Mining digital reality: exploring the virtual activities of undergraduate students

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This study explored the computer usage behaviour of undergraduate students, by using Reality Mining techniques to capture naturally-occurring digital traces. We harvested over 14,000 hours of computer usage data from 21 undergraduate students at a New Zealand university over the period of one semester. Our preliminary analysis has given us some insights into: 1] what applications students use most frequently, 2] how much students use their computes during the semester, 3] the multi-tasking/task-switching behaviours of students, and 4] the times most common for students to use their computer devices. These results, which are from a larger ongoing study, point to interesting areas for future research around the complexities of student digital behaviours, and illustrates the potential of new research methods to capture data about student practices.

Keywords: Reality Mining, computer usage, student behaviour, higher education

Introduction

It is generally accepted that higher education today incorporates a great deal of computer technology, and that students use digital devices in virtually all aspects of their academic life, from accessing their lectures online, to conducting research, to writing and publishing scholarly work. Most of the current undergraduate student cohort (referred to as Generation Z/Gen Z, the iGeneration or Post-Millennial) use multiple technologies on a daily basis; have had access to the internet since a young age; and are generally comfortable adopting new technologies and digital behaviours (e.g. interaction on social media). However, the lines between academic and non-academic technology use are also becoming increasingly blurred for GenZ students. Conole et. al. (2008) declare that the students' use of technologies is intermingled with social or leisure activities, and is almost indistinguishable from their academic use. Sim and Butson (2013) found that undergraduate students were typically unable to accurately judge how much of their technology use was for academic or non-academic purposes. Several studies have reported that students are likely to multi-task with technology when studying, constantly switching between academic and non-academic activities (e.g. Weimer, 2012; Burak, 2012).

Today, it is still relatively unclear exactly how students are using computer devices in their day-to-day life, and to what extent academic and non-academic activities are intertwined in their digital practices. A decade ago, Conole et al. (2008) wrote that digital technologies were changing student academic practice, particularly in terms of "anytime, anywhere" learning. However, other studies report on the negative impact that technology use can have on academic performance (see Wentworth & Middleton, 2014 for a review of the literature). These studies in particular correlate heavy internet use and social media use with lower performing students. These conflicting pressures present challenges to teachers and educational designers who want to provide environments and experiences that effectively cater to students' digital educational needs.

The problem is that most studies related to student computer use are based on self-reports rather than measures of actual practice. For example, Wentworth and Middleton (2014) conducted a large-scale survey to determine the effects of technology on student performance, but concluded by saying:

> …measures of technology use may need to be refined. Student self-reports may have been biased, either positively or negatively, due to memory errors and lack of awareness of their actual frequency of using technology. (p310)

However, we are now able to capture naturally-occurring behavioural data at precise temporal resolutions (e.g. down to seconds), which offers unprecedented insights into student computer activities. This has given rise to a new phenomenon of self-tracking typically termed the Quantified Self (Wolf & Kelly, 2014). The ability to self-monitor across a range of data forms could give students access to, and control over, learning and social related behaviours, leading to self-transformation.

This short paper reports on a study in which 21 undergraduate students at a New Zealand university had their daily computer behaviours monitored for one semester (approximately 4 months). This study is part of a larger doctoral research project investigating student experiences using new and emerging digital devices and research methods. In particular, we employ a Reality Mining technique (Pentland, 2009) which seeks to unobtrusively gather digital traces or footprints of students as they go about their daily routines. This research is exploratory in nature, and as such we do not have explicit research questions. We present here the method used to capture student computer usage data, preliminary findings, and future research directions.

Method

Computer activity data was generated from the personal digital devices (i.e., laptops and tablets) of 21 undergraduate health science students from a New Zealand university, over the course of 1 semester (February 2017 – June 2017). The data was gathered using a computer application called RescueTime (https://www.rescuetime.com). RescueTime is a personal time management application for logging and tracking digital activity hours. It sits in the background of the device without causing any interruptions to normal computer use, and records the date, time, duration and type of computer programmes used, as well as the date, time and duration of websites visited. Note that the software does not collect the content of documents or websites. This type of data capture is consistent and yields more authentic information rather than relying on student recollections of computer use, which are likely to be less accurate. RescueTime has been used to capture productivity measures of computer programmers (Meyer et. al., 2017), and similar activity tracking software has been used before in higher education to compare students' perceptions of computer use with actual use data (Sim, 2016).

In this study, participants were given full control over the software, including the ability to turn it on and off and to delete any data they did not want included in the study. As well as having access to the raw data throughout, participants were also emailed summary reports of their weekly activities. This was deemed an important part of the research design—since data tracking at this level has "Big Brother" overtones, we believed it was essential that students felt they were in control of their privacy and owned their data. We also wanted to encourage them to find utility in the data being generated, and learn more about their own practices. In this way, they were able to engage as co-researchers in the project.

Data was analysed using pandas, a library for statistical data analysis (McKinney, 2011). All computer usage data was cleaned of any identifying features to ensure anonymity prior to publication. Ethical approval for the study was obtained from the university prior to the commencement of data collection (Ethics 16/160).

Findings

This research generated over 14,487 total hours of students' computer usage data. While we are still in the early stages of analysing this dataset, we can report on a number of preliminary findings and interesting elements for future research.

Application use

First, we wanted to gain an overall appreciation of undergraduate use of computer devices. In particular, one that was based on actual rather than reported data. Namely, we wanted to know: what applications do undergraduate students use over the course of a semester? We achieved this by undertaking a word frequency analysis of software application names (including websites, which were classified as simply URL_ADDRESS). Overwhelmingly, for all students the most common activity was internet browsing. Note that we are not making any distinctions here between the kinds of websites students were visiting, thus we cannot say whether these were for academic or non-academic purposes (this will be a focus of future analysis). However, interestingly, the second most frequent occurrence was Microsoft OneNote, which is highly likely to be associated with academic use. OneNote is an ideal collaborative application for taking notes, and organising information.

Other frequently occurring applications included the traditional applications of email and media players, which suggest an intermingling of leisure (i.e. networking and entertainment) with study activities.

Computer use over time

The RescueTime data also gave us an overview of how the students' computer usage changed over the course of the semester. The students exhibited different usage patterns: some appeared random, while others showed

trends over time. For example, Figure 1 shows a third year student's daily usage, steadily increasing over the semester.

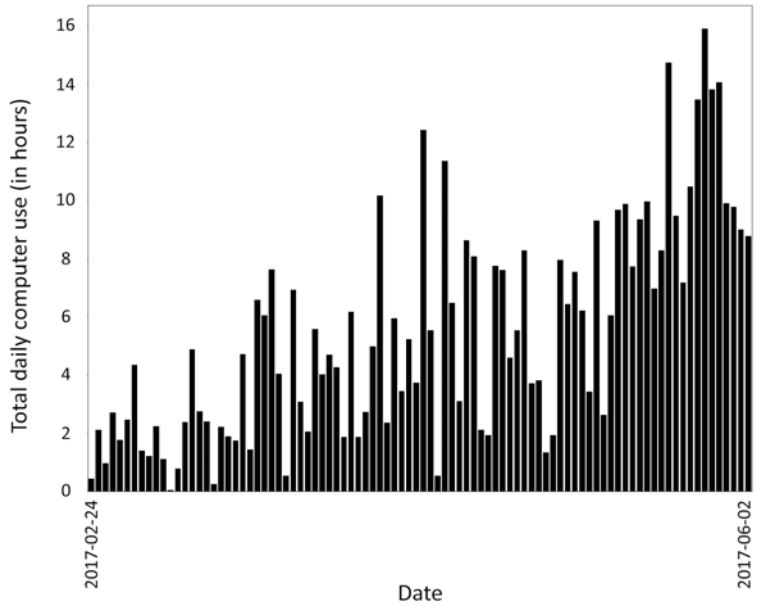

Figure 1. Daily computer usage (in hours) over a semester for one undergraduate student (note the start of semester is February, and end is June).

Possibly not surprisingly, many students showed their heaviest usage in the last couple weeks of the semester, likely when their final assignments and exams were due.

Multi-tasking and task-switching behaviours

As described before, students are constantly engaged in computer activity throughout the day, so it is not surprising to see frequent multi-tasking by students. Junco and Cotten (2012, p505-506) describe multi-tasking as "divided attention and non-sequential task-switching". Figure 2 shows an example of task-switching behaviour observed from one student: the darker the band, the greater the number of *different* activities taking place in that hourly slot. As with the daily computer usage, more task-switching was generally observed towards the end of the semester.

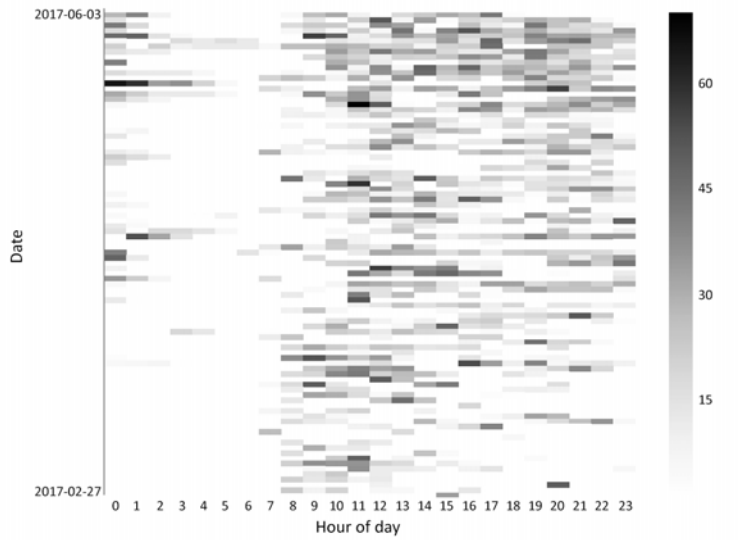

Figure 2. Heatmap of hourly computer usage from an undergraduate student showing a high degree of multi-tasking or task-switching behaviour (note the start of semester is February (bottom of graph), and the end is June (top of graph)).

Anytime, anywhere technologies

The findings also revealed how much activity the students engage in throughout the day. Most students generally showed more activity between 5pm and 12pm. It was interesting to note that several students showed considerably more activity around 10pm than any other periods of the day. Figure 3 shows an example of total computer usage over the semester for one student, broken down by hour.

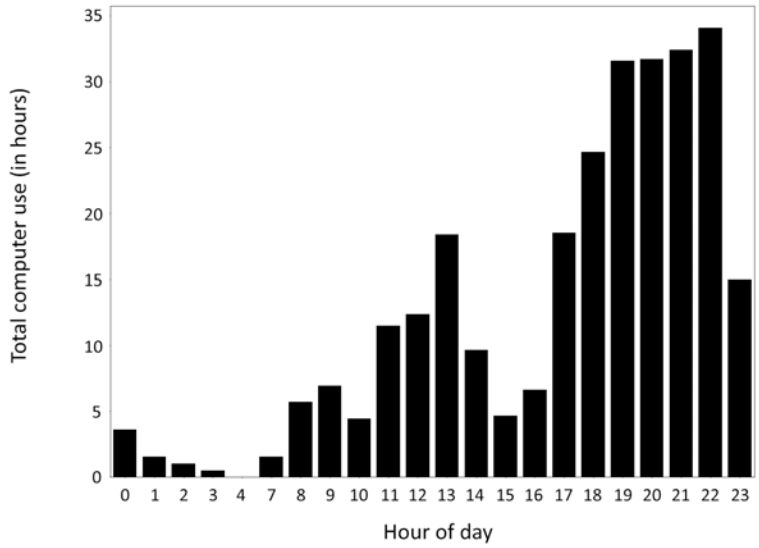

Figure 3. Example of total hourly computer usage for one semester from one participant.

While dissections of academic or non-academic activities have not been analysed at this stage, this finding shows computer devices play a significant role in students' 'awake' time.

Conclusions and future research

This research extends the notion of understanding student experience by better capturing student digital behaviour. This paper reported on undergraduate students' use of computers over the period of one semester. Overall, the extent to which this cohort of undergraduate students utilised their computers in their daily lives was extensive. Internet use was by far the most common computer activity of students. The students showed the most computer usage towards the end of the semester, and their heaviest hours of usage were in the latter part of the day. Students also exhibited frequent multi-tasking/task-switching behaviours.

These findings are in no way exhaustive, but merely offer a glimpse into the digital behaviours that can be captured through Reality Mining methods. Our future research includes categorising and quantifying academic and non-academic digital behaviours, further interrogating the usage data for patterns, and looking for evidence of producing and consuming behaviours in relation to learning (Sim, 2016). Finally, we want to raise awareness of these methods in the higher education community. In particular, we believe students can benefit from using self-monitoring software such as RescueTime to learn more about their own behaviours and make changes where necessary. Ultimately, the tensions concerning the place of technology in 21st century education may be resolved by the students themselves.

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