

Through the Looking Glass: STEM Students' Changing Relationships with Time Across the COVID-19 Pandemic

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Abstract

Recent research has emphasized that the collective experiences of the pandemic have influenced not only how students spend their time but have also impacted students' fundamental relationship with time itself. The present study is based on a large-scale survey, distributed to students (n=396) enrolled in two introductory engineering courses at a large, public research-intensive university, The Pennsylvania State University, in the northeastern United States during the Fall 2021 semester. Students were asked to respond to a series of open-ended questions asking them to articulate changes in how they spent their time compared to before, during, and (approaching) the end of the global COVID-19 pandemic. A team of coders then reviewed the students' responses and coded them for review.

The present study results suggest that many students have experienced fundamental shifts in their use, perception, and orientation towards social, academic, and personal time. Furthermore, the results from this study also suggest that these effects were neither universally experienced nor evenly distributed by all students. Our findings provide support for the notion that student time management is best framed as an optimization problem that students and faculty inherently view differently. By reconceptualizing the student time management question in this new light, new avenues for improving engineering education practice open, particularly with respect to the development of more inclusive and equitable teaching practices.

Introduction

The 2021-22 academic year has presented distinctive challenges in teaching and learning. With the transition from remote to face-to-face instruction, faculty have reported emerging patterns of behavior that suggest that the experience of remote instruction, including social isolation and collective trauma, have had a significant effect, especially on metacognitive learning, or awareness and development of skills as a learner. These metacognitive shifts manifest in a variety of ways, including academic procrastination (e.g. waiting until the last minute) and the related phenomenon of poor time management (e.g. not managing one's time efficiently and effectively).

Literature Review

From the very beginning of the so-called learning-centered revolution in higher education, effective time management had been identified as a fundamental skill undergraduate students need to succeed academically. Starting in the 1980's, several seminal studies established the statistical link between time management strategies and student success. Britton and Tesser [1], for example, identified a direct correlation between self-reported time management strategies and both standardized test scores and four-year grade point averages. A study from Macan et al. [2] with 165 undergraduate students confirmed a similar linkage, while also suggesting that proficiency in time management may also be positively correlated with lower levels of stress, an insight that has been affirmed in numerous subsequent studies [3, 4].

Prior research has further established that the phenomenon of poor time management was widespread in higher education well before the pandemic. Indeed, an influential 1992 study concluded that as high as 70% of Dutch undergraduates (n=278) engaged in academic procrastination, 20% of them chronically [5]. Similarly, several studies have identified poor time management as a significant common denominator for all under-performing students [6]. It should be noted that increased use of technology, especially cell phones, can exacerbate these issues [7]. In engineering education specifically, poor time management has been identified as a contributing factor to lower levels of retention and persistence [8].

These insights from the research literature have spawned a cottage industry of resources to advance how undergraduate students improve their ability to manage their time effectively. Largely based on a training model established by McCay [9], there are numerous textbooks (for example, see [10]), workshops, and even entire courses available to students who struggle with time management. McCay's model focuses on three inter-related activities: self-assessment, goal setting, and monitoring. The problem, however, is that research on the *effectiveness* of these interventions indicates mixed results [11]. While most studies indicate that participants in these interventions reported high levels of satisfaction, this positive disposition has not consistently translated into improvements in practice over time.

A spate of studies examined how time management fared under pandemic conditions [12, 13], most of which build on a body of prior learning design research regarding the effects of the online environment on time management skills, generally characterized as negative [14]. The phenomenon has yet to be studied in the context of post-pandemic conditions and the return to face-to-face instruction in the 2021-22 academic year, though there is reason to believe that the practice has changed. Because of the close connections between time management and affective responses such as stress or anxiety, it seems likely that the mental health crisis faced by many current undergraduates is likely to exacerbate, or be exacerbated by, challenges with time management.

Similarly, the prior link between weak time management and technology use, especially smart phone access, seems to have strengthened under social isolation and quarantine restrictions. While these factors may worsen the problem, the widespread adoption of compassionate pedagogy measures, including flexible deadlines, under remote teaching conditions could potentially alleviate many of the stressors that contribute to time management issues. The present study seeks to re-frame the historical challenge of time management in the context of post-pandemic teaching and learning, with particular attention not just to management, but also to temporality – the relationship between students, institutions, and time.

The Study

The Instrument. This Institutional Review Board-approved study utilized an electronic survey, for which students were asked to record how they spent their time, in 30-minute intervals over a period of two days of their choosing. It should be noted that while they were asked to do so for the purposes of research, similar diary exercises have been shown to have mildly positive effects on student time management. In addition to the diary entries, respondents were asked two open-ended questions, the first about how they spent their time under the pandemic and the

second regarding changes in time use with the return to face to face instruction; these questions are reproduced below in Table 1. The survey also included four demographic questions (age, gender, race/ethnicity, and economic security).

Table 1: Open-ended Survey Questions Regarding Changes in Time Usage

Q1	Please describe any/all major changes to how you spent your time when you were living under remote teaching/quarantine conditions (Spring 2020-21), as compared to how you spent your time before the pandemic.
Q2	Please describe any/all major changes to how you spent your time now (fall semester 2021), as compared to how you spent your time before the pandemic.

Participants. The survey was distributed to all students enrolled in an introductory MATLAB programming course for non-computer science majors, CMPSC 200, and a first-year seminar in engineering, ENGR 100, for the Fall 2021 semester at The Pennsylvania State University, a large, public Research 1 institution located in the north-east region of the United States. Acceptance into the program is very competitive and it could be inferred that most of the students are high academic achievers. Students typically enroll in these courses in the first or second year of their degree programs. Out of 457 student respondents, 396 participated in the survey, for a response rate of 87%. Students were incentivized to participate with a small amount of extra credit, which they could receive whether or not they consented for their responses to be included in the study. The incentives were provided in such a way that the instructor would not know who (or who did not) consent to participate in the study. Respondents were predominantly traditionally aged (i.e. under 25) (n=388, 99%), white (n=269, 63%) males (n=291, 74%) with few indicators of economic insecurity (average of 91% secure).

Method. For the purposes of this study, student responses to the open-ended questions were entered into MaxQDA, a qualitative software program, and coded using critical discourse analysis [15]. The analysis was conducted by two independent coders, both educational researchers with backgrounds in the humanities, in three successive rounds. A round of emergent coding was followed by two rounds of more structured coding, leading to the identification of four themes: academic inefficiency, social longing, resilient hope, and shifts in temporality. In keeping with quality standards for this form of analysis, the coders engaged in peer debriefing between each stage, as well as member checking with the instructor of the courses [16].

Findings

Affect. Student respondents often indicated an emotional and affective layer to their experiences of both the pandemic online conditions and the return to in-person on-campus courses. Of the pandemic online conditions students often used the phrase “rough times” or noted an experience of “loneliness” and a “decrease in motivation.” One student wrote of their pandemic experiences that they “[j]ust suffered lol.” Student’s affective responses related to their relationships, schooling, and their general sense of time. Most students, unless they self-proclaimed that they were introverts who liked being alone, noted a negative affect in relation to remote learning. One student remarked, “I was always depressed and very unmotivated [during the pandemic]. I wouldn’t want to do anything, it was like my energy was completely gone.” Other students identified coping mechanisms in the form of exercise especially “getting outside”

to combat self-identified mental illness, loneliness, isolation, or a general feeling of having a lot of time on their hands. A few were very enthusiastic about hobbies that they engaged in because they were able to reorient their time away from social activities and towards their own interests. This was mirrored in the more hopeful reflections of students who identified their pandemic experience as drawing them close to the “things that mattered” such as this student who stated, “[t]he pandemic wasn’t a good thing but it made me learn things I probably wouldn’t have known for awhile [sic],” commenting on the importance of their COVID-19-limited time with friends and family.

Overall, the responses to the second question prompt inquiring with respect to changes for the in-person Fall 2021 semester were more positive and hopeful, especially with relation to hope. One student wrote, “I am so much more involved now and meeting new people. So many major changes for the better.” Another student took a similar reflective and positive affect noting, “I have become more self-confident and introverted leading to me working on things I find interesting more than going out and exploring the world with other people.” Students often identified the pandemic as changing their emotional outlooks towards engaging with others and schooling. One student wrote, “I get to meet new people and share this life with everyone instead of always being inside. I feel more motivated and there’s more help for me.” Many of the responses were overwhelmingly positive. The majority of negative or neutral responses reflected on how walking between classes forced them to rethink their time management approaches. For many this “extra time” spent walking, moving from place to place, was a source of stress or frustration. Overwhelmingly students noted that even though the “new” necessary walking and movement was stressful, they much preferred to be at in-person classes and working around others.

Relationships. Relationships factored predominantly in responses to both qualitative questions. When reflecting on remote pandemic conditions students often pinpointed a failing or a lack of relationships with others, especially outside of small circles, as a negative factor in their experiences. Many students identified relationships that failed due to being unable to commit in-person time to them, such as high school friendships, clubs, sports, and other various activities. They frequently noted that pandemic conditions made friendships, even previously developed ones, difficult. One student stated, “I would stay inside a lot and friendships slowly broke up for me.” Another stated that they had “[l]ots of time spent in [their] room, didn’t go out much, not many friends. Lots of isolation.” One student remarked that the pandemic for them shifted their ability to make friends, observing “I can not [sic] communicate with others now.”

In contrast, students were largely neutral or positive about a return to in-person coursework especially in the realm of their relationships. One student remarked, “I now spend a lot more time outside of my home in public spaces and feel more comfortable socializing with others.” Other students remarked that their social circles increased or changed significantly increasing social circles and activities; for example, one student stated that “I also spent a lot of time with my parents and high school friends [previously], where now I spend my time with a more broad range of people.” Other students said the shift back to a semi-normal sociality has been the best change for them this year. When the two questions are next to each other, a pattern emerges where many students identified a significant amount of time spent on academic work in the pandemic since there was very little to do otherwise. With the shift back to in-person

instruction, students stated that what had seemed like a lot of time was subject to a lot more demands such as their re-emerging social life. This caused for some students self-reportedly a drop in their grades which many argued was an acceptable trade for an increased social life.

Academics. Student views regarding academics shifted more generally after the experience of remote learning. One student noted of the experience that “[s]ince all my classes were in front of [a] computer screen I barely left my room and subsequently lost motivation to work because my days became so mundane.” Another student expressed that during the pandemic “I had to spend a lot more time studying and learning on my own because online learning is difficult for me.” Students often noted that they had higher academic productivity under quarantine conditions. Many attribute this to not having many other obligations, including the time spent walking to class. One student remarked that they “[g]ot up 5 minutes before my classes.” Students were self-reflective on their own grading differences with most students identifying in-person learning as requiring what feels like less of their time spent on homework and studying, but more time spent on travel, extracurricular activities, and social forms of academic work. There were mixed responses to work intensity in remote and in-person work, but most students seem to allude to more time spent during the pandemic on schoolwork but feeling as if they achieved less.

Many students articulated a relationship between an improvement in their academics and studying in groups with friends. They identified connecting with peers as an important motivator and support for improved academic performance. Some students noted that the in-person experience provided opportunities for mentorship and communication. One student wrote that during in-person course work: “I found myself communicating more with my professors this year and goin [sic] to office hours in person because I missed the in[-]person interactions.” Notably, students mostly mentioned professors in response to the second question regarding in-person learning. Some of this is because many respondents were still in high school during the beginning of the pandemic and began their higher education careers online. When students did mention professors during remote conditions their responses were often negative pointing out a lack of perceived empathy with pandemic conditions or difficulty connecting with professors. Responses during in-person learning were more positive overall. However, students noted that some remote-era features are still at play. For example, one student remarked that “[u]nfortunately, there are still professors who post lectures online or utilize zoom, so there is still that aspect” of the pandemic. Overall, students’ relationship to their own academic work seemed to manifest as diminished time spent on course work, but increased motivation and resources in the context of in-person learning environments.

Shifts in Temporality. The student respondents frequently indicated shifts in their abilities to manage their time, especially noting an increase in academic procrastination and increasingly inefficient study habits. As one student noted, “[under pandemic conditions] you become lazy, you have little motivation to want to do things, and [you] don't learn nearly as much from classes.” That said, in subsequent rounds of coding, we also noted a tendency, at least for some students, to imply or suggest changes not just in how they managed their time, but in their temporality. Temporality can be defined as the relationship a person has with time, or how a person’s experience of time influences a host of other cognitive, affective, and behavioral perceptions. In this conception, how a person perceives time is highly subjective and sensitive to

individual and collective context. Many of the student respondents, for example, noted that, under quarantine conditions, time seemed to pass differently – more slowly in some instances, and, more quickly in others – than what they had been accustomed to prior to the pandemic. As one student noted, “it was the weirdest feeling because my schedule was always go go go and then it just stopped.”

In some cases, students spoke of time as almost having an elastic quality. As one respondent remarked, “I also had to balance my time differently... since I had more of it in my hands than before the pandemic.” For others, time differences played a part, especially for those students quarantined abroad who had to take on-line classes at night, putting their schedules out of step not only with their prior high school experience but also out of sync with the other inhabitants of their households. One student from Taiwan remarked that they were “living not [like] normal people,” whether those other people were other U.S. college students, their family members, or their local high school friends. Another student quarantined in Egypt referred to their time as “flipped upside down.”

Discussion and Implications

The results of this study suggest that students have not been unchanged by their experiences during the COVID-19 pandemic. There were two broad categories of student responses observed: first, responses of gratitude and hope, but also of continuing anxiety regarding the impacts of the COVID-19 pandemic on their lives and education. These responses are not necessarily contradictory, as the pandemic has impacted all individuals – including students, faculty, and academic support staff – in differing and nuanced ways in the varying aspects of one’s life. Admittedly, the nuanced impact on individuals has in turn made devising academic interventions more challenging for engineering educators, but a better-informed view of whom one is reaching does better facilitate such interventions.

Experiences. To an extent, some students displayed “the zeal of the convert” [17] with respect to their appreciation for their educational and social-educational experiences. Students generally appeared more enthusiastic and engaged with their “more typical” educational environment, but also with respect to the opportunities in which co-location of students, instructors, and academic support structures brings. In many ways, the students seemed further advanced in their self-authorship journeys [18] than one might have otherwise expected for their educational ages (largely traditional aged college students). Perhaps in some ways that speaks to how the COVID-19 pandemic has “aged” all individuals impacted by its reach.

Candor. The students’ candor at times was remarkable. In response to the prompt inquiring how they spend their time now relative to before the pandemic, one student very openly indicated that they took more drugs and had more sex now than they did before the pandemic. Furthermore, there were multiple open reports of marijuana use in the student time diaries despite its complicated legality. Such student candor with one of their engineering professors likely would have been unheard of in years gone past. That may suggest that, on some level, faculty candor with students in return (e.g. clearly laying out course learning objectives, explaining how individual assignments and activities advance the goals of the course, etc.) may

be fruitful with these students. The student motivation question remains extant but also appears to have taken on new dimensions.

Time. Students have (to varying degrees) experienced fundamental shifts in their use, perception, and orientation towards social, academic, and personal time. Though our findings provide insight into how students manage their time, they do not point to any clear interventions intended to address perceived deficiencies. As mentioned previously, the research on interventions to strengthen time management in students is decidedly mixed. The solution to the problem of time management, then, may be to overturn long-standing practices and to seek out new interventions. It is also possible that time management may be a skill that is best learned through modalities other than direct instruction, or perhaps that it requires additional time to develop in ways that are measurable. While others may pursue these strategies, our findings suggest, on the other hand, that the challenge may not be in coming up with just the right solution to the time management problem, but rather in re-framing the question.

As we note, the experiences of these students suggest not just changes in how they spend their time, but, even more fundamentally, their larger relationship to time [19]. Recent higher education scholarship has extended a critical lens to the concept of time management, suggesting that time itself may be a social construct. In a 2018 study, A. Bennett and P.J. Burke remarked that if students “are not able to conform to traditional structural timeframes and to deliver on time, they are considered to be lacking both the ability and commitment to study, rather than being understood as occupying a different ‘space-time’ or ‘timescape’ that is tied to socio-cultural positioning and context” [20]. When viewed through the intertwined frames of equity, inclusion, and collective trauma, the question shifts from being about what students cannot do, to how and why we, as instructors, continue to uphold the same rigid standards of time management for the present generation of college students [21].

Indeed, even prior to the pandemic, there were already conversations taking place regarding broader changes in temporality within higher education itself, suggesting radical shifts in how we position our teaching, research, and service work in relationship to an increasingly unknown future [22, 23]. For students, higher education scholars J. Stevenson and S. Clegg articulated the concept of “possible selves” in which students shift their future orientation from following a singular pathway to one of multiple, simultaneous possibilities [24]. Other scholars have pointed to the changing nature of work, in which hybrid work modalities, as well as technological capabilities, take the world even further away from the industrial experience of time – such as the punching of time clocks – that has remained prevalent in western society for over a century. In other words, it may be possible that we are already peering through the looking glass, seeing glimpses of a “brave new world” in which even time itself is experienced differently.

Where does this leave the engineering educator? We have previously argued [25] that students’ relationship with time can be best thought of as an optimization problem. Recall that the traditional framing of a mathematical optimization problem is the minimization or maximization of a cost (or objective) function, often subject to some sort of constraints. The disconnect between faculty and students with respect to the time management problem is therefore perhaps fairly characterized as a difference in how students choose to define *their own*

time optimization problems versus how faculty perceive the problem definition as the students' teachers. Beyond addressing market needs and their potential role in "disciplin[ing]" curricula [26], micro-credentials offer one example of a potential avenue to explore for directing student attention in how they define their time optimization problem – notably, at the point of problem formulation. Based on our findings herein, we offer no view on if such an approach is *the* answer. Other fruitful avenues are likely available, especially with respect to the development of more inclusive and equitable teaching practices in engineering. In any case, we perceive radical transformations on the horizon if engineering educators are prepared to rise to the challenge of solving new optimization problems of their own.

Conclusions and Implications for Further Research

As a result, the students involved by this study had their lives changed and shaped by the global COVID-19 pandemic. We all have. The results of this work inform educational intervention efforts and provide suggestive insights into characteristics of the "modern" students one might currently be seeing in the immediate aftermath of the socially distanced 2020-2021 academic year. Whether these research findings are applicable to different populations of college students is not immediately obvious; the students in this study were perhaps not entirely representative of all engineering college students nationally. Similarly, how these students continue progressing – and how younger students currently in middle school or high school during the heart of the COVID-19 pandemic ultimately progress as they approach college – remains to be seen and likely should be the subject of future research investigations. As engineering educators, it remains key now – as it does every semester – for faculty to rise to meet the challenge of reaching the students before us.

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