The Hidden Benefits of the Campus - What the Covid-19 Pandemic Can Teach Us About the Computing Learning Environment

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Abstract

The educational context for students and educators across the world changed when the Covid-19 pandemic forced many educational institutions to shut down all on-campus activities in the spring of 2020. In this paper, we explore how computing students' behaviors were affected by the transformation to online-based learning during the pandemic and what this can teach us about the learning environment. A mixed-method analysis of a survey sent out to students in the weeks after lockdown investigated the important aspects of the learning environment, both on campus and online. Results show that informal learning spaces are essential to students, yet challenging to transfer effectively to the online environment. Furthermore, the scaffolding for study behavior development provided by the schedule and structure in the on-campus environment was found to be valuable to students, but often difficult to replicate online. In the paper, these findings are described and discussed further, exploring the educators' short and long-term implications.

1 Introduction

After higher education institutions and large parts of the world were locked down in March because of the Covid-19 pandemic, we all had to move to an online-only mode of teaching. In the following weeks, the authors of this paper identified a need to investigate how the students handled this change and what their experiences were with online learning. Our initial goal was to create a survey to gather first impressions from students on different aspects of the learning activities and learning environment. To begin with, we analyzed the data and published reports providing insights into the immediate effects of the online transformation [9]. However, we also noticed the potential for further analysis of the data to highlight aspects of the campus-based and online learning environment in general, and students' ability to adapt and adjust their study behaviors. In this paper, we will present the results of this latter project. We have analyzed the

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survey responses looking for valuable insight into the role of the learning environment in students' learning and relating these results to relevant theories and related research.

Learning is a complex process, and there are many theories explaining and exploring this [14, 12]. Common for them all is the fact that there is a strong connection between the behaviors of a learner, the learning environment and the learning process [2]. One can generally and broadly divide the learning behavior into the behaviors guided by a teacher and the independent learning activities. The balance and relation between them vary throughout the educational ladder. In higher education, the learner, or student, must alternate their behavior between organized activities and independent learning. Learning is the actual absorption and processing of knowledge, skills and competency, studying is the organization and management of this process [15]. It is important to make this distinction when discussing students in higher education, because students are in a special position where their "job" is to learn. The behaviors they engage in to accomplish this learning is valuable to investigate [6, 10]. For example, when going to a lecture, a student has to consider how to prepare for the lecture, what tactics to employ during the lecture, and if and how to process the lecture afterwards. When the pandemic forced an online transformation of the education, it was the learning environment that drastically changed for the students. The organized learning activities and independent studying mostly stayed the same, however the context in which they were done changed from being campus based to an online setting. Lectures and labs, which used to be face-to-face on campus, were now online, while assignments and projects still needed to be submitted. It is within this context that the following questions underpin this research:

- RQ1: How did the students respond to the change of learning environment imposed by the Covid-19 restrictions?
- RQ2: What insights from RQ1 can inform academics about the importance of on campus activities in relation to student behaviour?

The paper aims to explore how computing students' study behavior was affected by the rapid transformation from campus to online learning and, more importantly, what educators can learn about the learning environment from this change. Firstly, we were interested in evaluating the effects of online learning with regards to the student experience. Secondly, this unfortunate situation provided an interesting natural experiment on what happens to the students' learning experience when locked out of the physical campus. The spring situation was exceptional, and there are likely aspects of the situation that are not applicable to traditional classes. Yet, we believe this research can increase our understanding of what aspects of the traditional campus-based design are most important to the students learning, what students can "live without," and where can we adjust and improve educational designs in the future.

2 Methodology

This research aimed to investigate *how the students interacted with the the online learning environment and what this can tell us about the importance of the physical campus*. The research design has an inductive approach, creating new knowledge towards the end of the research process based on the observations gathered [7]. When the pandemic caused the educational context to shift, the researchers observed the effects of this intervention through an open-ended survey, and then analyzed the gathered data looking for valuable and transferable findings. It was only in this last phase that relevant theories and related

work were introduced to explain and interpret the results. One could argue that the analysis of this research has a grounded theory inspired approach, considering 1) the very open data gathering process and 2) the goal of creating valuable knowledge (theories) from this [3, 5].

The data explored in this paper comes from a survey sent out to students across NTNU one week after the lockdown. The goal of the survey was to get a first impression of how students experienced the online transformation, identifying aspects of the online learning that worked well, as well as areas to improve. The results of this work can be found at [9]. For the purpose of the current study, we have re-examined this data with a specific focus on the study behaviors of computing students and the role of the learning environment. In total, the survey consisted of 13 questions with both open-ended text-based questions (qualitative) and Likert-style ratings (quantitative). The questions included the students' study program and consent, as well as inquiries about experiences with online learning activities, getting feedback, help and support, the learning environment and social aspects. When designing the survey, the researchers emphasized keeping the survey short and concise, and at the same time, open-ended. The complete survey can be viewed at [9] [1]. The survey was distributed on Monday, March 23rd, after one full week of online teaching and learning had been completed. For the survey's deployment, the authors used their own departments as a starting point, sending out invitations via email, announcement boards, and social media. Later the survey was distributed through the student parliament's Facebook page and via department heads. The data reported on in this paper is based on the responses that came in before March 31st.

Participants

In total, we received 332 responses from students at 61 different bachelor- and master programs in all years and across all campuses. However, for this paper, we will only look at responses from the 14 different computing programs (N=140). There were large differences between the different disciplines and study programs, therefore, the authors chose to extract only computing students for this analysis. Half of the respondents were in their first year of studies, 1/3 in their second and the remaining in third, fourth or fifth.

Qualitative analysis

The survey included five open-ended questions, where students could write their own answers. These questions were about how students experienced the learning activities, use of tools, quality of help and support, the new learning environment and social aspects. Most respondents answered all the text-based questions; however, they varied in length.

The text answers from students were read through, anonymized and categorized. Categorization was done by reading through the responses and assigning appropriate labels or codes [11, 5]. In this way, one can identify topics many students are referencing, and furthermore highlight possible tendencies. Every text answer from the student was given a code, and some responses were given several. In the results section, tables will list these codes and the number of references made. This coding process was done in two rounds. Firstly, one researcher read through all the answers for each question assigning codes. For the second round, the same researcher repeated the coding at a later time, adjusting and revising the codes, as well as making memos on important aspects and

[1] Survey in Norwegian can be viewed at this link (p.19-21).

interesting reflections [3]. A second researcher read thought the codes at this point as well.

Quantitative analysis

The survey included two quantitative, Likert-style matrices about how the students experienced organized activities (e.g., lectures), individual activities (e.g., doing assignments), obtaining help, and potentially having a home exam. The first question asked the students, ”to what extent these learning activities worked for them”, and the second question asked, ”to what extent the new learning environment allowed for the following activities”. Both questions were rated on a 5 point Likert scale from ”Not at all” to ”Extremely well”. For the analysis of these variables, both the questions were first analyzed in a descriptive manner, differentiating between the year of study. In addition, we statistically compared these variables to the categorization codes from the qualitative, text-based responses. A Spearman's correlation was run in Stata to assess the relationship between the six different ordinal variables and the various codes, which were treated as binary variables [4].

3 Results

In the following five subsections, we present the results from the coding of the qualitative questions by category. The full results of the analysis will be presented; however, with a specific focus on behaviors within the learning environment. The last subsection summarizes the results of the quantitative analysis.

Table 1: Description of how students experienced learning activities.

Category	**# references made**
General positive comments	31
Challenges with video lectures	23
Positive comments about video lectures	21
Lack of /slow response from teacher	11
Challenges with studying at home, missing physical campus	11
Online learning not the same quality as “regular learning”	9
Positive comments about not being tied to a schedule or campus	8
Lack of information and/or plan from teacher	7
References to tools that work well or not so well	6
Challenges with communication with teaching assistants	5
Missing the social interactions	4
Request for recording of lectures, not just live	4
Challenges with group work	2
Practical work/labs are hard to do online	1
Worried about exam	1

Experiences with online learning activities

When asked about their experiences with online learning activities (Table 1), students reported on different aspects of the learning environment. Firstly, the students' responses were often centered on lectures or the lack thereof. They reported that the quality of

video lectures varied, that they were difficult to follow and not as motivating on-campus lectures. On the other hand, some students were also very positive when describing their experiences with online or video lectures, enjoying the freedom it gives and the possibility to adapt tempo and timing. Many students also mentioned the lack of synchronous lectures in relation to structuring their study day. Furthermore, the students reported that information and communication about lectures as well as other activities (assignments, exams, help and support) were essential to their experience, particularly in the beginning. In some cases, there was no information about transitioning to online learning or a lack of communication about possible changes, causing confusion and stress for the students.

In general, many students reported that even though things were ”going OK,” considering the circumstances, they did not seem to think that the fully online situation was a good replacement for campus-based learning. The lack of formal and informal interactions, the physical learning environment and the structured study day provided by scheduled lectures and labs were mentioned as challenging.

Lastly, some students also reported difficulties with project- and group-based activities, both regarding what tools to use, when to meet and how to distribute the workload. The students reported that the lack of a mutual study structure lead to difficulties in scheduling meetings, and the lack of physical meetings seems to make it easier for some students to become freeloaders.

Table 2: Description of how students experienced getting help.

Category	**# references made**
Help from peers	23
Help from lecturer, teacher	16
Help from teaching assistants	15
Harder to ask for help	2
Things are good, better than before	1

Experiences getting help

As seen in Table 2, most students seemed to rely on peers and friends for help, and the online context made that challenging for many. In general, they expressed that getting help, asking questions, and the general difficulty of interacting with others as a significant drawback with the online environment. Many students reported that the response rate from teachers or teaching assistants was low and slow. Some students seemed discouraged to ask for help stating that ”everyone” seemed very busy. Some students also reported on a higher threshold for asking questions and asked for anonymous options. There seemed to be many different systems in use, with varying information about when and how to use them. In total, students reported 40 different tools in use, which was sometimes difficult to manage. Email seemed to be the most common medium for help; however, many students expressed a need for more discussion forums and, in general, a more open and accessible Q&A medium.

Experiences with being social

When it comes to the social aspects of the online environment (Table 3), some students reported having very little social activity outside the formal academic interactions. In contrast, others seemed to be very active and creative when it came to social activities

online or in their respective dorms. This might be an indication that the social bonds made before the online transformation were reinforced in the online sphere. This indicates that students with strong social ties uphold these, while students who might have struggled socially before, were having a more challenging time online. Student organizations were mentioned with positive initiatives. Many students reported that they missed the informal social interactions connected to lectures, labs and study areas. Some students found it more challenging to initiate contact online than in-person, especially if the interaction used to be informal, resulting in some students feeling very lonely. The lack of social interaction was reported to affect motivation and concentration negatively.

Table 3: Description of how students experienced being social.

Category	**# references made**
Same as before, it's going fine	59
Communication trough messages/chat	28
Communication trough voice-/videocalls	21
Little contact, less than before	19
Interaction through online gaming	12
Too little contact, feeling alone	8
Little interaction outside learning activities	8
It's very good, more than before	4
Interaction through the student organizations	3
Mostly social with family	2
Interaction through exercise or walks	2
Interaction through digital lunches	1

Experiences in the new learning environment

When asked about how the students experienced the new, home-based, learning environment, there were some mixed responses (Table 4). Many students reported that they struggled with a lack of structure in their study routines and staying focused. It seems like procrastination, distractions, lack of ideal physical spaces, and lack of motivation were underlying causes. A few students indicated severe problems with sleep, loneliness and declining mental health. On the other hand, some students responded that they were studying more and longer than before, and reported on time saved on transportation and cancellation of activities, leaving them with more time to focus on studying. Deadlines and assignments seemed to be important drivers for getting things done and sticking to a good routine. Many students left their study town and went to their parents' homes in other cities. Those who stayed in their study town reported various solutions for work-spaces ranging from a home office to studying in their bed.

It seems like the move from campus-based to online learning had varying impact on the students. Some students reported no actual change in routines or improvement of their ability to focus, while others reported struggling a lot more in the online learning environment. In general, there seemed to be a larger dichotomy between those who handled the transformation well and experienced mastery in their learning, and those who did not and felt stuck.

Table 4: Description of how students experienced the new learning environment.

Category	# references made
Lack of structure, struggling a lot	64
Difficult to structure day, focus and/or concentrate	32
Challenges sharing work-space with friends and/or family	11
Studying like before, it's working fine	9
Reference to being alone or feeling lonely	7

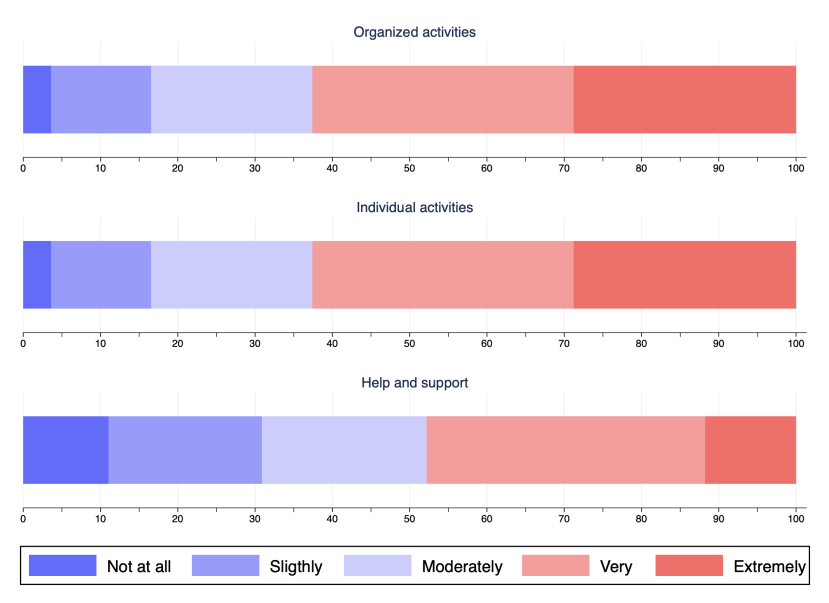

Figure 1: Experiences with online learning activities (%).

Quantitative results

The results from the quantitative questions are listed in Figures 1 and 2. Figure 1 shows that getting help and support in the online environment was something students struggled more with. In total, only 48% of students reported that help and support activities worked well or extremely well, and 11% reported that these do not work at all. When it comes to organized learning activities, such as lectures, 63% reported that they worked very well/extremely well, and a minimal number reported that they do not work at all (4%). Individual learning activities, such as self-study and completing assignments, are reported to work even better, with 64% saying they work well/extremely well. As seen in Figure 2, the students experienced the new learning environment differently than the learning activities. 57% of the students reported that organized activities worked very/extremely well. Similarly, 62% and 51% reported the same for the individual activities and a potential home exam, respectively. On the other side, approximately 20% of the students reported that the new learning environment (in general) does not work at all, or only slightly.

For the statistical analysis of these variables compared to the qualitative categories, a selection of the Spearman correlation analysis is listed in Table 5. As the correlation matrix in total for this data is quite large, we have only included the statistically significant results within a confidence level of 95%. Considering the positive correlations first, it is evident that general positive comments about the online learning activities (LA in Table 5) are positively related to individual and help activities, as well as all

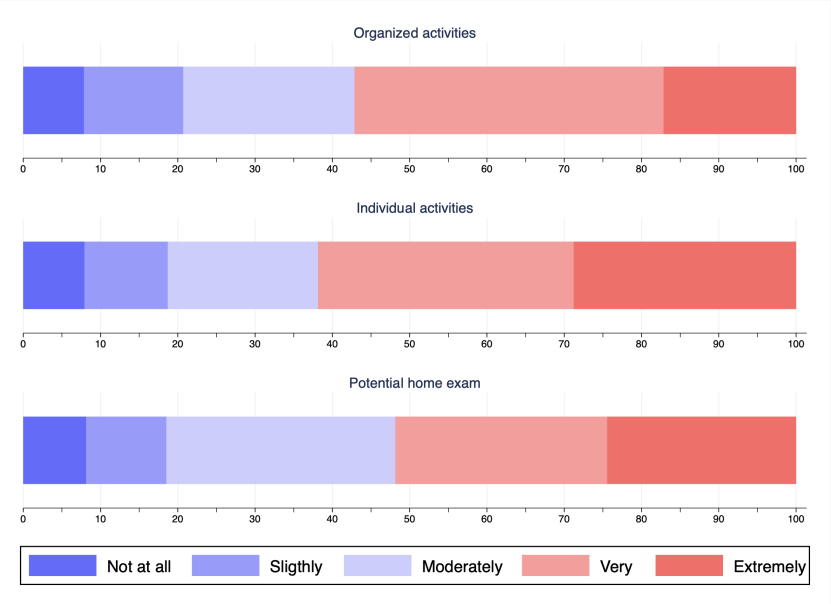

Figure 2: Experience with the new learning environment (%).

aspects of the learning environment. This means that students who reported on positive aspects of the learning activities also rated the learning environment, individual and help activities highly. Similarly, positive comments about not being tied to a schedule or campus correlate positively with help activities and a potential exam in the home-based learning environment. The students who reported a lack of structure in the new learning environment also rated the online learning activities and the organized environment highly. Lastly, students who reported on the new learning environment (LE in Table 5) and social aspects working well also rate organized and individual activities high.

When it comes to the negative correlations, we found that even though students were positive towards the new learning activities, they rated organized activities lower. Furthermore, the students who reported on challenges with online learning rated the individual activities and environment lower. Additionally, students who reported that online learning was ”not the same”, rated organized activities, getting help, and the individual and exam environment lower. Similarly, lower rates were found for organized and help activities, organized and exam environment, for students who had a challenging situation sharing their work-space. Lastly, for students who had little social interaction outside organized activities, lower rates in the organized and help activities were found.

It is also relevant to point out some aspects where there were no statistical correlations. For example, the notion of getting help was not correlated with anything. One would perhaps expect the students who were feeling lonely would rate individual activities and environment lower. Additionally, the students' comments on lack of structure would possibly be related to the individual activities and environment. However, such relationships were not identified.

4 Discussion and related work

This study set out to investigate how the students responded to the changes made to the learning environment due to the pandemic (RQ1), and identifying what educators can learn about the importance of the campus on students' study behaviors (RQ2). It is important to consider both the short term implications of the ongoing pandemic

Table 5: Selected results of Spearman correlation analysis.

		Activities			Environment		
	Category	Organized	Individual	Help	Organized	Individual	Exam
LA	General positive comments	-	+	+	+	+	+
	Positive comments about video lectures	+					
	Lack of /slow response from teacher						+
	Challenges with studying at home, missing physical campus		-			-	
	Online learning not the same quality as "regular learning"	-		-		-	-
	Positive comments about not being tied to a schedule or campus		+				+
	Lack of information and/or plan from teacher	-			-		
Help	Help from lecturer, teacher			+			
	Help from teaching assistants					+	
	Harder to ask for help		-				
Social	Same as before, it's going fine	+				+	
	Too little contact, feeling alone						-
	Little interaction outside learning activities	-		-			
LE	Lack of structure, struggling a lot	+	+	+	+		
	Difficult to structure day, focus and/or concentrate			-			
	Challenges sharing work-space with friends, family, children etc.	-		-	-		-
	Studying like before, it's working fine					+	

+ indicates significant positive correlation, - indicates significant negative correlation

and what this experience can teach us about the current state of traditional educational design in the computing discipline. In this study, we have explored computing students' experiences with online learning activities, help and support, social aspects, and the learning environment in general. Both from examining the learning environment directly, and indirectly by looking at how the different aspects of the educational design affect the experienced environment, this study has found some notable results.

Looking at the results as a whole, two main findings become apparent: the importance of the informal learning spaces (1) and the structure and routines (2) created by the physical campus and the scheduled activities. We will first consider the informal learning spaces. In all aspects of the experienced learning environment, students touch on the aspects of interactions and communications happening, or not happening, during their studies. When asked about the online learning activities, students reported missing the social interactions on campus and challenges communicating with educators and peers. They are here referencing the informal interactions taking place between lectures and in the physical labs. This is also evident in their experience with getting help, mostly through their peers, which again comes up when commenting on the lack of social interactions outside formal academic settings. A student described in a comment that he/she used to work closely with a peer in the labs but did not have a way to contact that person online since he/she did not have this person's name. Even if the online learning environment is accessible and intended to be informal, the practical matters of finding peers, times and spaces to interact are not. Second, there is the structure and routine created by the physical campus and the scheduled activities. Students described lectures as a pillar in their study day, and how asynchronous teaching has tampered with that structure. Furthermore, the reports on group work challenges is another example of how the campus-based environment provided a structure where students had a common time table and could find spaces to collaborate.

Additionally, the number of tools in use further complicates the matter because students are using different platforms. On campus, they are in the same space and the campus acts as the platform. When asked directly about the online-based learning environment, the effects of this lack of structure for many students become apparent. Students report that they are struggling with focus and concentration, motivation and the feeling of loneliness. The results of the quantitative analysis can perhaps explain these characteristics. We found that students who reported a lack of structure rated the online learning activities highly, meaning they were content with the educational design offered; however, they struggled nevertheless. This might indicate a lack of insight and self-efficacy, especially in independent study skills. The fact that there was no correlation between the comments on lack of structure and the individual activities and environment further informs this finding.

It is interesting to view these findings in light of different learning theories. Social interactions are essential in several theories of learning but have a different role [12]. Social learning theories state that new behaviors are acquired by observing others; hence learning happens *with* others; however, not *through* social interaction. On the other hand, constructivist learning theory places the interaction in the center of the learning experience [1]. Regardless of what theoretical lens is used, the informal learning described in the current study seems to play a role. As an example, we can consider the communities of practice framework presented by Lave and Wenger [8]. A community of practice is created among participants within a domain where they continuously contribute to the practices and creation of a shared identity. Furthermore, it has been found that creating such a community in the online or blended environment is more challenging than the physical space because the technology of an online environment does not guarantee that the resulting interactions support the kinds of meaning necessary [13].

Short term implications

We are currently facing at least one more semester in uncertain times, where access to the physical campus is limited and might completely disappear at short notice. In other words, the learning environment might still change rapidly, and educators should strive to evaluate and revise the educational design continuously. In this process, teachers and administrators can build on this study's findings with a focus on the importance of informal learning spaces and structure. When designing learning activities for the online environment, one should also consider the structure and context in which they happen, being mindful of the indirect effects of lecture times, lab sessions, tools, and platforms. On a more positive note, this past semester has proved that both educators and students can change and adapt fast, although, it is important to consider that the positive and willing attitude and spirit might dwindle as we keep having to adapt to new environments.

Long term implications

As time since March has passed, the temporariness of this situation has become less apparent. This study has identified some important gaps about how and what we teach computing students in the traditional campus-based context. Learning to learn is an essential competency for future computing professionals, and one of the important findings of this study is that many students struggle with this skill. It is important now to look back at the traditional educational design and reflect on what we can improve. Based on the results presented in this paper, some important questions to ask are:

- What can we do to improve students' ability to study and learn independently?
- Is the scaffolding provided by the set time-tables and educational structure doing the students a disservice?
- How can we teach students the ability to adapt to new situations fast? Is this even a skill they should have in the future?
- It seems like the campus is essential to the students. At the same time, we know many students spend a lot of time alone at home during a traditional semester. What can we do to engage these students on campus? Should this be a larger focus?
- Is the fact that lecture attendance is low in many courses an even greater problem than we thought?

Limitations

The main limitation of this research is the convenience sampling of the survey responses. Unfortunately, we were not able to perform a more controlled sampling of the population; however, the design allowed us to obtain data in a short time frame which in this unconventional context was valuable. In retrospect, the survey questions concerning tools and feedback could have been adjusted to promote more concrete answers. For example, after analysing the responses the researcher was left wondering to what degree the students actually had the hardware they needed for online education. Lastly, the transformation for students from a campus-based to an online environment was not the only change for the student during this time period. The country was in full lockdown for several weeks, and the students lost access to the campus and all other infrastructure such as gyms, cafes, and restaurants. Many students also moved from their student housing to their parents' house, where their whole family was also most likely working from home.

5 Conclusions and future work

When we lose something, we really learn to appreciate it. The same can be said for the physical campus during the Covid-19 pandemic. The current study has explored the effects on the study behaviors of computing students during the rapid change from a campus-based to an online learning environment. Through a mixed-method analysis of survey data, this study has found that informal learning spaces are essential to students but at the same time challenging to transfer effectively to the online environment. Furthermore, the scaffolding for effective study behavior development provided by the schedule and structure in the on-campus environment was found to be valuable for students. Educators may find these insights helpful when creating online or blended learning environments; however, the hidden benefits of the campus should also be remembered when we return back to campus. The results presented in this study can help assist academics to ask the right questions and identify the real problems associated with teaching in an online only environment.

Since the survey was concluded at the end of the spring semester, the authors have continued exploring and sharing the insights from this research. A follow-up study and/or a larger study would be useful in confirming and possibly extending the results found in this study. There are currently several large scale research projects in progress, with involvement from some of the authors, however, no decision on a follow-up to this concrete study has been made.

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