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What Should Teachers Do? Visibility of Faculty and TA Support Across Remote and Traditional Learning

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Abstract

The COVID-19 pandemic has altered best practices for instructors and teaching assistants (TAs) to support student learning in engineering. This does not necessarily mean that instructional support has diminished as a consequence of the transition to remote learning. In this study, instructional support was explored using quantitative and qualitative methods of data analysis. Surveys from over 600 students in sophomore and junior level courses in engineering at a large public institution were collected in the Spring of 2020 and compared to results from similar courses offered prior to the start of the COVID-19 crisis. Likert-scale items, as well as short answer items, that independently measured faculty support and TA support were analyzed in this study.

Initial t-tests indicated that perceptions of faculty support were not significantly different between remote and traditional learning. To consider the possibility that failure to reject the null hypothesis was due to course-by-course variations, additional t-tests were used to compare student perceptions of faculty support across pairs of courses taught in both settings. Post-hoc tests showed that faculty support was significantly higher in the remote learning setting in three of seven pairs of courses and significantly lower in the remote learning setting in the four remaining courses ($p < 0.05$). Similarly, in considering TA support, an initial t-test indicated that perceptions of TA support were not significantly different in remote learning compared to traditional learning, but in course-by-course comparisons, students believed they were offered significantly higher TA support in remote learning in three pairs of classes and significantly lower TA support in one pair of classes ($p < 0.05$) with three classes indicating no significant difference.

Students in both settings were also asked to identify one thing that faculty could do and one thing that TAs could do to better support their learning. Inductive coding of these short answer responses revealed that while in traditional learning, students emphasized faculty support in in-class and out of class delivery of materials, in remote learning, the emphasis shifted to needs for support in out of class delivery and out of class interactions. For TAs, student expectations were balanced between in-class delivery and out-of-class interactions in traditional learning but their needs for more out of class interactions dominated their concerns in remote learning. Overall, for faculty, about 20% of students requested greater availability in both remote and in-person settings. For TAs, 44% of students requested greater availability of and access to their TAs in remote learning, compared to 18% in in-person settings.

The analysis of both Likert-scale and short answer data regarding TA and faculty support in this study reinforces the importance of availability of instructional support regardless of setting. As students, TAs, and faculty continue to navigate the uncharted waters of the traditional college education system gone online, the nature of connection differs yet its importance remains the same.

Introduction

In March 2020, the World Health Organization declared the COVID-19 virus a global pandemic [1], which necessitated preventative measures such as social distancing and forced many higher education institutions to close campuses, suspend traditional practices of in-person classes, and rapidly switch to remote learning environments. In response, students had to adapt to their new and unprecedented learning environments in very limited time. During normal circumstances, remote instruction can be beneficial as it provides students and instructors with the flexibility to teach and learn from anywhere. However, the nature of remote learning during the COVID-19 pandemic is very different from traditional models of online education and learning. These models involve prior planning and preparation to deliver course content optimized for online delivery, as the development of a fully online university course can take substantial time prior to its delivery. Moreover, it can take multiple iterations of an online course for faculty and instructional staff to feel comfortable with teaching it. During the COVID-19 pandemic, instructors did not have the time to carefully design and transition face-to-face courses to an online environment. To reflect the differences between online teaching during the pandemic and traditional online teaching, remote instruction has been labelled emergency remote teaching (ERT) [2]. The abrupt and emergency nature of the transition to ERT (hereafter called *remote learning*) has led to the notion that the quality of higher education decreased as a result of the pandemic. But, at the present time, insufficient evidence is available to assess to what degree higher education and learning may have been compromised by the shift to remote learning. Early research assessing the impact of the COVID-19 pandemic on higher education in China and South Korea has found that students engaged in increased and proactive communication with peers and instructors to compensate for the lack of in-person engagement and were in fact, resilient in the face of the crisis [3].

Little is known about how instructors (both faculty and teaching assistants) fared during the crisis. Were they able to deliver comparable support during remote learning as compared to traditional learning? If so, did student expectations of faculty and TAs shift in remote versus traditional learning as part of students adapting to the crisis? To explore these questions, we asked over 1300 engineering students in sophomore and junior level courses at a large public institution to respond to a survey instrument consisting of a series of multiple choice and short answer questions. Our analysis focuses on comparing results from courses offered prior to the start of the COVID-19 pandemic and afterward in an effort to determine how perceptions of faculty and TA support may have changed since transitioning to remote learning. The results of our analysis offer insight into how faculty and TAs can best support engineering students during remote learning, whether that be in whole or in part how engineering courses are offered moving forward.

Background

During the transition to online learning in response to the COVID-19 pandemic, faculty and TA's pedagogical practices were forced to shift. Face-to-face classroom and office hour interactions were lost, and in their place, faculty and TAs used a variety of practices including pre-recorded videos, virtual office hours, and live, video lectures to engage their students. These shifts in pedagogy and class format have implications for student learning, as support from faculty and TAs play an important role in fostering student engagement.

Faculty Support

Support from faculty is an important element of student engagement in higher education institutions. Existing literature demonstrates the important role that faculty interactions, both formal and informal, can play regarding students' social and academic integration—known elements of students' successful degree completion [4]. Social engagement and feelings of connectedness at higher education institutions are heavily influenced by faculty support. Faculty support also has the potential to exceed the influence of overall student culture with regard to students' social engagement [5]. The care and respect that faculty members express has been associated with positive experiences and an emotional commitment to an institution [6]. Faculty support has also been found to mediate the relationship between student effort and student satisfaction [7]. In engineering, Chen et al. [8] found, across four institutions, that engineering students who reported higher levels of satisfaction with their faculty's availability and advising were less likely to be disengaged. More recently, faculty support was significantly linked to multiple forms of engagement among engineering students including attention and effort as well as positive and negative emotional engagement [9].

Supportive faculty also have the potential to greatly influence academic success and feelings of academic self-efficacy in college students [10]. In a large, multi-institutional study, more frequent student-faculty interactions were found to be correlated with higher levels of cognitive development across 43,000 students and over 100 major areas of study [11]. The pedagogical practices that faculty employ have been found to contribute to students' academic engagement. Umbach and Wawrzynski [12] demonstrated that active and collaborative teaching strategies, which challenge students academically, yield higher student engagement. Interactions with faculty, however, are not limited to the formal classroom setting. In a study of 242 students at a mid-size institution, Komarraju [13] found that students who felt that faculty were available to meet with them outside of the classroom reported higher levels of academic self-concept and intrinsic motivation as compared to those who felt that faculty were less available.

Faculty support is as important in online learning as it is in traditional learning. A recent study [14] demonstrated the important role that faculty interactions play in student engagement in online learning. In a survey of 161 online instructors and 155 students, Bolliger and Martin [14] found that in the context of online instruction, one of the most valuable engagement strategies reported across respondents was the presence of faculty and personal contact with those faculty indicating that instructional visibility matters in the virtual setting. Students and faculty agreed that students are more engaged in their courses when faculty members interact with them consistently, as it demonstrates that they value their students' learning. In online learning, it falls on the faculty member's shoulders to develop and maintain a strong and interactive learning community among students [15], [16]. Thus, in unique ways, the quantity and quality of faculty support in both traditional and online settings have important implications for supporting students' academic and social success on their journey to higher education degree completion.

Despite the existing research on faculty support in online learning and in traditional learning on college campuses, there is a distinct lack of research comparing the perceptions of and expectations for faculty support that students have in these two settings. The context of the COVID-19 pandemic further highlights the need for a better understanding of learning support

across traditional and remote settings. This study seeks to cross that bridge in part by examining these differences in faculty support between traditional and remote learning in engineering.

TA Support

TAs play an important role in higher education institutions in the United States [17]. Their responsibilities in undergraduate engineering courses includes leading classroom lectures and labs, holding office hours, providing support with questions, and more. In large, introductory courses at the freshman and sophomore levels, TAs might even be more visible to undergraduate students than tenure track faculty [18], [19], which means that they have a marked influence on perceived effectiveness of instruction [20], [21].

Given the high level of interaction that undergraduate students have with TAs, it is concerning that evidence has suggested that TAs may be less effective in teaching undergraduates as compared to tenure track faculty [22]. However, a study conducted by Kendall and Schussler [23] found that students perceive TAs as engaging, understanding, and relatable, so the nature of the impact that TA interactions have on students is likely different from and complimentary to interactions with faculty.

TA support, though not as widely studied as faculty support, has also been found to be associated with positive student outcomes. Interactions with TAs have been associated with students' positive academic self-concept [24], as well as positive student evaluations [25] and student engagement [26]. In engineering, consistent student-TA interactions have been found to contribute to higher student motivation and learning [27]. In contrast, a lack of connection between TAs and students has been found to lead to reduced motivation [28]. Again, this indicates that instructional visibility, including that of TAs, is an important component of perceived support in higher education settings.

To date, there is minimal research in the area of student perceptions of TA support in the context of online instruction. As with faculty support, knowledge regarding how student perceptions of and expectations for TAs are different between traditional and online instruction is largely anecdotal. Thus, this study seeks to expand on existing literature by investigating potential differences in the way that students perceive TA support across remote and traditional learning with an emphasis on the context of the COVID-19 pandemic. In combination with studying faculty support in these two settings, the goal of this study is to identify instruction team strategies that can serve students well whether instruction is traditional, remote, or blended in a combination of the two.

Method

This study uses quantitative and qualitative research and data analysis methods and is part of a larger, single institution research project to evaluate connections between various forms of support (from faculty, TAs, and peers) and multiple forms of course-level engagement (attention, participation, effort, positive and negative emotional engagement) both in traditional and remote learning. This study focuses on comparing student perceptions of faculty and TA support across traditional (pre-COVID) and remote learning as necessitated by the COVID-19 pandemic. Two research questions guided this comparison.

Research Question #1 (RQ1):
Do student perceptions of faculty and TA support differ in traditional vs. remote learning?
On traditional college campuses, faculty support their students both directly and indirectly during class time (e.g. lecture, in-class discussion) and outside of scheduled class time (e.g. office hours, homework assignments). On-campus courses offer structured time and space for students to work through course material in close proximity to faculty and TAs. Most of these opportunities to work together vanished when COVID-19 restrictions were implemented on college campuses and remote learning began in the spring of 2020. While it might seem logical that students would receive and report lower levels of faculty and TA support during remote learning, it is not necessarily a given. It is possible that faculty and TAs found ways to substitute in-person interactions with virtual interactions during remote learning and in combination with other instructional strategies and educational technologies reached a level of support comparable to traditional classrooms. Evaluating whether or not students reported significantly less faculty and TA support during remote learning is a first step toward supporting practitioners in developing strategies to better support students when their physical access to them is limited.

Research Question #2 (RQ2):
Do student expectations for faculty and TA support differ in traditional vs. remote learning?
The changes in the learning environment that occurred as engineering programs shifted from traditional to remote learning in spring of 2020 were not subtle. Daily college life changed for everyone: faculty, TAs, staff, students, and administrators. Therefore, it would be reasonable to expect that student expectations also changed. Our second and final research question evaluates whether or not student expectations for faculty and TA support changed from traditional to remote learning as well as how they changed. Shifting student expectations of faculty and TA support can affect the interpretation of RQ1 and also provide insight into where best to invest effort to improve perceived faculty and TA support for future remote learning experiences.

This study explored the first research question (RQ1) using ordinal data collected from a student survey while the second question (RQ2) was evaluated using nominal data resulting from the coding of short answer data collected in the same survey.

Study Context
Student surveys were conducted as part of a larger study of student engagement in undergraduate engineering courses at a large public research institution. Twelve courses were surveyed during remote learning in Spring of 2020 and seven courses were surveyed during traditional learning between 2016 and 2018. As a result, 45.70% of survey respondents reported their experiences in remote learning while 54.29% reported their experiences in traditional college classrooms.

Subjects and Procedures
This study included 1327 undergraduate students recruited across four engineering majors and 19 separate classes at the sophomore and junior levels (Table 1).

Table 1: Courses Studied					
Course	**Level**	**Setting (Year)**	**Topic**	**Enrolled**	**Participants (*N*)**
ME1[2]	Sophomore Junior Senior	Traditional (2018)	Visualization & CAD	179	140
		Remote (2020)		155	73
ME2[2]	Sophomore	Traditional (2018)	Engineering Statics	69	20
		Remote (2020)		92	6
ME3[1]	Sophomore	Traditional (2018)	Kinematics and Dynamics	263	218
		Remote (2020)		184	143
EE1[1]	Sophomore	Traditional (2016)	Introduction to Electrical Engineering	223	175
		Remote (2020)		105	73
EE2[1]	Sophomore	Traditional (2017)	Circuit Theory	91	70
		Remote (2020)		69	57
EE3[1]	Sophomore	Traditional (2018)	Continuous Time Linear Systems	84	63
		Remote (2020)		86	70
EE4[2]	Sophomore	Traditional (2018)	Digital Circuits and Systems	41	35
		Remote (2020)		37	27
EE5[3]	Junior	Remote (2020)	Devices and Circuits I	56	49
EE6[3]	Junior	Remote (2020)	Devices and Circuits II	36	25
EE7[3]	Junior	Remote (2020)	Discrete Time Linear Systems	47	37
EE8[3]	Junior	Remote (2020)	Energy Systems	71	37
EE9[3]	Junior	Remote (2020)	Applied Electromagnetics	15	10

[1] Course offered in both traditional and remote settings but not by the same instructor
[2] Course offered in both settings and by the same instructor
[3] Course offered in only remote setting

Self-reported ethnicity was: Asian (43.3%), Black (2.94%), Hispanic (3.05%), White (40.7%), Pacific-Islander (less than 1%), Native American (less than 1%), and Other (2.59%). Approximately 25.7% of the original sample was female, with 73.8% male and less than 1% reporting as non-binary. Students also reported their status as U.S. citizens (78.36%), Permanent Residents (5.06%), or International (16.26%) with the most common countries of origin China (16.16%) or India (4.21%). The demographic characteristics of the student population as used in the evaluation of our two research questions are summarized in Table 2.

Table 2: Population Characteristics

	Asian	Black	Latino	Native American	Pacific Islander	White	Other	Total
Total	567	39	40	3	4	533	34	1220
Gender								
Male	416	30	31	3	4	399	24	976
Female	149	9	9	0	0	128	10	340
Country of Origin								
U.S. Citizen	313	34	37	3	4	520	23	934
Permanent Resident	50	3	1	0	0	9	4	67
International Students	199	1	1	0	0	4	7	212
Learning Environment								
Remote	272	13	17	0	0	236	11	549
Traditional	295	26	23	3	4	297	23	671

IRB (Internal Review Board) approval was obtained to recruit and survey the 1327 undergraduate students who participated in this study (STUDY00000378). All participation was voluntary, and students were informed that their survey responses would remain confidential. In order to recruit participants, researchers solicited faculty to offer the survey to their students. In several courses, students were incentivized with a nominal amount of extra credit (worth 0.2 - 0.5 percent of their final grade) or survey completion replaced their lowest assignment score for the course in which they were recruited. In one traditional learning course, students completed a paper-and-pencil copy of the survey while in all remaining courses, students completed an electronic survey online and outside of class. Some students were present in more than one class; since survey questions referred to a specific class ("this class"), duplicate surveys were retained for analysis. All results were cross-sectional.

Instruments

The instrument used to collect data for this study was a student survey which asked students to report their perceptions of various items related to peer support, engagement, belonging, peer harassment, task value, self-efficacy, TA and faculty support, and TA and faculty interactions and as well as multiple demographic items. The survey also included five short answer questions which asked students to identify their primary expectations for faculty support (one question), TA support (one question), and peer support (three questions).

This study used the following data for analysis (Table 3):

- Faculty support: eleven previously validated, Likert-scale items
- Faculty support expectations: one short-answer question
- TA support: eight previously validated, Likert-scale items
- TA support expectations: one short-answer question

The faculty support scale was developed using items from previous studies in K-12 [29] and higher education [30] and is described in more detail in by Wilson, Summers, and Wright [9]. Students responded to a 5-point Likert-scale (strongly disagree to strongly agree) for each item on the faculty support scale. Cronbach's alpha (reliability) for the faculty support scales in this study was 0.92. Internal reliabilities above 0.7 are considered suitable to retain scales for further analysis [31].

The TA support scale was adapted from the faculty support scale and analyzed in a previous study [32] to arrive at eight total items measured on the same five-point Likert-scale as the faculty support scale. Cronbach's alpha (reliability) for the TA support scales in this study was 0.92. Thus, the TA support scale was also considered suitable for subsequent analyses.

Sample items for both faculty and TA support scales are outlined in Table 3.

Data Analysis

Both ordinal (Likert-scale) and nominal (coded short answer data) were analyzed using R (4.0.3) and R studio (version 1.3.1093). Descriptive statistics were calculated for the faculty and TA support scales as were skewness and kurtosis to verify suitability for statistical analysis.

To support the evaluation of RQ1, an independent samples t-test was first used to compare two groups: (a) students enrolled in remote learning classes and (b) students enrolled in traditional classes. Additional independent samples t-tests were used as needed to account for course by course variation. Homogeneity of variance was not assumed, and Bonferroni's correction was used in all analyses of means to account for multiple hypothesis testing and to reduce Type 1 error. Though non-parametric Mann Whitney tests are typically used for ordinal, Likert-scale data, a recent study [33] demonstrates t-tests and non-parametric Mann Whitney tests yield near identical Type 1 error rates without major compromise to statistical power. Thus, independent samples t-tests were deemed appropriate for use in this study.

Table 3: Faculty and TA Support Measures

Measure	*Sample Items*
Perceptions of Faculty Support 5-point Likert-scale ($\alpha = 0.92$)	The professor this class is willing to spend time outside of class to discuss issues that are of interest and importance to me. The professor in this class treats me with respect. The professor has clearly explained course goals and requirements. The professor (primary instructor) is often funny or interesting.
Expectations of Faculty Support Short Answer	What one action can your professors at UW take to best support you in your classes when they are delivered on-line like they are during spring quarter 2020 (please be as specific as possible)?
Perceptions of TA Support 5-point Likert-scale ($\alpha = 0.92$)	The TA for my quiz section in this class often stays after class to answer questions. At least one of the TAs in this class is willing to spend time outside of class to discuss issues that are of interest and importance to me. At least one of the TAs or secondary instructors in this class is interested in helping me learn.
Expectations of TA Support Short Answer	What one action can your TAs at UW take to best support you in your classes when they are delivered on-line like they are during spring quarter 2020 (please be as specific as possible)?

To evaluate RQ2, two short answer questions from the survey were qualitatively coded using a thematic analysis approach [34] then analyzed quantitatively using chi-square tests of independence. The data were coded by a single researcher using a practitioner's perspective and a focus on semantics. The codes derived emphasize broad areas of teaching and delivery, categorizing components of instruction explicitly referenced in student responses rather than deducing meaning from them, in an effort to reduce single coder bias. The researcher first gained familiarity with the data, thoroughly reviewing the overall data set prior to analyzing individual responses. Next, the researcher deductively coded the responses, creating the primary codes described below. After initial coding, secondary codes within each primary category were identified and the data was inductively coded to reflect these multiple categories. Both primary and secondary codes were reviewed during multiple passes to ensure they accurately reflected the data, then they were named and defined in the codebook. The researcher created a decision tree (Figure 1) to make the coding of responses explicit and replicable. Figure 1 shows the decision tree used to code responses referencing faculty support. A similar decision tree was used to code responses referencing TA support. Using the decision tree, all coding was Member

Checked [35] by another expert in the field of engineering education research as a means of error reduction and mitigation of single coder bias. Thirty-nine responses were randomly selected to be Member Checked. Across the selected responses, two (5%) were different across coders. This error rate was deemed acceptable for moving forward with further analysis.

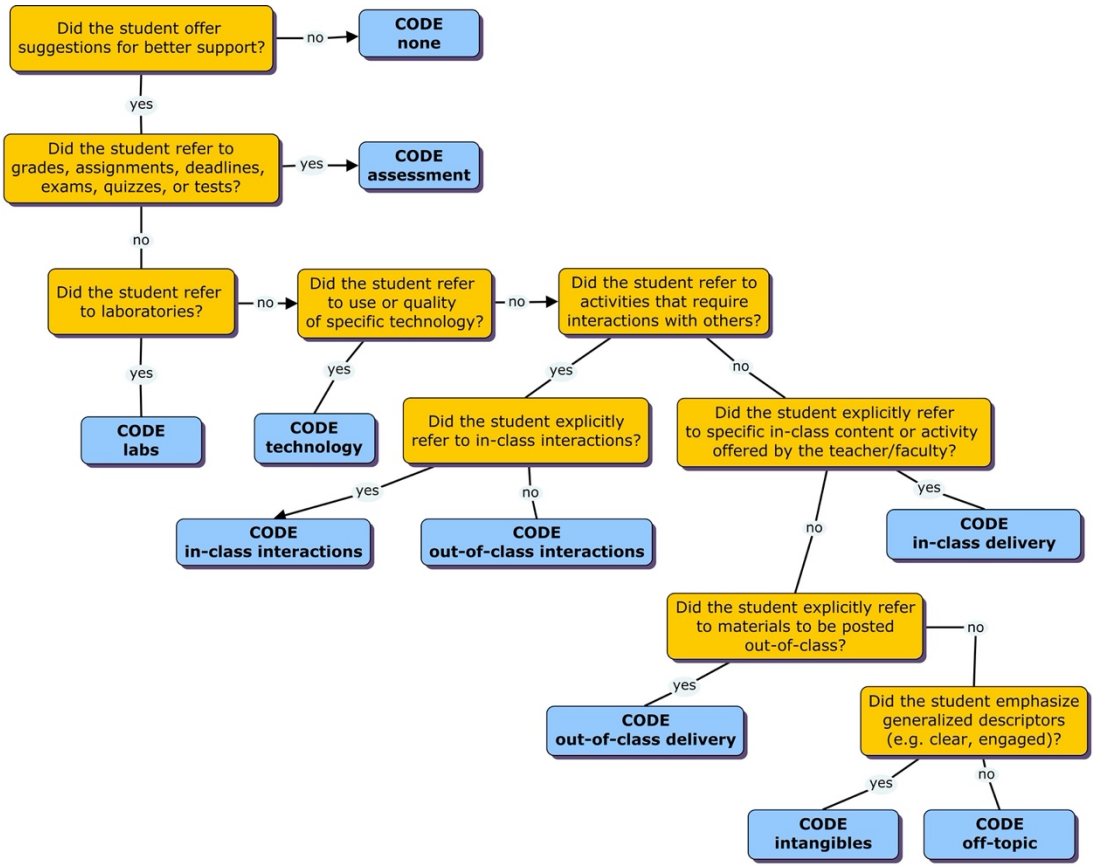

Figure 1: Faculty Support Qualitative Coding Decision Tree

The primary codes are defined as:

- Assessment: encompasses flexibility around deadlines, level of accountability, workload, speed of grading, nature of grading, quizzes, and tests.
- Labs: encompasses the facilitation of and support provided within lab sections.
- Educational Technology: encompasses audio and video quality, as well as use of visual aids, polling tools, forum tools, simulations, and other technological aids.
- In-Class Interactions: encompasses interactions with others during class time, including quantity of student and teacher questions, number of breaks, and facilitation of peer-to-peer interaction.
- Out-of-Class Interactions: encompasses any and all interactions outside of formal, regularly scheduled class sessions, including the quantity and type of interaction (e.g., office hours), as well as accessibility of faculty outside of class.
- In-Class Delivery: encompasses the format of the course, pacing of lecture, nature and quantity of examples provided in class, amount of active learning, and depth of coverage.

- Out-of-Class Delivery: encompasses the use of any supplemental videos, readings, notes, or examples provided outside of class, or lack thereof, as well as course logistics, including ease of finding materials and timeliness of their availability.

Additional codes included off topic responses, empty (none) responses, and responses referencing intangible, personality characteristics of faculty and TAs (flexibility, preparedness, organization, empathy, clarity, etc.).

After the coding was complete, categories were tallied and chi-square tests of independence were used to evaluate whether the responses of students in remote learning were different from those in traditional learning. Secondary codes within primary categories which exhibited differences in the frequency of student responses were then analyzed qualitatively to gain additional insight into differences in student expectations of faculty and TA support across settings.

Results

Results were analyzed using both quantitative and qualitative analysis methods. For the first research question (RQ1), faculty and TA support in traditional and remote learning were compared using multiple independent samples t-tests to identify significant differences between the two settings. The second research question (RQ2) was analyzed using deductive coding of short answer responses to broadly categorize student expectations for faculty and TA support. Then, chi-square tests of independence were used to understand if differences emerged between student expectations in remote vs. traditional learning and in a final qualitative analysis step, inductive coding was used to generate sub-categories within each broader category to gain deeper insight into how students expected faculty and TAs to support them.

Research Question #1 (RQ1)

Did student perceptions of faculty and TA support differ in traditional vs. remote learning?

Descriptive statistics of faculty and TA support are summarized for remote and traditional learning in Table 4. Skewness and kurtosis of faculty and TA support were first calculated to confirm the normality of the sample data in each setting and to determine the best choice of statistical tests to compare remote and traditional learning. Skewness values ranged between -0.41 (symmetrical) and -0.71 (moderate negative skew) indicating that faculty and TA support were biased or skewed toward more positive responses but sufficiently symmetric to proceed with assumptions of normality [31]. Kurtosis of faculty and TA support ranged between 2.84 and 3.48 indicating that none of the data exhibited outliers that were significantly more extreme or less extreme than a normal distribution [31]. Thus, subsequent statistical analyses proceeded with assumptions of normality of the data.

Table 4: Descriptive Statistics for Faculty and TA Support (all courses

	Faculty Support			TA Support		
	Traditional	Remote	Total	Traditional	Remote	Total
N	721	606	1327	721	606	1327
Mean	3.96	3.95	3.96	3.61	3.67	3.64
Median	4	4	4	3.67	3.75	3.75
SD	0.64	0.73	0.68	0.77	0.77	0.77
Skewness	-0.56	-0.71	-0.65	-0.46	-0.41	-0.43
Kurtosis	3.48	3.33	3.46	3.00	2.84	2.93

A broad comparison of remote and traditional learning which included all courses studied failed to reject the null hypothesis (t (1211.8)=.25, *p-value*=.80) that faculty support in remote learning (M=3.95, SD=0.73) was the same as that in traditional learning (M=3.96, SD=0.64). The same was true for TA support. Perceptions of TA support in traditional learning (M=3.61, SD=0.77) were also not significantly different, (t (1325)=-1.46, *p-value*=.15), from TA support in remote learning (M=3.67, SD=0.77).

The lack of significant results raised the possibility that the junior level courses in remote learning (which were not studied in traditional learning) were confounding the analysis. A subsequent comparison of junior level courses (M=4.25, SD=.61) to sophomore level courses (M=3.84, SD=.74) in remote learning indicated that students perceived significantly higher levels of faculty support in junior level courses compared to sophomore level courses (t (333.52)=-6.75, *p-value*<.001). When comparing only the sophomore level courses which were offered across the remote and traditional settings, perceived faculty support was significantly lower in remote learning (M=3.84, SD=.74) as compared to traditional learning (M=3.96, SD=.64), t(842.5)=2.70, *p-value*<.01. These same analyses were repeated for TA support, however, no significant differences were found for TA support between remote and traditional learning.

Table 5: Multiple Comparisons of Faculty and TA Support

Group	Faculty Support					TA Support				
	N	*Mean*	*Median*	*SD*	*p*	*N*	*Mean*	*Median*	*SD*	*p*
Comparison by Setting (All Courses)										
Remote	606	3.95	4.00	0.73		606	3.67	3.75	0.77	
Traditional	721	3.96	4.00	0.64		721	3.61	3.67	0.77	
Comparison by Setting (Sophomore Level Courses Only)										
Remote	448	3.84	3.91	0.74		448	3.64	3.75	0.77	
Traditional	721	3.96	4.00	0.64	**	721	3.61	3.67	0.77	
Comparison by Level (Remote Setting Only)										
Sophomore	448	3.84	3.91	0.74		448	3.64	3.75	0.77	
Junior	158	4.25	4.27	0.61	***	158	3.75	3.75	0.77	

** p < 0.05; ** p < 0.01; *** p < 0.001*

While these results provide general conclusions regarding faculty and TA support in traditional and remote settings, they did not allow more nuanced differences across individual courses to emerge. These possibilities are addressed next.

Course-by-Course Comparisons: To understand if there were individual course differences in how students perceived faculty and TA support, independent samples t-tests were used to compare means in remote vs. traditional learning for courses in which data were available for both settings. ANOVAs and post hoc tests to compare pairs of individual courses were not used in this analysis because control of type 1 errors (i.e., false positives) was likely to obscure significant results given the number of pairwise comparisons associated with such a large

number of courses [36]. Instead, select pairwise comparisons were conducted using independent samples t-tests between courses that were taught both in remote and traditional learning. Seven of 12 courses (58.3%) were taught in both settings (ME1, ME2, ME3, EE1, EE2, EE3, EE4), and three of these courses (ME1, ME2, EE4) were taught in both settings and by the same instructor. These seven courses were all offered at the sophomore level (Table 3).

Faculty Support: All seven course-by-course comparisons rejected the null hypothesis (Table 6). In four of the seven courses (ME2, ME3, EE1, EE2), students perceived significantly higher faculty support in traditional compared to remote learning and in the remaining three courses (ME1, EE3, EE4), the opposite was true. Among the significant results, three had low practical significance (Cohen's D < 0.49), three had moderate practical significance (Cohen's D between 0.5 and 0.79), and one had high practical significance (Cohen's D > 0.8) [37].

Further, three of the seven courses (ME1, ME2, EE4) were taught by the same instructor. Students in ME1 and EE4 reported significantly higher faculty support in remote than traditional learning (ME1, EE4) while in ME2, the opposite was true.

Table 6: Results of Course-by-Course Comparisons for Faculty Support

	Traditional		Remote			
Course	*N*	*Mean (SD)*	*N*	*Mean (SD)*	*p*	*Cohen's D*
ME1[2]	140	3.76 (0.59)	73	4.04 (0.62)	**	0.46
ME2[2]	20	3.91 (0.93)	6	3.68 (0.55)	***	0.28
ME3[1]	218	4.12 (0.56)	143	3.64 (0.73)	***	0.76
EE1[1]	175	3.93 (0.65)	72	3.67 (0.81)	*	0.38
EE2[1]	70	4.02 (0.74)	57	3.59 (0.78)	**	0.58
EE3[1]	63	3.89 (0.66)	70	4.22 (0.53)	**	0.56
EE4[2]	35	3.88 (0.62)	27	4.46 (0.60)	***	0.95

* p<0.05; **p<0.01; ***p<0.001

[1] Course offered in both traditional and remote settings, but not by the same instructor

[2] Course offered in both settings and by the same instructor

TA Support: Among student reports of TA support, four of seven course-by-course comparisons rejected the null hypothesis (Table 7). In three of the seven courses (ME1, ME2, EE4), students perceived significantly higher TA support in remote compared to traditional learning and all three courses were taught by the same three instructors in remote and traditional learning. In the remaining course (EE2), the opposite was true. Students perceived significantly lower TA support in the remote learning offering of EE2 than in the traditional offering. Among the significant results, three had low practical significance (Cohen's D < 0.49) and one had high practical significance (Cohen's D > 0.8) [37].

While the faculty and TA support scales provided insight into how well students perceived their instructors and TAs were supporting them in a particular course, differences that emerged from this analysis could be influenced by multiple factors. One possibility is that differences (or lack thereof) in perceived faculty and TA support reflected a change in student expectations for instructional support. This possibility is investigated in RQ2, next.

Table 7: Results of Course-by-Course Comparisons for TA Support

Course	Traditional		Remote			
	N	Mean (SD)	*N*	Mean (SD)	p	Cohen's D
ME1[2]	140	3.93 (0.56)	73	4.18 (0.51)	**	0.45
ME2[2]	20	3.92 (0.70)	6	3.96 (0.40)	***	0.07
ME3[1]	218	3.10 (0.75)	142	3.09 (0.72)		0.02
EE1[1]	175	3.69 (0.68)	73	3.78 (0.68)		0.13
EE2[1]	70	3.93 (0.72)	57	3.60 (0.71)	*	0.46
EE3[1]	63	3.95 (0.67)	70	3.87 (0.62)		0.13
EE4[2]	35	3.58 (0.71)	27	4.17 (0.48)	***	0.96

* p<0.05; **p<0.01; ***p<0.001

[1] Course offered in both traditional and remote settings, but not by the same instructor

[2] Course offered in both settings and by the same instructor

Research Question #2 (RQ2)

Did student expectations for faculty and TA support differ in traditional vs. remote learning?

Short answer questions regarding what students expected from faculty and TAs were analyzed first by deductively coding student responses into broad categories that identified where in course planning and delivery changes were desired: out of class (interactions, delivery), in class (interactions, delivery), assessment, laboratory support, and educational technology. These results are summarized in Table 8 for faculty support and in Table 10 for TA support. Some students did not have any additional suggestions to provide for faculty or TAs to support their learning. These responses were coded as "None." Some responses were off topic in that neither faculty or TAs had control over what was being requested. These responses were coded as "Off Topic." Finally, some responses were descriptive and not specific enough to place into any primary category of course planning and delivery. These responses were coded as "Intangible."

In order to understand whether student expectations shifted from traditional to remote learning, chi-square tests of independence were conducted between the two settings. For faculty support, seven categories were compared between the two settings. Lab support was largely regarded as a TA support duty and was discarded from the analysis due to the small number of responses. Off topic and intangible responses were also discarded from the analysis due to their heterogeneous nature (i.e., responses in this category represented multiple ideas). Chi-square tests of independence of the remaining categories revealed that there were significant differences in student expectations of faculty support between traditional and remote learning (Table 8). The largest differences in student expectations emerged with regard to assessment (5.1% of students prioritized expectations for assessment in traditional learning vs. 13.2% in remote learning) and in (in class) delivery (27.7% of student responses referred to this category in traditional learning vs. 12.5% in remote learning). Expectations for the use of educational technology also rose from traditional learning (1.8% of student responses) to remote learning (4.7% of student responses).

Table 8: Student Expectations for Faculty Support						
	Traditional		Remote		Chi-Square Tests	
Category of Response	*N*	%	*N*	%	X^2	*p* value
Primary Codes						
Assessment	36	5.1%	100	13.2%	80.88	p<0.001
(in class) Delivery	196	27.7%	95	12.5%		
(in class) Interactions	25	3.5%	36	4.7%		
(out of class) Delivery	212	29.9%	230	30.3%		
(out of class) Interactions	122	17.2%	152	20.0%		
Educational Technology	13	1.8%	36	4.7%		
None	20	2.8%	26	3.4%		
Discarded Categories						
Labs	5	0.7%	13	1.7%	N/A	N/A
Intangible	75	10.6%	69	9.1%		
Off Topic	6	0.8%	2	0.3%		
Total	**710**	**100%**	**759**	**100%**		

A second, inductive coding pass in the assessment, (in class) delivery, and educational technology categories provided insight into how student expectations of faculty had shifted from traditional to remote learning (Table 9).

Table 9: Student Expectations for Assessment, (in class) delivery, and Technology				
	Traditional Learning		Remote Learning	
	N	%	N	%
Assessment				
Flexibility (deadlines, extra credit, grading structure)	8	18%	60	52%
Stakes (increased use of lower stakes grading)	4	9%	12	10%
Accountability (ensuring honesty and participation)	1	2%	13	11%
Other	32	72%	31	27%
Total	45	100%	116	100%
(in class) Delivery				
In Class Examples	78	42%	33	39%
Pace	29	16%	9	11%
Depth (of coverage)	17	9%	0	0%
Other	61	33%	42	50%
Total	185	100%	84	100%
Educational Technology				
Video Quality	1	10%	12	34%
Audio Quality	0	0%	8	23%
Polling Tools	1	10%	9	26%
Other	8	80%	6	17%
Total	10	100%	35	100%

Unlike in traditional learning, a large number of students in remote learning expressed a desire for increased flexibility regarding exams and deadlines. For example:

> Being flexible with exam and grading structures has been helpful, and this continual action will be beneficial for future online courses. (EE2, Remote)

The uptick in responses regarding assessment also included increased calls for accountability measures to ensure academic integrity and engagement among classmates. For instance:

> Professors can proctor tests with students required to turn on their cameras to maintain academic integrity. (EE5, Remote)

> Even though classes are being held online, I feel professors should promote active participation during class, by requiring webcams and attendance. (EE6, Remote)

Regarding in class delivery, in both settings, students frequently expressed a desire for faculty to use in class examples to support their understanding of the material. In remote learning, the number of responses that included requests for examples increased alongside a desire for faculty to slow down and check in with students regarding the appropriate pace of in class delivery. For example:

> Allow for flexibility by providing accessible recordings. Be sensitive to the speed of the lecture and adjust based on student feedback (EE2, Remote)

Some students made it very clear that they just wanted remote learning to be like normal:

> Continue to teach the same as they did in class. I think some professors have this idea that because classes are online, they have to completely restructure their class. Most of the time, classes can just proceed as normal (EE3, Remote)

Finally and not surprisingly, with regard to educational technology, students had a lot more to say about the use of polling, forum, and other educational tools to support the remote learning experience than traditional learning. In some courses, video and audio quality were sufficiently inconsistent that ensuring high audio and video quality both for pre-recorded and live video lectures rose to the top of students' priority list.

A closer look into the intangible expectations of students (Figure 2) revealed that while in traditional learning, appeals to faculty to be clear in their instruction dominated all other responses, multiple appeals rose to the top in remote learning. These appeals included requests for faculty to be understanding, caring, clear, engaging, and flexible.

(a) (b)

Figure 2: Intangibles among Student Expectations
Intangible Descriptors that could not be placed into any one of the primary codes for (a) traditional learning; and (b) remote learning.

For TA support (Table 10), seven categories were compared between the two settings. Educational technology was largely regarded as a faculty duty and was discarded from the analysis due to the small number of responses. Off topic, overall, and intangible responses were also discarded from the analysis due to their heterogeneous nature. Chi-square analysis of the remaining categories revealed that there were significant differences in student expectations of TAs between traditional and remote learning.

Table 10: Student Expectations for TA Support

	Traditional		Remote		Chi-Square Tests	
Category of Response	*N*	%	*N*	%	X^2	*p* value
Primary Codes						
Assessment	14	2.0%	24	3.4%	102.43	p<0.001
(in class) Delivery	219	30.2%	125	17.5%		
(in class) Interactions	28	3.9%	53	7.4%		
(out of class) Delivery	25	3.4%	42	6.0%		
(out of class) Interactions	132	18.2%	311	44.0%		
Labs	19	2.6%	42	6.0%		
None	27	3.7%	56	8.0%		
Discarded Categories						
Educational Technology	5	0.7%	11	1.5%	N/A	N/A
Overall	155	21.3%	7	1.0%		
Intangible	90	12.4%	40	5.6%		
Off Topic	12	1.7%	2	0.3%		
Total	**726**	**100%**	**713**	**100%**		

The largest differences in student expectations emerged with regard to out of class interactions (18.2% of students prioritized expectations for out of class interactions in traditional learning vs. 44% in remote learning) and in class delivery (30.2% of student responses referred to this category in traditional learning vs. 17.5% in remote learning). Expectations for in class interactions also changed between traditional learning (3.9% of student responses) and remote learning (7.4% of student responses). A second, inductive coding pass in the (out of class)

interactions, (in class) delivery, and (in class) interactions categories provided insight into how student expectations of TAs had shifted from traditional to remote learning (Table 11). In terms of (out of class) interactions, a large number of students in remote learning desired increased TA availability in the form of either one-on-one or group office hours. For example:

> Lots of office hours are helpful. It can be really hard to retain information when you're on the computer all day and having that extra low-stress time to ask questions helps a lot. (ME1, Remote)

In the (in class) delivery category, a much higher number of students referenced a desire for in-class examples in traditional learning compared to those in remote learning. However, both groups emphasized a need for examples to support their learning, particularly with regard to what would be seen on exams and quizzes:

> I think going over test-style questions in lab section would be really helpful since there are not traditional practice tests for the online platforms. (EE1, Remote)

Regarding the (in class) interactions, students in traditional learning held no expectations that TAs would be present during the main lecture period. However, during remote learning, this expectation shifted dramatically as students uniquely expected TAs to be part of lecture periods taught by the primary faculty:

> Answer the question in Zoom chat when prof didn't see it. (EE5, Remote)

> Attend lectures to answer private questions when the instructor is teaching. (ME1, Remote)

Table 11: Student Expectations for (in class) delivery, (in class) interactions, and (out of class) interactions

	Traditional Learning		Remote Learning	
	N	%	N	%
(in class) Delivery				
In Class Examples	97	52%	36	50%
Active Learning	27	14%	7	10%
Audio Quality	27	14%	0	0%
Other	37	20%	29	40%
Total	188	100%	72	100%
(in class) Interactions				
Facilitation (of peer interactions)	1	2%	11	19%
Student Questions	29	62%	43	73%
Teacher Questions	17	36%	5	8%
Total	47	100%	59	100%
(out of class) Interactions				
Quantity	60	46%	135	43%
Speed (responsiveness)	13	10%	64	20%
Type (office hours, review sessions, etc.)	13	10%	43	14%
Other	45	34%	75	24%
Total	131	100%	317	100%

Discussion

Prior to the COVID-19 pandemic, students had opportunities to interact with faculty and TAs both formally (i.e. during lectures and labs) and informally (i.e. during office hours and in passing). When instruction shifted to remote delivery, the quantity and nature of both formal and informal interactions shifted as faculty and TAs quickly did their best to adapt to the change in setting. As such, we expected to see differences in both students' perceptions of faculty and TA support as well as their expectations of faculty and TAs across remote and traditional learning.

The present study demonstrates differences in students' perceptions and expectations of faculty and TAs across remote and traditional instructional settings. Significant differences emerged across traditional and remote groups and between course-by-course comparisons of faculty support, as well as across course-by-course comparisons of TA support. Further, when students were asked to describe what they were seeking from their faculty and TAs, significant differences emerged between remote and traditional learning.

Research Question #1 (RQ1)

Did student perceptions of faculty and TA support differ in traditional vs. remote learning?

Results from this research question did not confirm the generally accepted notion that the quality of higher education dropped as a result of the transition to remote learning. While students reported faculty support to be significantly lower in remote learning for most courses offered in both settings, this was not always true. Interestingly, in two of three courses which were taught in both settings and by the same instructor, student perceptions of faculty support were significantly higher in remote learning as compared to traditional learning. In both cases, the instructors were female.

One possible explanation for the differences in perceptions of faculty support is that the structure of class sessions contributed to this result. In fact, in four of five courses where faculty support was significantly lower in remote compared to traditional learning, the instructor chose to pre-record lectures and conduct office hours or question and answer sessions during the regularly scheduled class period. In two of the courses where faculty support was significantly higher in remote compared to traditional learning, the instructors provided class sessions that were very similar to traditional learning -- mixing problem solving in with regular lecture and providing opportunities for students to solve problems on their own.

When comparing courses taught both traditionally and remotely, significant differences emerged between students' perceptions of faculty support across courses. However, the sample of courses taught across both settings was limited to the sophomore level, as junior level courses were only surveyed during remote instruction. In subsequent comparison, there were significant differences between junior and sophomore level students' perceptions of faculty support. It is possible that the higher perceptions of faculty support at the junior level could be attributed to changes in students' perception of faculty due to class size. The junior level courses studied were smaller than the sophomore level courses, and research from Spooren, Brockx, and Mortelmans [38] has demonstrated that increasingly larger class sizes are correlated with increasingly lower student evaluations of teaching (and by extension -- student satisfaction).

Regarding TA support, overall group comparisons failed to reject the null hypothesis that students' perceptions of TAs were different across remote and traditional learning. However, course-by-course comparisons revealed significant differences between students' perceptions of TA support across settings in four of seven classes. In three of the four courses where significant differences were present, student perceptions of TAs were higher in remote learning. To better understand the effective practices of TAs in courses where students perceived TA support to be higher, we looked at student expectations (RQ2). Overwhelmingly, students' responses emphasized the importance of interactions with TAs which suggests that these interactions were of great value to them. Upon further inspection, we learned that TAs in the remote learning courses that resulted in higher perceptions of support had maximized their availability during remote learning by holding frequent office hours. These shifts were, in part, made to accommodate students learning across various time zones. By offering a broader spectrum of office hours to accommodate students in different time zones, TAs were likely seen as more available overall.

Research Question #2 (RQ2)

Did student expectations for faculty and TA support differ in traditional vs. remote learning?

We hypothesized that there would be differences in expectations of faculty and TAs between traditional and remote instruction, as students' needs were likely different across instructional settings given the shifts in the nature of instruction. As hypothesized, expectations of faculty and TAs shifted as students' needs shifted.

Expectations of faculty in the remote setting included increased desire for flexibility and leniency, academic integrity and accountability, and high audio and video quality. The increase in requests for flexibility is unsurprising given the context of the COVID-19 pandemic. As Bronfenbrenner's ecological systems theory [39] suggests, learning is situated within the context of an individual's environment, including the broader state of society. Students desired a softness and lenience from faculty which suggests they were feeling the effects of the stress of their environment. Many students also expressed concerns regarding their peers' academic integrity during assessments and lectures, requesting that students be urged to have their cameras on. When shifting to remote learning, opportunities to cheat increased without a precedent set for how to manage academic honesty. And unsurprisingly, students also desired high audio and video quality so that they could see and hear faculty lectures clearly.

Expectations of TAs in the remote setting included an increased desire for office hours, as well as communication during class lecture. Students' expectations for out-of-class interactions with TAs increased dramatically in remote learning, as interactions that would otherwise be informal in traditional learning had to be formalized in remote learning. Informal interactions with TAs likely offer a unique, relatable element that students may not get from their interactions with faculty, as suggested by research from Kendall and Schussler [23]. Students requested more group and one-on-one office hours with TAs to review questions and examples from class. They also expressed the desire for TAs to communicate with students more during synchronous lectures, utilizing Zoom's chat feature to answer students' questions. Interestingly, audio quality concerns seemingly disappeared in remote learning. This suggests that challenges with hearing TAs that may have been present in-person due to varying levels of audibility and comfort speaking in front of large groups were mitigated in remote learning.

In all, within the context of remote instruction, students increasingly desired visibility. Students were hungry for interaction with both their faculty and TAs. Bolliger and Martin [14] confirm that in the context of online instruction, presence and personal contact are highly valued by both students and faculty. In all, the level of visibility of that faculty and TAs offer students has a meaningful impact on the level of support that students feel in the context of remote instruction. Interactions, no matter how small, cannot be taken for granted; faculty and TA connections with students are powerful, now more than ever.

Limitations

This study offers a unique contribution to the instructional support literature by focusing on students' distinct perceptions of faculty and TA support during the COVID-19 pandemic; however, there are limitations to generalizability and validity of findings. Since the study focused on the student experience at a single institution and in a limited number of majors (primarily electrical and mechanical engineering), the generalizability to other academic settings may be limited. The context of the COVID-19 pandemic also presents a possible confounding variable that may limit generalizability. Additionally, the remote learning data were collected in the first full term of remote learning and do not reflect longer term adjustments that students may have made as remote learning extended into the 2020-2021 academic year. Further, data from the traditional learning setting were collected during different academic quarters, and grouping these courses together presents the possibility that individual course differences went unseen. In general, course by course and instructor by instructor differences present possible confounding variables that were not able to be resolved within the scope of this paper. The surveyed population represents a convenience sample and results may be subject to self-selection bias, as survey completion was not incentivized and was provided as a form of course evaluation. It is plausible that students who chose to participate might have been motivated to respond in order to communicate either extreme positive or extreme negative perceptions. Thus, the respondents may not be reflective of students who had a neutral or average experience. Because qualitative coding of short answer items was completed by one researcher, there is also a possibility of single coder bias. Lastly, within the scope of this paper, we were not able to discuss differences across students' experiences based on demographics, including racial identity, gender identity, socio-economic status, (dis)ability status, country of origin, native language, etc.. It is well known that people who identify as Black, Indigenous, and non-Asian People of Color, as well as those who identify as women, non-binary, or transgender are underrepresented in the field of engineering [40], [41], [42]. Further research could illuminate what more faculty and TAs can do to prioritize supporting historically marginalized groups in the context of remote instruction.

Implications

Nevertheless, the quantitative data analysis results from this research complement existing studies as to the importance of instructional support in college. Even under emergency circumstances, the care and support that both TAs and faculty give can provide an experience that is as good or better than the pre-crisis circumstances. What faculty and TAs did in courses where students' sense of support was reported to be higher in remote than traditional learning merits further study as it provides important insight into instructor behaviors that can make a large difference in the student experience. Further, this study has underscored the importance of student expectations as well as their perceived sense of support. Shifting expectations can render

some instructional choices more or less effective depending on the nature of the shift. In combination, these insights highlight the fact that no magic recipe for exemplary teaching and supporting students exists and that individual faculty and TAs can, with supporting information about student expectations, upgrade the quality of instruction and support in engineering in different ways.

Concluding Remarks

The COVID-19 pandemic forced faculty and TAs to quickly adapt their teaching practices as courses that were traditionally held in-person moved to online delivery. In this study, we found that both perceptions of and expectations for faculty and TA support shifted between traditional and remote learning. In some courses, students reported higher levels of faculty and TA support in traditional learning, and in other courses, they reported higher levels of faculty and TA support in remote learning. The commonality among courses where students reported higher levels of faculty and TA support in the remote setting was an increase in visibility through synchronous lectures and increased offerings of office hours. Expectations of faculty and TAs in remote learning were also tied together by a common theme of improved visibility, both in a literal and metaphorical sense. Students desired high audio and video quality, transparent academic integrity, frequent communication, and increased availability. During a time when our interactions are filtered through what comes across our screens, visibility matters.

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