Moving a Low-Code Software Development Course Online During the Pandemic: Changes in Students’ Perceptions of Learning and Suggestions for Improvement

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# Abstract

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| Aim/Purpose | At universities across the United States, the COVID-19 pandemic triggered an abrupt pivot from traditional face-to-face instruction to online instruction. Both computing faculty and students scrambled to adjust to teaching and learning in this modality. |
| Background | Software development courses typically taught in a lab with a high level of interaction between faculty and students suddenly turned into a format akin to an independent study, with no real-time interaction between faculty and students. |
| Methodology | This study examines the impact of moving a low-code application development course from a face-to-face format to an asynchronous online format during the pandemic. The goal is to discover how this change impacted students’ perceptions of the course, using both quantitative and qualitative measurements. The research examines how changing the course delivery format affected students’ perceptions of how much they learned and the suggestions for improvement in the comments section of the course evaluations. The research also examines how the change impacted the response rate for evaluations. Evaluations from the last pre-pandemic face-to-face section were compared against evaluations for the first asynchronous online section held during the pandemic. |
| Contribution | NA |
| Findings | While the response rate for evaluations dropped post-pandemic, the students’ perception of how much they learned rose and the number of suggestions for improvement fell. The implication is despite prior research showing online courses are evaluated more negatively by students, this trend was not true for the low-code development course. Instead, students perceived they learned more and gave zero suggestions for improvement in the online section when compared to the face-to-face section. |
| Recommendations  for Practitioners | The implication for computing education is that low-code development can successfully be taught in an asynchronous online environment, without real-time faculty and student interaction. |
| Recommendations  for Researchers | NA |
| Impact on Society | NA |
| Future Research | Future research is needed on low-code development courses to see if this type of online course upends the trend of negative student evaluations. |
| Keywords | Software creation and management, education, applied computing |

# Introduction

In the spring of 2020, the COVID-19 pandemic triggered a sudden pivot from face-to-face classroom instruction to online instruction at universities across the United States. In the midst of the stressors of the pandemic, computing faculty and students alike struggled to adjust to teaching and learning in this new modality. Computing courses, such as software development, are typically taught in a lab setting with a high level of interaction between faculty and students, so students can receive immediate feedback to acquire technical skills. During the pandemic, software development courses suddenly turned into an asynchronous online format akin to an independent study, with no real-time interaction between faculty and students and no immediate feedback to help students develop skills.

The impact of moving a low-code application development course from a face-to-face format to an asynchronous online format in the midst of the pandemic is examined in this study. The goal of the study is to discover how this transformation in course modality impacted students’ perceptions of the course, using both quantitative and qualitative measurements, gathered through anonymous surveys. The research examines how changing the course delivery influenced students’ perceptions of how much they learned and impacted the students’ suggestions for improving the course. Additionally, the research investigates how changing the course delivery mode affected the response rate for evaluations.

# Related Work

This literature review examines the differences between software development courses taught in an online format versus those taught in a face-to-face format as well as the phenomenon of low-code development environments. In addition, this literature review examines students’ perceptions of learning and performance in online courses, their suggestions for improvement of online courses, and the response rate for online course evaluations.

Introductory software development courses are difficult to teach due to the difficulty and time investment required to learn the syntax of a traditional programming language (Stapel et al., 2008). Some college faculty have tried alternative no-code approaches, such as assigning students to build a wiki, solve an IT business case, or construct a building using Legos (Cubric, 2008; Rush & Connolly, 2020; Steghöfer et al., 2016). However, with the rise of new low-code development environments in the past few years, students can now learn how develop applications without the difficulty of learning the intricate syntax of traditional programming languages, making low-code an ideal choice for introducing students to software development (Rymer & Koplowitz, 2019). Low-code development environments are a rising trend in Information Technology (IT), with 23% of developers reporting in 2018 that they were using low-code development platforms, and another 22% reporting they planned to switch to low-code within the next year (Rymer & Koplowitz, 2019). The popularity of low-code environments in IT means students learning low-code software development will gain valuable career skills.

While low-code environments are less difficult for students to learn in introductory courses, students still require time to practice using the low-code environment. Introductory courses typically feature lab time to allow students to practice software development, as practicing hands-on skills is viewed as essential to process of learning how to develop software (Bey et al., 2018). In addition to practicing development skills, students must also acquire the social skills necessary to work successfully on a software development team (Zschaler et al., 2014). Research has found students are more successful in learning software development when team work is a course component (Shongwe, 2015). Students must be assessed not only on the final application, but also on the process they used to develop the application to ensure they are learning good software development practices (Restrepo‐Calle et al., 2019). Immediate feedback and personalized classroom instruction are critical to student success in introductory programming courses, yet these teaching methods are missing entirely from asynchronous online courses (Brito & de Sá-Soares, 2014). While research has shown students have favorable perceptions of their learning in blended introductory software development courses which retain lab time, the lab component is removed from asynchronous online courses so it is unknown if students will still have positive perceptions of learning in this format (Djenic et al., 2011). Lab time and face-to-face interaction with the instructor in teammates are also absent in asynchronous online software development courses, raising questions as to whether students will perceive that they learn as much in an online section as in a face-to-face section.

The literature is mixed on students’ perceptions of learning in online courses, with some studies showing students feel they learn less in online courses than in traditional face-to-face courses, while other studies show students perceive learning equally between both formats (Bettinger et al., 2017; Dobbs et al., 2017; Ladyshewsky, 2013; Zhan & Mei, 2013). In a study of 280 students at a U.S. University in the Southwest, 26.4% of students felt they learned less in online courses than face-to-face courses, while over 50% felt they learned equally in both modalities (Dobbs et al., 2017). In a more recent 2020 survey of 300,000 students attending over 1,000 U.S. universities, a whopping 78% of students felt online learning was less effective than face-to-face learning, indicating students perceptions of online learning grew more negative after the onset of the pandemic (*COVID-19 on Campus The Future of Learning*, 2020).

Perceptions of learning are tied to instructor presence, as shown by studies of both undergraduate and graduate courses, where students who described a low level of instructor presence also felt they learned less in the course (Ladyshewsky, 2013; Zhan & Mei, 2013). Students perceptions of learning in online courses is also tied to the perception that online instructors are less involved, as interviews with forty-seven community college students showed a majority felt they had to “teach themselves” in online courses (Jaggars, 2014). More responsibility is placed on the learner, especially in asynchronous online courses, which may contribute to students’ perception that they are teaching themselves (Kauffman, 2015; Nguyen, 2015). A meta-analysis of the literature on students’ perceptions of online courses showed students report feeling a lack of interaction with their professor and this lack of interaction leads to higher attrition in online courses (Bawa, 2016; Bowers & Kumar, 2015; Kebritchi et al., 2017). Completion rates in online courses are markedly lower than face-to-face, particularly for universities which only offer online programs, like the U.K.’s Open University, Canada’s Athabasca University, and the University of Phoenix, which in 2013 had graduation rates of 22%,5%, and 9%, respectively (Simpson, 2013).

Not only do students’ perceptions of learning in online courses differ from face-to-face courses, their performance is lower in online courses (Bettinger et al., 2017). Research on over 230,000 college students in more than 168,000 sections of 750 different courses showed the effect of taking a course online is a 0.44 grade point drop in the student’s grade, meaning a student who earned a C in the online course would have earned a B- in the face-to-face course (Bettinger et al., 2017). A study of over 500,000 courses taken by community and technical college students in Washington State found a significant, negative gap in student performance in online versus face-to-face courses (Xu & Jaggars, 2014). In 2014, a study of close to one million students enrolled in the California community college system found students are less likely to complete an online course than a traditional course, and they are less likely to complete an online course with a passing grade (Johnson & Mejia, 2014). Once researchers controlled for a set of student characteristics and institutional factors, they found online course success rates were between 11-14% lower than face-to-face course success rates (Johnson & Mejia, 2014).

While students’ perceptions of learning are mixed and their performance lower in online courses, their criticisms of online courses differ from criticisms of face-to-face courses, with online courses receiving a higher volume of student suggestions for improvement (*COVID-19 on Campus The Future of Learning*, 2020, p. 19). In the aforementioned 2020 survey of 300,000 college students, the majority of students felt online courses could be improved by providing better technology and more opportunities for students to connect to jobs through internships and mentoring (*COVID-19 on Campus The Future of Learning*, 2020). In a study of 420 students at a Midwestern U.S. university, 69% of students felt online courses could be improved by more interaction with the instructor and 60.7% suggested courses could be improved with better technology (Eom & Ashill, 2016). Another study found the top three areas online students suggested needed to be improved were communication with the professor, feedback from the professor, and providing a reasonable level of challenge (Rayens & Ellis, 2018).

Although course evaluations are highly valuable because they provide an insight into student perceptions of online learning and collect students’ suggestions for improvement, course evaluation response rates in online courses are lower (Chapman & Joines, 2017; Nulty, 2008). A 2008 review of the literature found response rates of 23% to 47% for online evaluations (Nulty, 2008). A more recent 2018 meta-analysis of studies reporting response rates for online course evaluations found average response rates of around 20% (Van Mol, 2017). One contributing factor to this lower response rate is learners with a grade of “W” or “F” are not typically included in course evaluations, and online courses have higher attrition and failure rates (Fetzner, 2013). Another contributing factor is asynchronous courses do not allow professors to provide time during a class session to complete evaluations, a strategy which has been shown to significantly increase response rates (Guder & Malliaris, 2010).

## Hypotheses

Based on the review of the literature, the following hypotheses were developed:

H01: The delivery format of the course has no effect on the students’ perceptions of how much they learned.

H11: If the course is moved from a face-to-face format to an online asynchronous format, then the students’ perceptions of how much they learned will decrease.

H02: The delivery format of the course has no effect on the number of suggestions for improvement in the comments for course evaluations.

H12: If the course is moved from a face-to-face format to an online asynchronous format, then the number of suggestions for improvement in the comments for course evaluations will increase.

H03: The delivery format of the course has no effect on the response rate for course evaluations.

H13: If the course is moved from a face-to-face format to an online asynchronous format, then the response rate for course evaluations will decrease.

# Methodology

Gathering the data involved conducting a survey of the college students in a face-to-face section prior to the pandemic and in an asynchronous online section after the onset of the pandemic. Both course sections were taught by the same professor using the same curriculum, which minimized differences between the sections other than the delivery method. The course studied was an introductory software development course that used a low-code platform to teach software development.

## Participants

The participants in the study were information systems students at an urban, mid-size university in the midwestern area of the United States. The university serves primarily non-traditional students with an average student age of 29 years old.

## Materials

The data for the study was gathered using a standard course evaluation survey, developed and implemented by third-part company IOTA 360. (IOTA Solutions, 2020). Students’ perceptions of learning were assessed using a quantitative approach. The following Likert-scale question and answer choices were used to gather students’ perceptions of learning:

How much have you learned in this course?

* Exceptional Amount
* Very Much
* Much
* Some
* Little

A qualitative approach was used to assess how students felt the course should be improved. The students’ suggestions for improvement were gathered using following prompt and an accompanying open-ended textbox:

Please suggest ways of improving this course.

## Procedure

The spring 2019 face-to-face section used a paper IOTA 360 Scantron survey form with an open-ended response space for students to write comments. To ensure anonymity, the professor left the room, and a student volunteer distributed the paper surveys, then collected them in a sealed envelope, and placed the envelope into a locked metal survey box at the building office. Due to the pandemic, the fall 2020 online section used an electronic version of the survey form. Approximately two weeks before the end of the term, students received an email from the third-party company that administers the survey. The email contained a link to the survey along with instructions on how to complete the survey. In addition to the email sent by the third-part company, the professor sent students an email reminding them to complete the survey and posted a reminder in the course announcements. The survey results were processed anonymously by the third-party company and posted on a secured website for faculty to access after the end of the term.

# Results

As shown in Table 1, 87% of the students in the face-to-face course section perceived they learned an exceptional amount or very much during the course, compared to 92% of students in the online asynchronous course section. In both course sections, the remaining students perceived they learned much in the course, with no students perceiving that they learned some or little in the course, as shown in Figure 1. This finding disproves hypothesis H11, since when the course was moved from a face-to-face format to an online asynchronous format, the students’ perceptions of how much they learned increased slightly.

**Table 1: Responses to question “How much have you learned in this course?”**

| Section | Exceptional Amount | Very Much | Much | Some | Little |
| --- | --- | --- | --- | --- | --- |
| Spring 2019 | 63% | 25% | 13% | 0% | 0% |
| Fall 2020 | 72% | 20% | 8% | 0% | 0% |

**Figure 1: Student Perceptions of Learning in the Face-to-Face versus the Online Course Section**

Surprisingly, there were zero suggestions for improvement in the comments for the online section, compared to three suggestions for the face-to-face section, as shown in Table 2 and in Figure 2. This finding disproves H12, since the number of suggestions for improvement decreased when the course was changed from a face-to-face to an asynchronous online delivery mode. The spring 2019 surveys contained three suggestions for improvement, based on responses to the prompt “Please suggest ways of improving this course”:

“Some assignments were not necessary to do such as the online videos”

“Chair[sic] are uncomfortable and noisy”

“Clean up D2L, too many items to sort through”\*

\* Desire2Learn (D2L) is the Learning Management System (LMS) used for both course sections being studied.

**Table 2: Responses to prompt “Please suggest ways of improving this course”**

| Section | Total surveys competed | Total surveys containing suggestions for improvement | Percentage of surveys with suggestions for improvement |
| --- | --- | --- | --- |
| Spring 2019 | 25 | 3 | 12% |
| Fall 2020 | 24 | 0 | 0% |

**Figure 2: Decline in Student Suggestions for Improvement from Spring 2019 to Fall 2020**

The response rates for the course evaluation surveys decreased from 92% in the face-to-face section to 81% for the online section, as shown in Table 3. The decline in response rates is illustrated in Figure 3. This finding lends support for hypothesis H13 that online course sections will have a lower response rate for course evaluations than face-to-face sections.

**Table 3: Survey response rates**

| Section | Students enrolled | Surveys completed | Response rate |
| --- | --- | --- | --- |
| Spring 2019 | 26 | 24 | 92% |
| Fall 2020 | 31 | 25 | 81% |

**Figure 3: Decline in Response Rate from Spring 2019 to Fall 2020**

# Discussion

Based on the review of the literature, it seemed likely that students’ perceptions of how much they learned in the online section would be the same or lower than the amount learned in the face-to-face section. Although the research on students’ perception of learning in online courses is mixed, the most recent research that occurred during the pandemic showed a majority of students felt they were learning less in online courses (*COVID-19 on Campus The Future of Learning*, 2020, p. 19). Surprisingly, though, students’ perceptions of learning in the online section of the software development course were slightly higher than in the face-to-face section, despite the outside stressors wrought by the pandemic. The implication of this finding is that shifting a low-code software development course from a face-to-face to an online format does not necessarily mean students will feel they learn less in the online section. This finding is encouraging for computing faculty who are planning to teach software development online.

The literature pointed to a lack of instructor presence as negatively influencing students’ perceptions of learning in online courses, so it seems that moving to an asynchronous model where this is no real-time interaction between students and their professor would hurt students’ perceptions of learning. This did not occur in this study, however. This is possibly due to other teaching methods that were used in the course that may have amplified instructor presence, such as posting weekly videos describing assignments, providing interactive lecture modules recorded by the instructor, and giving customized feedback on student work. These teaching practices may have mitigated the inherent deficiency in instructor presence that is caused by the asynchronous nature of online courses. Research has shown teaching methods which amplify instructor presence, like instructor-made videos and custom feedback, positively influence students perceptions of online courses (Bowers & Kumar, 2015; Ladyshewsky, 2013). Further research is needed to compare online computing courses which use teaching methods to amplify instructor presence against online computing courses which do not incorporate these methods to see if students’ perceptions of learning are higher in the courses with higher instructor presence.

Even more surprising than the students’ positive perceptions of learning in the online course section was the complete lack of suggestions for improving the course. The literature points to a higher volume of suggestions for improvement in online courses, particularly in the areas of technology and instruction (*COVID-19 on Campus The Future of Learning*, 2020). Multiple studies showed students wanted more interaction with their instructor, including more feedback and better communication (*COVID-19 on Campus The Future of Learning*, 2020; Eom & Ashill, 2016; Rayens & Ellis, 2018). While it is not surprising that no suggestions were made to improve the course technology, since the same LMS and low-code environment were used in both sections, it is surprising that the students did not give suggestions for improving the instruction. Given the findings in the literature, it seems students would have provided suggestions for improvement in instruction, since the literature points to students being less satisfied with instruction in online courses. The implication of this finding is that students are less likely to provide suggestions for improvement in an online section of a low-code software development course than a face-to-face section. Perhaps students are more rushed or less candid in the online course evaluations versus the paper course evaluations, and less likely to leave suggestions as a result. Further research is warranted to examine the differences in student suggestions for improvement between online course evaluations and paper evaluations.

While it is not remarkable that the response rate for the online course evaluations was lower than the paper evaluations, it is encouraging that the response rate only declined to 81%, given that the literature pointed to response rates as low as 20%-47% in online courses (Chapman & Joines, 2017; Nulty, 2008; Van Mol, 2017). It should be noted that the professor teaching the online section reminded students to complete the course evaluations, both through email and the course website announcements. Several research studies have found sending emails or providing other types of reminders can increase the response rate for course evaluations, particularly if those reminders come directly from the student’s professor (Guder & Malliaris, 2010; Lipsey & Shepperd, 2020; Ravenscroft & Enyeart, 2009). The professor’s reminders to complete the survey may have helped mitigate a precipitous drop in response rates when the course evaluations shifted from a paper-based to an online format. The implication of this finding is that faculty teaching online sections of computing courses do not need to necessarily experience a large drop in response rates for course evaluations, particularly if they provide reminders to their students to complete the evaluations. Additional research on more courses is necessary to determine if this finding is limited to online software development courses, or generalizable to a broader range of computing courses, and even courses in other disciplines.

A key limitation to this study is that only two sections of the course could be examined. The course content was radically reworked for the spring 2019 section to incorporate the low-code development platform. All of the earlier sections of the course used a traditional Object-Oriented Programming (OOP) language with a complex Integrated Development Environment (IDE), so the course evaluations were not comparable with the evaluations received after the introduction of the low-code development platform. Additionally, at the time of this research, the transition to the online course format was still quite new, so the number of online course sections were limited. Additional research on more online course sections is required to see if the positive trend in students’ perceptions of learning, the absence of suggestions for improvement, and the course evaluation response rates hold steady. Another limitation is the sample size for this study, since only two course sections were available to be studied. Replication of this study in additional low-code software development courses is needed to demonstrate if the findings hold true across a larger sample of students.

# Conclusion

This study advances upon previous research in computing education by demonstrating that moving a low-code software development course online does not necessarily harm students’ perceptions of learning, even in the midst of a global pandemic, which wrought untold stressors on students outside of their coursework. This result reveals a conflict with prior research that shows students perceive they learn less in online courses than in face-to-face courses. Additionally, this study advances on prior research by showing that students’ suggestions for course improvements may actually decline when a computing course is moved online, which is surprising given previous research showing most students are critical of online courses, particularly in the areas of technology and instruction. Lastly, this study shows that course evaluation response rates do not necessarily drop precipitously when a computing course is shifted online, and that providing students with reminders to complete the evaluations may mitigate a drop in response rates. More broadly, the results of this study provide computing faculty with reassurance that transforming the delivery mode of a software development course from face-to-face to online can be successful, even in the midst of a pandemic. These results are encouraging, particularly if the pandemic pivot to online learning proves permanent.

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