

# A Preliminary Assessment of an MIT Campus Experiment with an edX Online Course:

## *The Pilot of 6.S064 Circuits and Electronics*

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## Executive Summary

During the Fall Semester of 2016 EECS (Electrical Engineering and Computer Science) department, with approval from the MIT Committee on the Undergraduate Program (CUP), piloted the subject 6.S064, allowing MIT students to complete the edX version of 6.002 Circuits and Electronics for course credit. The primary rationale for offering 6.S064 was to provide flexibility in learning for students with scheduling conflicts. Flexibility was also intended to reduce student stress. This report provides a descriptive assessment of the student experiences and learning in this subject based on edX system data, instructor data, and student surveys and interviews. Key points from this first pilot of 6.S064 include:

- A total of 27 students completed the course. Two students initially started the class but dropped before the first quiz and two others dropped around the time or just after the first quiz.
- 70% of students who completed the September survey said it is either “Somewhat difficult” or “Extremely difficult” to fit the classes they wanted to take into their schedule. In sample of students from 6.002, 54% of students reported having difficulty. More than half of students who enrolled in 6.S064 noted specific class scheduling conflicts as their reason for taking 6.S064.
- Most of the students’ learning time was spent working on homework and viewing lecture videos. The online homework was seen as very useful by students because it provided immediate feedback and allowed multiple attempts to get a correct answer. This encouraged students to keep working until they understood the material while lowering the stress of waiting to find out if they got the answer correct.
- Students rated 6.S064 as significantly less stressful than their on-campus classes. The online exam format was one component of the class that some students identified as more stressful. Although students have multiple tries to get a correct answer, the online system does not allow for partial credit, making exam responses all-or-nothing. Students were also unable to review graded exams to find out what they had done wrong.
- Students did have opportunities for on-campus interaction and assistance from professors and the TA, although few opted to attend office hours. In interviews students noted that that they did not feel the need for help. A few students did seek out help and valued the office hours. The role and impact of live interaction with faculty and TAs in student learning at MIT requires further study and discussion.
- Students who completed a pre- and post-diagnostic assessment showed statistically significant growth. There are limitations to this data that warrant further consideration.
- The distribution of final grades in the class was comparable to distributions for 6.002 sections from the past three semesters. Although differences between the classes prohibit conclusions on student learning, the distributions indicate that success in 6.S064 was not dramatically harder or easier than the traditional subject.

# A Preliminary Assessment of an MIT Campus Experiment with an edX Online Course: The Pilot of 6.S064 Circuits and Electronics

## Description of the Project

In the fall semester of 2016, MIT students were given the option to complete the three-part Circuits and Electronics offered on edX<sup>1</sup> as an equivalent to MIT's 6.002 for course credit. MIT's Committee on the Undergraduate Program (CUP) (<http://web.mit.edu/committees/cup/>) approved this experimental online version of 6.002 for MIT residential students as a way to collect information about student experiences with using online subjects in conjunction with standard classroom-based academics and co-curricular activities, and on the effectiveness of this mode of pedagogy in MIT student learning. On the recommendation of the CUP, the project team met with the Teaching + Learning Lab to discuss the proposed experiment and to develop an assessment plan. This collaboration continues throughout the project to ensure that it would provide meaningful data without interfering with student learning. At the end of the experiment, a final report will be provided to the CUP with complete assessment results, including a comparative analysis of student learning in the campus and online subjects collected during Spring 2017.

The experimental subject was offered as 6.S064 Special Subjects: Circuits and Electronics. Students were invited to enroll via fliers and an announcement made by Professor Sussman at the first meeting of the traditional campus Circuits and Electronics 6.002. Of the 40 students who expressed interest, 31 enrolled and 27 students ultimately completed the course. All students were currently enrolled in MIT on-campus courses as well. Enrolled students were invited to a voluntary on-campus information session held by Professors Sussman and Agarwal during the first week of classes to find out how the course worked and to answer questions about the project. Students were also asked to complete two questions from each of the three online practice tests to serve as a diagnostic pre-test and to complete an online survey. The TA, Bonnie Lam, created a cohort within the world-wide edX course for the MIT students. This gave students immediate access to all of the 6.002x content for the semester, access to both the world-wide discussion boards and a private online discussion board for the MIT students. The separate MIT cohort on edX also allowed the course staff to send private emails through the edX system to only the MIT students.

Students completed weekly online homework and lab assignments, and although deadlines were published, they were not enforced to allow students the flexibility of working at their own pace. The TA sent weekly emails to students with announcements and updates and also posted information on the online discussion board. To monitor student progress, the project team met weekly and reviewed data on student assignment completion from the edX system. Students who seemed to be lagging or struggling were identified during these meetings and were sent personalized emails to encourage them to complete the work or to come to on-campus office hours for help. Two meet-and-greet sessions were organized by the instructors during the semester to encourage students to connect with them and with each other.

In addition to homework and online lab exercises, students were graded on two midterm exams and a final exam. Prior to the final exam, a review session was held that began with time to eat and socialize. All three exams were proctored on campus by Professors Sussman and Bonnie Lam.

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<sup>1</sup> <http://www.edx.org/course/circuits-electronics-1-basic-circuit-mitx-6-002-1x-0>  
<http://www.edx.org/course/circuits-electronics-2-amplification-mitx-6-002-2x-0>  
<http://www.edx.org/course/circuits-electronics-3-applications-mitx-6-002-3x-0>

Students completed the exams on the edX system using their laptops and were given three hours to complete the questions.

For the project assessment, students were asked to complete another online survey at the end of the semester and were invited to participate in a one-on-one interview at the Teaching + Learning Lab. Student performance data was obtained from class records and from the edX system. This report focuses on data related to how 6.S064: 1) addressed the student needs that were the impetus for the project – namely flexibility and stress; 2) how students utilized the flexibility and resources; and 3) preliminary data concerning student learning and outcomes.

## Findings

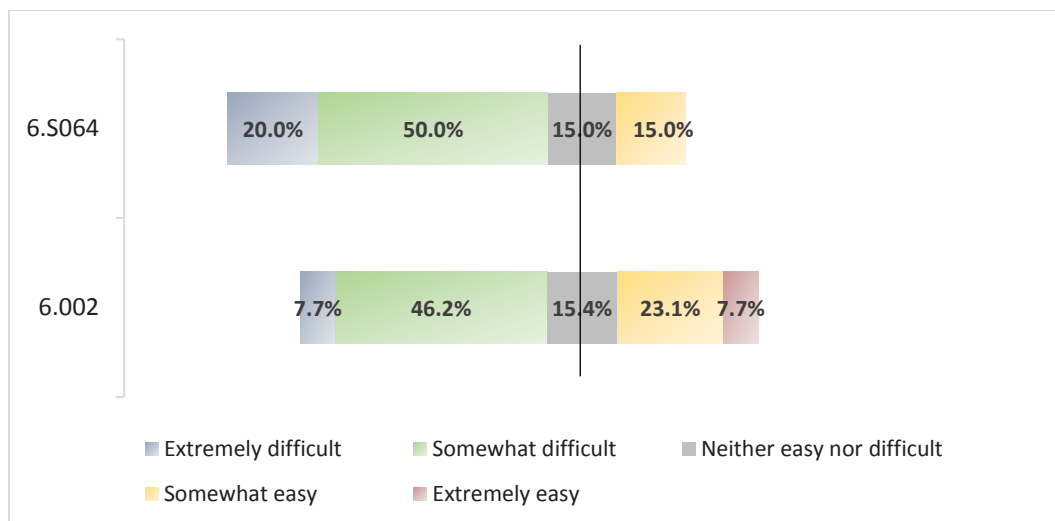
### *Flexibility for Students*

#### Class Schedules

A primary impetus for piloting 6.S064 was to address scheduling conflicts that students reported with the on-campus 6.002. On the September survey of enrolled students, the most common reason cited for enrolling in 6.S064 was a time conflict, with 55% of respondents noting specific conflicts with 6.002 or other course-related activities.

The challenge in scheduling desired classes extends beyond conflicts with 6.002. When asked how easy or difficult it is to fit desired classes into their schedule, a majority of both 6.S064 students and a sample of students in 6.002 indicated difficulties. Figure 1 shows the level of difficulty reported by both groups. The issue is a greater problem for students who opted for the online class, but students who took the on-campus class have also had trouble with scheduling.

**Figure 1. How easy or difficult has it been to fit the classes you wanted to take into your schedule?**



In interviews, students further explained the challenges they face in course scheduling.

“Almost every semester there’s like, I make like a schedule, and I’m very happy about it, thinking of the classes I’m going to take. And then the Registrar’s schedule come out, and I eventually look things up. And you say, “Oh, I can’t do that.” So, then I make modifications, but it’s usually about like one class that I have to switch from my initial plan.”

Some students opt to enroll in their desired classes despite the time conflicts, leading to missed class time:

“And then it happened again last year, and I decided to take both classes, even though they overlapped by 30 minutes. And that was just really awkward, because I had to choose every class to be like, “I’m going to stay here, or leave early, and go to the other one. How am I going to catch up, and what’s more important?”

It should be noted that not all students had enrolled in 6.S064 to address scheduling conflicts. A couple of students had previously completed the online material and saw it as a way to get credit or meet program requirements by reviewing work they had already done. Another student admitted enrolling in 6.S064 because of a poor attendance record for classes and decided that the online version would eliminate the issue:

“I think mainly it was just to not have to go to a lecture physically. I think for me, particularly, I’m not very good at attendance.... anything later in the afternoon is better, and things early in the morning are just – it’s very likely that I won’t show up to like 50 percent of the classes in a given semester.”

This student went on to explain that shyness about asking questions in class was also a factor. The online format allows learning to be private and any questions could be asked online or during office hours rather than in front of the class.

### **Scheduling Non-class Activities**

Other reasons given for enrolling in the class included an interest in online learning and greater flexibility to explore other non-course activities. In September, students were asked about the time they spent on different types of extra-curricular activities during the spring 2016 semester and were later asked how much time they had spent on these activities while taking 6.S064. The Wilcoxon signed-rank test was used to test for changes in time spent on extra-curricular activities before and while taking 6.S064. For most activity types, there was no significant difference in the amount of time spent. The amount of time reportedly spent on athletic activities decreased during the fall ( $Z=-2.264$ ,  $p<.05$ ) and time spent on career-related organizations increased ( $Z=-2.203$ ,  $p<.05$ ). There could very well be reasons other than the flexibility of taking an online class for these changes, such as seasonality of sports, timing of career-related opportunities, etc.

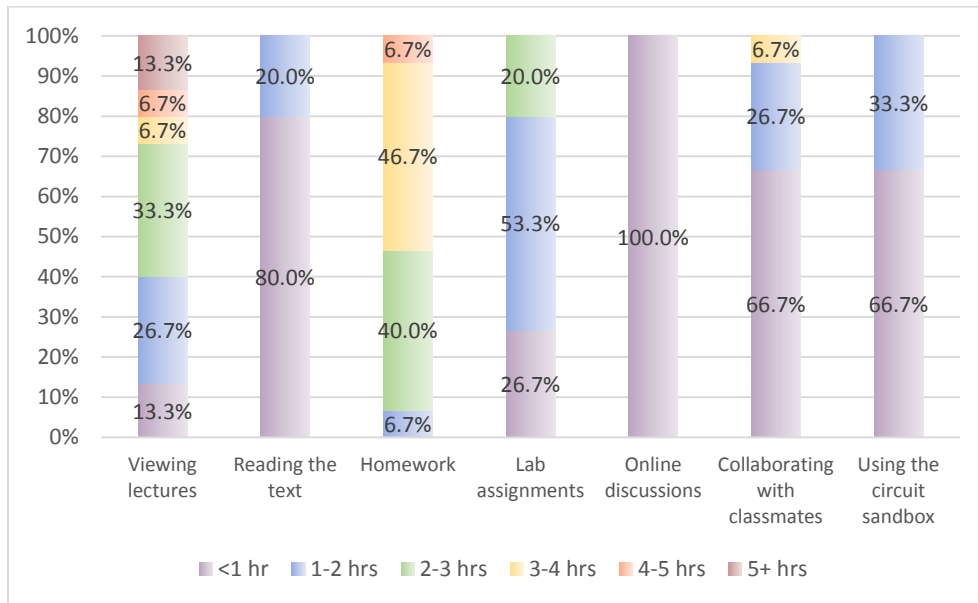
Although one student noted having friends with more rigid schedules, the students from 6.S064 who had done UROPs all said that the scheduling for their UROP was flexible enough that their class schedules did not create a conflict. As with the extra-curricular activities, students were asked about time spent on academic activities such as UROPs, study groups, etc. during the previous term and then during fall 2016. There was no reported difference.

### **How Students Spent Course Time**

In addition to providing flexibility in when students worked on the course, the edX course allowed students greater flexibility in how they spent time completing the class. While all students have flexibility in how much time they spend homework or studying, official lecture and recitation schedules for on-campus classes dictate how much time students spend on these activities. Student surveys asked students how much time they spent on several activities that were a part of the edX class. Students spent most of their time viewing the video lectures and working on the weekly

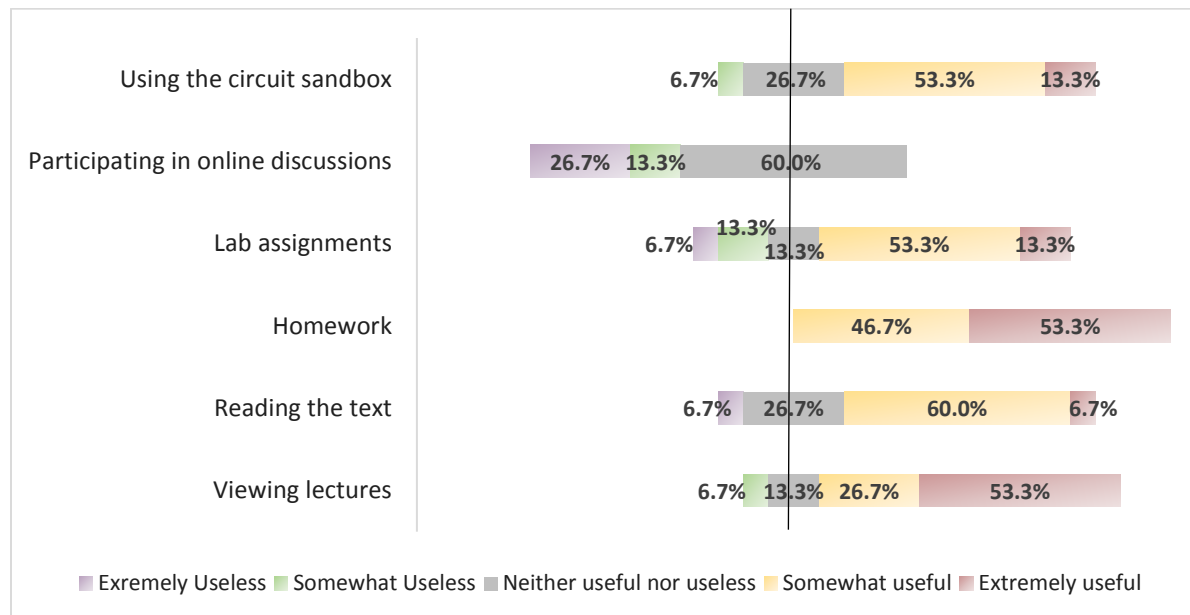
homework assignments. Students spent much less time using the online discussion boards or reading the textbook.

**Figure 2. How much time students reported spending each week on course activities**



How students spend their learning time is often a reflection of what they find helpful. Students were asked to rate how useful several components of the online class were. Working on the online homework assignments and viewing the lecture videos were rated as “extremely useful” by more than half of the students who completed the survey. As can be seen in Figure 3, participating in the online discussion forum was rated as not useful or useless by the majority of students. This may reflect a lack of use of the online discussions or explain why students did not participate in them.

**Figure 3. Student ratings of the utility of online course components**

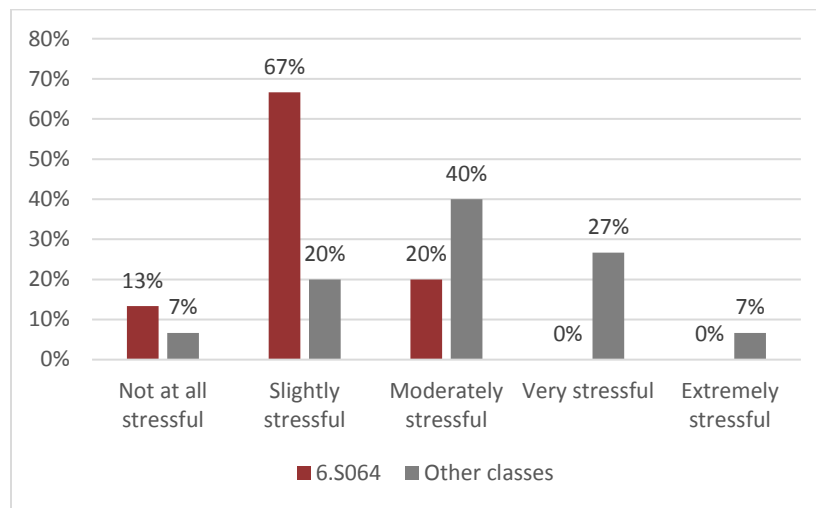


## Student Stress

One important issue for students and faculty is the level of stress in the curriculum. On the September pre-course survey, students rated how stressed they had been during the spring semester. They were then asked in December about the overall stress level for the fall semester. Although the ratings for stress for fall were slightly higher than for the previous spring, the difference was not statistically significant ( $M_{\text{spr16}}=2.75$ ,  $M_{\text{fall16}}=3.00$ ,  $n=12$ ). It should also be noted that overall stress encompasses not only stress from courses, but from all domains of life.

In order to assess course-specific stress levels, students were also asked to rate their stress for the 6.S064 class and for their other fall semester classes on the five point scale from “Not at all stressful” to “Extremely stressful.” Figure 4 displays the distribution of responses. A paired-sample t-test yielded a statistically significant difference, with 6.S064 rated as less stressful than the students’ other classes ( $t = 3.240$ ,  $p < .01$ ,  $M_{6.S064} = 2.07$ ,  $M_{\text{other}} = 3.07$ ,  $n=15$ ).

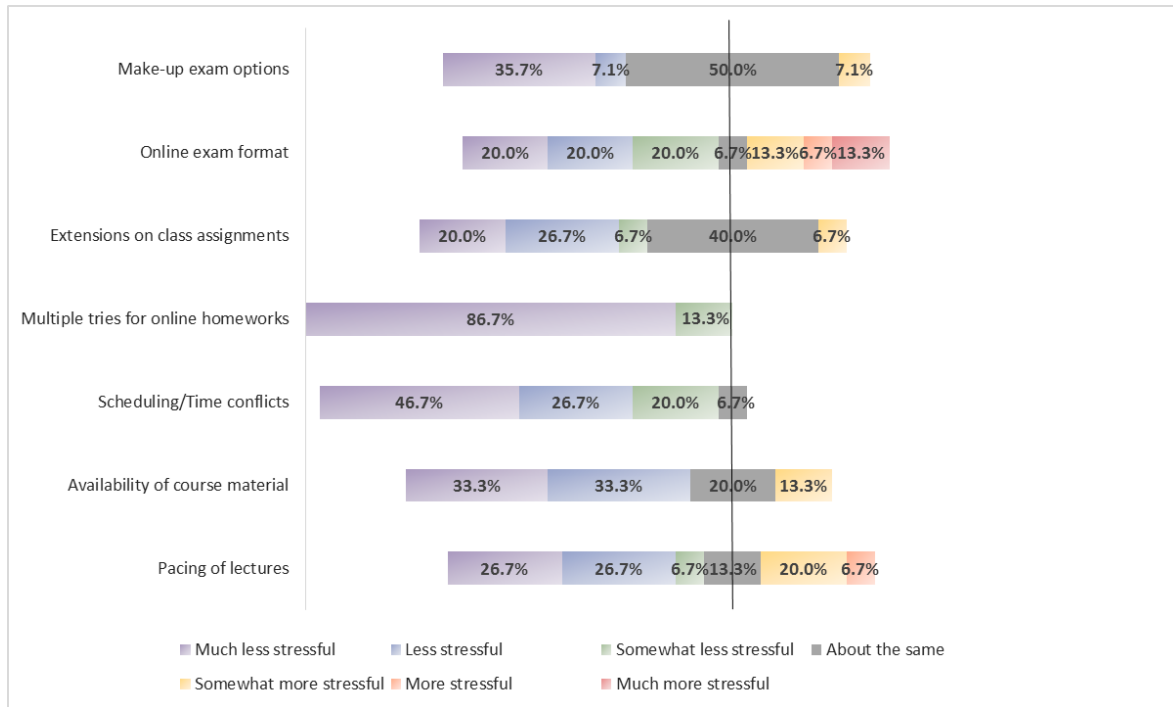
**Figure 4. Student Reports of Course Stress for Fall 2016 Semester**



## Course Features

Students were also asked to rate several features of 6.S064 as to how more or less stressful the features made the class compared to their on-campus classes. The majority of students completing the survey reported that the key features of 6.S064 online class made it less stressful than their on-campus classes. As can be seen in Figure 5, the multiple tries for homework assignments and scheduling were overwhelmingly less stressful. In interviews, students explained that there were multiple benefits to the online homework in 6.S064.

**Figure 4. Comparison of 6.S064 to on campus classes features for impact on stress**



In addition to getting several tries to answer each question, the multiple-tries feature means that students receive immediate feedback as to whether or not their answer was correct. This encourages them to review their work or the course material until they understand it. As one student explained:

“I really like just getting the instant feedback of knowing that after the homework is done I know I’m done now, and I don’t have to worry about, like, “Oh, but what if this question was wrong?” And then you’d have that in the back of your mind, and so you turn it in. That’s stressful, and it was nice just getting that feedback. Another thing that I really liked is just getting the answers right away, so if I tried a question, and I’m like, ‘Oh, whoa, I got that, but I don’t really know exactly why this worked.’ I could go back instantly when I’m involved with a question, and it’s still fresh in my mind, and like look at the solution, and be, ‘Okay, that’s how they did it.’ So, having the solutions available instantly was really nice for the homework...so they take longer but they’re not more stressful.”

One student did note that they had taken on-campus classes that used the MITx/edX system for homework. Thus, the benefits of the online homework or other MITx/edX features are not restricted to fully online classes.

At least a few students did express a desire for additional practice problems beyond the homework and practice problems available online. During an interview, one explained:

“There’s only seven per week, and you can get through them very quickly, and beyond that there’s not much additional practice. There’s the practice problems from the exams. There’s still only about seven per exam, so seven for each module. And so, that felt like very little kind of practice.”



In response to a request to the TA for additional problems, the course instructors made additional practice problems from the 6.002 class available to students during the semester.

### **Exams**

In the edX exam format, students receive immediate feedback on whether their answer is correct and get four tries to enter a correct answer to each question. Although the four attempts is helpful, students were not able to receive partial credit. As one student explained:

“I think if you come prepared for the exam, you can have a great time with the instant feedback. You’ll just be like, ‘Oh, nice. I’m done, done.’ And, again, being done with the exam is really nice, because if you already got everything right, you don’t need to double-check your work or anything. You’re done. You can leave an hour early, and not feel bad, because you were finished. But if you don’t come prepared, then it can feel really bad to be working on one problem for 20 minutes, and be very close to the answer, and get just that red X with zero credit, even though the error might be like move the decimal place over one, because your unit is wrong, or something like that. So, that can be a little frustrating, and stressful, because you’re almost there, but you have one try left, and in a test you would have gotten a lot of partial credit, versus here you wouldn’t have.”

For the spring semester the faculty plan to address this source of stress by allowing students to submit their work for partial credit for the computerized final exam. (The first two exams of the spring semester will use the traditional paper-and-pencil format in coordination with the on-campus 6.002 as a part of Phase 2 of the assessment.)

### ***Student Learning Time in the Online Approach***

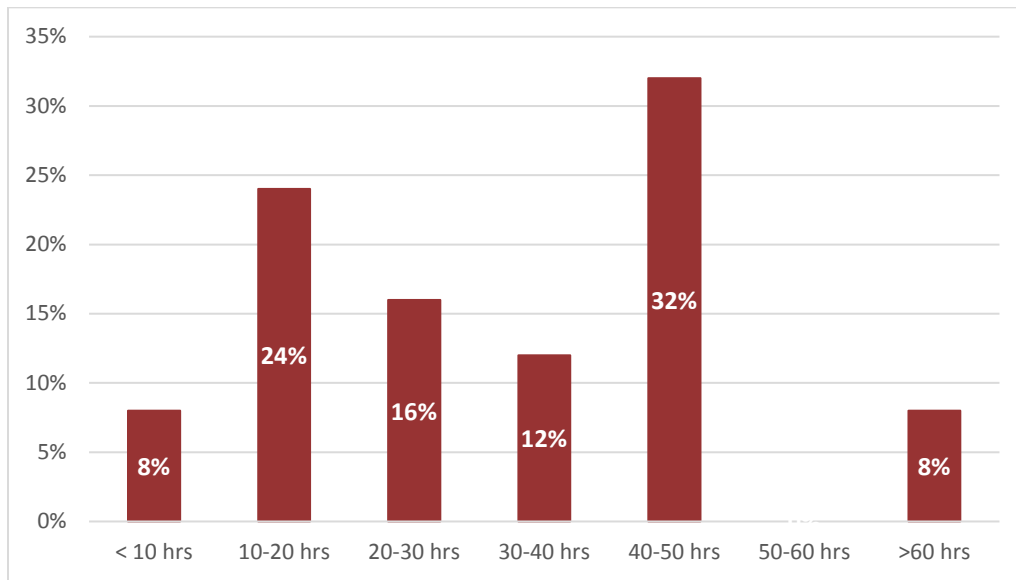
Student use of the edX platform to learn the material varied greatly. The edX system provides a measure of total time spent by the user on the course based upon the time between consecutive events in the tracking log, with a 5 minute maximum cutoff. This cutoff is intended to control for users staying logged into the course but not actually interacting with it. Time for each of the three edX units comprising 6.002x were combined for a total time spent on the class. Students in 6.S064 spent an average of 32 hours working in the online course system. There was a great deal of variability in time spent, ranging from 8 to 62 hours for the semester.

It is important to note that this is not a measure of total time spent on the class material. Students can download notes or videos and can read the text outside of their interaction with the edX system. In interviews students described different approaches to completing the class, including dividing up the videos to watch with a classmate and teaching each other, rewinding videos to review difficult topics and fast-forwarding through easier material, and accessing additional materials from the OCW 6.002 resources.

“But on the open courseware version of the class, they have lecture slides for each topic that also almost match identically in order of topic... And so, I’d just read through all those lecture slides, and which were similar, but just like a little cleaner, and a little easier to go through. And they had nice like summaries at the beginning of each lecture, like review of what was covered in the previous set ...So, I went through those, and then I’d go to the homework, and then while doing the homework, as needed, I’d go back to the videos, and like watch to listen and review over anything that I didn’t get.”

The flexibility of the online course led to students using their learning time in ways that they felt best fit their individual needs.

Figure 5. Total Time Spent on the edX course material



### ***The Relationship Between Flexibility and Stress***

The flexibility of the fully-online class was a clear benefit for many students, but can also pose a challenge. Some students reported difficulty with self-pacing the course, which can also create stress. In interviews, these students noted some stress from waiting until the last minute to try to cram in all of the work for the week in the few hours before a homework deadline:

“So, it was just like trying to remember that like the class was a thing, because you’re not physically going to class, so a lot of times I’d end up like Friday, I would like finish the week, and be like, “Okay, I can relax now.” But then I’d be like, “Hmm, I feel like I’m missing a class or something.” And then I’d remember this was there, so then I’d try to like go through all the lectures really quickly, and do the psets.”

The flexibility of the course posed a challenge to this student despite weekly emails from the TA with reminders of work to be completed. However, other students did well with the self-paced format. As one student explained:

I worked like a week ahead from when the things were officially due, so keeping with the learning schedule, and not like the deadline schedule.

Because this student had access to lectures and problem sets for the entire course from day one of the semester, he was able to work ahead and reduce the stress of deadlines. Thus, the flexibility of the online class may be highly beneficial for some students, but pose a challenge to others.

## Office Hours

Office hours were offered weekly by both Professor Gerald Sussman and the TA Bonnie Lam. Of students completing the survey, 36% never attended these office hours and about 35% of students attended only once or twice. As one student explained

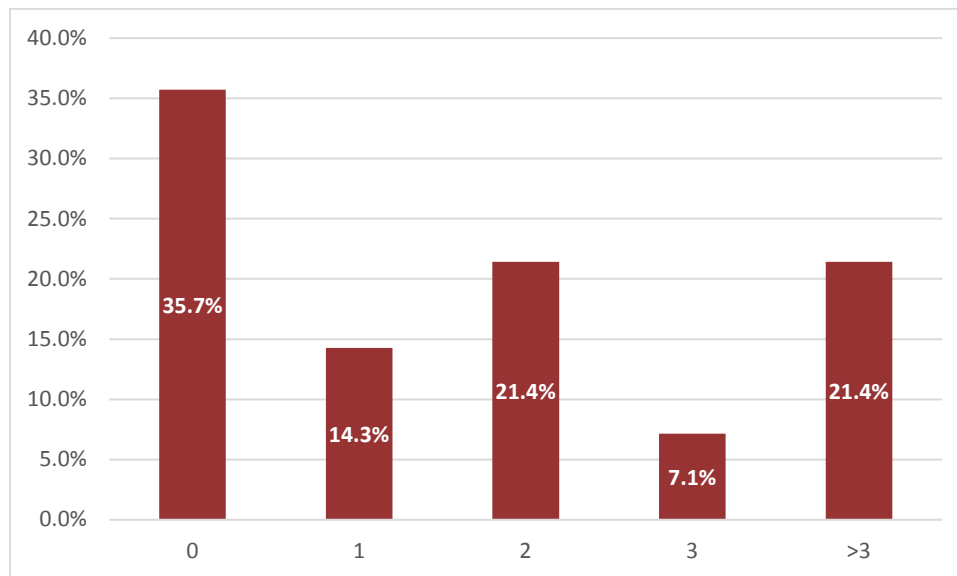
“I didn’t get like stuck at a problem enough to warrant going to office hours. I’d usually just think about it the next day, and read the textbook a little bit, and then, like, “Okay, I get it now.” So, that worked out.”

Some students did take advantage of the on-campus assistance and found it helpful.

“I did like being able to go to office hours with Sussman... I don’t think I realized that his office hours were useful until like halfway through the course was gone. So, then I started going...”

Students indicate that their primary reason for attending office hours is to get extra help when struggling with a problem. As has been noted by Professor Sussman, office hours can also serve the purpose of learning other approaches to problems or thinking about course material as well and developing a connection with faculty on topics beyond the scope of the course content. While it is unclear whether faculty in general share this perspective or whether students value these other purposes, the option of getting this additional instruction was valued by the few students who took advantage of it.

**Figure 6. Number of office hours attended during the course**



## Student Learning

Students were asked to complete a brief diagnostic assessment at the beginning of the course in order to control for previous content mastery before taking Circuits and Electronics. The assessment consisted of two questions from each of the three units of the course. The total scores could range from zero to six. Performance on this pretest did not predict student performance in

the course. A subset of students also completed the same pretest questions in preparation for each of the exams. To examine student learning, their performance on the questions after completing course material was compared to their performance on the pretest.

Mean scores for each of pre and post diagnostic questions as well as the diagnostic total score are presented in Table 1. Despite the small sample size, the growth in scores from the time of the pre-testing to the post-testing was statistically significant both for the overall and each of the three sub-sections.

**Table 1. Mean scores and t tests for pre- and post-diagnostic assessment**

	Mean of Pre-Test	Mean of Post-Test	Paired Sample t Value	n
Unit 1	1.08	2.00	-3.488 (p<.01)	13
Unit 2	.10	2.00	-19.00 (p<.001)	10
Unit 3	.50	1.79	-5.824 (p<.001)	14
Total	1.43	5.71	-7.579 (p<.001)	7

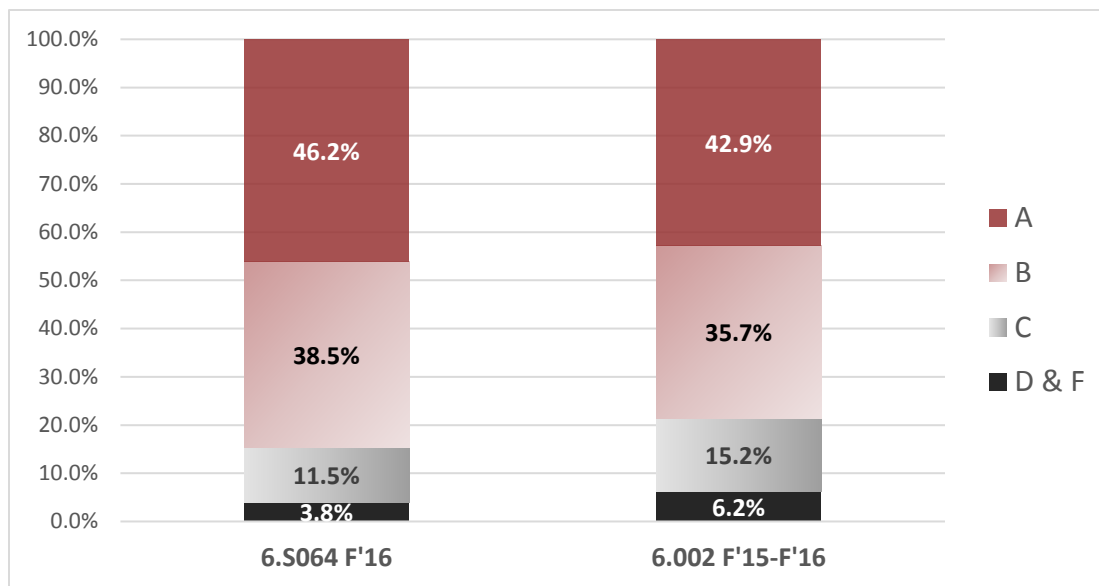
It should be noted that there are limitations to this post-test data. In addition to only being completed by some of the students, the online assessment allows for multiple attempts for each question and students can revisit all of the instructional material in between these attempts. Because they were more invested in getting the correct answer in the days just prior to their exam, students made significantly more attempts on each question for the post-test. It could be argued that the improvement in scores reflects greater effort rather than having mastered the course content. However, it should also be noted that these multiple attempts are in themselves a learning activity and demonstrate student learning of the material. Therefore, to further assess student learning of course content, we also looked at student final grade distributions in comparison to recent on-campus sections of 6.002 to assess student learning.

### ***Final Grades***

As explained earlier, the purpose and design of this first assessment focuses on a descriptive study of the initial implementation of 6.S064. Because the sequence and emphasis in course material differed between this online course and the fall section of 6.002, comparisons of student grades is not appropriate. However, a key question for the assessment is whether or not students learn the material and are as successful in the subject as students taking the traditional format.

To gain a general sense of student outcomes in this initial launch of 6.S064, the distribution of final grades was compared between students in the online class and three sections of the traditional 6.002 offered between fall of 2015 and fall of 2016. Figure 7 shows the distribution of final grades for the two classes. Despite being taught by different instructors with different styles and/or topics of focus, the distributions are quite comparable. There were a slightly greater percentage of A's and B's earned in 6.S064 than in the traditional 6.002 classes; however, this difference in distributions was not statistically significant.

**Figure 7. Grade Distributions for 6.S064 and F15-F16 6.002**

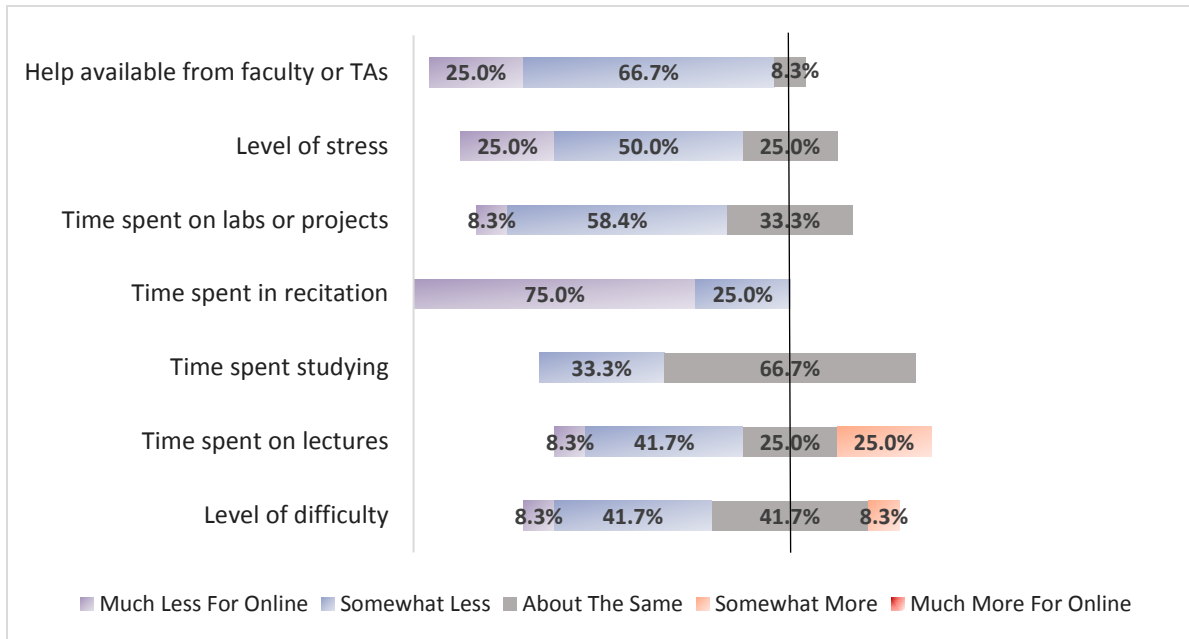


Several variables, including time spent viewing videos and other material on the edX system, self-reported time spent on class activities, and a diagnostic pre-test, were tested to determine their relationship to final grades. The only variable significantly correlated to student outcomes in the course was the students' self-reported overall GPA ( $r=.832$ ,  $p<.000$ ,  $n=16$ ).

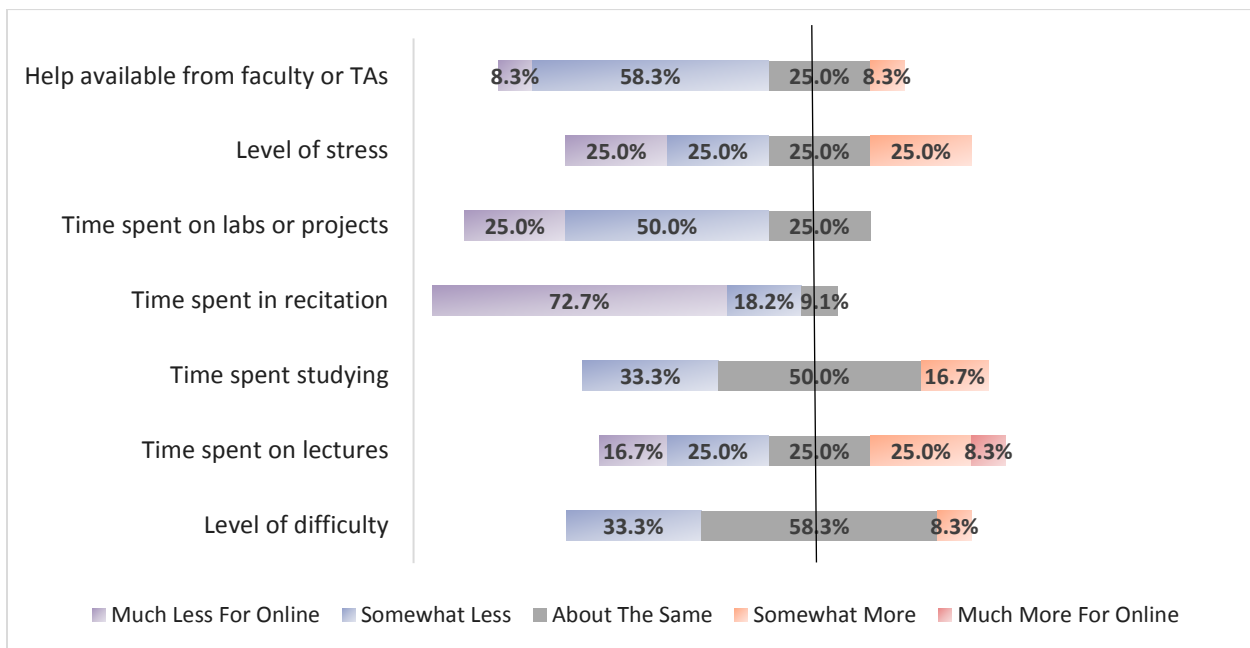
### ***Perceptions of Online Learning Compared to On-Campus Classes***

In order to assess students' perceptions of online learning compared to typical on-campus classes, students were asked to rate how they thought online classes compared on seven items: level of difficulty, time spent on lectures, time spent studying, time spent in recitation, time spent on labs, level of stress, and help available from faculty and TAs. At the end of the semester, students were asked to compare their experience of 6.S064 to their traditional on-campus classes on the same items. Figure 8 displays the responses from the September survey while Figure 9 shows how students compared 6.S064 to their typical on-campus classes. Small shifts can be seen on several items, including availability of help from faculty and TAs, level of stress, and time spent on lectures and studying. However, none of these differences are statistically significant. This may suggest that most students had realistic expectations of what an online class would be like. However, additional data with a larger sample size will be necessary to confirm or refute this preliminary finding.

**Figure 8. Perceptions before completing 6.S064: How do online classes compare to typical classes?**



**Figure 9. Perceptions based on completing 6.S064: How did 6.S064 compare to on-campus classes?**



## ***Student Satisfaction***

Only nine students completed the university subject evaluations for 6.S064, limiting the reliability of the results. The students who did respond gave an overall rating of 5.8 out of 7. Table 2 shows the ratings for both overall and key aspects of the subject. These ratings indicate that, at least for those students responding, the subject was highly regarded.

**Table 2. Student ratings on subject evaluations**

	Mean	Median	Standard Deviation	# Responses
Subject expectations were clearly defined	6.2	6	0.97	9
Subject's learning objectives were met	6.1	7	1.62	9
Assignments contributed to my learning	6.7	7	0.71	9
Grading thus far has been fair	6.6	7	0.73	9
Overall rating of the subject	5.8	6	0.89	8

## ***Next Steps***

As noted above, this preliminary assessment did not allow for direct comparison in student learning between the online 6.S064 and the on-campus 6.002. For the Spring 2017 Semester, the project team is coordinating with the instructor of the on-campus class to align sequence of topics and to have students from the separate classes take two identical exams under identical testing conditions. This will allow for a direct comparison of student learning. Student surveys, edX system data, and institutional records will also be collected to further explore the experience and impact of the class on students.

## Appendix A

### Student Characteristics

The self-selection of students into 6.S064 raises the question as to whether or not the experimental sample is representative of students who take the 6.002 subject on campus. To assist in answering this question, students in the on-campus 6.002 were asked to complete a subset of questions from the survey given to students in 6.S064 in September. Only 15 students from the campus section of the class completed the survey. Although this does not provide enough data to draw definitive conclusions, it is provided here to allow for rough comparisons.

**Table A. Academic background of students enrolled in 6.S064 versus 6.002**

	<b>6.S064</b>	<b>6.002</b>
<b>Academic Year:</b>		
Freshman	0%	6.7%
Sophomore	37.0%	60.0%
Junior	44.4%	33.3%
Senior	18.5%	0%
<b>Mean GPA:</b>	4.38	4.47
<b>Grade in 8.02:</b>		
A	38.1%	30.8%
B	38.1%	38.5%
C	9.5%	0%
D	0%	0%
Other/Not Taken	14.3%	30.8%

**Table B. Demographic background of students enrolled in 6.S064 versus 6.002**

	<b>6.S064</b>	<b>6.002</b>
<b>Gender</b>		
Female	37.0%	35.7%
Male	63.0%	64.3%
<b>Race/Ethnicity:</b>		
Asian	35%	13%
Black or African American	0%	7%
Hispanic or Latino	20%	20%
White	20%	40%
Multi-ethnic or Other	25%	20%
<b>Highest Parental Level of Education:</b>		
No HS diploma	4.8%	20.0%
HS diploma or equivalent	9.5%	13.3%
Some college or Associates degree	14.3%	0%
Bachelor's degree	28.6%	33.3%
Graduate or professional degree	42.9%	33.3%



## **Appendix B**

### **Data Sources for the Assessment**

#### **Course Activity and Performance Data**

Data on student performance was obtained from the course TA and included grades on homework, labs, and exams. More detailed data on student use and navigation of the online materials was provided by the Office of Institutional Research, which compiles variables on the number of interactions and time engaged with the online course from the MITx/edX system. Because student educational data is protected, only data for 28 students who gave written informed consent was included in the assessment. Identifiable information such as student names were removed from data files to protect the privacy of participating students.

#### **Surveys**

In September a survey for enrolled students was distributed through Qualtrics (©2017, Provo, UT) to collect data on educational backgrounds and reasons for interest in the online course. Questions also addressed scheduling, non-class academic and non-academic activities, stress, and perceptions of online learning. In December a post-course survey was also administered through Qualtrics. This survey included comparable questions to the September survey to allow for pre and post comparisons, as well as additional questions about experiences in the course. The completion rates for the survey were 64% for the September survey and 50% for the December survey. Identification numbers were used to match pre and post surveys without the use of student names.

In order to assess whether or not the students enrolled in 6.S064 reflected a comparable sample of MIT students who take Circuits and Electronics, the survey was also sent to students enrolled in 6.002. A link to the survey was emailed to students by their instructor. A total of fifteen students from 6.002 completed the survey.

#### **Interviews**

All students enrolled in 6.S064 were emailed an invitation to participate in a one-on-one interview with a researcher at the Teaching + Learning Lab after completion of the course. The semi-structured interviews explored students' reasons for taking the online version of Circuits and Electronics, how they utilized the course material and resources, and their recommendations for future courses. Eight students participated in the interviews, which ranged from approximately 25-60 minutes. Transcribed interviews were analyzed with NVivo11 (QSR International Pty Ltd.) using codes that were created to align with the original research questions as well as additional themes that emerged during project team meetings and from the survey data. No names were recorded in the interviews and quotes selected for the report were screened to ensure that they did not include identifiable information.