

Introductory Biology Students' Opinions on the Pivot to Crisis Distance Education in Response to the COVID-19 Pandemic

By J. Phil Gibson and Kristen Shelton

The COVID-19 pandemic forced higher-education institutions to close campuses and pivot all face-to-face (F2F) instruction online. This transition to Crisis Distance Education (CDE) was unprecedented in scope and speed as it was implemented globally. We surveyed students in a large, introductory-level biology course to understand their opinions about the curricular changes we implemented, usefulness of resources we provided, and the extent to which they felt supported by course personnel during the transition to CDE. The survey included both Likert-scale and open-ended questions. In general, students had a positive opinion of the transition, particularly the option for synchronous or asynchronous participation in the remainder of the course. Students valued opportunities to communicate with course personnel, but gave mixed responses for whether more or less communication was desired. Students reported high use of graded resources, but low use of ungraded resources. Our results suggest that when faced with an unexpected transition to CDE, it is important to maintain regular, supportive, and synchronous communication, but also remain flexible for asynchronous participation. Grades and immediate point rewards were important factors motivating student use of e-resources and maintaining student engagement. These factors are important considerations when shifting instruction to CDE for a limited or extended time.

In March 2020, higher education course structures worldwide were destabilized when the World Health Organization designated the COVID-19 disease outbreak a global pandemic (Cucinotta & Vanelli, 2020). In response, colleges and universities across the United States and other countries closed campuses mid-semester. Educators transitioned traditional, face-to-face (F2F) instruction to remote distance education (DE) in response to the COVID-19 crisis (Smalley, 2020). Although DE has existed for many years, there has never been a transition from F2F to DE on such

a large scale in such a short period of time as occurred in response to the COVID-19 pandemic (Al Lily et al., 2020; Bozkurt & Sharma, 2020; UNESCO, 2020; Youmans, 2020).

Al Lily et al. (2020) named the unexpected, rapid shift in response to the COVID-19 pandemic Crisis Distance Education (CDE) because of distinct features from typical DE. For example, under noncrisis conditions, faculty expect online course delivery and adopt DE-based pedagogy from the beginning of course development. There is opportunity beforehand to plan the curriculum and choose appropriate media, re-

sources, and assignments. In contrast, implementing CDE in response to COVID-19 required faculty to rapidly shift instruction online and change to DE-based pedagogy regardless of previous experience, preparation, or desire to teach online (Bozkurt & Sharma, 2020; Cutri & Mena, 2020; Gardner, 2020; Johnson et al., 2020). Because CDE was implemented to “save” the academic term and act as a nonpharmaceutical intervention to slow disease spread, faculty typically had under two weeks to adapt courses to an uncertain teaching and learning environment (Al Lily et al., 2020; Bojović et al., 2020; Bozkurt & Sharma, 2020; Cutri & Mena, 2020; Gardner, 2020; Lederman, 2020; Ralph, 2020; Smalley, 2020; Youmans, 2020).

Students likewise experienced unique consequences and challenges with the transition. Students choose DE under noncrisis conditions with expectations about online learning and readiness for unique technology demands and need to work autonomously that are critically important factors affecting their satisfaction and success (Bernard et al., 2004; Lou et al., 2006; Swan, 2001; Wallace & Clariana, 2001). These considerations were not possible when the COVID-19 pandemic forced CDE implementation, but they still shape student experiences. Displacement from their normal educational settings, altered personal responsibilities, public health regulations, and

additional crises-related disruptions can further affect students' ability to engage in CDE (Antommaria, 2020; O'Byrne et al., 2020).

Course Context: We studied an introductory biology course for life science majors that moved instruction from three, 50-minute lecture sessions and one, three-hour laboratory session per week to exclusively online instruction for the final seven weeks of the 2020 spring semester. The course was taught by an instructor supported by seven graduate teaching assistants (GTAs). This course was developed and has been taught by the instructor for over a decade. It includes multiple active learning activities (e.g., case studies, small group work, problem-based learning) and frequent low-stakes, in-class assessments ("clicker-questions") to promote student engagement with content and interaction. GTAs instruct students in laboratory techniques and methods of data analysis to support lecture content. This study primarily addressed the lecture component of this course.

Two-way web conferencing, videos, and other electronic resources ("e-resources" hereafter) were used to adapt the lecture to a CDE footing for the remainder of the semester. Synchronous sessions were scheduled to promote communication and engagement between instructors and students and reduce feelings of isolation. All video-conference activities were recorded to allow asynchronous engagement at a student's convenience, a critical feature of successful DE (Bernard et al., 2004; Lou et al., 2006; McBrien et al., 2009).

Because the COVID-19 pandemic provided a unique opportunity to study satisfaction and use of e-resources during CDE, we conducted a survey to evaluate students' reported use of the chosen e-resources and their opinions about the transition to CDE. The objective of this study was to investigate student perspec-

tives on the curriculum modifications we implemented, the e-resources we chose, and the support we provided for students in response to the CDE transition. Three questions guided our research:

1. To what extent did students use various e-resources?
2. Did the e-resources students used support their learning?
3. How did communication between students and course personnel affect student CDE experience?

These results can inform future decisions when DE must be implemented rapidly to continue instruction not only in crises such as pandemics, but other situations when F2F instruction must transition to DE for some or all students.

Methods

The goal of our CDE transition was to provide digital-learning activities that would emulate the in-class lecture experiences that engage students during F2F instruction (Table 1). Transactional distance theory (Moore, 1989) describes how faculty should consider not only content and learning objectives, but also the way technology can be used to promote

student interaction with content, other students, and instructors in light of the unique challenges that DE poses for each learner. We used this as our theoretical framework to provide a structured learning environment during CDE that offered opportunities for interaction, while accommodating different needs for students to work autonomously.

Lecture sessions were replaced with a weekly, instructor-led, synchronous video conference to give an overview of topics and answer questions. Twenty-three video e-resources that addressed remaining topics in the course were assigned to replace the other two lecture sessions each week (Table 2). Thirteen e-resources were videos with embedded questions. Ten were videos without embedded questions. E-resources with embedded questions were chosen to provide students a video case study experience to replace the "clicker questions" that were originally planned for F2F lectures. (Prud'homme-Généreux et al., 2019). Videos with embedded questions were made available through EdPuzzle, TED-Ed, and HHMI Bio-Interactive. Videos without questions were accessed via YouTube.

Data: We designed a survey to use

TABLE 1

In-person class activities (face to face), interventions used to replace them under Crisis Distance Education, and the objective of the replacement activities for a large, introductory-level biology course.

F2F activity	CDE replacement	Objective
Synchronous lectures	Synchronous video conference recorded for asynchronous viewing, professional videos, lecture recordings	Provide opportunities for content delivery, information sharing, question-and-answer opportunities, connecting with students, and schedule flexibility
"Clicker" case studies	Video case studies on EdPuzzle, TedED, and HHMI BioInteractive	Provide low-stakes, graded, and ungraded case study experiences to engage students with course content

F2F = Face to face
CDE = Crisis distance education

purposeful sampling and anonymous responses. The survey consisted of 22 questions, including one question of consent to participate, seven limited background information questions pertaining to education and experience with online learning, 10 Likert-scale questions, and four open-ended response questions. The survey was created using Qualtrics and administered via the course LMS using a university-supported survey platform.

Students' opinions about the transition to CDE were explored by questions that addressed their overall satisfaction with the transition, teacher access and availability, and teacher communication. Open-ended questions probed students' feelings regarding to what extent they felt supported during the transition, how support efforts can be improved, and suggested adjustments in CDE curriculum design and course structure. Likert-scale questions were designed to assess students' engagement of e-resources as well as to gauge student perception as to how well each e-resource contributed to their overall understanding of the material. Students were asked how much of each resource they completed and to what extent that resource contributed to their understanding of the topic.

All 338 students enrolled in the course were invited to participate by a link sent via secure message on the university LMS. The recruit-

ment message ensured students that survey responses are anonymous and that there would be no influence on course outcomes based on participation. Only willing participants who formally consented were able to access the questions associated with the survey. The survey remained open for two weeks.

Data analysis: Responses to background and Likert-scale questions were initially accessed and visualized directly from the Qualtrics data analysis output. Responses to the four open-ended questions were analyzed using open coding. Responses to each question were first analyzed individually. Each response was assessed and sorted based on type of information provided, such as teacher engagement, comments about e-resources, or similar course-oriented responses. Analysis was continued by assigning initial categories to the responses, such as clear expectations, instructor understanding, number of assignments, instructor/GTA availability, etc. This process continued for each question. Analysis continued with the use of axial coding across question responses. Once all responses to each question were coded, themes were identified across all responses. Each response was then assigned a theme. Findings were then compared between researchers to verify the identified common themes within

and among the responses.

Levels of completion were compared among e-resources in the four categories via nonparametric Kruskal-Wallis tests and post hoc Scheffe's pairwise tests to evaluate the degree students used the different resources. Resources completed by over 50% of respondents were further analyzed via Mann-Whitney U tests to evaluate how students perceived the contributions of the resources to their learning. All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 26.0.

Results

Approximately one-third of invited students participated (Table 3). The majority were underclassmen and declared life science majors who had completed one semester of introductory-level biology. Under half reported previous experience with an online course at the college/university level, and fewer had completed an online science or biology course.

Transition to CDE: Over 80% of the responses described being slightly or extremely satisfied with the transition to CDE, teacher access and availability, and teacher communication. (Table 4). Three themes emerged from iterative rounds of coding: communication, resources, and support. Communication was the most important need expressed by students to support their learning during CDE. Students reported that they desired streamlined communication with specific guidance on expectations for assignments. Most students were happy with the level of communication about assignments, and many participants responded that they appreciated the frequency of updates and communication from course personnel. Some respondents implied that communication became overwhelming and they would have preferred less.

Students frequently commented that the flexibility and understand-

TABLE 2

The number of e-resources (N) and examples of e-resources in five categories of e-resources used in the transition of a large, introductory biology course to crisis distance education.

E-resource category	N	Examples
EdPuzzle Assignments	8	Plant Diversity, Plant Life Cycles, (Bozeman Science), Seven Million Years of Human Evolution (AMNH)
TedEd assignments	5	A Plant's Eye View of the World, How We See Color, Human Skin Color
HHMI BioInteractive	2	Fungicides and Bees, Search For The Mutated Gene
YouTube videos	8	Bioluminescence, Skin Color, Genes as Medicine

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ing of course personnel provided the necessary support during this time. One example of this is found in one student's response who wrote, "I also really appreciated that the course became almost entirely asynchronous, especially since the Zoom lectures were recorded so we didn't have to be there to see them. I think that's really helpful and allows more flexibility for students who need to work more during this online period or have other factors contributing to changing schedules." In contrast, other students wanted more rigid structure and additional accountability. For example, one student responded, "I would like lectures to be live and online. I know it is difficult, but some form of attendance would also be great. It is so easy to skip online lectures and difficult to self motivate [sic]."

Although many students felt course personnel were supportive and sensitive to their predicament, some expressed a desire for more emotional support during CDE. In particular, there were multiple comments indicating students wanted even greater understanding of academic challenges due to personal distractions in their new learning environments. One student responded, "It is hard to go from a campus setting to being back in my home state and recreate the same focused environment. I went from the dorms to back home and my family expected a lot of my time." Another indicated that the stress of the pandemic prevented engaging

in the course, writing, "dealing with my own personal crisis did not make things easier."

Several students indicated frustration with or dislike of online learning. One student responded, "it was difficult to learn online as well as i [sic] would have done in a physical setting." Some students stated they would have preferred, as one wrote, "Not having online learning," reflecting a sentiment by some students that the semester should have ended and not moved online. Multiple responses indicated they would have liked more student-to-student communication. For example, one stated, "I think the use of something like an official classroom GroupMe or other group chat application as a way to have access to classmates at all times would be incredibly helpful. It would be a good way for students to ask each other questions and facilitate the peer support that we're missing now that we're physically separated." A small number of responses indicated a desire for even more instructor and GTA availability, and, unfortunately, a small number of students felt unsupported.

E-resource use and satisfaction: There were distinct differences in *e-resource* use. On average, over 92% of students completed all e-resources on EdPuzzle and TedEd, but significantly lower completion of the other e-resources (Table 5). Only the EdPuzzle and TedEd e-resources were attempted by at least 50% of the

respondents. A majority of students reported that the EdPuzzle and TedEd e-resources made a slightly above average to far above average contribution to their learning (Table 6).

Feedback for video e-resources was generally positive, as exemplified by this typical response from one student, "I also appreciated the variety of videos that were offered. I didn't necessarily feel like I needed to watch them, but in general, the ones I did watch I found helpful to my understanding of concepts that I was struggling with." However, comments about the number of resources were mixed. Some students wanted more homework, videos, and worksheets. A common theme in many responses was a request for practice questions to prepare for exams or more opportunities for grades. However, other students expressed a preference for fewer resources or no course assignments after transitioning online.

Discussion

Although it was unanticipated and rapid, our survey found that most students had a positive opinion of our approach to the pandemic-driven, mid-semester transition to CDE. Student responses indicated overall satisfaction with the combination of synchronous and asynchronous activities used during CDE, and they generally felt there was adequate communication and support during this time (Table 4). Students valued

TABLE 3

Background information provided by study participants (*N* = 99).

Year in school <i>N</i> (%)		Major		Completed online course previously		Completed college-level, introductory biology course		Completed online college-level introductory biology course	
First-year	41.4%	Biology	74.8%	Yes	41.9%	Yes	86.8%	Yes	9.3%
Sophomore	40.4%	Microbiology	6.1%	No	58.1%	No	13.2%	No	90.7%
Junior	9.1%	Plant Biology	1.0%						
Senior	9.1%	Other	18.1%						

the opportunities to maintain “live” connection with the course through synchronous video conferencing. They also indicated that they appreciated the option to participate asynchronously, which allowed them to continue learning despite unpredictability and uncertainty in their learning environment. Overall, students felt that communication, guidance, and empathy they received from the instructors and GTAs were what they needed most to complete the course under CDE.

Students reported that the e-resources they were provided were useful and made a positive contribution to their learning. However, there was a distinct difference in use among e-resources. The only difference be-

tween the e-resources with high use and low use is, unsurprisingly, that the e-resources with high completion contained graded questions. Although informed that content in all e-resources would be on exams, students preferentially completed resources with graded questions. Student responses did not indicate whether e-resources with low use were not completed because they were viewed as unimportant or whether other factors may have prevented use. However, we contend that our results indicate that in this instance of CDE, the immediate reward of points drove student engagement and use of resources.

Our intention in having some graded and some ungraded e-resources was to provide a mixture of graded

and ungraded activities, similar to structure in F2F lectures when there are graded “clicker questions” during some class sessions and not during others. By having grades associated with some e-resource and not others, we may have unintentionally sent a false signal of differences in quality among e-resource that impacted student motivation to use them. We think this may reflect the importance of grades as a major factor influencing student motivation under CDE. For example, although the course moved completely online in response to the pandemic, analytics of online engagement on the course LMS did not show a significant increase in web traffic during CDE over previous semesters. Although other factors could influ-

TABLE 4

Student satisfaction (*N* = 99) with transition, instructor/graduate teaching assistants access, and instructor/graduate teaching assistants communication during implementation of Crisis Distance Education.

Satisfaction category	<i>N</i>	Extremely dissatisfied	Slightly dissatisfied	Neither satisfied nor dissatisfied	Slightly satisfied	Extremely satisfied
Student satisfaction with transition	99	3%	11%	5%	37%	44%
Student satisfaction with instructor/GTA access	99	4%	7%	6%	32%	51%
Student satisfaction with instructor/GTA communication	99	3%	10%	5%	27%	55%

GTA = Graduate teaching assistants
CDE = Crisis Distance Education

TABLE 5

Mean percent (standard deviation) of students (*N* = 99) reporting different levels of completion for 27 e-resources in five categories.

Resource categories	Number of resources	Did not attempt % (SD)	Partially completed % (SD)	Mostly completed % (SD)	Completed % (SD)
EdPuzzle Assignments	8	1.38 ^a (0.43)	0.30 ^a (0.05)	1.23 ^a (0.93)	97.07 ^a (1.46)
TedEd assignments	5	5.67 ^a (2.24)	2.46 ^a (0.55)	0.24 ^a (0.55)	93.83 ^a (2.46)
HHMI BioInteractive	2	67.9 ^b (5.23)	4.32 ^b (0.87)	4.93 ^b (1.74)	22.84 ^b (2.60)
YouTube videos	8	54.78 ^b (6.82)	9.26 ^c (1.14)	8.95 ^c (1.58)	27.00 ^b (7.36)
Mean (SD)		26.67 (28.13)	3.75 (4.33)	4.03 (4.03)	65.54 (35.6)

Within columns, values followed by the same letter are not significantly different ($p < 0.05$).

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ence student engagement during CDE (Antommara, 2020), the decision by the university to offer a pass/no pass option to students during CDE may have additionally reduced student motivation, which would influence their interest in using different e-resources. The effects that change in assessments, grades, and institution-level grade policies have on student engagement under CDE conditions should be investigated further.

Studies have shown that student readiness for DE, awareness of the demands of DE, and comfort with technology are important elements of student satisfaction and success in online learning (Bernard et al., 2004). Our students were largely able to navigate the transition, use the necessary technology, and successfully adapt to the CDE teaching and learning environment despite not initially choosing or expecting distance learning to be implemented. Similar to other studies, communication, empathy, and added support were reported to be of greatest value for navigating the unique social context, modes of presentation, and learning experiences of distance education (Yeung et al., 2016) the interplay between lecture recordings, lecture attendance and grades needs further examination particularly for large cohorts of over 1,000 students in 500-seat lecture theatres. This paper reports on such an investigation with a cohort of 1,450 first-year psychology

students who indicated whether they frequently attended lectures or not. The division helped ascertain differences and similarities in preferences for using online recordings. Overall, non-frequent attendees were more likely not to use lecture recordings (48.1%).

The results of this study have provided guidance for the following semesters in which DE has persisted in this course. Combinations of synchronous and asynchronous activities continue to be used and there are expanded opportunities to interact with the instructor remotely. Online office hours are held immediately after lectures, which has had a noticeable increase in student interaction. E-resources, including videos, are assigned, but assessments with grades or other accountability measures are conducted in assignments. Likewise, student-to-student communication has been facilitated through breakout rooms during virtual class sessions to promote interaction.

Although stimulated by a catastrophic public health crisis, the shift to CDE provided an unprecedented opportunity to evaluate course content and use of e-resources that can be used in crisis and noncrisis conditions. The forced consideration of how technology and e-resources can be implemented and used by students in a crisis situation gave new insights on use of the same resources

for future F2F and DE teaching and learning. The essence of pivoting requires changing direction without changing your objective. Our results from the COVID-19 pandemic show that it is possible to pivot from F2F to CDE by providing online e-resources and a supportive learning environment that contains opportunities for live engagement, but also offers the “anytime anywhere” flexibility that defines DE. This can support accessibility and continued engagement in education when students are unable to physically attend courses for a definite or indefinite period of time. Thus, beyond guidance on what to do if CDE must be implemented again, our results provide insights on how to engage students and support them during any situation requiring a rapid pivot to remote learning.

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TABLE 6

Mean percent (standard deviation) of students ($N = 99$) reporting amount learned for 17 e-resources in two categories that had at least 50% completion. Within columns, values followed by the same letter are not significantly different ($p < 0.05$).

Resource categories	Number of resources	Did not attempt	Far below average learned	Slightly below average learned	Average amount learned	Slightly above average learned	Far above average learned
EdPuzzle	8	1.51 (0.88)	3.55 (1.90)	11.75 (4.99)	35.68 (6.78)	32.75 (3.82)	14.82 (4.30)
TedEd	5	5.67 (2.24)	2.98 (1.07)	7.18 (5.55)	24.94 (3.65)	36.78 (2.38)	22.46 (4.78)
Mean (SD)		3.59 (2.94)	3.26 (0.40)	9.47 (3.23)	30.31 (7.59)	34.77 (2.85)	18.64 (6.50)

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J. Phil Gibson (jpgibson@ou.edu) is a professor in the Department of Botany and Microbiology and the Department of Biology and **Kristen Shelton** is a doctoral student in the Instructional Leadership and Academic Curriculum for Science Education Program, both at the University of Oklahoma in Norman, Oklahoma.
