What impact does online learning have on carbon emissions and mental health compared to classroom learning at the University of Canterbury?

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Executive Summary

The University of Canterbury aims to be carbon neutral by 2030 through the use of biomass and the removal of coal burners by the end of 2022. As revealed in our research, heating is the most consumptive form of energy production. Research conducted post-pandemic also shows a general preference for working from home, proving it to boost productivity and mental health factors.

This research was conducted using the opinions and habits of a GEOG106 class at the University of Canterbury obtained through a survey distributed amongst the class. The survey examined their viewpoints regarding online learning and observed their methods of transport and carbon producing behaviours.

Our research has highlighted that GEOG106 students find their productivity and general sense of wellbeing to increase when on campus, and revealed that the habits of GEOG106 students align with typically environmentally friendly carbon practices. Our recommendations include looking towards blended learning, namely the incorporation of both online learning and on-campus learning, and greater student involvement in consultation and decision

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1. Introduction

The sudden global Covid-19 crisis which occurred in 2020 forced and imposed many changes on individuals, having public modes of transport suggest UC transport behaviour is trending in a positive direction. However, the UC Transport Advisory Panel (2016) identify the persistent high use of private motor vehicles as a key issue.

2.2. Devices

According to research on device emissions, carbon emissions produced from laptops is significant (Corless, 2021). From its manufacturing process to transportation, as well as the first four years of the use device, it is estimated that one laptop approximately produces 422.5kg of carbon emissions. Considering the number of students enrolled at the University of Canterbury, 20,919 as of 2021, if every person owned a laptop device, UCs carbon footprint from laptops alone would be around 8,838,277.5kg. Since UC is seeking to become carbon neutral by 2030, it is important to recognise that the resources used for our learning contribute much to UC carbon footprint. In addition to this, energy consumption such as electricity use of device is not included in this estimate, making it a more important factor to consider when looking at UC's overall carbon emissions. Literature review suggests that being more aware of the size of the carbon footprint an individual produces from the use of devices can help promote positive changes in reducing and reversing carbon dioxide. Prototypes including Direct Air Capture (to extract CO2) and Green Algorithms allow users to measure their own computer carbon footprint.

2.3. Power

Literature illustrates how energy consumption including electricity, heating and gas contribute the most to worldwide university carbon footprints, with more than 70% of contributions originating from Ireland, Australia and the USA. When translated to CO2 emissions per capita, the USA and Australia are still the two largest contributors (Helmers et al, 2021). These statistics also demonstrate little correlation between geographical location and total power consumption, alluding to the fact that carbon emissions produced by the usage of power, particularly heating, are down to processes and strategies tertiary institutions have in place to reduce their own carbon footprints.

The University of Canterbury's strategic objective to become carbon net neutral by 2030 is largely reliant on the switch from coal to biomass as a heating source. This biomass, inclusive of woodchips and pellets will reduce the amount of carbon dioxide as a greenhouse gas by approximately 80%, and will eventually run off an entirely renewable recourse scheme. A tree planting progr-6(uB)4(n( )o7(o)-9(w)-6(im)4wdc Tf1 0(g)10(r)Ck710(a)4(santina)4(santina)4(santina)4(

Studying at home is strongly correlated with higher levels of stress in students, according to a review of the literature on learning effectiveness and stress. The literature review was based on earlier research conducted during the pandemic, which may have also been a factor contributing to the students' elevated levels of stress (Rajab et al., 2020). Further examination of literature on learning effectiveness revealed that students who were enrolled in an online university retained 20% less of the lecture on average than those students who took it in a classroom context (James et al., 2016). However, there appeared to be no difference in grades between the students who took online courses and those who took them in a traditional classroom, making this factor of overall final grades insignificant in attempts to evaluate the learning effectiveness of online learning (Alghazo, 2015).

2.5. Separation of Work and Home

Recent studies have shown that a blurring of boundaries between work and one’s life impacts their ability to work effectively (Galanti et al. 2021). Additionally, it was found that work hours significantly increased where boundaries were not clearly in place (Baudot & Kelly, 2020). A subjective measurement of productivity was used by Baudot & Kelly (2020), which will be employed as a form of measurement in the survey of the GEOG106 class. In the form of perceived productivity, the GEOG106 survey will gain an understanding of how effective students perceive themselves to be when studying at home. A university-based study relates the use of remote learning and study within scientific disciplines at universities with lower quality work due to the lack of close supervision and mentoring (Hunter, 2019).

3. Methods

Students who selected driving as their main mode of transport *additionally* provided details of their vehicle class: Small, Medium, Large, Diesel, Hybrid, or Electric. From this information, an average fuel economy *for each class* was calculated from five common vehicles within each class sold in New Zealand (EPA, n.d.). Data was gathered from vehicles produced near 2008 as this is the average age New Zealand's car fleet (Ministry of Transport, 2021). Using the fuel economy data, a carbon emissions factor of 2.3 Kg Co2/L of unleaded petrol was than applied to each vehicle class, and subsequently student travel, per kilometre (NTC, 2019). A carbon emissions factor of 0.122kg/km, as used by Davison et al (2015), was applied to students who selected bussing as their main mode of transport.

In this analysis, students who selected active modes of transport, including walking or cycling, were carbon neutral. Although some literature suggests there is an associated carbon cost with these transport modes, the impact is minimal, and it requires many assumptions regarding the participants lifestyle choices (Walsh et al, 2008). Thus, its exclusion from this report is justified.

The final transport related carbon emissions figure was calculated by multiplying the following variables: Vehicle carbon emissions factor, frequency of travel to UC per week, distance travelled to UC x2 (accounting for a return trip), and x24 which considers each week of the University year. As the survey received 42 responses from a total class population of 245, the transport emissions figure of 1,879.05 calculated from the sample has a weight of 5.83. This results in a final figure of 10,955.29 kilograms of carbon dioxide produced from GEOG106 students' yearly university related travel.

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To calculate emissions associated with the use of devices, participants were questioned on the frequency at which they replaced university related devices, the number of students who bring devices to university for lecture notes, and the time spent on computers at UC. We then calculated the average carbon foot-print of a laptop at 422.5kgs, using circular computing, by the number of the students who responded to our survey from Geog106 who said yes to owning a device. 35x 422.5=14,787.5kgs.

To calculate the final emissions for the whole class we multiplied the average carbon foot-print of a laptop by the number of people that own devices which gave us 14,787.5. We then calculated this by 5.833 which is the proportion that have laptops out of the whole class. This

mental wellbeing of students also showed to be lower when studying online. This is shown by 66.7% of students that felt a strong sense of well-being studying on campus over online learning, with 23.8% of students feeling neutral about the question. This finding demonstrates that students prefer to study on campus.

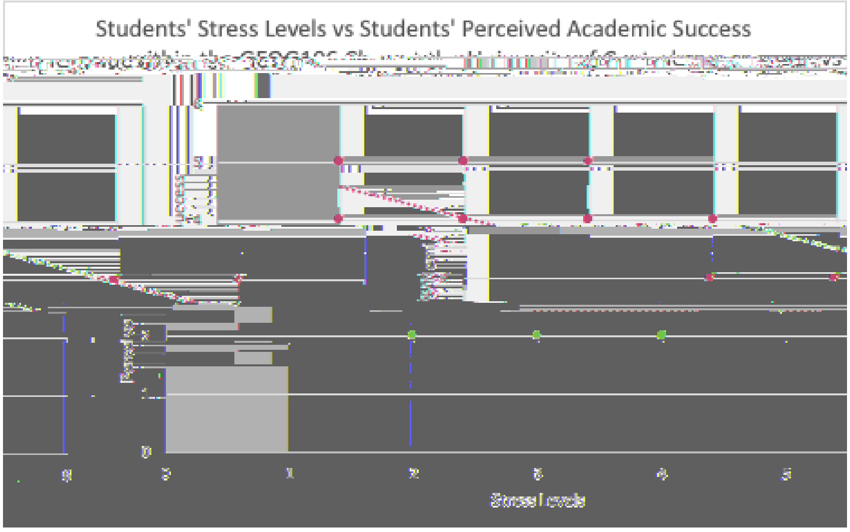

Figure 2. Students Stress Levels vs Students Perceived Academic Success

61.9% of students achieve greater success doing university on campus compared to online, and, as shown in *Figure 2*, there appears to be a negative correlation between stress and perceived academic success. This demonstrates that when students experience high levels of stress of stress, their perceived academic stress decreases.

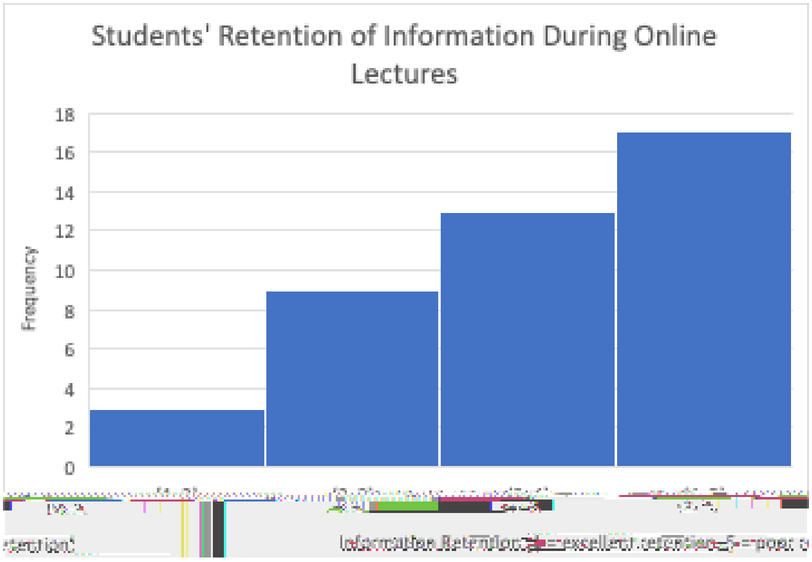

Figure 3. Students Retention of Information During Online Lectures

From the bar graph shown in *Figure 3* , the responses of the students are negatively skewed, which shows that 71.5% in GEOG106 strongly believe that they retain more of a lecture when in person in comparison to watching it online.

5. Discussion

5.1. Transport

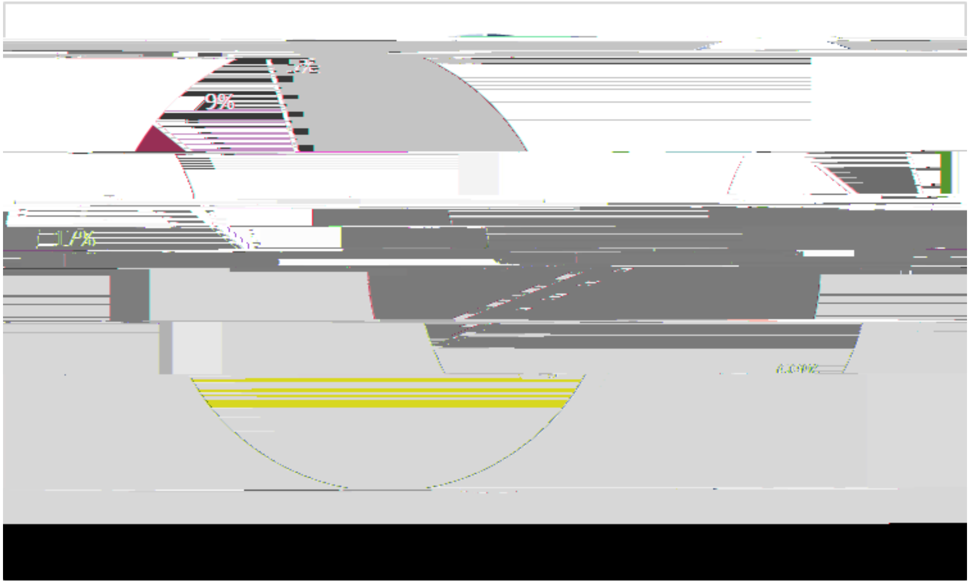

Figure 4. **Pie Chart of GEOG106 Student's Mode of Transport**

A recurring theme observed in the literature is that transport related emissions are among the highest contributors to a university's carbon footprint. Our results show this may still be true for GEOG106, but to a smaller degree. *Figure 4* shows 78% of students use active transport as their primary mode to UC campus. This is significantly higher than the 45.53% figure found by the 2020 UC travel survey (UC Sustainability Office, 2020) which assessed the total UC student population. The high use of active transport in GEOG106 can be largely attributed to the proximity of student accommodation, where 57.1% of students have identified they live, as shown in Figure 2. Most of these students will move into flats for the following years of their tuition which has a high likelihood of reducing active transport use as many students travel further to UC. Therefore, on a wider scale the data gathered for this report is best used to understand the transport trends of 100 level courses only.

***Figure 5.* Pie Chart of GEOG106 Students' Housing Situation**

Interestingly, 86% of the students who drive to UC travel a distance of at least 5km each way. Beyond this distance, driving is a valid option as many would perceive this to be too far to use active transport. Bussing would be a suitable alternative at this distance; however, the 2020 UC travel survey identifies lack of connections to UC as a key barrier preventing the use of this service. Mitigation strategies that promote a change in transport mode would therefore be of very low impact as there is an existing high penetration of a climate positive behaviour in GEOG106. This suggests the yearly transport carbon emissions figure of 10,955.29 kg of CO_2 is relatively low considering the class population of 245 students.

This is to account for each answers' two-hour variance, and allows us to address the most accurate power summary for each time period. For students who gauged their daily heating time as 6 hours or more, we have calculated both a figure for 6 hours of use and 12 hours of use to account for participants who may use home heating for up to 12 hours (or all typical daylight hours). The total CO_2e emissions for the following calculations will therefore range between 1 hour and 6-12 hours for consistency.

Considering our survey did not specify a particular heating source (eg, heat pump, oil heater, heating fan etc), our calculations have been based off an average emission estimate from New

Accommodation Services (n.d.) *Halls of Residence*. University of Canterbury. https://www.canterbury.ac.nz/life/accommodation/halls/

Alghazo, A. M. (2015, October). *Comparing effectiveness of online and traditional teaching ... - opensiuc*. Retrieved October 18, 2022, from

Engagement, and Stress Journal of Occupational and Environmental Medicine 63(7) 426-432 https://doi.org/10.1097%2FJOM.0000000000002236

Helmers, E., Chang, C.C. & Dauwels, J. Carbon footprinting of universities worldwide: Part I—objective comparison by standardized metrics. *Environ Sci Eur* **33**, 30 (2021). https://doi.org/10.1186/s12302-021-00454-6

Hunter, P. (2019) Remote working in research (Report No. 20) Heidelberg: EMBO Press

James, S., Daston, C., & Swan, K. (2016, June). *Retention, progression and the taking of online courses* -

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https://www.canterbury.ac.nz/life/sustainability/sustainable-operations/energy-and-carbon/

The University of Canterbury. (n.d.). *Sustainability Office: Life at UC: University of Canterbury*. The University of Canterbury. Retrieved October 20, 2022, from https://www.canterbury.ac.nz/life/sustainability/sustainability-office-and-programme-board/

UC Sustainability Office. (2020). *University of Canterbury 2020 Travel Survey report.* https://www.canterbury.ac.nz/media/documents/sustain/UC-Travel-Survey-Report-2020.pdf

UC Transport Advisory Panel. (2016). *University of Canterbury Transport Issues and Options 2017.* https://www.canterbury.ac.nz/media/documents/sustain/TAP_Issues_and_Options_Document_2016.pdf

University of Canterbury (n.d.) Our Energy Journey. Retrieved from https://www.canterbury.ac.nz/life/sustainability/sustainable-operations/energy-and-carbon/