

Article

Exploring Faculty Perspectives during Emergency Remote Teaching in Engineering at a Large Public University

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Abstract: In Spring 2020, the College of Engineering at San José State University (SJSU) conducted a comprehensive analysis of the impact of COVID-19 on faculty who were forced to transition to an online learning environment. The purpose of this study is to assess the impact of COVID-19 on faculty teaching methods, assessment methods, and personal well-being. The study was a combination of a quantitative survey and a qualitative study using interviews of engineering faculty teaching in Spring 2020. In the first part, we surveyed all faculty teaching during Spring 2020 in the SJSU College of Engineering about their experiences after the move to 100% online instruction in March 2020. In the second part of the research, we interviewed 23 faculty members to obtain a more in-depth understanding of their experiences during the move online in Spring 2020. Overall, 98 faculty participated in the survey: lecturers (58), tenure-track (18), tenured (13), adjunct (1), and Teaching Associates (1). The faculty reported being worried about their family and their students' well-being. In addition, 65% of faculty members reported either a moderate or a great deal of stress related to the shelter in place, and this percentage was higher for female faculty (74%) and for tenure-track faculty (83%). Overall, faculty members felt that they had their classes under control most of the time and that the transition to online teaching was positive, even if they felt they had too much work to do and felt always in a hurry and under pressure. From a teaching perspective, the interviews highlight that faculty members' main concerns focus on testing and assessment and students' engagement. Overall, SJSU College of Engineering faculty members felt under stress in the transition to online teaching, especially the tenure-track faculty members, but were able to transition their classes with ease.



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Keywords: distance learning; faculty attitudes; emergency online teaching; engineering; COVID-19; higher education; survey; interviews

1. Introduction

The California State University system, the largest four-year public university system in the United States, was among the first to call for an immediate transition to online learning in Spring 2020 across the whole 23-campus system. It was also the first system across the country to announce that both the Fall 2020 and Spring 2021 semesters would remain primarily online, with limited hybrid course offerings. These early decisions prompted a group of faculty members in the College of Engineering (COE) at SJSU to survey students and faculty members to better understand their experiences as a result of the sudden shift to online learning due to the shelter-in-place order, with the intent to better prepare for Fall 2020 and Spring 2021 online instruction. The rapid switch to online instruction in March 2020 did not allow faculty members to train, plan, and reflect upon the best teaching modes for online instruction, unless they had previously taught an online class. Therefore, as with many other researchers [1], we consider the Spring semester to be an example of emergency remote learning rather than planned online learning.

Online education (also called online learning, remote learning, distance learning, or e-learning) has grown in popularity across the U.S. over the last 10+ years, with increased

online options across all universities, including public, private, non-profit, and for-profit institutions. Online learning is defined as education that takes place online, either synchronously and/or asynchronously. In Fall 2018, approximately 35% of undergraduates in U.S. two and four year colleges took at least one online course [2].

One consistent factor for effective online learning is the recognition that quality online education requires careful and effective design, delivery, and assessment that goes beyond shifting in-person practices to an online environment. The need for high quality online education tools is greatest when student populations are underserved or at-risk, including students who are low-income, first-generation, and persons of color [3]. The students of the College of Engineering and SJSU are diverse, with a significant number of students identified as one or more “at-risk” markers including first-generation college students, low-income students, and underrepresented students. Table 1 presents demographic data for SJSU and the College of Engineering.

Table 1. Demographic data for the College of Engineering and the University in Spring 2020 [4].

	College of Engineering		SJSU	
	Headcount	Percentage	Headcount	Percentage
American Indian/Alaskan Native	1	0.01%	18	0.06%
Asian	2136	33.5%	10,221	33.3%
Black or African American	107	1.7%	986	3.2%
Hispanic/Latinx	974	16.8%	8292	27%
Native Hawaiian or Other Pacific Islander	19	0.29%	136	0.44%
White	799	12.5%	4728	15.4%
Two or More Races	208	3.3%	1393	4.5%
Non-Resident Alien	1895	29.7%	3669	11.9
Unknown	233	3.7%	1266	4.1%
Total	6371	100.00%	30,709	100%
Persons of Color	3445	54.1%	21,046	68.5%
Pell Recipient *	1444	22.7%	9991	32.5%
First Generation Student *	2281	35.8%	13,733	44.7%

* Pell recipients are used by SJSU as a measure of low-income status. A First Generation student is a student who is the first in their family to attend college.

Online course offerings are an important component of higher education. However, online education, similar to other major transitions in higher education, has been met with resistance from instructors [5]. Administrators who promote online education are accused of prioritizing cost over quality, student outcomes, and faculty expertise [6]. In engineering, there are few online courses or degrees available in the U.S.; however, online engineering courses are more available at the graduate level.

Online instruction, which has grown in popularity in the last decade in the US, requires thoughtful instructional design, delivery, and assessment. Online instruction is different from teaching in-person and requires skills and expertise that are generally not part of faculty members’ education and experience. Use of technology, which is of paramount importance in online instruction, can be a barrier to some of the faculty members.

Generally, online learning comprises of a combination of synchronous (real-time) and asynchronous learning (on-demand). Most common pedagogies in online teaching include discussion boards, audio and video submissions, text-based assessment, collaboration, emails exchanges, text-based chat, audio and video conferencing, real-time polls, real-time collaboration, and real-time assessment [7,8]. These teaching modes can be classified as “surface structures” (pedagogies that transmit the information between the teacher and students), “deep structures” (pedagogies that encourage higher order thinking and problem-solving), and “implicit structures” (pedagogies that develop a moral dimension in terms of professional values and attitudes). According to Eaton et al. [7], some teaching

activities in the online environment have “the potentials to cultivate deeper learning experiences, but they can fail to do so if activities are not designed and implemented properly”.

Since the emergency move online in Spring 2020, there have been several surveys of faculty to ask them about their experiences. The Higher Education Data Sharing Consortium (HEDS), in their survey of faculty, received responses from 4000 faculty from 28 different colleges [9]. The faculty felt overwhelmed in Spring 2020 by the increased amount of work in the newly online classes, with 61% of faculty indicating they had too many things to do, 55% felt that they were in a hurry, and 51% felt under pressure from deadlines.

A second survey of university faculty in Spring 2020 was done by Tyton Partners, in conjunction with Every Learner Everywhere [3]. Nearly 5000 faculty from over 1500 institutions responded. This survey found that almost all faculty (91%) had to move online in Spring 2020 because of COVID-19. Fewer than half of the faculty had ever taught online. The Tyton study also found that faculty had difficulties in engaging and motivating their students after the move online. Faculty also indicated that child or elder care was a significant challenge for 40% of faculty, with women and tenure-track faculty more likely to report this concern. In addition, research indicates that many faculty had technical issues after the move online [10], such as lack of reliable internet connection, no access to a webcam or camera for use during online instruction, and no access or technical difficulties with online writing tools.

Faculty challenges with the emergency remote learning include a decreased interaction with students during class time and decreased students' engagement [11,12], increasing concerns about students well-being [13], and a general feeling that their course quality has decreased [12]. In addition, faculty members needed to juggle work with personal needs. Some of the strategies that faculty members adopted to adapt to the remote environment include modifying or dropping assignments and exams and lowering their expectations about the quantity and quality of the work performed by the students [14]. Despite the challenges, according to Williams [12], faculty members had a positive experience in teaching remotely in Spring 2020.

Almost all faculty members in the United States were required to shift their pedagogy in Spring 2020, in what has probably been the quickest shift in teaching pedagogy that the academic environment ever experienced. In order to understand the underlying assumptions that drove faculty members in re-evaluating their teaching practices and adapting them to the remote environment at the end of the Spring 2020 semester, Deters et al. [15] conducted semi-structured interviews of three mechanical engineering faculty members and eight students. This study identified three main core beliefs that motivated faculty members' decision: fear of cheating, valuing of hardiness, and views on flexibility. The personal challenges that faculty members experienced likely influenced their ability to effectively shift their pedagogy and testify to the resilience of the faculty body. Morelock et al. [16] created a novel research platform to collect the experience of students, faculty members, and staff (for a total of 70 participants, of which 25 were faculty members). The study identifies that students and instructors struggled to recover a sense of connectedness in a remote environment, as well as a disconnect between faculty members' and students' experiences. Students and faculty members faced a range of COVID-19-related challenges within and outside of academia.

There also has been increased stress reported by faculty after the move online because of COVID-19 [17–19]. For example, Bizot et al. [19] found that over half of the computer science faculty who responded to the survey had used active learning before the move online. However, 34.9% of the faculty discontinued their use of active learning after the move online, while 43.4% made minor changes and 21.3% made significant changes. Bizot also found that the Computer Science faculty had higher levels of stress after the switch online because of COVID-19.

In October 2020, the Chronicle of Higher Education conducted a survey among faculty members at U.S. institutions to gain insights into how the pandemic affected faculty

members from a mental and emotional perspective [20]. A total of 1122 faculty members responded to the survey from four-year and two-year universities. The analysis of the data highlights that the majority of faculty members experienced elevated levels of frustration, anxiety, and stress as they struggled with increased workloads and a deterioration of work-life balance. This is especially true for female faculty members. The survey also highlights that more than two-thirds of all faculty members were discouraged enough to consider retiring or changing careers and leaving higher education, with tenured faculty members even more likely to retire than others. In addition, tenure-track faculty had some of the highest levels of stress and fatigue. Faculty members faced a multitude of challenges at the same time: abruptly changing their work strategies and habits, learning new technologies, job insecurity due to the economic challenges of higher education, worries about the health and well-being of their families as well as students, and losing collaboration opportunities. The Chronicle of Higher Education's survey, however, did not explore the experiences of the faculty members from a teaching perspective.

This paper is part of a larger study completed at SJSU which looked at the impact of COVID-19 on students and faculty members [21–24]. We surveyed all the faculty members that taught a class in the College of Engineering at SJSU in Spring 2020 (more than a hundred of responses) and interviewed 23 of them. In addition, we surveyed all the students enrolled in the College of Engineering at SJSU in Spring 2020 and interviewed 40 students [22,23]. This paper presents a comprehensive description of the results of the survey and of the set of interviews with engineering faculty members at SJSU University after the end of Spring 2020 semester and explores faculty members' experiences as well as the novel teaching approaches they used in the emergency remote environment.

This paper is organized as follows: there is a description of the research questions in Section 2, the methodology for the survey is in Section 3, and the methodology for the faculty interviews is in Section 4. The results of the survey and interviews are presented in Section 5 and extensively discussed in Section 6, followed by a conclusion section (Section 7). A discussion of the limitations of the approach is presented in Sections 8 and 9 discusses possible future work.

2. Research Questions

The current article describes the results from the faculty survey and the faculty interviews. The research questions of the study are:

- Did faculty experience pressure and stress during the COVID-19 transition to emergency online learning?
- What challenges have faculty identified during the online transition and how do they plan to improve instruction?
- Is there a difference in the effect of COVID-19 among tenured faculty and tenure-track faculty and lecturers?
- What are the impressions of faculty members to the learning environments in engineering courses after the switch to emergency remote learning in Spring 2020?
- What was the impact of the switch online in Spring 2020 to lab classes?

3. Materials and Method: Faculty Survey

The research team based the surveys on the questions that were developed by researchers at Georgetown [25] and HEDS [9] to survey the student population, and modified them to be relevant to the faculty participants. In designing our students' survey, we used questions from the Georgetown survey that related to the students' personal experiences with life during COVID-19, including questions about the students' medical situation, living situation, financial situation, and perceptions about the future. We added questions from the HEDS survey about student worries including stress levels, satisfaction with institutional responses to COVID-19, and intent to return. The research team also added questions that investigated student access to resources, student communication with instructors, the availability of faculty for office hours, experiences with controlled testing

environments, and specific questions related to laboratories and project-based classes that are relevant to the engineering classes at SJSU. As much as possible, the faculty survey asked similar questions as our student survey. We mirrored the questions for the faculty survey from the Georgetown [25] survey, which related to personal experiences with life during COVID-19 including questions about the faculty member's medical situation, living situation, and financial situation. We also mirrored the questions about stress from the HEDS [9] student survey for the faculty survey. The team submitted an IRB application, and it was approved on 28 May 2020.

The survey design was based upon the Lazarus' Theory of Stress: "psychological stress is a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" ([26] p. 19). This theory is defined as a transactional theory of stress and coping and is related to other constructs in psychology including locus of control [27] and self-efficacy [28]. Existing research has shown that the COVID-19 pandemic was stressful to many colleges students and faculty who underwent changes that taxed their resources. According to Lazarus and Folkman, there are two phases in psychological stress: appraisal and coping. An individual in a potentially stressful situation first appraises the situation in relationship to their own sense of well-being: "Primary appraisal is an assessment of what is at stake: "Am I in trouble or being benefited, now or in the future, and in what ways?" If the answer to this question is yes, then people categorize the situation as being a threat, a challenge or a loss." [29]. Coping relates to a secondary appraisal of the situation and the individual's self-confidence to have the resources to deal with the situation. The resources can include physical, social supports, or financial or psychological resources. According to Lazarus and Folkman [26], coping has two major purposes. First, it regulates the negative emotions that relate to the stressful situation, in this case, the COVID-19 pandemic. Second, individuals can manage the problem by attempting to change the stressful situation. In the COVID-19 pandemic, since the situation was not usually able to be managed by some faculty and students, most of the coping relates to faculty and students attempting to regulate their emotions or distress caused by the pandemic.

Coping with the COVID-19 pandemic was a unique experience for most faculty members students and challenged their regular patterns of coping behaviors. Most faculty and students were not prepared for the lifestyle and education changes initiated by the pandemic and found they lacked the coping strategies to deal with it. "If the individual does not believe he or she has the capacity to respond to the challenge or feels a lack of control, he or she is most likely to turn to an emotion-focused coping response such as wishful thinking (e.g., I wish that I could change what is happening or how I feel), distancing (e.g., I'll try to forget the whole thing), or emphasizing the positive (e.g., I'll just look for the silver lining)" [30].

3.1. Recruitment

The survey was distributed to all lecturers and tenured/tenure-track faculty using the SJSU College of Engineering email distribution list. An email distributed to all faculty teaching in Spring 2020 contained a link to the faculty survey. About one week after the initial email, a reminder was sent to the faculty who have not filled out the survey or have not finished it. A final reminder was sent in week 3. One of the last questions in the survey asked for volunteers to participate in an interview.

3.2. Participants

There were 288 faculty (lecturers, tenure-track and tenured) that taught a class in the College of Engineering at SJSU in Spring 2020. Overall, 98 faculty completed this survey, which represents 34% of the faculty population and equates to a confidence level of 95% with a margin of error of 8%. Because of this low margin of error, the research team is confident that this survey is representative of the faculty teaching in the College in Spring 2020 [31].

The majority of the respondents who answered the question about rank were lecturers (58); there were fewer tenure-track (18), tenured (13), adjunct (1), and Teaching Associates (1) responding. Of the faculty who identified their gender, 66 were men and 27 were women. It is interesting to note that there were more responses from newer faculty; 45.1% of the faculty responses were from faculty with five or fewer years teaching at SJSU (see Table 2). Before Spring 2020, only 26 of the 88 respondents had taught a course online. Of the faculty who previously taught online, only seven had taught online for five or more years.

Table 2. Reported number of years teaching at SJSU for Faculty Responding to the Survey.

Answer	Headcount	Percentage
0–5 years	41	45.1%
6–10 years	15	16.5%
11–15 years	12	13.2%
More than 15 years	23	25.3%

Faculty from every department in the College responded to the survey. The survey respondents were generally representative of the faculty in the College of Engineering with the exception of the faculty in Computer Engineering and Chemical and Materials Engineering who were under-sampled and the faculty in Civil and Environmental Engineering and General Engineering who were over-sampled, as shown in Table 3.

Table 3. Comparison of the total number of Faculty in the SJSU College of Engineering (SJSU Institutional Research, Spring 2020) to the Survey Respondents.

Department	SJSU Data		Survey Respondents	
	Headcount	Percentage	Headcount	Percentage
Aerospace Engineering	15	4.9%	8	7.7%
Aviation and Technology	40	13.5%	11	10.6%
Biomedical Engineering	10	3.3%	3	2.9%
Chemical and Materials Engineering	27	8.9%	5	4.8%
Civil and Environmental Engineering	30	9.9%	15	14.4%
Computer Engineering	63	20.7%	12	11.5%
Electrical Engineering	30	9.9%	13	12.5%
General Engineering	33	10.8%	16	15.4%
Industrial and Systems Engineering	21	6.9%	6	5.8%
Mechanical Engineering	35	11.5%	11	10.6%
Other/NA	1		4	
Total	305		104 *	

* The number of faculty in the departments is greater than the total number of faculty respondents ($n = 98$) because some faculty members in the COE work for more than one department.

About half of those who responded to this question (48.9%) did not work outside of SJSU in Spring 2020; however, a significant number, 27 faculty members (31%), worked full-time outside of SJSU in Spring 2020.

4. Materials and Method: Faculty Interviews

4.1. Recruitment

A final question in the faculty survey asked for volunteers to participate in an interview. All volunteers were contacted by the research team to conduct interviews, except for faculty

members that were currently acting as Department Chair in the college. A total of 23 faculty interviews were conducted.

4.2. Interview Protocol

Our interview protocol was informed by the interview protocol that was used by Pawley [32] at Purdue University. The interview consisted of two questions: “How did you do in your classes in Spring 2020?” and “How did SJSU as an institution do in this transition?”. According to Pawley, these open questions allow “participants to tell their stories in whatever way they chose”. Some participants asked for more guidance in answering the questions, and the research team therefore developed a variety of prompts such as “Tell me a little about yourself. Tell me about your experiences at SJSU after the transition to 100% online instruction. Has COVID 19 made any impact on your life? Let’s talk about that for a minute; Tell me more about that; So, just to clarify . . . How did you learn about this? What was important to you? Any regrets? Anything you wish you had done differently? Anything else you would like to tell me?”.

The interviews lasted about 20–30 min. The interview recordings were completed through Zoom cloud and Zoom automatically created a transcript of the recording. The research team reviewed the transcripts and recordings together for typos in the transcript and words that the transcriber misheard or misunderstood. The research team then pseudonymized the transcripts, masking names, places, ages, organizations, ethnic groups (replacing them with broader racial categories), nationalities, languages, and religious affiliations or communities for those participants who desired it and the names of people participants mentioned. The participants were then sent both the original transcript (for their records) and the pseudonymized transcripts to review for inaccuracies or things they regretted saying.

At this point, the revised transcripts were coded by two members of the research team, a faculty member and a graduate student [33]. An iterative inductive stage was used that involved several close readings of the transcribed interviews to code the results. This reading provided a holistic perspective of the responses. At this stage, points of interest and interpreted significance were coded by the two coders, respectively, who then compared and arbitrated their results until they achieved a valence of consistency that approximated near complete calibration. The coding was defined using NVivo 12, a qualitative data analysis tool, to code responses and identify outstanding themes of perceived in the student and faculty interviews. Once the codes were arbitrated and calibrated, the team completed a step-by-step analysis that went into the description of the analytic themes previously derived that culminated into a rich description of the phenomena from the participants’ point of view and a subsequent conceptual interpretation conducted by the team.

4.3. Participants

The research team conducted 23 interviews with faculty of the SJSU College of Engineering of which six identified as female, 16 identified as male, and one identified as unassigned. Most of the participants were lecturers (18 out of 23), with two tenure-track faculty and three tenured faculty. Of these, nine participants have been teaching at SJSU less than five years, six participants for 6–10 years, two participants for 11–15 years, and six participants for more than 15 years, as shown in Table 4. All departments in the college were represented across the participants. Department data has been excluded from the reported data out of concern of identification due to the small number of teaching faculty in many departments. Each participant was assigned a pseudonym, taken from the Atlantic Tropical Cyclone Names [34] for 2020 and 2021 to limit any potential bias that could arise from the research team choosing random pseudonyms.

Table 4. Interview faculty participants identified by their pseudonym, gender, status, and time teaching at SJSU.

Participant	Gender	Status	Years Teaching at SJSU
Josephine	Female	Lecturer	6–10 years
Dolly	Female	Lecturer	more than 15 years
Hanna	Female	Tenure-track	0–5 years
Laura	Female	Lecturer	6–10 years
Paulette	Female	Lecturer	6–10 years
Vicky	Female	Lecturer	11–15 years
Kyle	Male	Tenured	more than 15 years
Arthur	Male	Tenured	0–5 years
Isaias	Male	Lecturer	0–5 years
Cristobal	Male	Lecturer	0–5 years
Edouard	Male	Tenured	more than 15 years
Victor	Male	Lecturer	6–10 years
Gonzalo	Male	Lecturer	0–5 years
Peter	Male	Lecturer	11–15 years
Nicholas	Male	Lecturer	0–5 years
Omar	Male	Lecturer	6–10 years
Marco	Male	Lecturer	more than 15 years
Larry	Male	Tenure-track	0–5 years
Henri	Male	Lecturer	0–5 years
Bill	Male	Lecturer	more than 15 years
Fred	Male	Lecturer	more than 15 years
Wilfred	Male	Lecturer	0–5 years
Bertha	Unassigned	Lecturer	6–10 years

5. Results and Discussion

5.1. Survey Results

The survey explored two main themes. Initially, faculties reflected about their personal experiences and psychological well-being in Spring 2020, including the stress and pressure that they experienced. Then, the survey explored the pedagogies and tools that faculty adopted in the transition to emergency online instruction.

5.1.1. Personal Experience and Psychological Well-Being

Several faculty members (29 responses out of 92 responses) are living with someone over the age of 65 or who has a risk factor for COVID-19, mostly lecturer and tenured faculty. In addition, 34.8% of faculty (32 faculty members) either had to care for children or elderly people either full-time or part-time during the shelter-in-place in Spring 2020 (see Figure 1 and Table 5). A higher number of faculty (39%) who had taught less than five years had to care for children or elderly people either full-time or part-time, although this was not significant. Slightly more lecturers (36%) and tenure-track faculty (38%) had to care for children or elderly people either full-time or part-time than tenured faculty (30%). As could be expected, female faculty had much higher care responsibilities than male faculty; 59% of all female faculty had to care for children or elderly people either full-time or part-time during the shelter in place compared to 24.6% of the male faculty.

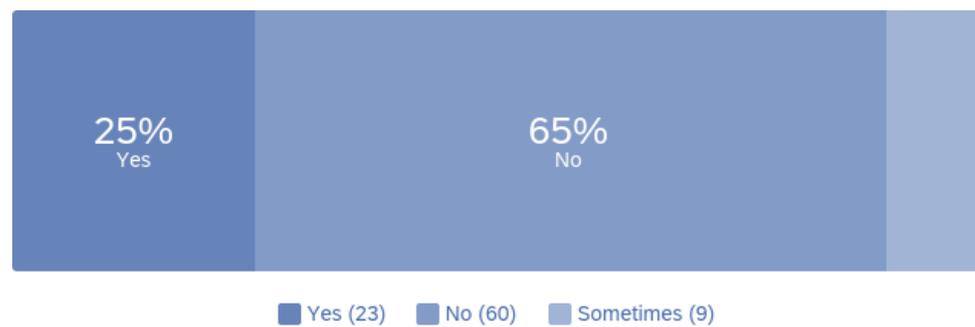


Figure 1. Responses to the question “Do you currently have to care for children or elderly while under quarantine?” for all faculty members.

Table 5. Responses to the question “Do you currently have to care for children or elderly while under quarantine?” broken down by faculty rank and gender.

	Yes	No	Sometimes
All faculty	25% (23)	65% (60)	10% (9)
Female:	52% (14)	41% (11)	7% (2)
Male:	14% (9)	75% (49)	11% (7)
Tenure-track	39% (7)	61% (11)	0% (0)
Female:	50% (5)	50% (5)	0% (0)
Male:	25% (2)	75% (6)	0% (0)
Lecturer	22% (12)	64% (35)	15% (8)
Female:	46% (6)	38% (5)	15% (2)
Male:	14% (6)	71% (30)	14% (6)
Tenured	31% (4)	69% (9)	0% (0)
Female:	75% (3)	25% (1)	0% (0)
Male:	11% (1)	89% (8)	0% (0)

Several faculty members reported difficulties in traveling (22 faculty), changes in their living situations (5), and adverse discrimination (2) since the shelter-in-place in March 2020. With respect to all three of the five questions relating to different aspects since the shelter-in-place, faculty reported that their ability to socialize with peers (89.5%), ability to socialize with friends (91.9%), time management (43.2%), and overall psychological well-being (47.7%) was worse or much worse since the shelter-in-place began. Most faculty reported feeling more stress as a result of COVID-19, in particular tenure-track faculty (see Table 6). In addition, tenure-track faculty and female faculty experienced higher stress levels than other faculty groups; 83% of tenure-track faculty reported a moderate or a great deal of stress compared to 63% of lecturers and 46% of tenured faculty. Moreover, 73% of female faculty reported a moderate or great deal of stress compared to 63% of male faculty.

Table 6. Responses to the question: “Overall, how much stress are you feeling about the consequences of COVID 19?” for all faculty members and broken down by gender.

	A Little or no Stress	A moderate Amount of Stress	A Great Deal of Stress
All faculty	34% (30)	57% (50)	8% (7)
Female:	27% (7)	62% (16)	12% (3)
Male:	38% (23)	56% (34)	7% (4)
Tenure-track	18% (3)	71% (12)	12% (2)
Female:	22% (2)	67% (6)	11% (1)
Male:	13% (1)	75% (6)	13% (1)

Faculty D: “I feel I am on call 24/7 and it is difficult to take a break. Summer is the time I revamp my courses, work on educating myself and other personal development routines; However, because I feel that I am on call 24/7, I am unable to do those.” (Female—Lecturer)

Faculty E: “It has been extremely difficult to maintain the normal pace and responsibilities of this job while caring for two young children full-time at home. After mid-March, there was no childcare available for either, and we as faculty were expected to continue making progress, meeting deadlines, and fulfilling all our normal job responsibilities as if nothing had changed.” (Female—Tenure-Track)

Faculty reported that both their expenses (41%) and their income (20.7%) had decreased since the shelter-in-place. The survey asked faculty to reflect on five areas that could lead to stress. The responses show that there are a significant number of faculty who were worried about the health and well-being of their families, friends, and students. Additionally, they worried about doing their job well despite the changes made to classes when the classes moved 100% online (see Figure 3).

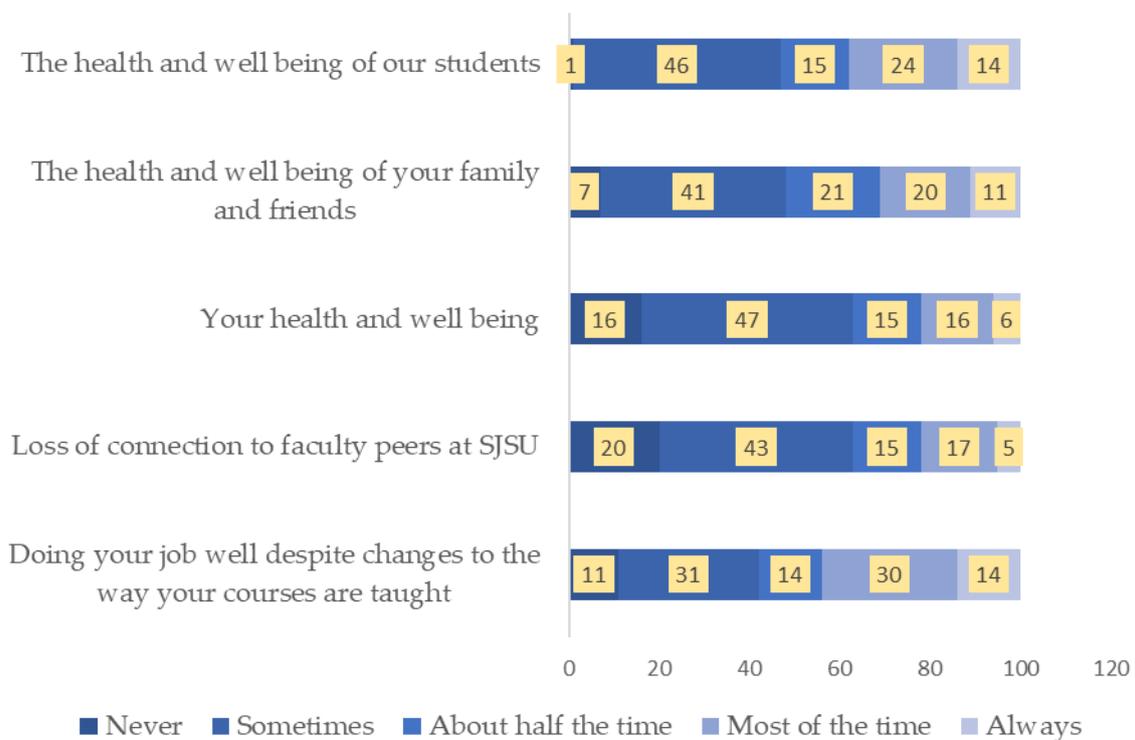


Figure 3. Responses to the Question: “Given the changes in your classes in Spring 2020 and the shelter in place, how often do you worry about the following?” for all faculty.

When asked about several areas of potential stress/pressure, most faculty (64.8%) generally felt that they had everything under control, although they also felt that there was too much to do in their classes (55%) and they were under pressure from deadlines in their courses (48.9%). When analyzing these questions by gender, we found some differences; 50% of the female faculty felt they had things under control compared to 70% of male faculty. In addition, fewer male faculty (37.7%) felt they were under pressure from deadlines compared to female faculty (77%), and female faculty felt they had too much to do in their classes (76%) compared to male faculty (47%). Since female faculty reported higher stress levels and more care responsibilities (see Section 5.1.1 above), it is not surprising that their work responsibilities also were affected. All responses to this question are shown in Table 7 as well as in Figures 4–9.

Table 7. Faculty responses to the Question: “Since SJSU made the decision in March 2020 to move to 100% online instruction, how often have you (Never/Sometimes/About half of the time/Most of the time/Always [%])”.

	Had too Much to Do for Your Courses	Felt You Were in a Hurry	Felt You Were under Pressure from Deadlines	Felt That Work Was Piling up so High That You Could Not Finish It	Felt That You Had Everything under Control in Your Classes
All faculty	15/30/22/23/10	18/35/13/19/15	18/33/16/19/14	32/31/13/16/9	9/26/15/36/14
Lecturer	17/35/23/13/12	21/42/10/13/13	21/42/10/13/13	38/30/12/12/8	6/19/19/38/17
Tenure-track	6/13/13/50/19	6/24/12/29/29	6/12/24/29/29	12/29/12/29/18	12/53/6/24/6
Tenured	15/31/0/38/15	15/31/31/23/0	15/31/31/23/0	31/38/8/15/8	15/31/0/38/15
Female faculty	1/5/8/7/4	1/6/7/6/6	0/6/7/7/6	3/11/3/5/4	3/11/3/5/4
Male faculty	13/25/19/20/9	15/31/11/17/13	15/29/14/17/12	27/27/11/14/8	8/23/13/31/12

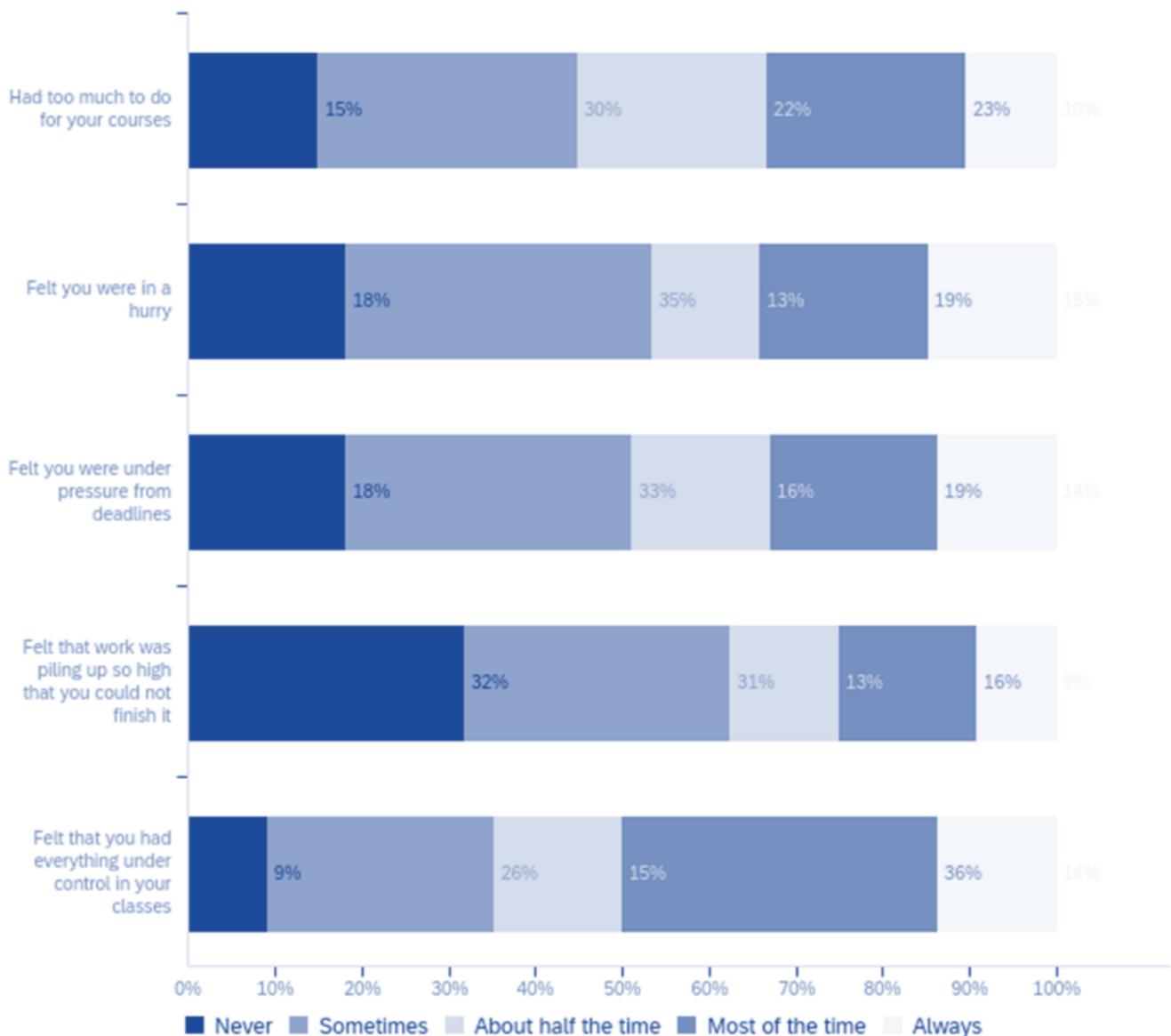


Figure 4. Faculty responses to the Question: “Since SJSU made the decision in March 2020 to move to 100% online instruction, how often have you”.

Table 7 and Figures 4–9 show that the perception about the Spring 2020 transition was felt differently by faculty of different ranks. Overall, tenure-track faculty were more likely to report negative feelings than both lecturers and tenured faculty. For example, 33% of all faculty (Figure 4) felt they had too much to do for their courses all or most of the time, but

this percentage increases to 69% for tenure-track faculty and 53% of the tenured faculty (Figure 5). Moreover, 58% of tenure-track felt they were in a hurry as a result of online instruction (Figure 6), in contrast with 34% of all faculty (Figure 4). Lecturers were the least likely to feel hurried, as 68% reported they never or only sometimes felt this way. Similarly, 33% of all faculty (Figure 4) felt under pressure from deadlines all or most of the time; this percentage rises to 58% for tenure-track faculty (Figure 7). Additionally, only 25% of the entire faculty (Figure 4) felt that work was piling up so high that they could not finish it all or most of the time, but the same answer was given by 47% of the tenure-track faculty (Figure 8). In terms of teaching, 35% of the entire faculty (Figure 4) felt they were in control of the class only sometimes or never, but this same feeling of loss of control was felt by 65% of tenure-track faculty member (Figure 9).

Had too much to do for your courses

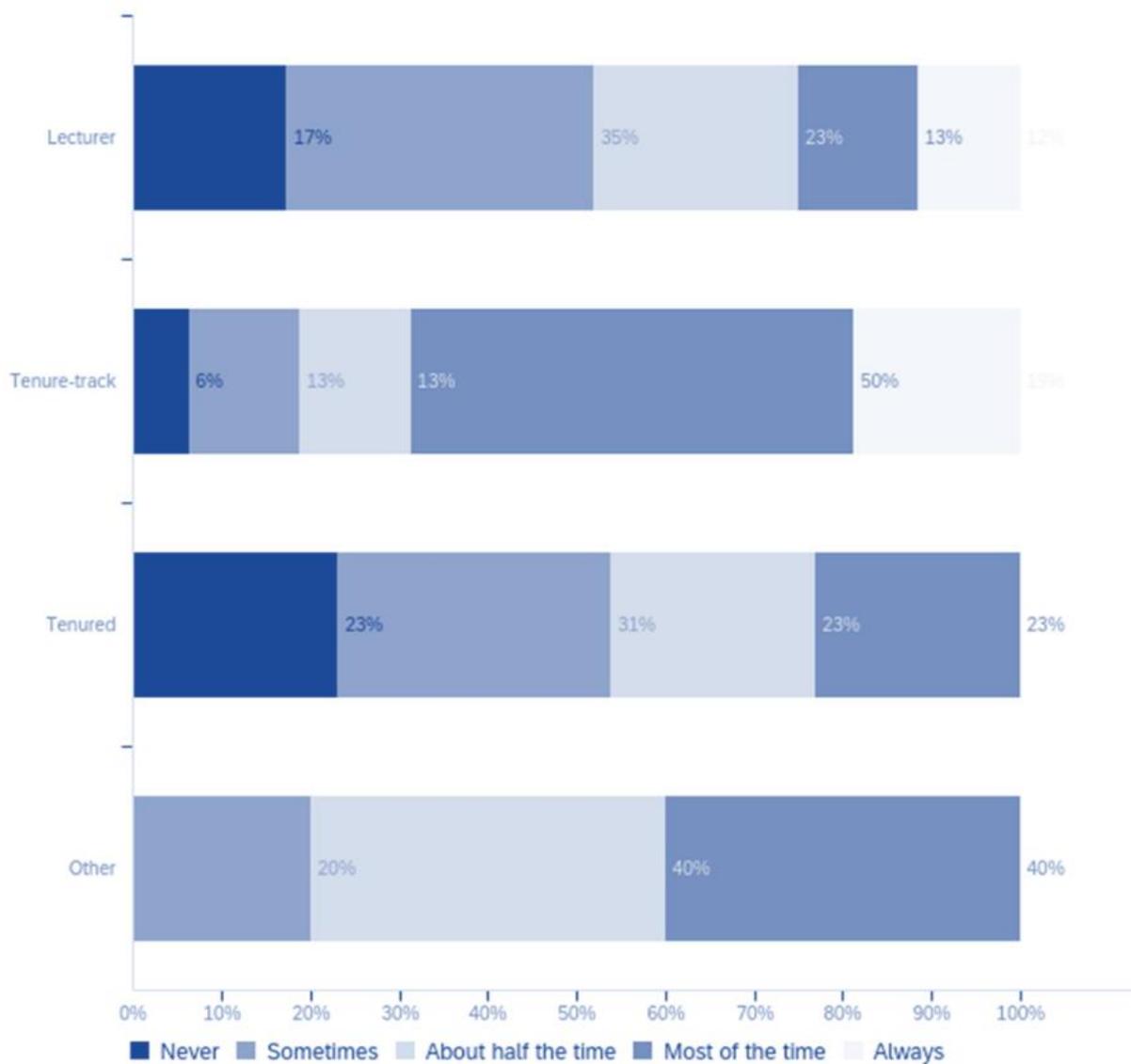


Figure 5. Faculty responses to the Question: “Since SJSU made the decision in March 2020 to move to 100% online instruction, how often have you had too much to do for your courses?” divided by faculty rank.

Felt you were in a hurry

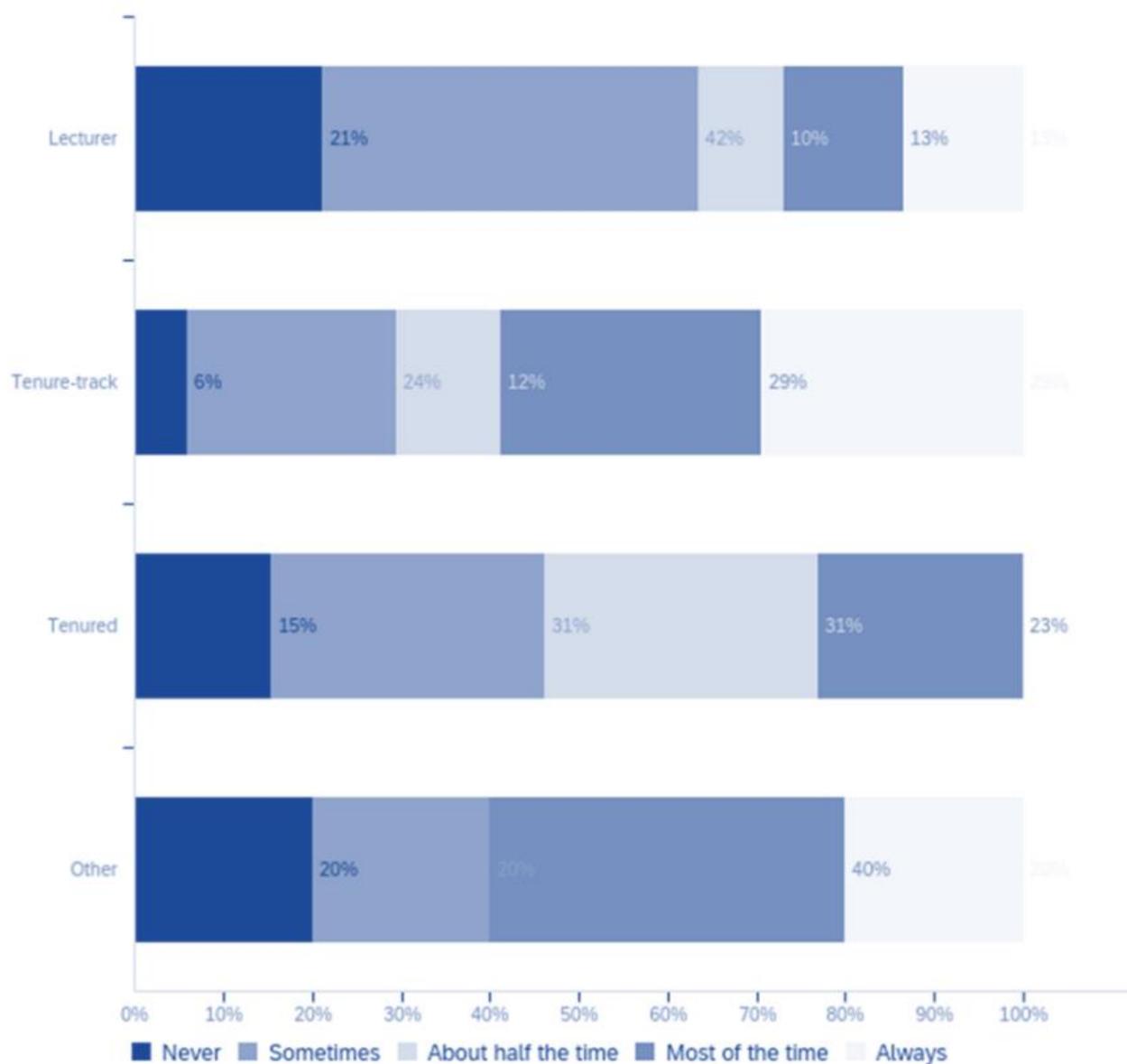


Figure 6. Faculty responses to the Question: “Since SJSU made the decision in March 2020 to move to 100% online instruction, how often have you felt you were in a hurry?” divided by faculty rank.

Felt you were under pressure from deadlines

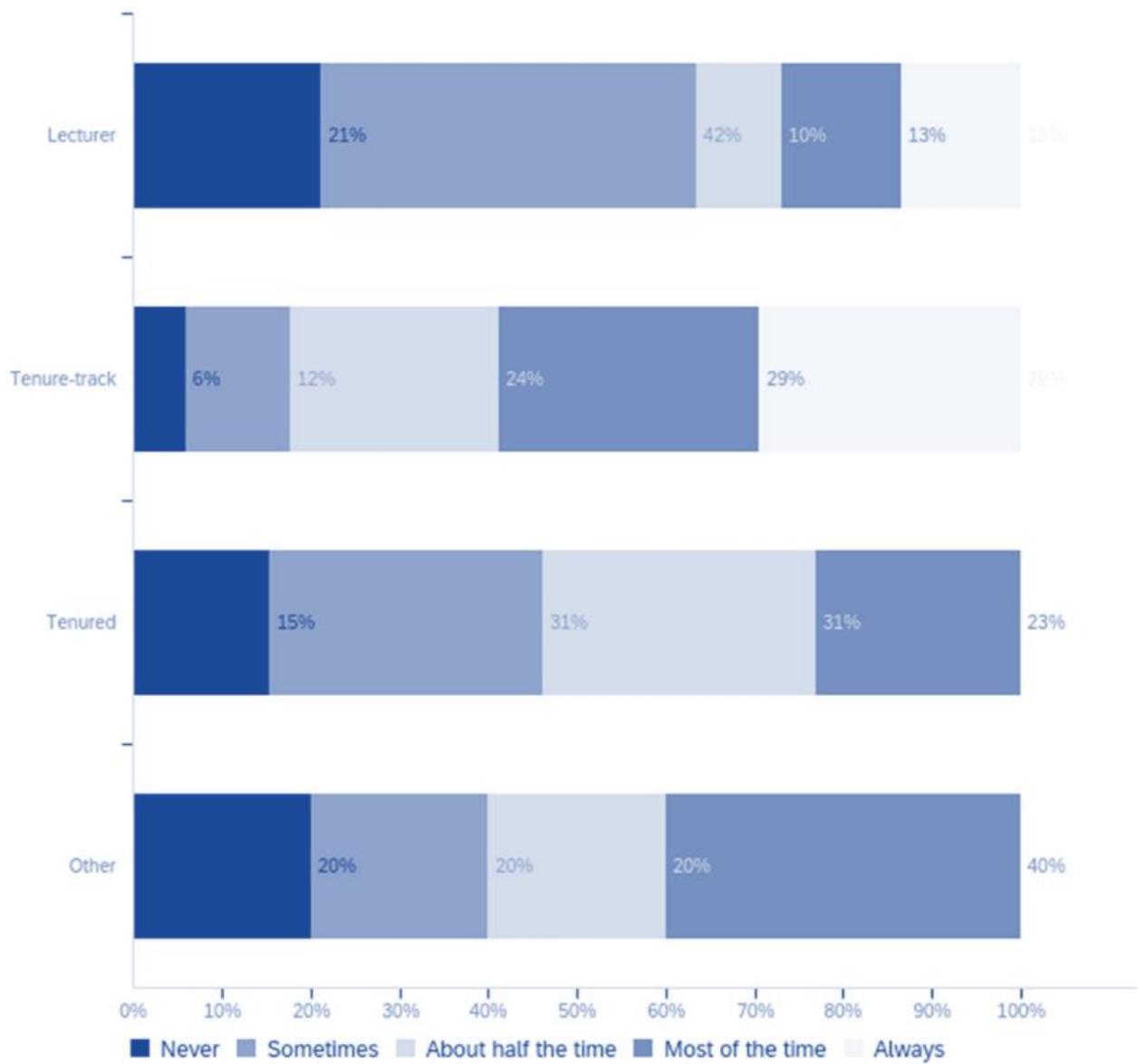


Figure 7. Faculty responses to the Question: “Since SJSU made the decision in March 2020 to move to 100% online instruction, how often have you felt you were under pressure from deadlines?” divided by faculty rank.

Felt that work was piling up so high that you could not finish it

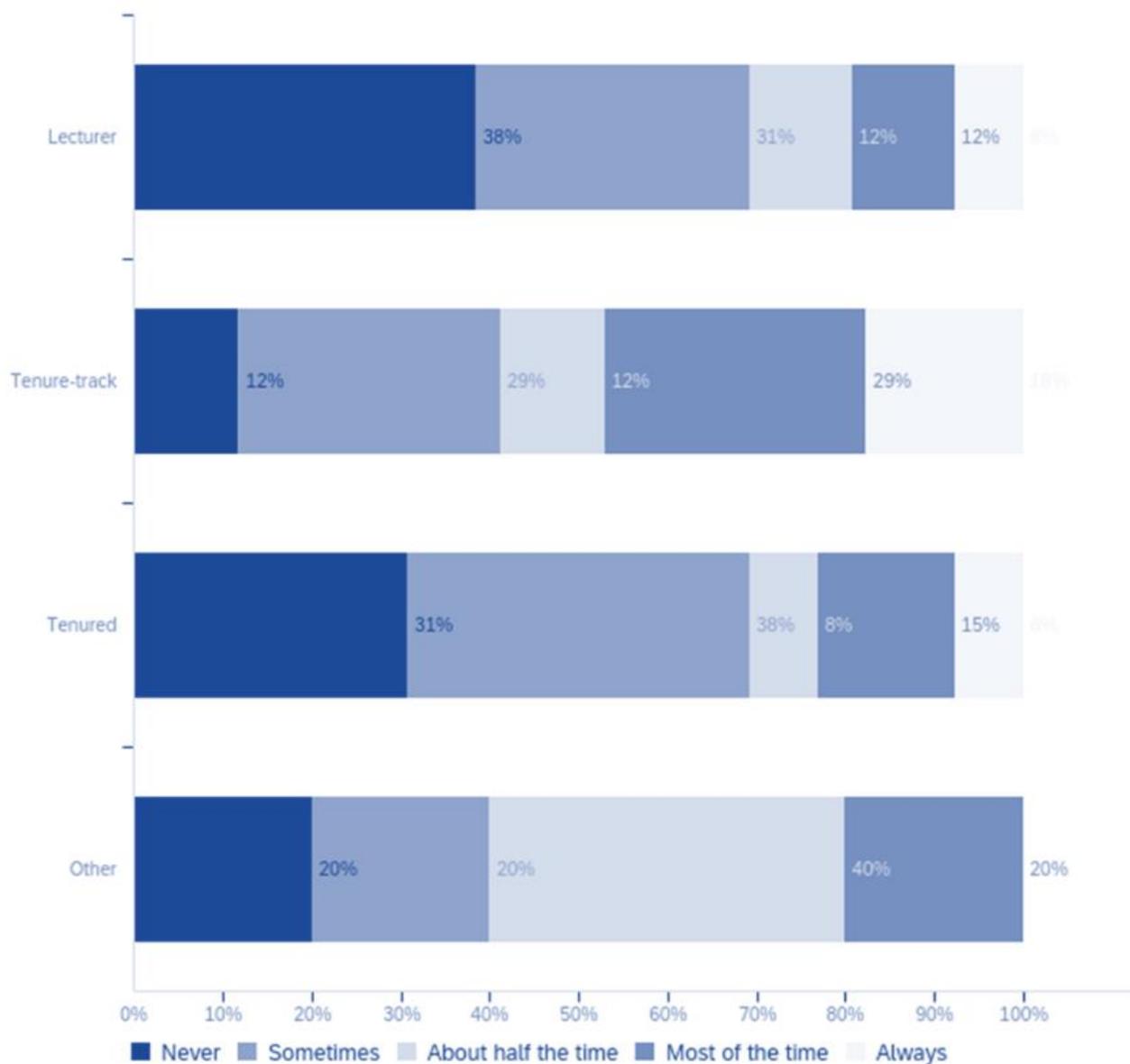


Figure 8. Faculty responses to the Question: “Since SJSU made the decision in March 2020 to move to 100% online instruction, how often have you felt that work was piling up so high that you could not finish it?” divided by faculty rank.

Felt that you had everything under control in your classes

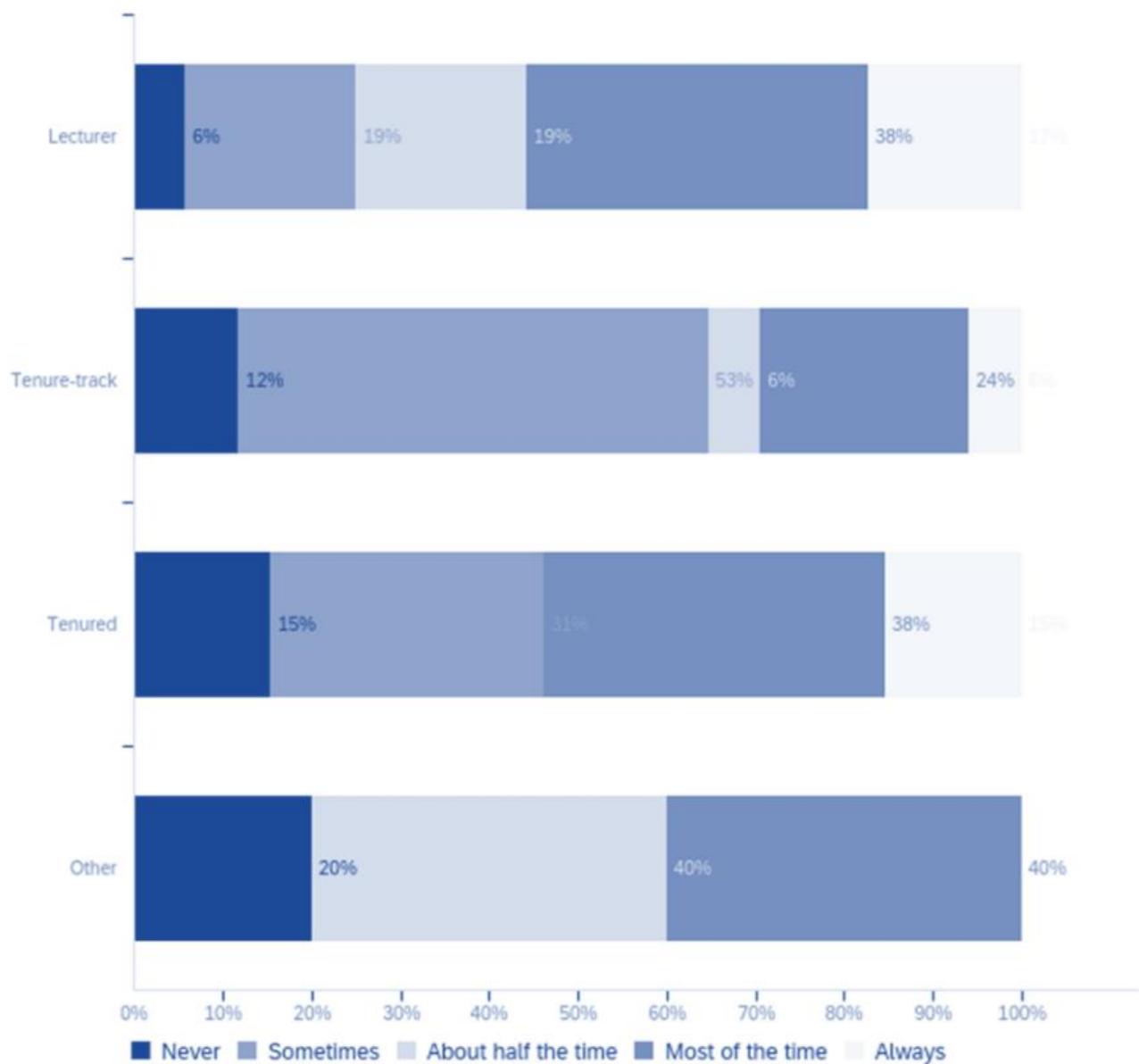


Figure 9. Faculty responses to the Question: “Since YYY made the decision in March 2020 to move to 100% online instruction, how often have you felt that you had everything under control in your classes?” divided by faculty rank.

5.1.2. Online Instruction

The research team was interested in seeing how many faculty members had ever used active learning in their in-person courses. Research has shown that integrating active learning techniques into STEM classes has produced gains in student learning. A study completed by Hake [35] in Physics showed that when active engagement methods were used, students’ scores on a Force Concept Inventory (FCI) were higher than students in traditional classrooms. Hake’s research is supported by research by ENGAGE that shows that faculty–student interactions increase student retention rates in STEM courses [36]. At Purdue University, large STEM lecture courses were redesigned to include active learning strategies in STEM classes; this is part of the Purdue Academic Course Transformation program (IMPACT) [37]. As a result of IMPACT, overall student retention increased by 1%, while retention in their respective STEM courses increased by 2%. After the redesign, the student GPAs of those taking IMPACT made a significant increase, making a significant

difference between non-IMPACT and IMPACT classes. Freeman et al. [38] conducted a meta-analysis of 225 studies that compared student performance in undergraduate traditional lecture classes with active learning classes in STEM. They found that the failure rate in lecture classes was 1.5 times that of active learning classes. Theobald et al. [39] also performed a meta-analysis, but it was focused on comparing the achievement levels of underrepresented students and majority students in STEM classes; they analyzed student examination data from 15 studies and student failure rates from 25 studies (a total of 53,844 students). Theobald et al. found that “active learning reduced achievement gaps in examination scores by 33% and narrowed gaps in passing rates by 45%”.

The number of engineering faculty using active learning is lower than other fields: a national survey of engineering faculty [40] found that only 47% of engineering professors use active learning in their classrooms. Indeed, Borrego et al. [40] found that, although 83% of engineering chairs were aware of active learning techniques, only 36% of engineering faculty were using them. In Fall 2011, SJSU surveyed the faculty in the Colleges of Science and Engineering to gauge the instructional methods used. Using the Survey of Instruction and Assessment Strategies (SIAS) that was developed by the NSF-funded *Louisiana Collaborative for Excellence in the Preparation of Teachers* (LaCEPT) [41], and the results indicated that 71% of the SJSU science and engineering instructors gave lectures for the majority of the class periods. This survey was repeated in Spring 2016 and Spring 2019. In Spring 2019, the number of SJSU engineering faculty using some active learning in their classes increased to 60%.

The results of this survey showed that most SJSU faculty (70.5%) used active learning in their in-person classes although this number was slightly higher for female faculty (77%). In addition, most faculty (60%) took training to learn about online tools; the most common training was for audio or video conferencing tools, Canvas, controlled testing environments, and online videos or tutorials. Figure 10 displays the most common active learning pedagogies used by survey respondents. Most faculty were satisfied with the support they received from SJSU after the shelter-in-place with 63% of the faculty indicating that they were moderately or extremely satisfied with the support.

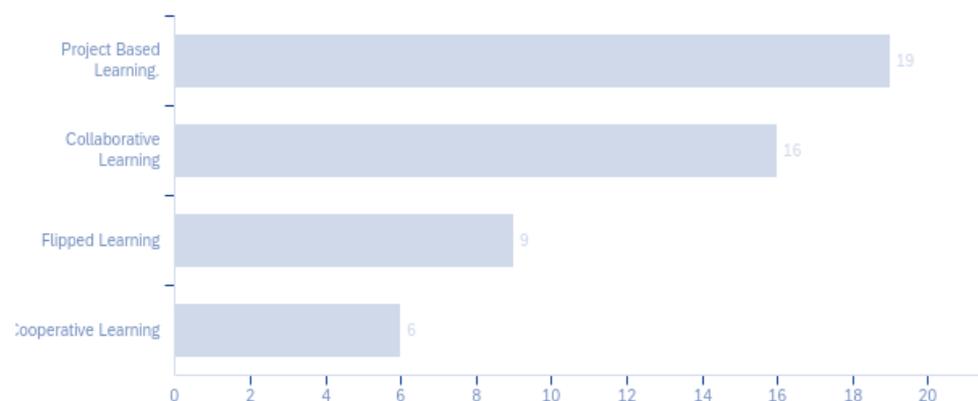


Figure 10. Faculty responses to the Question: What active learning pedagogies have you used in your classes?

Faculty reported using a wide variety of online tools since the move online in March 2020. Prior to the shelter-in-place, almost all faculty reported using Canvas and online videos and tutorials in their in-person courses (see Table 8). After the shelter-in-place and transition to online learning, faculty understandably reported using different online tools and more online tools than with in-person classes. After the move to online learning, more faculty reported using audio and video conferencing tools (90.6%), webcams (77.3%), online videos or tutorials (68.8%), and YouTube (50%) (See Table 9).

Table 8. Online tools that faculty report having used in their in-person classes.

Tools	Never Use		Sometimes Use		Always Use		Sometimes & Always Use	
Canvas	3	4.4%	2	2.9%	64	92.8%	66	95.7%
Online videos or tutorials	9	13.6%	38	57.6%	19	28.8%	57	86.4%
YouTube	14	21.2%	36	54.6%	16	24.2%	52	78.8%
Collaboration tools (Google Docs or other collaborative tools)	21	35.6%	30	50.9%	8	13.6%	38	64.4%
Audio or video conferencing tools (Google Hangout, Zoom, Microsoft Teams, etc.)	23	37.7%	15	24.6%	23	37.7%	38	62.3%
Real-time polls	26	41.9%	28	45.2%	8	12.9%	36	58.1%
Discussion boards	27	43.6%	24	38.7%	11	17.7%	35	57.4
Text-based chat	31	53.5%	21	36.2%	6	10.3%	27	46.6%
Controlled online testing environments (ProctorU, Proctorio, LockDown Browsers, etc.)	40	63.5%	15	23.8%	8	12.7%	23	36.5%
Video editing software	43	70.5%	17	27.9%	1	1.6%	18	29.5%
Digital whiteboard apps	47	75.8%	8	12.9%	7	11.3%	15	24.2%
Podcasts	53	94.6%	0	0.0%	3	5.4%	3	5.4%

Table 9. Online tools that faculty have used in their online classes after the shelter-in-place.

Tools	Yes, Tool Used		No, Tool Not Used		Sometimes		Not Needed	
Computer or laptop	83	96.5%	2	2.3%	1	1.2%	0	0.0%
Canvas	80	96.4%	3	3.6%	0	0.0%	0	0.0%
Audio or video conferencing tools (Google Hangout, Zoom, Microsoft Teams, etc.)	77	90.6%	7	8.2%	0	0.0%	1	1.2%
Webcam	58	77.3%	10	13.3%	2	2.7%	5	6.7%
Online videos or tutorials	55	68.8%	13	16.3%	5	6.3%	7	8.8%
YouTube	39	50.0%	18	23.1%	13	16.7%	8	10.3%
Text-based chat	37	49.3%	21	28.0%	9	12.0%	8	10.7%
Collaboration tools (Google Docs or other collaborative tools)	35	46.7%	23	30.7%	9	12.0%	8	10.7%
Controlled online testing environments (ProctorU, Proctorio, LockDown Browsers, etc.)	37	45.7%	27	33.3%	7	8.6%	10	12.4%
iPad or tablet	32	42.1%	32	42.1%	5	6.6%	7	9.2%
Real-time polls	32	42.1%	28	36.8%	7	9.2%	9	11.8%

Table 9. Cont.

Tools	Yes, Tool Used		No, Tool Not Used		Sometimes		Not Needed	
Scanner	30	41.1%	31	42.5%	7	9.6%	5	6.9%
Discussion boards	28	35.9%	29	37.2%	8	10.3%	13	16.7%
Digital whiteboard apps	26	34.7%	33	44.0%	3	4.0%	13	17.3%
Video editing software	19	26.0%	37	50.7%	6	8.2%	11	15.1%
Document camera	15	20.8%	42	58.3%	2	2.8%	13	18.1%
Podcasts	3	4.3%	46	65.7%	2	2.9%	19	27.1%

Faculty responses were mixed when asked about concerns related to privacy and security of online tools, with 44.6% indicating they were concerned, 42.2% indicating that they were not concerned, and 13.2% indicating they were unsure. Most faculty (70.4%) spent more hours than usual on course preparation after the shelter-in-place. All the female faculty who responded to this question indicated that they spent more hours than usual on course preparation. The additional hours spent on course preparation by faculty were significant with 41% of the faculty reporting spending 5 or more hours per week for online instruction as compared to their normal course preparation for in-person classes, with female faculty spending about the same amount of time as male faculty.

Faculty reported that students indicated they had issues with several digital technologies after classes moved online. More than two-thirds of students had problems with Internet connectivity either always or sometimes during Spring 2020. In addition, as can be seen in Table 10, more than 50% of the students had issues with a physical space for studying and webcams.

Table 10. Faculty responses to the Question: “Have your students indicated that they have issues with access to any of the following after the move to 100% online instruction in March 2020?”

Issue for Students	Yes	Sometimes	No	Not Needed	Total
Enough internet access for doing your classwork online	32	22	26	0	80
Physical space for studying and doing assignments	26	14	38	1	79
Webcam	23	17	34	4	78
Computer, laptop, or tablet	16	16	48	0	80
Library resources (including books, articles, etc.)	14	5	53	3	75
Scanner	10	2	50	12	74
Printer	6	8	48	15	77

5.2. Analysis of the Interviews

Interviews were conducted throughout Summer 2020, with the majority of them occurring in late July and early August. The analysis of the interviews is divided into four main themes: “Testing and assessment”, “Experience”, “Teaching approach”, and “Hands-on laboratories”.

The majority of the interviewed faculty reported never having taught online before Spring 2020, and they were therefore required to transition to the emergency online format with very little preparation and formal training. Courses were canceled for 4 days after the shelter-in-place announcement in mid-March to allow faculty time to transition to online instruction. Faculty needed to quickly get up to speed in online teaching and were able to attend brief trainings offered by the college and university, receive one-on-one support

from IT and instructional designers, and collaborate with other faculty members skilled in online instruction. This model of just-in-time support continued through Spring 2020.

In preparation for Fall 2020, which had been announced to be primarily online in late May, the university utilized federal funds received from the CARES Act to offer training to all faculty in Summer 2020. More than 1000 faculty remotely attended a 3-week course in online teaching and assessment offered by the university's Center for Faculty Development and eCampus.

5.2.1. Testing and Assessment

Testing and assessment was the main point of discussion during the faculty interviews. The research team associated the following codes with the "Testing and Assessment" category:

- Online testing: 15 out of 23 faculty;
- Concerns about cheating: 9 out of 23 faculty;
- Grading issues: 8 out of 23 faculty;
- Students had higher grades: 6 out of 23 faculty;
- Students had lower grades: 4 out of 23 faculty;
- Faculty made more exceptions to students: 3 out of 23 faculty.

Faculty members in Engineering were highly concerned about finding assessment tools that were meaningful and allowed them to assess both lower taxonomy and higher taxonomy skills [42]. When planning for online testing, the majority of the interviewed faculty changed their assessment strategies, moving from traditional closed book exams to open books exams. They also reported experimenting with different types of assessment methods, such as open-ended exams, multiple choice exams, or asynchronous "take-home" exams. Kyle, for example, discusses the need to experiment with different types of online assessment strategies during the semester:

"The exam I mean that that was a little bit difficult experience the exam, the first exam, which we did we use Zoom [. . .] Now the second exam that I use a different process. I use the lockdown. [. . .] And then I change it to a multiple-choice question and now with the multiple choice question the computer can generate the answers randomly." —Kyle

Many faculty members reported being concerned about students cheating and academic dishonesty and were not very confident in their ability to truly assess individual students' skills:

"I think testing in an online environment is very, very difficult. [. . .] I think testing is a real, real challenge for the engineering curriculum, to be honest with you. [. . .] Students are cheating. I'm not saying that at all. I think I think exam integrity is a big, big challenge, for engineering for the engineering curriculum." —Peter

To minimize cheating, some faculty experimented using video proctoring during assessment, either using software such as LockDown browser, ProctorU, and Impendus, or monitoring students using synchronous Zoom meetings. In some cases, these monitoring techniques resulted in students' push back, with faculty feeling under pressure about their assessment strategies:

"And they were saying like why I'm only using this because many other faculties are giving take home exam and I'm the only one who does like who tortures them you know like basically, they felt that way a little bit, and I tried to compromise with them. [. . .] they were like trying to push me even say that they even send email to our chairs if there is a way to do not have tests online. [. . .] from one side, I felt like they were under the stress and I understand that situation, but at the same time, they just wanted to take advantage of it." —Hanna

Faculty felt responsible for preventing cheating, but in many cases, they were not sure about best practices for online testing or found that it took excessive faculty time to prepare the assessment:

“On exams, there was a lot of rampant cheating. [. . .] some of the students are, you know, told me that they were constantly you know messaging, or, you know. How are you going to you know stop it without making faculty responsible for them not to cheat? [. . .] So, I, I don’t know. I mean, you cannot make you know 10 different question papers. I mean, that will be ridiculous, right. So, I just don’t know how to do it. And if you don’t go the traditional testing route, you know, how would you test them? Is it more pop quizzes and giving more weightage to those? I don’t know, So, if you can come up with some guidelines and those, and how to, you know the, the whole academic integrity and how do they, how, you know, how do you make them responsible for the learning, I think, I think that would be important” —Arthur

5.2.2. Experience

Faculty experience was reported as positive, with faculty generally finding it easy to transition to emergency online instruction. The following codes were associated with this category:

- SJSU acted appropriately as an institution: 14 out of 23 faculty;
- Positive experience: 14 out of 23 faculty;
- Online teaching and learning difficulties: 13 out of 23 faculty;
- Faculty found it easy to transition to online teaching: 11 out of 23 faculty;
- SJSU should provide more support: 6 out of 23 faculty;
- Faculty SOTES: 3 out of 23 faculty.

Faculty, in general, reported having a positive experience teaching in an online environment and defined the transition as easy. Online teaching was found by some faculty to be convenient. The transition to emergency online teaching was reported by the interviewed faculty as “smooth,” “seamless,” “pretty easy,” “not that hard,” “not as challenging,” and “convenient”:

“I feel like Spring was a fairly seamless transition, as seamless as it could have possibly been” —Cristobal

“I just continued with the lectures, you know, didn’t really skip a beat and it went well and went really well. [. . .] It was good. [. . .] With respect to the class. I think, I think it went fine. [. . .] I was able to get through those this time so I did find the online format, more efficient and it was definitely easier for me. You know, I didn’t have to drive commute to nest apart didn’t have to walk over to the class set up the audio visual. [. . .] So I, I liked it.” —Fred

“I think, I think it worked out very well for me. It, I was very happy like I’m now comfortable teaching online or in-class. Both are okay with me.” —Isaias

At the same time, faculty noted that they were faced with challenges in their teaching approach during the transition to emergency online teaching. They reported challenges with grading and assessment, forming a personal connection with the students, listening and supporting students who were struggling because of their personal situation, maintaining students’ engagement, and “Zoom drain.” Faculty noted that students were struggling because of the difficult situation, as described by Vicky below:

“They [students were thrown into this mess. They had family problems and stress because people were losing the jobs. It was just a mess. [. . .] But it was so there was a lot of stress, our students suffered a lot of stress, more than I thought would happen. [. . .] I didn’t realize that they would be out of work or the parents would have been laid off. Then they felt the stress that they had to work to help their families. I really had never seen anything quite like it. [. . .] And then, as I said, I think I don’t know what caused some of them I reached out to them. Never heard back for them just to drop be gone. And what one of them was even my best student, I mean, he was a solid A up to that point. And because of family pressure. He had to quit. That one broke my heart.” —Vicky

For some faculty, meeting students’ needs came at a cost of personal well-being:

“That it helped them, but it was incredibly draining for me because I would be on Zoom for five hours every Monday and Wednesday. I have, a five-minute break here and there they go get another drink and use the facilities and rush back and get started again. So, the Zoom drain was incredible. And I would basically I’d be done for the rest of the day I interact with my family but mentally I was just put. And my students seem to have very similar reactions to having to be engaged with their classes online, whether it was my class or another class but many times I heard that they were struggling to keep up with the dates, because there wasn’t always that engagement directly with their instructors and even with the engagement with me. It was hard for them to keep up.” —Josephine

Some faculty noted a discrepancy between their experience as a faculty and the students’ experience:

“It turned out that, I thought okay, I thought in terms of delivery from my side, I did not see any difference. But then students did not like it at all. [. . .] They had difficulty and I had to a lot of times I had to go over things repeatedly, they wouldn’t get it so it take, it’s, most of them did not like that.” —Arthur

SJSU, as an institution, was reported to be effective in how it responded to the difficult circumstances. Many faculty members praised the IT team for the quick transition and the many trainings offered regarding online teaching resources and software offered to faculty members:

“I thought they did a great job in the way they handled everything because it had to happen so fast, especially the training that was available.” —Bertha

“I feel like the IT people did a wonderful job of helping get everyone up to speed as best as possible with Zoom and remote learning technologies.” —Cristobal

“It’s actually hard for me to imagine anything that could have been done better. It doesn’t mean that things were great, but this is catastrophic. This is before all of this happened. I think what is happening is beyond all of our imaginations.” —Laura

“I’m really grateful and happy that the prompt response from SJSU. In terms you know again, limiting the exposure to the students and myself by making that early call of just transferring everything online.” —Wilfred

At the same time, some faculty noted that SJSU could have been more supportive of their faculty and students by asking faculty what they needed and how they could be best supported in their teaching, by promptly providing devices needed to teach (laptops, tablets, printers, scanners, etc.), and by providing some guidance and best practices for grading and assessment strategies:

“So, I really feel that it was a lot of scrambling that was doing a lot of, some faculty members were allowed to do things that I found unacceptable, like one faculty member I know decided they weren’t going to have any Zoom, they weren’t going to have any anything, and they just assigned homework. [. . .] So, I think that that’s where the university really let faculty down. Is they did not have a collective effort where they said, okay, we’re taking this week off and basically, they said we’re taking this week off so you can get your act together. [. . .] there was never anything that went out and said, how can we support you?” —Dolly

“We need more support from the university to the student [. . .] Okay, so, if a faculty doesn’t have a computer. Then this is a problem. The second thing a faculty need a scanner and I need a, I need a scanner and then needs a printer. Well, I do have a printer. Okay. And it’s a fast printer. I didn’t have a problem. I did have a page-by-page scanner but I have one at work, which is a fast, fast scanner, you can do 50 pages per minute.” —Kyle

“I wish that the purchasing for things would be a little bit easier I requested to get like a tablets that I could work through some laboratory problems and structures, just to be able to write and draw. Because if not, I’m gonna have to set up a camera” —Nicholas

“Effort by the university to help us on the testing side to you know, some kind of guide that they can they can provide that would help all the professors with testing and how to maximize exam integrity look even in the classroom.” —Peter

5.2.3. Teaching Approach

Many participants discussed how their teaching approach changed in the transition from in-person to emergency online classes. The following codes were identified as part of this theme:

- Faculty used PowerPoint: 9 out of 23 faculty;
- Faculty recorded classes: 9 out of 23 faculty;
- Use of technology in the classroom: 9 out of 23 faculty;
- Faculty changed teaching approach in online class: 8 out of 23 faculty;
- Faculty lectured entire time: 8 out of 23 faculty;
- Faculty assigned project: 7 out of 23 faculty;
- Faculty run office hours: 6 out of 23 faculty;
- Internet or connection issues: 5 out of 23 faculty;
- Faculty used active learning: 4 out of 23 faculty;
- Faculty taught synchronously: 17 out of 23 faculty;
- Faculty taught asynchronously: 3 out of 23 faculty;
- Students were highly engaged during class: 6 out of 23 faculty.

In many cases, faculty changed their teaching approach *“a whole 180 degree”* (Dolly) as they recognized that the emergency online format required different strategies to keep students engaged. Some faculty reported decreasing the pace of the class and the quantity of material covered, while other faculty were able to cover a bit more material:

“I had to make changes to the material to make it . . . work better with the, you know, online delivery. . . . And also, I had to . . . learn, of course, the tools, getting the ins and outs of Zoom. I was only . . . casually familiar with Zoom before that. So, I didn’t know the . . . screen sharing and breakout rooms and . . . all the other good stuff that that we need to know for a good teaching experience. And . . . then in terms of some of the deliverables, the assignments, I had to make some changes to . . . make sure that they are compatible with online and the biggest challenge was with one of our hardware labs, which required . . . holding things in your hand and doing things.” —Bill

The majority of the interviewed faculty taught synchronously with the same schedule as during in-person teaching, used PowerPoint slides to present their lessons, recorded their lectures and made them available to students, and had office hours. A large number of faculty lectured for the entire class time, finding it difficult to incorporate active learning activities to keep students engaged.

“That remained mostly unchanged with the exception of not having, probably if I had to estimate, 20 to 25% of the time in the, of the lecture before people working through a problem in like a small group or something like that, which really I didn’t judge is feasible with remote lecture via Zoom and that was discontinued when classes went remote” —Cristobal

A few faculty were instead able to incorporate active learning into their online classes, taking advantage of the digital environment they were suddenly teaching in:

“Later, what I did is beforehand the students need which readings, they needed to cover, so I enforce the concept with announcements, say, hey, heads up, we’re covering this material this week, make sure you’re ready, we will do exercises first and so, implement the flipped learning Idea and concept right and approach. [. . .] The students beforehand they will know or they knew what things they will be working on. And right at the beginning of the class. I’m just giving them a quick introduction [. . .] Then ask some questions to engage and to get an understanding of what the general where the class was in terms of their understanding to the concept [. . .] I did use polls. [. . .] So, asking

those questions that will get a baseline for the class and understanding. [. . .] Then I'll give them exercises without, without covering the material myself like because the expectation was you already learned this material. So, now you go and try it out. [. . .] So, then I'll jump. Probably for about 45 min, at the beginning of the class I will separate the class into groups, then I'll be joining each of the rooms in a rotating manner, and I'll go and you know ask questions and see if they were struggling with the material. [. . .] I will create another poll and run a comparison between this is where you started in class."
—Wilfred

Some of the faculty found that students were highly engaged during their online classes, and this was especially true for faculty who experimented with active learning:

"The engagement in the class was much higher that's compared to the beginning of the semester." —Wilfred

5.2.4. Hands-on Laboratories

In the SJSU College of Engineering, many classes have hands-on activities and laboratories incorporated into the schedule. Transitioning laboratory activities to an online format was reported to be particularly challenging given the sudden transition and the inability to provide hardware or materials to students because of the campus closure and safety concerns.

Faculty used different strategies to conduct their laboratory activities, such as using "a simulator" (Larry) or conducting demonstrations (Cristobal):

"then for the labs, I used a simulator. Yeah, So the good thing about SJSU is that I could use simulator . . . For SJSU and YYY, I use Multisim." —Larry

"So, what I did is I personally went to the lab, took the data for them, took images of the setup, and went through my normal in text format, my normal spiel that I would give to them at the beginning of the lab. You know, generally what we're doing what we're looking for, etc. And basically, handed the photos and the data off to them for them to process as they normally would and write a report on it. [. . .] As they normally would, if it weren't in person thing. So, really, the part that got lost in that was they weren't physically there to see the setup themselves or actually run the equipment. And ideally, I would have liked to actually record the entire process of the lab. But because it was basically required that I'd be the only one in the lab for that. That really wasn't a practical possibility with the ad hoc nature of the online transition." —Cristobal

Some faculty discussed their frustration on the inability to conduct labs in a safe environment:

"What I'm saying is, is if my karate studio can open up with social distancing, why can't, I mean my lab would have like one person per area and if you wear the mask and you do all this business. It's not like Texas reopening with like no rules. No, we're, we're in a lab. I mean, the people who run labs" —Edouard

5.2.5. Preparing for the Next Semester

Many of the faculty (11 out of 23) discussed their plans for their Fall 2020 online instruction. They planned to make changes after the lessons they learned in Spring 2020 in delivering the class material and their teaching approach, as well as in conducting laboratory activities:

"I'm going to be teaching the same class and I am actually making fairly extensive changes to the way it's being taught and part of that is based, it's . . . because of the experiences in the spring. . . . I'm making it a lot more interactive. [. . .] And then the lab part that I mentioned earlier, the hardware lab revamping that so instead of building it ourselves, . . . I've identified a piece of hardware that they could order on the web, which is just as cheap, if not cheaper. So, I think that would be that would also be a little, should run a little, more smoothly." —Bill

Some faculty planned to move to an online “asynchronous” flipped classroom approach, so they could prepare their class material and videos beforehand and then use class sessions to engage students in problem solving activities, answer questions, or meet in small groups to review projects:

“But as far as, you know, fall is concerned, I’m going to make asynchronous lectures, make it available at least a week in advance and then use the sessions more for you know, you know, a lot of problem solving” —Arthur

“Okay, I’m going to teach online, but now it will be asynchronous. So, what I’m doing now I’m spending all the time to do some lectures and it will be posted on YouTube. And then I download it to Canvas and then I’m going to make, make some meetings with them because this is a design class. So, I have to see how do they do? So, it will be regular meetings with each group. So, I, I will have next semester 12 groups. So, that will be 12 meetings for these groups.” —Omar

Faculty also planned to incorporate more active learning strategies, such as synchronous group activities, using breakout rooms and *“to really do more to encourage discussion amongst them, and with me” (Gonzalo):*

In terms of testing and assessment, faculty planned to be clearer with the students from the beginning of the semester with respect to their expectations, particularly if they planned to use video proctoring.

6. Discussion

For the discussion, we related the results of our interviews back to the research questions. We will summarize the results in this manner.

Research Question 1: Did faculty experience pressure and stress during the COVID-19 transition to emergency online learning?

Faculty members, in general, had a positive experience teaching in the online environment and defined the transition as easy. For some faculty members, online teaching is convenient. The transition to online teaching was defined by the interviewed faculty members as “smooth”, “seamless”, “pretty easy”, “not that hard”, “not as challenging”, and “convenient”.

Most faculty reported feeling more stress as a result of COVID-19, in particular tenure-track faculty, as described in Table 6. A large number (31) of faculty members provided comments about their quality of life. As Figure 2 shows, the most common words mentioned were work, home, and stress. These findings agree with those of other researchers [13–15]. For example, Bizot et al. [19] found that over half of the computer science faculty who responded to the survey had used active learning before the move online. However, 34.9% of the faculty discontinued their use of active learning after the move online, while 43.4% made minor changes and 21.3% made significant changes. Bizot also found that the Computer Science faculty had higher levels of stress after the switch online because of COVID-19.

In the Higher Education Data Sharing Consortium (HEDS) survey of faculty [9], faculty felt overwhelmed in Spring 2020 by the increased amount of work in the newly online classes, with 61% of faculty indicating that they had too many things to do, 55% felt that they were in a hurry, and 51% felt under pressure from deadlines. A second survey, the Chronicle of Higher Education faculty survey [20], also showed that faculty were experiencing elevated levels of frustration, anxiety, and stress and were struggling with increased workloads and a deterioration of work–life balance. These findings agree with our survey of faculty. However, in our survey, there was a gender difference in stress levels and in the pressures experienced by faculty. Female faculty experienced higher stress levels than male faculty; 73% of female faculty reported a moderate or great deal of stress compared to 63% of male faculty. In addition, fewer male faculty (37.7%) felt they were under pressure from deadlines compared to female faculty (77%), and the female faculty felt they had too much to do in their classes (76%) compared to male faculty (47%).

Research Question 2: What challenges have faculty identified during the online transition and how do they plan to improve instruction?

The Chronicle of Higher Education survey of U.S. faculty [20] also showed that faculty faced a multitude of challenges at the same time: abruptly changing their work strategies and habits and learning new technologies. Our survey also documented that faculty used new online tools after the switch to a remote learning environment. After the move to online learning, more faculty reported using audio and video conferencing tools (90.6%), webcams (77.3%), online videos or tutorials (68.8%), and YouTube (50%) (See Table 9).

Most faculty (70.4%) in our survey spent more hours than usual on course preparation after the shelter-in-place. All the female faculty who responded to this survey indicated that they spent more hours than usual on course preparation. In addition, faculty members in Engineering were highly concerned about finding assessments that are meaningful and allow them to assess both lower taxonomy and higher taxonomy skills. The interviewed faculty members changed their assessment strategies, moving from traditional, closed book exams to open books exams, and experimented with different types of assessment strategies such as open-ended exams, multiple choice, or take-home exams. Kyle (see comment above), for example, discussed the need to experiment with different types of online assessment strategies during the semester. This finding agrees with other research on the impact of COVID-19 on assessments which showed that faculty members adopted new strategies to adapt to the remote environment including modifying or dropping assignments and exams and lowering their expectations about the quantity and quality of the work performed by the students [10,14].

Most of the faculty members in SJSU engineering have always viewed online teaching with skepticism, and prior to Spring 2020, very few classes in the STEM disciplines were taught fully online. The traditional teaching approach was completely shifted by the COVID-19 pandemic and all engineering classes at SJSU transitioned to online learning in Spring 2020, with limited training and planning for the faculty members. As a result, faculty members experienced an increase in workload at a time in which many also experience an increase in personal needs. Faculty members were also challenged to keep students engaged online and by the organization of hands-on laboratories in a fully online environment.

The survey would have been strengthened if we had asked faculty more details about specific challenges they had during the move to remote learning in Spring 2020. Other studies have shown that faculty challenges with the emergency remote learning include a decreased interaction with students during class time and decreased students' engagement [11,12], increasing concerns about students well-being [13], and a general feeling that their course quality has decreased [12]. We did not include questions that asked faculty about these issues specifically in our survey.

Research Question 3: Is there a difference in the effect of COVID-19 among tenured faculty, tenure-track faculty, and lecturers?

Table 7 and Figures 4–9 show that the perception about the Spring 2020 transition was felt differently by faculty of different ranks. Overall, tenure-track faculty were more likely to report negative feelings than both lecturers and tenured faculty. For example, 33% of all faculty (Figure 4) felt they had too much to do for their courses all or most of the time, but this percentage increases to 69% for tenure-track faculty and 53% of the tenured faculty (Figure 5). Moreover, 58% of the tenure-track faculty (Figure 6) felt they were in a hurry as a result of online instruction, which is in contrast with 34% of all faculty (Figure 4). Lecturers were the least likely to feel hurried, as 68% reported they never or only sometimes felt this way. Similarly, 33% of all faculty (Figure 4) felt under pressure from deadlines all or most of the time; this percentage rises to 58% for tenure-track faculty (Figure 7). Additionally, only 25% of the entire faculty (Figure 4) felt that work was piling up so high that they could not finish it all or most of the time, but the same answer was given by 47% of tenure-track faculty (Figure 8). In terms of teaching, 35% of the entire faculty (Figure 4) felt they were in

control of the class only sometimes or never, but this same feeling of loss of control was felt by 65% of tenure-track faculty members (Figure 9).

Few other studies look at the differences between faculty ranks. The Chronicle of Higher Education survey of U.S. faculty [20] found that tenure-track faculty had some of the highest levels of stress and fatigue. Our faculty survey agrees with this finding. Tenure-track faculty in our survey experienced higher stress levels than other faculty. In addition, 83% of tenure-track faculty reported a moderate or a great deal of stress compared to 63% of lecturers and 46% of the tenured faculty.

The survey by Tyton Partners, in conjunction with Every Learner Everywhere [3] included some analysis of the differences among different faculty ranks. The Tyton Partners survey found that child or elder care was a significant challenge for 40% of women faculty members, and tenure-track faculty were more likely to report this concern. In our survey, slightly more lecturers (36%) and tenure-track faculty (38%) had to care for children or elderly people either full-time or part-time than the tenured faculty (30%).

Research Question 4: What are the impressions of faculty members to the learning environments in engineering courses after the switch to emergency remote learning in Spring 2020?

Overall, despite the challenges, at the end of the semester faculty members shared a positive experience in how they were able to transition their classes despite the fact that the majority of the interviewed faculty reported never having taught online before Spring 2020 and were therefore required to transition to the emergency online format with very little preparation and formal training. The general positive experience identified by the engineering faculty members is in clear contrast to the experience described by the students in the transition to online learning, who struggled both from an academic and non-academic perspective [22,23]. Most faculty (64.8%) in our survey generally felt that they had everything under control in the remote environment although they also felt that there was too much to do in their classes (55%) and they were under pressure from deadlines in their courses (48.9%). When analyzing these questions by gender, we found some differences; 50% of female faculty felt they had things under control compared to 70% of male faculty.

Our faculty interviews showed that faculty reported that they were faced with challenges in their teaching approach during the transition to emergency online teaching. The faculty reported challenges with grading and assessment, forming a personal connection with the students, listening to and supporting students who were struggling because of their personal situation, maintaining students' engagement, and "Zoom drain." In many cases, faculty changed their teaching approach "a whole 180 degree" (Dolly) as they recognize that the emergency online format required different strategies to keep students engaged. Some faculty report decreasing the pace of the class and the quantity of material covered, while other faculty were able to cover a bit more material. The majority of the interviewed faculty taught synchronously with the same schedule as during in-person teaching, used PowerPoint slides to present their lessons, recorded their lectures and made them available to students, and had office hours. A large number of faculty lectured for the entire class time, finding it difficult to incorporate active learning activities to keep students engaged. Both the surveys and the interviews of engineering students point to a large disconnect between the faculty members and students' experiences in remote learning in Spring 2020 with the students describing their experiences as more negative. Some faculty noted a discrepancy between their experience as a faculty and the students' experience although one of our faculty interviewees (Arthur) noted that students pointed out to him that their perceptions of the Spring were much different than his. Our faculty interviews also indicated that faculty members generally were unaware of best practices in teaching online including best practices in terms of presentations, grading, and assessment strategies. This aspect is fundamental in an online environment, in which visual clues are eliminated and the student–faculty contact time is diminished.

Research Question 5: What was the impact of the switch online in Spring 2020 to lab classes?

The faculty members interviewed found that moving laboratories to a remote mode was difficult. Specifically, the faculty members found it challenging to provide hardware to the students because of campus closure and safety concerns: Faculty members used different strategies to conduct their laboratory activities, such as using “a simulator” (Larry), and conducting demonstrations (Cristobal). In addition, some faculty members discussed their frustration on the inability to conduct labs in a safe environment (Edouard).

We did not ask any specific questions related to the impact of remote learning on labs in our faculty survey. This, in retrospect, would have given us more insight to the experiences of a larger number of faculty than our faculty interviews about the impact of the COVID-19 shelter-in-place on instruction in labs.

7. Conclusions

Most of the faculty members in engineering have always viewed online teaching with skepticism, and prior to Spring 2020, very few classes in the STEM disciplines were taught fully online. The COVID-19 pandemic has completely shifted the traditional teaching approach, forcing all engineering classes at SJSU to be taught in an emergency online mode. Faculty shifted their classes in a matter of days; as a result, they felt under stress and under pressure from the work piling up, from deadlines, and from the lack of training in teaching in an online environment. Faculty members were worried both for their families and their students and experienced an increase in workload at a time in which many also experience an increase in family responsibilities. Tenure-track faculty members were impacted the most. Challenges that faculty have identified focus on testing and assessment, which found many faculty members unprepared and quite a bit at loss in dealing with suspected cheating and new testing formats. Faculty were also challenged to keep students engaged online and by the organization of hands-on laboratories in a fully online environment. Overall, at the end of the semester faculty share a positive experience in how they were able to transition their classes.

8. Limitations

The main limitation of the current analysis stands in the limited number of participants, which represent a small portion of the total number of faculty members in the college of engineering at SJSU. In addition, the participants were self-selected and not randomly selected, as we interviewed all the volunteers that offered to participate in the interview process. These limitations are common practice for qualitative analysis. To our knowledge, this study represents the largest qualitative study of the experience of engineering faculty members during the online transition due to the coronavirus pandemic. All interviews were conducted by one author, who is a white female engineering educator, an engineering education researcher, and an advocate for active learning and active communication. The epistemological commitments and positionality of the interviewer might have affected the follow up questions asked to the participants, although the interviewer kept the follow-up questions as consistent as possible.

9. Suggestions for Future Work

The emergency move to online learning in Spring 2020 caught many faculty unprepared. SJSU, as well as many other institutions in the U.S., planned to continue with most classes taught online in Fall 2020 and Spring 2021. It would be interesting to determine if faculty had less stress during Fall 2020 and Spring 2021 and used better pedagogical techniques in their online classes.

After the pandemic has ended and instructors are teaching again in face-to-face instruction, additional research could be done comparing stress, working conditions, and pedagogy and compare these results to our interview and survey as well as to other completed research. Despite increasing research on active learning, the teacher-centered

lecture model still persists in STEM fields [43]. Although the number of faculty using active learning (or student centered) methods has increased in the last ten years, the Higher Education Research Institute survey of faculty in 2016–2017 showed that about half of faculty participated in teaching-related professional development opportunities [44]. After the changes in pedagogy that arose from the emergency remote learning in Spring 2020, more research could be conducted on the number of Engineering faculty who pursue faculty development to improve their delivery of courses and change their pedagogical methods. Research into professional development programs for engineering faculty [45] indicates that single seminars or trainings are insufficient to promote change in pedagogy. Therefore, more research should be done on the type of training that the engineering faculty receive and how it impacts their teaching.

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