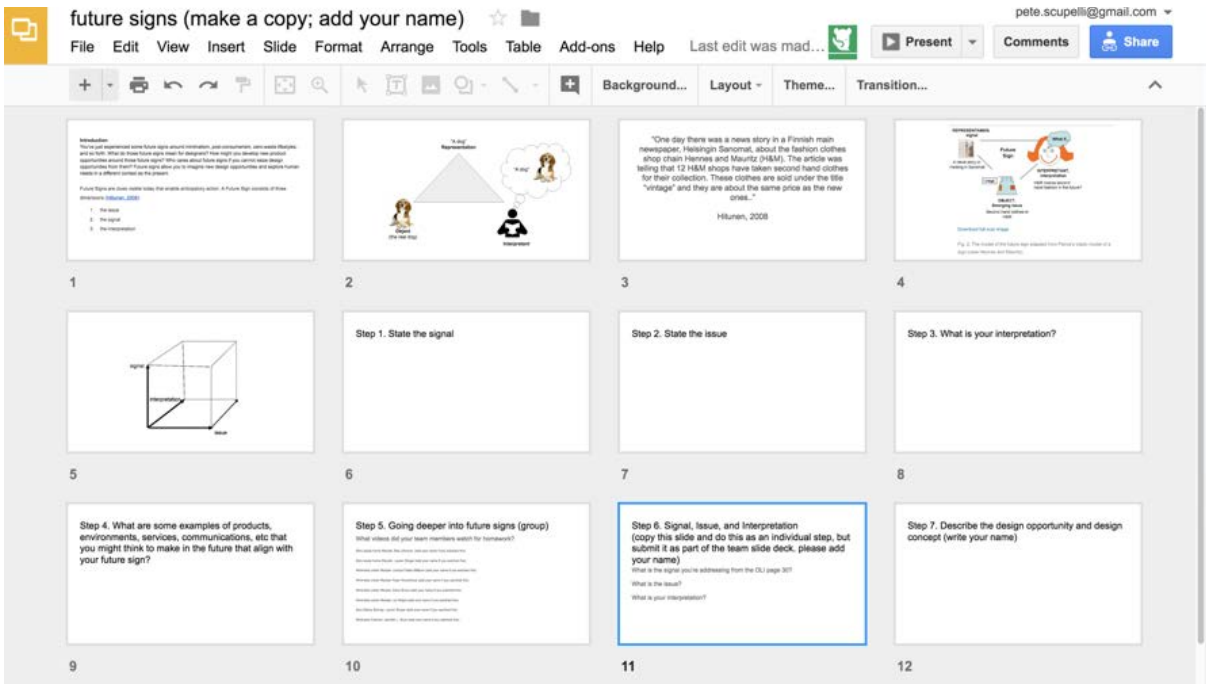

Figure 14. Google slide deck shared with students in 2017 for the same session as Figure 15. The slide deck includes a 5 slide mini-lecture followed by stepwise instruction for students to follow.

Feedback was not mentioned as an issue in the 2016 and 2017 courses (Figure 7) though there was a significant increase in feedback reported in FCEs (Table 6; Figure 9). The OLI homework likely provided immediate correctness and explanatory feedback. And for the interactive in-class activities the design classroom in 2017, compared to the 2016 lecture hall, afforded more interaction and feedback opportunities for peer and instructor feedback.

In future work scheduled for Fall 2019, we plan to use a fully instrumented classroom to explore such hypotheses empirically.

In the 2018 course, students expressed lower levels of feedback given (Figure 9). We conjecture that this may be the result of assigning readings combined with a homework comprehension quiz that provided correctness feedback only, as well as an unusual peer-to-peer review process for "future artifact" creation that might be more explicitly highlighted as a form of project feedback and insight. Some students struggled with the first artifact design projects, where peer responses were incorporated as the primary feedback mechanism, and reported a desire for additional in-process feedback from instructors.

The 2018 artifact assignments were scaffolded with explanation and process guidance to the point of being nearly self-explanatory. However, some students still produced concepts that could be critiqued as glib or uninteresting from a critical futures perspective; for instance, in positing an idealized personal future unmoored from larger societal concerns.

The challenging task of creating personal future artifacts was scaffolded with more "how-to" and process-oriented assistance, but less directive with regards to "what to make" in the service of greatest meaning and impact. More personalized process feedback may help newcomers to avoid the trap of superficial personal futures, although individualized in-progress feedback at the scale of ~40 students is a perennial structural challenge.

Noting this difficulty in the first half of the 2018 course, we incorporated five feedback touchpoints for the experiential futures project in the second half of semester, responding to the evolving plans of eight project groups, both in writing and during class sessions.

Next, we interpret the differences in grades of student learning on the Time Machine project for the three years the assignment was given.

First, time on task estimates, measured as number of hours spent on the Time Machine assignments, went from 10 hours in 2016 to 34 hours in 2017 and finally to 54 hours in 2018 (Figure 4, Table 3). The increased time afforded students more opportunities to generate and explore ideas, refine their thinking, and iterate. Dow's research shows that exploring more design ideas is linked with higher quality design outcomes (e.g., Dow et al., 2011).

Second, instances of feedback on the Time Machine project rose from one, to three, to five. In 2018, feedback was both written and face-to-face in class throughout different stages of the project. Meta-analysis studies on over 800 published studies indicate that feedback is the single most effective intervention for learning (Hattie, 2008).

Third, co-instructors can offer more support to the students than one instructor; furthermore, having two instructors from different backgrounds can provide alternative perspectives and the potential to broaden student thinking.

Link to design. Noticing the linkages between a topic and professional practice is inherently motivating to students (Ambrose et al. 2010), and highlighting multiple connections to professional practice (e.g., methods, content expertise, professional skills) helps students to persist in face of learning challenges.

To our surprise, in 2018, 6% of student responses (N=79) missed how the *Futures* course related to design (Figure 7) and 12% could not connect the course with other projects or their personal life (Figure 6). We speculate that six activities in a multi-tier strategy utilized in the 2016-2017 *Dexign Futures* courses allowed students to make more connections to design practice: (a) mini-lectures in class prior to the in-class activity, (b) applied workshop-

like exercises that forced students to apply concepts learned in the online modules to specific design thinking problems, (c) lesson recaps reinforcing the connections (both verbal and written in the class agenda), (d) weekly reflections where students were explicitly prompted to make connections to design, (e) students discussing and presenting back on their online reflections, and (f) the instructor's practice of explicitly describing how such future methods applied to his own professional practice and how such methods could be used in studio projects. Future work will explore if the six-tier strategy is indeed linked to deeper connections between futures studies and design practice.

Active learning. Research indicates active learning is better for learning outcomes; unsurprisingly we also found it to be more effortful for students. The learning science community clearly links active learning to improved learning outcomes. As previously mentioned, limited interaction in class with content and instructor may result in superficial understanding rather than deep learning (e.g. Pellegrino & Hilton, 2012).

In 2016-2017 the class activities were based on extremely active learning modes, and students voiced a desire for more passive sessions (e.g., lectures). In 2017 students commented on how intense the 80-minute class sessions were, due to constant active learning and time pressure to complete tasks due by the end of class. By contrast, in 2018 the requests were for more active modes such as interactive critiques, fishbowl discussions, and participatory discussions (Figure 7); all of which were used in the course in differing proportions. During lectures and class discussions some tendencies towards student disengagement emerged, with the ever-present temptations of laptops and mobile devices; also likely hindered by scheduling (three-hour sessions each Friday afternoon). These two observations point to the challenge of striking a balance between active learning activities and passive learning, especially in relation to class duration.

4.5 Timing is everything (for learning)

Time management, timing, and pacing were mentioned in all three courses (Figure 7). In 2016 and 2017, students commented on lacking time to finish the in-class activities. In 2018, students related three issues with the once-weekly, 170-minute class: (a) a strict absentee policy (because the class met only once a week, missing any class meant missing a lot); (b) the end-of-week timeslot (Fridays 1:30-4:20pm) was unpopular, and classes often ran slightly long; (c) students opined that too much time was spent on the first two artifact-based projects, relative to the Time Machine group project.

There were no significant differences in average number of hours that students reported spending on the courses (Table 6).

In Fall 2019, we plan to split the futures studies requirement into two 7-week mini courses. Scupelli will teach *Futures 1* as two weekly 80-minute classes, with a condensed version of the *Dexign Futures* course described, focused on linking futures methods to design practice and using a flipped design classroom pedagogy (e.g., OLI interactive homework, in-class hands-on activities, weekly reflections). Candy will teach a studio-based format for 170 minutes weekly, called *Futures 2*, focused on experiential futures. New data collected from the *Futures 1&2* mini courses may help clarify the multiple factors at play.

5. Summary

In this paper, we compared two versions of a futures studies course developed as a core class for undergraduate design students: *Dexign Futures* (flipped pedagogy) and *Futures (studio hybrid)*.

We looked at three measures in particular: learning activity inventory, course quality with faculty course evaluations, student experience with a post-course survey.

We found five design trade-offs for teaching and learning: format of reflections is linked to transfer activities, time on learning activities shapes perceptions, less (interference) is more, more (scaffolding, feedback, links to practice, active learning) is better, and timing is everything.

The data presented in this paper also informs our plans for the next iteration of *Futures* courses. We expect to see gains in FCE scores similar in scale to what we observed between the first two runs of *Dexign Futures* courses (Figure 12). Clearly more research is needed to disambiguate the questions raised in this paper.

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