Learning in the Pandemic: How the possibility to play video games during class and attend lessons without getting out of bed affects time-on-task

Johan Snider
NTI Gymnasiet Uppsala
Uppsala, Sweden
johan.snider@ntig.se

Olle Bälter
KTH Royal Institute of Technology
Stockholm, Sweden
ob1@kth.se

Daniel Bosk
KTH Royal Institute of Technology
Stockholm, Sweden
daniel@bosk.se

***Abstract*—This Innovate Practice work-in-progress paper presents findings around how distance learning, due to the the COVID-19 pandemic, affected students as measured by time-on-task in programming.**

In this qualitative study, we examine a group of 36 second year upper-secondary students in Programming 1 during a nine week period in Spring 2021. During this time, they alternated between one whole week of distance learning followed by two weeks of in school instruction. For the Programming 1 lessons, students used an online platform to write, edit and run code in. We analyzed the log data from the platform to estimate time-on-task for each student for every lesson both at home and at school.

We observed that students were affected differently by distance learning as measured by time-on-task. 12 students had more average time-on-task at school. 15 students had more average time-on-task at home. Nine students had less than five minutes difference on average.

In addition to the analysis of time-on-task, students were given a survey in Fall 2021 to follow up on their experiences with in-school teaching and distance learning. In the survey, students were asked questions about their study environment at home during distance learning. From the responses, 13 students described their study environment as "in bed" despite having access to a table and chair in a room for themselves and twenty-three students described their study environment as "playing video games during online lectures". Not surprisingly, students that said they were playing video games during online lectures had a lower average time-on-task by about ten minutes than their peers. Interestingly, students that said they participated in class in bed had a higher average time-on-task by about ten minutes than their peers.

Correlating responses from the survey and time-on-task data, we reason about how students' study environments at home affected their time-on-task and how distance learning has affected students in the pandemic.

***Index Terms*—Computer science**

I. Background

Teaching at upper secondary schools during the COVID-19 pandemic was a challenge unlike anything ever faced before. From Spring 2020 to Spring 2021, NTI Gymnasiet in Uppsala, Sweden was required to offer distance learning to mitigate the risks associated with the COVID-19 pandemic. At the beginning of the pandemic in Spring 2020, all lessons at the school were switched to online-distance-learning. At NTI Gymnasiet Uppsala, all students were equipped with computers provided by the school before the pandemic. Anecdotal evidence suggests that distance learning proved challenging for teachers and students alike. Non-technical problems around students focusing at home, screen fatigue, lack of social interaction were all topics discussed at the school. Technical problems with Internet connections from home occasionally prevented teachers and students from participating in classes using the online meeting software Microsoft (MS) Teams.

In the Fall 2021 semester, teachers and students had their first experience with blended learning, having some students at school and others at home. NTI Gymnasiet Uppsala choose to prioritize first year students by having them in school every week, with second and third year students rotating every other week. This proved uniquely challenging for classes with both second and third year students, which required teachers to teach in a classroom with students both physically and virtually present. In the Spring 2021 semester NTI Gymnasiet Uppsala prioritized third year students preparing to graduate and had third year students at school most weeks with first year and second year students alternating back and forth from home and school. This created the situation where most second year students were between distance learning at home and in school instruction every one to two weeks.

A. Research question

Through all of the turmoil of the pandemic, we were most curious about how going back and forth from home and school affected students. This motivated us to investigate the research question:

> How can we understand the ways distance learning has affected students as measured by time-on-task in Programming 1?

II. Related Works

The COVID-19 pandemic caused worldwide school closures, with many school resorting to distance learning as an alternative to not having instruction [1]. Estimates from countries in Europe amount to months of either lost or

compromised education time during the two-year span of the pandemic from Spring 2020 to Spring 2021. In the aftermath of the pandemic, countries, researchers and schools around the world have attempted to estimate the cost of this unprecedented disruption to students' learning. In a general review of published papers focused on the topic of pandemic related school closures, seven publications were found aimed at measuring the effects of the pandemic on students learning [2]. Each paper focused on a quantitative approach using standardized tests from before, during and after the pandemic. Thousands of students, from hundreds of schools in multiple subjects from countries in the USA, Belgium, the Netherlands Switzerland and Germany were included in the analysis. Overall, most results suggested a negative impact on students' learning during the pandemic. These results are not conclusive however, and vary in regards to: country, students' age, and subject matter. Specifically, no study attempted to compare the best case of distance learning with the worst case of face-to-face learning. As suggested by Hietanen and Svedholm-Häkkinen [3], it probably depends on the teachers, that was the case in Swedish higher education. Hietanen and Svedholm-Häkkinen found that university teachers more experienced in distance teaching fared better during the pandemic. In other words, it is not possible to say that distance learning was not effective, but the evidence that we can gather suggests a negative impact on students' learning and, as suggested above, this is probably due to the majortiy of teachers lacking experience in distance teaching.

Time-on-task is the measure of how long a student has worked with a task. Specifically, time-on-task can be used as a metric to give insight into how long a student has been able to focus. Fine-grained log data such as keystrokes with timestamps gives a better estimate of time-on-task than course-grained data such as the starting and submission date of an assignment [4]. Specifically, given a threshold for the amount of time a break can last, the time-on-task can be approximated by minutes.

CMU CS Academy is an upper-secondary web platform for learning Python programming [5]. It has a many-small-assignments approach to teaching programming and focuses on graphics programming. In every unit, students work through interactive lessons with checkpoints which are then followed by a series of small programming exercises (20-50 lines of code). At the end of every unit, students program on an individual project to demonstrate what they have learned. In addition, students are required to finish each section before moving on and can to a large extent work at their own pace. Conveniently, Carnegie Mellon University (CMU) Computer Science (CS) Academy logs events while students are online such as: page views, file edits, program runs, and program errors.

III. Method

This project focuses on a nine week window in the Spring 2021 semester following thirty-six second year students studying Programming 1. The aim of the project was to measure students' time-on-task using fine-grained log data to see if they generally spent more time-on-task programming at home or at school.

Students attended one week of class at home followed by two weeks of classes at school. This pattern repeated three times. Every lesson at home and at school was at most one hour and twenty minutes. Every lesson at home and at school followed approximately the same format with a fifteen to twenty minute instruction period followed by approximately sixty minutes to make progress on exercises in CMU CS Academy. Students were also able to ask questions and receive help during the sixty minute work period. For every student, we estimated time-on-task for every class on every day. To compute the average time-on-task for a student at home, we take all the time-on-task measurements at home and average them together, excluding absenses. This gives us one number which represents the number of minutes on average that the student spent actively engaged in programming at home. We do the same thing to compute the average time-on-task at school. For this analysis we used a one minute break threshold to calculate time-on-task, meaning if a student is not active for more than one minute we do not include that minute in the time on task measurement. This threshold was intentionally set low to focus on the active time-on-task programming The purpose of these measurements are to show the difference between how much time students *usually* spent actively engaged in programming tasks at home and at school.

Noteworthily, students were able to work outside of class on the platform. Therefore, time spent before or after a class is included in the measurements for that day. This means that students were able to have an average time-on-task higher than the length of a regular class. Time spent outside of class was included in the measurements because it more accurately reflects students experience in the course, especially with respect to the pandemic and studying from home. However, during in-school weeks, even if the student has time-on-task outside of class, possibly at home, we count it to the in-school time-on-task.

Additionally, interviews were conducted with five students to create a survey with relevant questions about students' experiences and study environments during the pandemic. The students were surveyed in Fall 2021 to capture how they experienced distance learning. Through the survey students also consented to the use of their data and responses to be used for research. The survey asked students to rate their emotions of: joy, anger, confidence, sadness, comfort and anxiety on a scale of one to four, one being the least and four being the most, for weeks at home and weeks at school. The survey included true/false questions about the students' study environment at home with questions such as:

- do you have a space for just yourself?
- do you have a place where you can focus?
- do you have a comfortable place to study?
- do you have a place with a table and chair?
- do you study in bed?
- do you have a clean space?

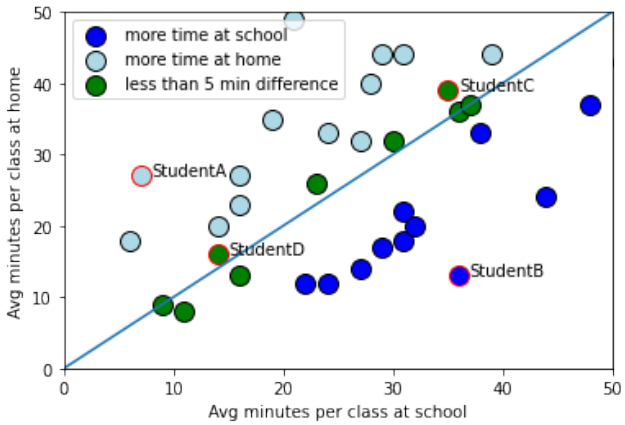

Fig. 1. Average time-on-task at home and at school per student

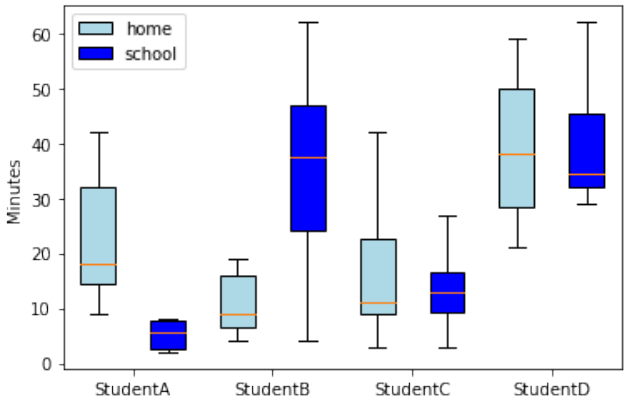

Fig. 2. Time-on-task for four students during classes at home and at school

- do you have a space full of distractions?
- do you play video games during online lectures?

We combined these survey responses with the time-on-task data to see if there were any responses that correlated with noticeably higher or lower time-on-task at home or at school. This analysis is set in the context of a Programming 1 course where students were able to a large extent work at their own pace, and work outside of established class times. Additionally, since the data set only has thirty-six students in it, we do not try to determine significant factors for higher or lower time-on-task. Rather we present correlations which can hopefully be meaningful to other teachers and schools in reasoning about the affects of the pandemic on students learning.

IV. Results

The results show that students were affected differently by distance learning. Figure 1 shows the results of how students' time-on-task compared at home and at school. 12 students had more average time-on-task at school. 15 students had more average time-on-task at home. Three students were excluded from the figure as outliers becuase they had more than 50 minutes of time-on-task either at home or at school. Nine students had less than five minutes difference on average between time-on-task at home and at school, which was the threshold we set for the analysis. Overall, the average time-on-task was 26 minutes for classes at school and 30 minutes for classes at home. We can also see the students who had lower or higher time-on-task at home and at school overall.

Figure 2 shows patterns for four selected students in the study. Here we can see that over the period of nine weeks, StudentA consistently had low time-on-task at school, on average about 5 minutes. At home however, the same student had higher time-on-task, with an average of almost 20 minutes. This student shows the case for the group of twelve students that had more time-on-task at school. These students were not able to focus on programming at school as much as their peers compared to how much they were able to focus at home.

StudentB shows the opposite behavior. StudentB has an average time-on-task of less than ten minutes at home, and a higher average time-on-task at school of almost 40 minutes. StudentB shows the case for the group of fifteen students that had more time-on-task at home. These students were able to work more as measured by time-on-task at home than in school.

Two additional patterns are shown by StudentC and StudentD. StudentC and StudentD have similar average time-on-tasks at school and at home, but with different magnitudes of time. These students illustrate the behavior of the nine students who had less than five minute difference on average between time-on-task at home or at school. StudentC also has similar average time-on-task at home and at school, but the majority of time-on-task measurements are all under 20 minutes. This means that StudentC both at home and at school had an average work session of 10–20 minutes. StudentD shows the same behavior, but with higher time-on-task measurements overall. The majority of the time StudentD worked 30–50 minutes per day both at home and at school.

The survey questions about the students study environments at home gives us insights into why students exhibited one pattern during distance learning or another. Figure 3 shows the results when the students were asked about their feeling of comfort during weeks at home, and how those responses related to time-on-task at home and at school. We can see that students who responded with either more or most comfort at home had higher average time-on-task measurements at home. Whereas students who responded less or least comfort at home had lower average time-on-task at home. This suggests that how comfortable students felt at home played a role in how long they were able to work.

We asked specific questions about students study environment during weeks at home. Most of the answers were homogeneous and did not give insight as to what factors could influence time-on-task at home. Practically all of the students had a comfortable space for just themselves in a room with a door they could close with a table and chair to study at. One of the few questions that split the group was if the students described their study environment as "in bed". 20 students responded that they do not study in bed (false), and 15 students

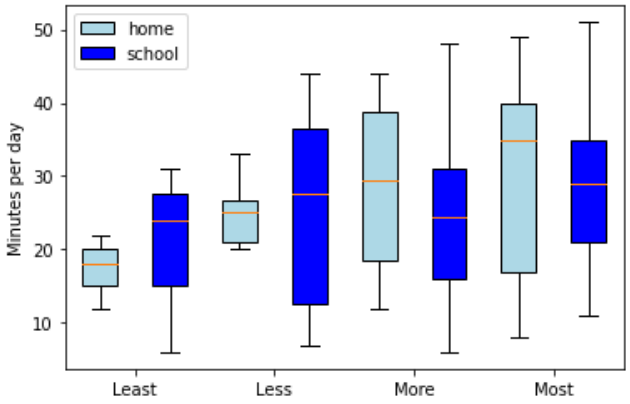

Fig. 3. Students self-reported *comfort during weeks at home* and time-on-task

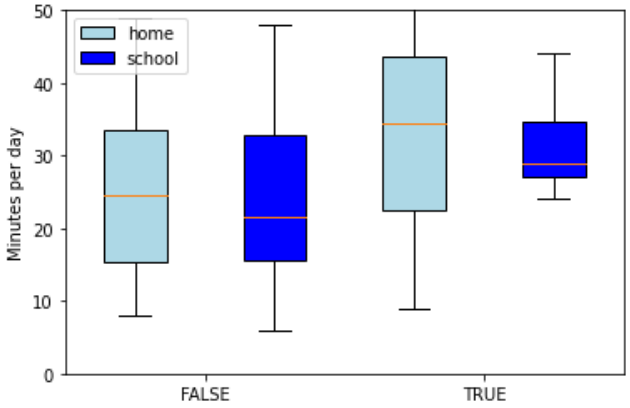

Fig. 4. Students' self-reported study environment at home described as "in bed" and time-on-task

responded that they did (true). Figure 4 shows the average time-on-task measurements at home and at school for both groups. Students that responded false had an average time-on-task at home and at school of around 25 minutes. The students that answered true had higher average time-on-task at home of around 35 minutes. This shows that students who were participating in distance learning in bed did more work as measured by time-on-task.

Similarly another question that split the group was if the students described their study environment as "playing video games during online lessons". This question was included bluntly after it came up during multiple interviews with students. 26 students responded that they did play videogames during online lessons (true) and nine students responded that they did not (false). Figure 5 shows the average time-on-task measurements at home and at school for both groups. Here we see that the students who did not play videogames at home had higher time-on-task at school and at home.

V. Discussion

In this study we presented findings about how distance learning has affected students during the COVID-19 pandemic as measured by time-on-task. We found that students needed

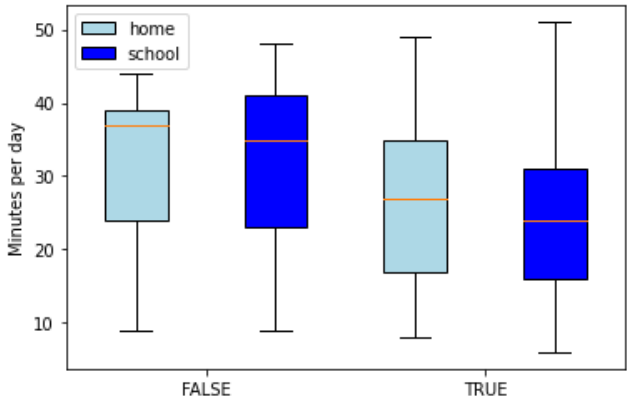

Fig. 5. Student self-reported study environment at home described as in "playing video games during online lectures" and time-on-task

to be treated as individuals for this analysis and that while some students flourished being able to spend time at home other students were not able to put in as much time as their peers.

With such a small number of students in this study, we can only present our findings as possible correlations as to reasons why students were affected one way or another. Nevertheless, we feel like our experience can be representative for educators during the pandemic. Specifically dealing with the reality of distance learning where students were able to be in bed playing videogames while listening to their lecturer in the background. We need to keep these lessons in mind to evaluate if the way we have implemented distance learning is sensible. If we would go back to distance learning, educators need to be acutely aware that some students will struggle with the self-motivation required to keep on task while at home. One way to measure this in other courses would be to use digital learning tools that activate the students, such as the question-based learning methodology developed at Carnegie Mellon [6].

Our results also suggests that schools should try to increase students comfort at home during distance learning, and that this could help students focus on school work. While many may be horrified that students study in bed, supported by ergonomics, it might actually be a good study environment according to the students. Many of the students programming in bed, did have access to a desk and a chair, but preferred the bed. As time on task is important, it might be better to have them studying longer in bed rather than shorter at the desk. Either way we recommend that basic ergonimics be discussed with the students as a part of distance learning.

Finally, for the future: It would be interesting to analyse the students' task data (edits and runs) in more detail, for instance from a variation theoretic perspective [for instance 7, Ch. 3, 5]. This way we could explore if there are different types of "times-on-task", such as efficient and inefficient time-on-task. For instance, those students who played videogames during class, maybe they had to spend more inefficient time-on-task later due to the effects of multitasking?

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