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What Do Students Need from other Students? Peer Support During Remote Learning

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What do Students Need from other Students?
Peer Support during Remote Learning

Abstract

The COVID-19 pandemic has isolated students as they work from home, often in different time zones and in different locations around the world. In traditional learning settings, college students have ample opportunities for face-to-face interactions to work and learn together. In contrast, in remote learning settings, social isolation drastically reduces these opportunities, which puts the responsibility on faculty and administrators to offer alternative means for students to develop peer support.

This research collected over 1,000 surveys and used a convergent parallel mixed-methods approach to investigate peer support in both remote and in-person settings. Students from 19 courses in junior and sophomore level classes in electrical and mechanical engineering at a large public research institution reported existing and preferred levels of peer support within in-person and remote learning settings. An independent sample t-test and Mann Whitney test conducted between all courses showed that there was no significant difference in perceived peer support between remote and in-person learning environments. However, when these tests were repeated pairwise for those individual courses that were surveyed both during in-person and remote learning settings, significant differences were observed in students' perceived peer support in some courses but not others. These results suggested that course-to-course and instructor-to-instructor variations overshadowed any differences in perceived peer support between remote and traditional learning.

Analyses of existing peer support were supplemented by qualitative analysis of short answer questions regarding student expectations for peer support. Short answer questions were deductively coded according to a cooperative learning framework. The qualitative data indicated that the tools needed to obtain support in both situations were largely the same, but differed in implementation. This is demonstrated by student responses that were unique to the remote learning context, such as the importance of peers behaving respectfully in chats and being considerate of others in Zoom sessions.

This study underscores the importance of peer support regardless of setting. During remote learning, engineering students adapted to the restrictions in peer interaction incurred by the COVID-19 pandemic by utilizing a variety of tools such as Canvas, Zoom, or Slack and developing rules of conduct for chat, audio, and video.

Introduction

At the beginning of 2020, COVID-19 was declared a pandemic by the World Health Organization (WHO). Since that time, COVID-19 has affected lives all over the world [1]. WHO recommended social distancing practices to reduce transmission of the virus. In some countries, including the U.S., this social distancing practice was mandated, which resulted in the closure of schools, colleges, and universities to protect the welfare of faculty, staff, and students. Many educational institutions opted to switch from face-to-face teaching to online learning by

using the internet and networking infrastructure that has made it possible for people to interact with each other regardless of where they live. The transition posed a huge challenge to faculty because the methods used for teaching in conventional, in-person learning environments differ significantly from those used in remote learning. Instructors had to quickly develop emergency remote teaching (ERT) methods so that students could continue to learn despite the crisis [2]. In such circumstances, students did their best to adapt to the new way of learning, but the change in their educational experience was drastic. In particular, students lost the opportunity to engage with peers in person and form personal connections with them. This is especially concerning given that, as Alexander Astin writes, “the student's peer group is the single most potent source of influence on growth and development during the undergraduate years" [15, p. 54][3].

The existing knowledge base repeatedly validates the importance of peer support in both social and academic systems in college. Ideally, students should have all the resources they need to communicate with peers, whether in a physical or virtual learning environment. However, we believe that due to the abrupt and rapid change in the style of teaching caused by the pandemic, teachers did not have adequate time to develop teaching methodologies that would provide students with the same amount of peer help in an online setting as they would in a traditional learning environment. The aim of the study is to determine if those gaps changed, how much peer support students perceived in their classes, and if their expectations for such peer support shifted as a result of the transition from traditional to remote learning.

Background

For many college students, the undergraduate years are the first time that they have spent significant time away from their families. Not surprisingly, students begin to spend most of their social time with their peers and draw much of their social and emotional support from their peer groups. In such circumstances, peers can have both positive and negative impacts on the college experience. For instance, students can easily be influenced by one another to use drugs or alcohol, particularly in the freshman year. On the other hand, students can experience peer pressure to work towards better grades, leading some students to perform better than they otherwise would [4]. Social categorization further complicates peer relationships -- for example, causing those of similar race and ethnicity to be drawn to one another and to avoid others who are dissimilar. People feel more connected with others when they share the same culture and tend to become judgmental when they interact with people from different cultures. Individuals are more likely to resolve conflict quickly with someone from a similar cultural background as compared to someone from another culture [5]. In an educational context, cultural diversity brings students together, but it also creates a communication barrier between students and dissimilar peers. Students whose first language is not English might feel hesitant to share their ideas when studying in a group, or sometimes their words may be perceived differently by other group members or even disrespectful due to their difficulty with the language or mode of expression. In these scenarios, time spent with peers becomes a time of isolation and anxiety rather than time for teamwork and bonding. The bottom line is that time spent with peers in college is complex and can lead to negative or positive outcomes or both. These nuances regarding the impact of peer groups have produced mixed results in the literature on this topic. Mixed results on multiple fronts call for the need for more research on peer support, which *this study* offers in the context of studying peer support in traditional vs. remote learning settings.

Studies of Peer Support produce Inconsistent Results

For studies that focus on mental health outcomes such as depression, loneliness, and coping skills, the results regarding peer support have been mixed. For example, a literature review by John [6] failed to show evidence that peer support in college improved mental well-being among college students when such well-being was measured as sense of coherence (i.e., an individual's ability to use resources to reduce stress and sustain mental health), absence of negative affect, and overall quality of life. In contrast, other studies have shown that social support from family and friends is effective in reducing feelings of depression [7] and loneliness [8] with support from peers emerging as more influential than support from family when college students leave home to attend college [8].

Studies that investigate the role of peers in persistence in college have also generated mixed results. For example, a study of over 7,500 first-year students showed that academic integration had a positive and significant effect on student persistence in the first year of college, but social integration had no significant effect [9]. The academic integration scale in this study included items that reported both student interactions with faculty and student participation in study groups (with their peers). The social integration scale, however, focused exclusively on informal time with peers through participation in fine arts activities, sports, and other extracurricular activities. In contrast, a study of 401 freshmen that focused on the degree to which peers met personal and emotional needs of students rather than how much time was spent with those peers demonstrated that such social support was significantly and positively associated with academic persistence [10].

Studies that focus on academic outcomes other than persistence also highlight the important difference between time spent with peers and the support students perceive from those peers. For example, a study about Latino students in STEM majors both failed to demonstrate a significant connection between working with other students on projects and GPA [11] and demonstrated a significantly negative association between time spent studying with other students and GPA. In contrast, in a longitudinal study of 100 ethnic minority, first generation college students, which used perceived support rather than time spent with peers as a central measure, peer support significantly and positively predicted both adjustment to college and college GPA [12]. Studies of engineering undergraduates have also demonstrated that the degree to which students perceive respect from peers in their classes is positively and significantly correlated to satisfaction with their chosen engineering major and their long-term interest in pursuing and remaining in an engineering career [13]. Through the personal validation that strong peer support provides, students are better able to cope in college [14], which in turn results in improved academic outcomes [15].

Peer Support is a multi-faceted Construct

Existing research underscores the importance of studying how students perceive support from their peers rather than only measuring time spent with them. However, Thompson and Mazer [16] delved further into perceived peer support by developing four different scales from 15 total peer support items, thereby demonstrating that peer support is not a single measure but rather has multiple facets, including informational, esteem, motivation, and venting support. Students feel better when they can interact with their peers, who provide academic assistance and increase their self-esteem, which is labeled as ***esteem support***. However, during the pandemic, students

were unable to communicate with their peers in the same way they did in traditional classes, which caused many to lose confidence in their ability to succeed in college. According to the study, ***motivational support*** is provided by encouraging or assisting peers in studying or staying focused, such as ensuring that their peers attend classes, comprehend lectures, and complete assignments on time, which was difficult to accomplish during the remote learning environment immediately following the pandemic due to lack of in-person interaction with peers. This also resulted in the loss of ***venting support*** because students do not know their peers well in an online teaching setting. Therefore, the choice to trust their peers so that they can listen to them to express any frustrations they may have regarding class structure or teaching was lost. Similarly, the ***informational support*** students used to receive in an in-person classroom has decreased during the pandemic as it is difficult to explain a problem to peers online while also having clarity on understanding the class subject. In-person conversation is more personal, students feel more at ease, and they form emotional connections with their peers because facial expressions of approval, rejection, concern, or excitement are more obvious in-person than when conversing with peers online. Considering the multi-faceted nature of peer support demonstrated by Thompson and Mazer [16], *this study* uses a peer support scale containing items that speak to esteem, motivational, venting, and informational support.

Given the research that points to the nature of perceived peer support rather than the actual time spent with peers as the critical element in supporting positive academic and mental health outcomes, we can not assume that peer support has necessarily dropped during the transition from traditional to remote learning. Students who have already made the adjustment to college are likely to be more resilient than we might first assume in facing the changes wrought by COVID-19 [17]. Thus, it stands to reason that they may have exercised that resilience during remote learning to find alternative pathways toward adequate peer support.

In addition to using a multi-faceted peer support scale and assessing the unique learning environments invoked by the COVID-19 pandemic, *this study* differs from earlier research in that it focuses on peer support at a research level institution in engineering rather than in K-12 where much of the peer support literature is situated. It not only quantifies peer support, but also identifies essential components of peer support. Additionally, it investigates what has happened to peer support for college students during the pandemic and to what degree students successfully adapted to or struggled with the physical restrictions of the pandemic in terms of their peer support networks.

Research Questions

Given the many opportunities for peer-to-peer interactions that have simply disappeared due to the switch to remote learning as necessitated by the COVID-19 pandemic, this study sought first to understand whether student perceptions of peer support declined in transitioning from the traditional classroom to remote learning settings.

Research Question #1 (RQ1)

Did students' sense of peer support change between traditional and remote learning settings?
While it might seem logical that with fewer opportunities to interact with peers, students would experience less peer support, this research question sought to explore whether this was indeed the case. If students report less peer support in remote settings, we can likely attribute such

reductions, in whole or in part, to the reduced opportunities for peer-to-peer interactions. If, however, students report more peer support, no differences in peer support, or inconsistent levels of support between the two settings, then we must look at other possible causes to explain these differences. One potentially important influence on perceptions of peer support could be a shift in student expectations. In the process of adjusting to remote learning, students' expectations for the type and amount of peer support they might receive may also have been adjusted. To further explore what underlies the answer to RQ1, we posed a second research question designed to explore these differences in student expectations.

Research Question #2 (RQ2)

Did students' expectations for peer support change between traditional and remote settings? The changes in the learning environment that occurred as engineering programs shifted from traditional to remote learning in the spring of 2020 were not subtle. Daily college life changed for everyone: faculty, staff, students, and administrators. Therefore, it would be reasonable to expect that student expectations also changed. Our second research question (RQ2) evaluated whether or not student expectations for peer support changed from traditional to remote learning and how they changed. Student expectations are explored by analyzing responses to short answer questions that allow for a deeper dive into understanding what students expected from their peers during the COVID-19 pandemic. Such insight can, in turn, be used to support or reject potential explanations for the results in RQ1.

Understanding how student expectations did or did not change requires interpreting student responses within an appropriate framework for student learning. Since our study focused on peers associated with study groups, lab groups, and project teams, a cooperative learning lens was selected to frame and code the results for RQ2. This framework is described next.

Conceptual Framework

This study employs the cooperative learning framework developed by Johnson and Johnson [20] [35]. Cooperative learning is defined by researchers as a method that can be applied to a variety of situations, such as teaching specific content (formal cooperative learning groups), ensuring effective cognitive review of information during a lecture or presentation (informal cooperative learning groups), and providing long-term support for academic achievement (cooperative base groups) [36]. Another research paper on cooperative learning discusses how students work together to achieve a shared goal while being assessed individually [18]. Research conducted in the K-12 context shows that students learning cooperatively in groups achieve higher academic test scores, higher self-respect, a higher number of constructive social skills, less typecast about people of different racial groups, and greater appreciation for the knowledge they are learning [19]. The cooperative model used in this study describes five key elements (Fig. 1) as being essential for cooperation in a group: positive interdependence, individual accountability, promotive interaction, social skills and group processing, each of which are described next [36 & 37].

Positive interdependence refers to the perception of being connected to others in a way that the student's success depends on whether others also succeed. It incentivizes students to conduct group work such that it maximizes the learning of all members, share resources, offer mutual

support, and celebrate successes. It leads students to believe that they must sink or swim together.

Individual accountability is created when each individual student in the group is assessed. The individual assessments are shared with the group so that the group can recognize who needs more assistance, support and encouragement to complete the task. Maintaining individual accountability also helps ensure that "freeloading" does not occur and that all group members are contributing equally to the goal.

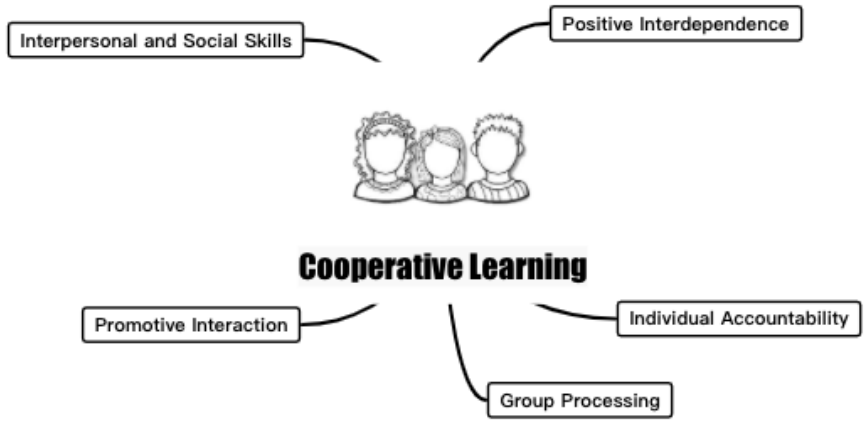

Figure 1: Key elements of Cooperative Learning

Promotive interaction occurs when students promote one another's success by supporting, encouraging, and praising one another's efforts to learn. Activities that promote such behavior include teaching one's knowledge to a classmate, discussing the nature of concepts being learned, and connecting the present with past learning. The verbal and nonverbal responses of group members provide valuable feedback to a student's performance. Promotive interaction also facilitates the formation of personal connections between group members. In the original framework [20], the authors emphasized face-to-face interactions as being the catalyst driving promotive interaction. Therefore, this is one aspect of cooperative learning that should be severely affected by the pandemic.

Interpersonal and social skills refer to various skills that a student needs to successfully cooperate in a group. Some of these skills include leadership, decision-making, trust-building, communication, and conflict management, which need to be taught just as intentionally as academic skills.

Group processing occurs when a group of students engage in identifying how they can improve various processes to maximize individual and collective learning. Students may engage in group processing by discussing what actions were helpful in maintaining effective working relationships and making decisions about what behaviors to continue or change. This type of reflection may lead to the group streamlining their learning process, continuously improving their skills, and recognizing their success and achievements.

Understanding the workings of the five key elements of cooperative learning can enable educators to structure their lessons in a way that promotes cooperative learning. It can also enable educators to modify cooperative learning to suit the specific needs of particular courses.

Finally, the cooperative learning framework provides a tool that can be used to understand where students are struggling in working with their peers and to devise interventions to address problems of groups that may be having difficulty working together.

RQ #2 short answer questions are coded based on the cooperative learning framework just described. The students' survey responses from the short answer questions were analyzed in various coding stages before classifying the responses into categories based on this framework. Four out of the five categories were used in this study. Group Processing was excluded as it had no student responses.

Methods

This study is part of a larger, single-institution research project that evaluated the 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 settings. The study used quantitative data analysis methods of both nominal and ordinal data to compare student perceptions of peer support across traditional classroom settings and the remote learning settings necessitated by the pandemic. The quantitative data analysis methods were supplemented with qualitative analysis methods to distill student responses to short answer questions into codes that could be analyzed quantitatively. To reduce the survey length, this study used a single peer support scale that included components of both nurturant and informational support. Similar to Thompson and Mazer's approach to surveying students [16], this peer support scale was supplemented by open-ended short answer questions that asked students to identify what was most important to them in terms of peer support. Students were surveyed both in pre-COVID traditional learning and in COVID necessitated remote learning to understand what happened to student perceptions of peer support when campus closed and opportunities for peer involvement suddenly and dramatically dropped.

Participants

The study includes a student population of 1328 undergraduate students recruited across four engineering majors and 19 separate classes at the sophomore and junior levels in both traditional and remote learning settings from a large public research institution located in an urban area. Self-reported ethnicity was Asian (43.3%), Black (2.9%), Hispanic (3.1%), White (40.7%), Pacific-Islander (less than 1%), Native American (less than 1%), and Other (2.6%). A number of students were mixed race (6.7%) among which White-Asian was the most common (73%). 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 (78.4%), Permanent Residents (5.1%), or International (16.3%) with the most common countries of origin being China (16.2%) or India (4.2%). Preliminary data analyses of peer support indicated no emerging differences between permanent residents and citizens, so these groups were combined in the final analyses, accounting for 83.5% of the sample population. Similarly, all international students were combined into a single group (16.3% of the sample population) as supported by the preliminary analyses of peer support.

Twelve courses were surveyed during remote learning in the Spring of 2020 and 7 courses were surveyed during traditional learning between 2016 and 2018. As a result, 45.7% of survey respondents reported their experiences in remote learning while 54.3% reported their experiences in traditional college classrooms. Of the 19 courses studied, seven were taught in both remote and traditional learning and three (ME1, ME2, EE4) were taught by the same instructor in both

settings (Table 1). Students were given additional credit worth 0.5 - 2.0 percent of their final grade, or surveys were replaced with their lowest assignment score.

Table 1: Courses Studied

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

Thompson and Mazer's first study (action-facilitating support) items were based on Thompson's (2008) student academic support grounded theory model, which serves as the foundation for scale development purposes and has been identified as a rigorous method of scale-item creation. Thompson's grounded theory research from 2008 offered a foundation of qualitative evidence to help "recognize or limit the focus of the possible variables" to be calculated on the scale. The scale is subjected to confirmatory factor analysis (CFA), a methodology that measures data holistically and deductively against a theoretical factor structure defined by the researcher. The second study (nurturant support) discusses the prevalence and significance of particular supportive behaviors, as well as the forms that students typically use to express academic support. The results of this study informed the inclusion of multi-faceted items in the peer support scale used in this study.

Procedures

IRB (Internal Review Board) approval (STUDY00000378) was obtained to recruit and survey undergraduate students for this study. Researchers interacted with faculty teaching the courses relevant to this study, but the researchers did not engage directly with the students. Since the vast majority of the students in this study began their academic careers at four-year colleges, it was unlikely that they had any direct experience of online learning prior to spring 2020. All participation was voluntary in this study, and students were informed that their survey responses

would remain confidential. In several courses, students were incentivized with a nominal amount of extra credit for the course in which they were recruited. In one traditional learning course (EE1), 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 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 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). Two of these short answer questions were included in this analysis.

The four Likert scale items used to measure peer support (Table 2) included elements of informational support (e.g.,'students are a reliable resource for me') and nurturant support (e.g.,'students are friendly to me'), which is consistent with Thompson and Mazer's [16] multiple facets of peer support. Peer support was measured at the class level using a variation of the Peer Support subscale of the Classroom Life Scale [38] and validated in previous studies of engineering students [39]. The wording of the four items used to measure peer support was adapted from previous studies in the K-12 [21] and college [22] settings. The resulting scale has demonstrated adequate internal consistency and construct validity [23]. Students responded to a 5-point Likert scale (strongly disagree to strongly agree) for each item on the peer support scale. The reliability (Cronbach's alpha) for the peer support scale in this sample population was 0.87. Internal reliabilities above 0.8 are considered as having good internal consistency of the items in the scale for further analysis [24]. The two short answer questions addressing peer support in the survey asked students to identify one action that their peers could take to improve their experience in lab groups/design teams (first question) or in study groups (second question).

Data Analysis

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

To support the evaluation of RQ1, an independent sample t-test was first used to compare two groups: (a) students enrolled in remote learning and (b) students enrolled in traditional learning. The results of this initial analysis informed additional t-tests to further evaluate differences that may have been present between courses offered in both traditional and remote settings.

While Likert-scale data are ordinal and better suited for non-parametric Mann Whitney tests, a recent study indicated that the results for parametric t-tests and the non-parametric Mann Whitney counterpart produce almost equal type 1 errors and demonstrate very small differences in statistical power between the two tests [35]. Thus, independent samples t-tests and Mann Whitney tests were conducted to compare remote and traditional learning, but only t-tests results were reported in this study.

Table 2: Peer Support Survey Questions

Type of Question	*Items*
Measure #1 Likert-scale ($\alpha = 0.87$)	In this class, other students are friendly to me. In this class, other students are helpful to me. In this class, other students are supportive In this class, other students are a reliable resource to me.
Measure #2 and #3 Short-answer	What one action can students in your lab groups (or design teams) take to improve your educational experience (please be as specific as possible)?
	What one action can students in your study groups take to improve your educational experience (please be as specific as possible)?

To evaluate RQ2, two short answer questions from the survey were coded to generate quantitative data using a thematic analysis approach. The themes generated from the students' responses were based on deductive research and a semantic approach to analyze the content of the survey responses. Two research assistants coded the short answer responses from all the students in the survey population using the cooperative learning framework previously described. First, the researchers familiarized themselves with the responses by going through the data thoroughly and then coded each response with a label which described the students' experience with their peers in remote and in-person learning settings. The labels were further analyzed by identifying the patterns among them which helped in generating a broader theme. In the process of generating themes, some labels were combined together to form a comprehensive theme while other labels remained independent. Finally, the themes were defined and named succinctly for understanding the data effectively and were placed into different categories consistent with the conceptual framework (Figure 1). In total, the researchers coded a total of 2005 responses from two short answers provided by 1055 survey respondents. Of these responses, 1214 (57.5%) were from remote learning settings and 896 (42.5%) were from traditional learning settings.

Results

The peer support scale used in the quantitative analysis demonstrated adequate skewness and kurtosis to proceed with analysis. The skewness of peer support in both settings was negative and between 0 and -0.5, indicating low negative skew for both populations. Excess kurtosis for the two populations was between -0.2 and -0.3; values between -2 and +2 are considered acceptable to prove a normal univariate distribution [34]. Thus, subsequent statistical analysis used tests that assumed the underlying data were normally distributed. Alpha levels of 0.05, 0.01, and 0.001 were used to determine the significance of statistical tests in RQ1; a single alpha level of 0.05 was used for all tests associated with RQ2.

Research Question #1 (RQ1)

Did students' sense of peer support change between traditional and remote learning settings?
Descriptive statistics for peer support in traditional and remote learning are summarized in Table 3. An independent samples t-test of peer support between remote and traditional learning failed to reject the null hypothesis that there was a significant difference in peer support between the two settings. However, the peer-support in remote learning (M=3.74, SD=0.87) was marginally

lower than traditional learning (*M*=3.83, *SD*= 0.77) -- *t(1219.3)*=1.88, *p*-value = 0.059. For this comparison, Cohen's D (*d* = 0.10) also indicated a small effect size value indicating low practical significance of the results.

Table 3: Descriptive Statistics for Peer Support (Measure #1)

Statistic	Remote	Traditional
Mean	3.74	3.83
Median	3.75	4
Standard Deviation	0.87	0.77
Skew	-0.48 (to the left)	-0.42 (to the left)
Kurtosis	-0.2 (light tailed)	-0.27 (light tailed)

The marginally significant differences between remote and traditional learning prompted additional course-for-course comparisons. Detailed results for these comparisons are summarized in Table 2. Of the seven courses (ME1, ME2, ME3, EE1, EE2, EE3, EE4) that were offered in both traditional and remote settings, four rejected the null hypothesis that peer support was the same in both settings. In three of those courses (ME1, ME2, EE2), peer support in the traditional setting was significantly higher than in the remote setting, albeit with different effect sizes (Table 4). In contrast, in EE4, students reported significantly stronger peer support in remote learning compared to traditional learning. All comparisons were repeated using nonparametric Mann Whitney tests. The significance of results were identical with the exception that peer support in ME2 was no longer significantly different between remote and traditional settings. This difference is likely due to the small sample size in the remote population of ME2 (*N*=6).

Table 4: Course-by-Course Comparisons of Peer Support

	Traditional		Remote		*t*	*p*		*Cohen's D*
Course	*N*	*Mean (SD)*	*N*	*Mean (SD)*				
ME1[2]	140	3.78(0.77)	73	3.36(0.87)	3.48	0.0006	***	0.51
ME2[2]	20	3.91(0.79)	6	3.21(0.48)	2.64	0.0192	*	0.89
ME3	218	3.78(0.74)	142	3.70(0.84)	0.90	0.3664		
EE1	175	3.80(0.78)	73	3.63(0.81)	1.56	0.1199		
EE2	70	4.03(0.80)	57	3.72(0.88)	2.02	0.0452	*	0.36
EE3	63	3.94(0.76)	70	3.84(0.85)	0.74	0.4578		
EE4[2]	35	3.80(0.75)	27	4.25(0.74)	-2.35	0.0221	*	0.58

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

[1] Practical significance: small (d< 0.2); medium (0.2<d<0.5); large (d>0.5)

[2] Course taught by the same instructor

An additional analysis of variance (ANOVA) among all courses studied revealed statistically significant differences, *F(11,594)=3.419, p<0.001*. Follow-up pairwise comparisons using Tukey's test with Bonferroni correction to reduce Type I error revealed only three significant results. Peer support in ME1 was significantly lower than in EE2 (*F(1,125)= 4.178, p=0.0431*), EE4 (*F(1,60) = 5.512, p=0.0222*), and ME2 (*F(1,24)= 4.157, p=0.0526*). No other significant differences were detected in the remote setting. The final ANOVA of all courses offered in traditional learning demonstrated no significant differences among courses studied *F(6,714)=1.342, p=0.236*.

Research Question #2 (RQ2)

Did students' expectations for peer support change between traditional and remote settings?
Responses to two short answer questions regarding students' expectations for peer support in their lab teams (SA3) and in study groups (SA4) were deductively coded according to the cooperative learning framework in Figure 1. Less than 5% of student responses did not fit into any of the cooperative learning categories and were coded as "Other." Less than 10% of students had nothing to suggest in terms of improvements in peer support. The number of students who gave off topic answers, defined as requests for action that peers had little control over, ranged from 12.2 to 22.4% of responses in a particular setting (remote or traditional) and short answer questions (SA3 or SA4). The frequency of responses in each category is summarized in Table 5. Due to the heterogeneous nature of the "Other" and "Off Topic" categories, these categories were not included in subsequent chi square analyses.

Table 5: Student Expectations of Peer Support

Primary Category	Frequency of Response (%)			
	SA3 (lab/project groups) *N* (%)		SA4 (study groups) *N* (%)	
	Trad	Remote	Trad	Remote
Other	14 (2.93%)	7(1.10%)	22(4.60%)	14(2.29%)
Off-Topic	60(12.6%)	77(12.2%)	85(17.8%)	137(22.4%)
None	48(10.0%)	60(9.50%)	19(3.97%)	36(5.89%)
Promotive Interaction	130(27.3%)	216(34.2%)	143(29.9%)	179(29.3%)
Individual Accountability	135(28.3%)	105(16.6%)	102(21.3%)	86(14.1%)
Interpersonal/Social Skills	52(10.9%)	76(12.4%)	51(10.7%)	139(22.7%)
Positive Interdependence	38(7.96%)	93(14.7%)	56(11.7%)	20(3.27%)
Total	**477**	**631**	**478**	**611**

Pearson's chi square tests of independence were conducted on homogenous groups (promotive interaction, individual accountability, interpersonal/social skills and positive interdependence) for SA3 and SA4 to understand if student responses in remote and traditional learning were significantly different. Results for both SA3 $(X^2\ (2, N=1108) = 31.96, p= 5.323\ e^{-07})$ and SA4 $(X^2\ (2, N=1089) = 57.00, p= 2.561\ e^{-12})$ indicated that the distribution of student responses in both contexts were significantly different between the two settings.

Student Expectations for Peer Support with respect to Labs (SA3)
The most dramatic change in student expectations for their peers in their lab teams occurred with the degree to which they spoke about *individual accountability*. In traditional learning, 28.3% of student responses expressed a need for more accountability from their peers, while in remote learning, this was true of only 16.6% of the responses. In traditional learning, students often expressed that they wanted their peers to be more prepared by completing all the pre-lab work before coming to the in-person labs while in remote learning, student concerns shifted to frustration with students not showing up to meetings at all.

In contrast, the need for *positive interdependence* among students almost doubled from 7.96% of student responses in traditional learning to 14.7% of student responses in remote learning. The majority of students' responses to both learning environments revolved around inspiring each other to collaborate more, delegate lab work equally, and meet frequently to get the work completed. Above and beyond these basics, students in the remote environment also appealed to their peers to gain familiarity with the software being used for collaboration in order to participate effectively. They also spoke to the need for using technology to support positive interdependence through such simple actions as muting their microphones as needed, turning on the camera, and screen sharing effectively.

Although not as dramatic as the differences in *individual accountability* and *positive interdependence*, more students (34.2%) in remote learning expressed the need for *promotive interaction* from their peers than in traditional learning (27.3%). In traditional learning, student responses focused on discussing lab procedures, encouraging others to participate, working together to solve questions, sharing knowledge to understand concepts, and ensuring frequent communication. Students in remote learning referred to similar issues as students in traditional learning, but they also stressed the importance of using dedicated technology for communication such as Discord, Slack, Zoom, and online discussion boards in order to ensure maximum involvement from their peers.

Finally, students referenced *interpersonal/social competence* slightly more (1.5% more) in remote learning than in traditional learning. In traditional learning, responses centered on building a welcoming, supportive, and respectful atmosphere. Students also encouraged their classmates to develop a sense of belonging and camaraderie. In remote learning, however, students expressed a much broader range of concerns, including the need for their peers to collaborate across different time zones when organizing meetings, to be mindful of the technical problems that may arise, and to switch on their microphones and cameras for a more personalized interaction.

Student Expectations for Peer Support with respect to Study groups (SA4)
When students reflected on what they needed from their study groups, some trends were similar to those of lab groups. For example, 21.3% of students prioritized *individual accountability* in traditional learning while only 14.1% did so in remote learning. This downward trend is similar to what students said about their lab groups. With regard to individual accountability, while students made more frequent comments about *interpersonal and social skills* in remote learning with regard to their lab groups, the increase in these types of comments in their study groups was much larger. Students in remote learning mentioned *interpersonal and social skills* with respect to their peer groups at over twice the frequency (22.7%) of students in traditional learning (10.7%). This substantial uptick emerged in the context of overcoming the absence of face-to-face interactions. Sometimes, this was about expecting peers to be more active in creating opportunities to interact and work together, but in other cases, students expressed frustration with the lack of effective behavioral norms among their peers. Students also felt differently about *positive interdependence* in their peer groups compared to their lab groups. Student responses with regard to their peer groups decreased from 11.7% to 3.27% from traditional to remote learning in positive interdependence while responses with regard to lab groups increased. Also noteworthy was the large number of student responses that were categorized as off-topic with

regard to peer groups (SA4). 17.8% of student responses in traditional learning and 24.2% of student responses in remote learning were off-topic.

Finally, when compared with the total number of respondents, 10% of students admitted to not having study groups in traditional learning, while in remote learning this number was 15.4%. Many students indicated that they like to study individually because it helps them learn more easily, while others studied alone because of the lack of the right study group for their needs. Students also readily acknowledged that forming study groups became more challenging during remote learning.

Discussion

The present study demonstrated multiple differences in perceived peer support both within and across traditional and remote learning. When asked to identify their needs and expectations for peer support, regardless of the course in which they were enrolled, students responded in ways that suggested what they valued had indeed shifted significantly as they moved from traditional learning to remote learning.

Research Question #1 (RQ1)

Did students' sense of peer support change between traditional and remote learning?

Students had many ways to interact with their peers prior to COVID-19, as lectures were delivered in person. Students could readily see each other in the classroom, talk with each other before and after class, interact at campus events, and congregate in different social spaces on and off campus. Most of these opportunities abruptly disappeared when institutions shifted to remote learning at the start of the pandemic (Spring 2020). The online learning model made it difficult for students to interact with their peers because, more often than not, once a Zoom lecture ended, students immediately disconnected from the session and from their peers. This new mode of instruction triggered feelings of disappointment, boredom, and loneliness [25]. As a result, we anticipated that students would feel lower peer support as opportunities for developing such support were drastically reduced in remote learning.

In six out of seven course-for-course comparisons, this proved to be the case. In three of these cases, the differences were significant. Only one course (EE4) had a mean peer support level that was greater in remote than traditional settings and significantly so. What made the difference? In EE4, the instructor actively facilitated peer interaction by (a) including extra credit in labs for peers helping peers; (b) leaving zoom rooms open after class for students to interact (with the instructor absent); and (c) using graded, active learning exercises to ensure students interacted in breakout rooms during class. This is entirely consistent with on-line educational research. In such settings, Garrison and Cleveland [26] confirmed that without instructor facilitation, peer learning and interaction online are not likely to be fruitful. In an online learning environment, these researchers found that the instructor must encourage students to actively participate in class discussions, offer input on their work and update them on their success on a regular basis, while using current technologies as a teaching tool [27]. Instructors must recognize that their responsibility to students in an online setting extends beyond direct interaction with students. Facilitation of fruitful interactions with peers takes planning and integration of peer-based activities into lesson plans and course organization.

Unfortunately, the emergency nature of the shift to remote learning as a response to COVID-19 did not allow such planning time. In crisis mode, faculty simply had insufficient opportunity to learn and implement tools for peer interaction and peer support. With little planning, it was unlikely that faculty would be able to successfully navigate the student's role online, including enabling students to complete problems, answer questions, explore simulation and resources, and – important to developing peer support – collaborate with peers [2]. The takeaway is not so much that peer support is impossible in remote learning but, instead, that it takes time, energy, and prior planning to create opportunities to develop that support [26].

Research Question #2 (RQ2)

Did students' expectations for peer support change between traditional and remote settings?

The results from the two short answer questions regarding peer support analyzed in this study support the notion that students' expectations shifted in moving from traditional to remote learning. The cooperative learning model used to code student responses relevant to RQ2 subsumes five key elements, namely promotive interaction, individual accountability, interpersonal and social skills, positive interdependence, and group processing.

Table 6: Students' Shift in Expectations (Frequency of Responses)

	Students discussed these topics after transitioning from traditional to remote learning.	
Element	**With Regard to Lab Groups**	**With Regard to Study Groups**
Promotive Interaction	More Frequent	Approximately the Same
Individual Accountability	Less Frequent	Less Frequent
Interpersonal and Social Skills	More Frequent	More Frequent
Positive Interdependence	More Frequent	Less Frequent

Student survey responses from the nominal data were coded based on these categories (Table 5) and differences emerged between traditional and remote learning (Table 6).

Promotive Interaction

Students spoke to the need for promotive interaction much more frequently when asked about their lab groups in remote learning than in traditional learning. This is not surprising considering that two of the main sources of dissatisfaction in remote learning have been the lack of successful collaboration with peers, and the lack of opportunities for students to exchange feedback [28]. In traditional learning, promotive interaction is often more organic with plentiful opportunities to work together in laboratory and public spaces on campus; students in remote learning needed to be more active in promotive interaction because it was not automatic or convenient. When students did so, labs evolved into a positive experience:

> My lab teams this quarter have been good, one reason that is the case is that they keep on top of communication which is especially important in the absence of a traditional classroom setting. (Male, White, Remote Learning)

Students needed to transition from successful traditional students to successful online students, which required a different set of strengths. In the online setting, academic success is highly dependent on a student being self-motivated and self-directed with above-average executive

functioning, connectivity, engagement, and technical skills [27]. To expect students to make this transition as abruptly as remote learning took hold in their college lives is unrealistic. But, the increase in their expectations for peers to actively engage in promotive interaction was reflected in their awareness of the problem and its impact on their lab groups.

Interestingly, student expectations for their study groups did not show the same trend as for their lab groups. Students responded that they needed the same amount of promotional interaction in both remote and traditional learning. In both settings, students called for regular meetings with their peers, clear communication, active participation, opportunities to solve problems together, and motivation to discuss concepts in greater depth. It is possible that these stable expectations were a result of the fact that study groups were entirely voluntary in all courses studied. Students who chose to participate in study groups were likely already motivated to engage in promotive interaction, while those who were not likely studied alone. In contrast, in lab groups, all students were expected to work together, and those who preferred to work alone likely contributed to large differences in engagement in the cooperative learning process.

Individual Accountability (IA)

Surprisingly, students appeared to prioritize individual accountability less so in remote learning than in traditional learning. This was true in both lab group and study group contexts. The nature of their comments in both settings were very similar: be present, be responsive, participate, and come prepared. Given these similarities, it seems that individual accountability became less of a priority for students in remote learning because other issues took on more importance. Students were asked in the survey to list the one thing that peers could do better to support them (as opposed to all things their peers could do). Thus, in lab groups, the collective jump in comments referring to promotive interactions and positive interdependence (from 35.3% of the total responses in traditional learning to 48.9% in remote learning) could explain the dramatic drop in individual accountability (from 28.3% of total responses in the traditional learning to 16.6% in remote learning). For study groups, the situation is different. The number of student responses that emphasized individual accountability dropped from 21.3% to 14.1% from traditional to remote learning, while the number of students who did not have study groups increased from 10.0% to 15.4%. Thus, it is possible that students who were frustrated with individual accountability in traditional learning simply went without study groups once it was harder to work together in remote learning.

Interpersonal and Social Skills (ISS)

In both lab groups and study groups, students in remote learning more frequently expressed a desire for students to demonstrate better interpersonal and social skills than in traditional learning. In multiple responses, students appealed to their peers for better support and understanding in the unprecedented situations they found themselves in during the pandemic. For example:

> The best thing other student can do is to be supportive of students that don't understand and to meet that with non critical help and patience (Male, Non-Hispanic White, Traditional Learning)

However, a larger majority of student responses in this category referenced interpersonal skills that related directly to the use of technology in a remote setting. These included a strong desire

for face-to-face interaction, appealing to students to turn on their video cameras. One student stressed the immense importance of a simple thing like turning on the video camera in meetings:

> No one in break out rooms talk or put on videos. SUPER HARD to work together. don't see that improving with stricter participatory guidelines because it is difficult. (Female, White, Remote Learning)

Pre-pandemic, Thomas and Mazer [16] found that students preferred face-to-face interaction despite the many opportunities, media, and technology available to communicate in other ways. In remote learning, students also often discussed technology and multiple online communication tools to facilitate successful interpersonal interactions far more than they did in traditional learning. This is no surprise and, in combination with the use of video cameras, was responsible for a majority of the uptick in emphasis on interpersonal and social skills in the remote setting for both lab groups and study groups. Many of the online communication tools that students discussed as important for peer support during remote learning were similar to tools that have demonstrated value for active learning in online education, such as message forums, talk sessions, websites, and wikis [29].

Positive Interdependence (POSI)

In lab groups, students in remote learning more often appealed for positive interdependence than in traditional learning. In both traditional and remote learning, lab groups were structured, and students were required to participate in labs in each of the courses studied. The main goal in these groups was to perform experiments in a team, making it obvious that students would want their peers to collaborate as much as possible to get the work done smoothly. Many of the responses regarding peer support in both settings referred to similar needs, appealing to peers to work together, be proactive, collaboratively formulate a lab work schedule, work as a team, and delegate work more efficiently. However, in the remote setting, students also appealed to peers to use technology properly to support positive interdependence. Thus, the proper use of technology appears to have been a noteworthy barrier to supporting positive interdependence among peers.

Among peer groups, appeals for positive interdependence decreased rather than increased in transitioning from traditional to remote learning. The most distinct difference between lab and study groups is that lab groups were mandatory while study groups were voluntary. In traditional learning, students often lamented that their peers would show up only to get answers to homework problems:

> Actively participate in the group, as opposed to just showing up to get answers to homework problems (Male, Black, Traditional Learning)

In remote learning, many students forewent study groups which would eliminate opportunities for this kind of behavior. It is also possible that the option provided by the university for students to switch to S/NS grading at any time during the course also diminished grade pressure with a corresponding decrease in leaning on peers for answers.

Limitations

This study focused on the student experience at a single institution and in a limited number of majors (primarily electrical and mechanical engineering), therefore the generalizability to other

academic settings may be limited. Despite the fact that no survey questions asked if students had prior online survey experience, the vast majority of students in this study began their college education at the traditional, in-person institution participating in this study. As a result, it is fair to say that most students have little or no exposure to online classes prior to Spring 2020. Further, 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. Another drawback is that the data obtained from the courses in this study was taught by different professors, and the survey was conducted outside of the control of the researchers. Nevertheless, the quantitative results are consistent with on-line educational research studies which highlight the necessity of increased instructor facilitation of peer interactions and peer support when education moves outside of the traditional classroom setting. The qualitative analysis of responses to short answer questions provides important insight as to what kinds of behaviors and contributions students expect from their peers and what they believe to be the most important contributions from their peers. Therefore, despite the limitations, the results of this study offer a rich perspective regarding what students perceive as necessary support from their peers during a crisis.

Implications

This study suggests that a student's peer group has the most influence on their development and academic achievement, which is particularly true during the undergraduate years when students are new to college and struggling to make sense of their surroundings [3]. Students spend a significant amount of time in college with their peers, which provides social and emotional support. The research shows mixed findings when it comes to the degree to which peers can influence a student's well-being [6]. Most of these findings suggest the amount of time spent with peers and the degree to which interactions have taken place can predict varying academic and emotional outcomes. In this research study, we wanted to know how perceived peer support changed from traditional learning to emergency remote learning during the COVID-19 pandemic. Unfortunately, this massive shift in learning impacted peer support and it did not give much time to the instructors to take more action to facilitate peer interaction and peer support. In the future, if instructors are allowed more time to plan online courses with techniques that can allow students to participate fully and provide opportunities for them to engage with their peers, then remote learning can also offer as good peer support as conventional learning [30]. Furthermore, students also have a huge role in being an active agent in facilitating collaborative learning. A thought can be given on developing a framework that would enable all students to reflect on and contribute to their classroom experiences [31] along with certain online learning ground rules for prospective students. Finally, emergency remote teaching can borrow resources from the online education community, such as collaborative learning activities that can foster a sense of belonging and camaraderie among online students, encouraging them to persevere [32].

Conclusions

This paper summarized the findings of a study on students' perceived peer support during remote learning. While quantitative analyses across all courses showed no significant differences in perceived peer support between traditional and remote learning, course-by-course comparison revealed significant differences in perceived peer support, indicating that faculty involvement is critical in promoting peer engagement [33]. In order to understand the expectations of students from their peers and how they have changed between two learning environments, a qualitative

analysis was performed based on a cooperative learning framework. The findings show that the two learning environments have significantly different distributions of student responses. Overall, students want their peers to efficiently use online collaborative tools, engage more, communicate clearly, be responsible for assigned tasks, and be flexible when organizing online meetings. Finally, the COVID-19 pandemic has shown the value of virtual learning, which can be successful if students and faculty do their part in working together to make the learning process simpler.

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