The carbon-based environmental impact of learning at the University of Waikato

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Abstract

In a world where man-made carbon emissions are exacerbating the natural warming of the earth, with serious consequences, it is beholden on universities to show leadership by accounting for, and mitigating, their carbon emissions. This research accounts for the carbon-based environmental impact of the face-to-face and online delivery of higher education at the University of Waikato. Drawing on an existing environmental assessment methodology, data was gathered by web-based survey on the key sources of carbon emissions associated with a student's university study, namely: travel, place of residence, and use of Information and Communication Technology (ICT) and paper. As part of updating and localising the methodology, new calculations were made for internet, textbook, residential and campus site energies and an improved method for computing the impact of printing was developed. The data were analysed, allowing for comparisons to be made between online and face-to-face students' carbon emissions, and with some care the limited previous research. The main sources of carbon-based environmental impact were travel, campus and residential energy. Online students' emissions were, on average, one-third of those of their on-campus peers.

Introduction

Levels of greenhouse gases (GHG) in the earth's atmosphere are increasing and amplifying the earth's natural greenhouse effect. This will have serious implications for life on earth. The scientific consensus is that the increase in GHG emissions is due to anthropogenic sources (IPCC, 2013). Given the amount of GHG emitted into the atmosphere needs to be sharply reduced, then it is beholden on all sectors of society to mitigate their emissions. Carbon footprinting is a useful strategy to understand and manage those emissions (Williams, Kemp, Coello, Turner, & Wright, 2012). The higher education sector is growing worldwide, as is its carbon footprint. Many higher education institutions have been measuring their carbon footprints, but comparisons are few and difficult to make because of the lack of one standard approach (Vaughter, Wright, McKenzie, & Lidstone, 2013).

E-learning is often assumed to be an environmentally sustainable, or an "inherently green" mode of education provision (Bourke & Simpson, 2009) thus the use of e-learning has long been identified as a potential way for institutions to reduce their environmental impact (Eneroth, 2000). This is primarily

based on the substitution of carbon-intensive travel for, what is assumed to be, lower energy intensity ICT. Few studies move beyond single issues to consider both the impact of travel, as well as the confounding issues of ICT energy intensity, embodied energy and rebound effects. Of those studies that have quantified the level of GHG emission reduction the adoption of e-learning makes possible, none have been carried out in the New Zealand context. The SusTEACH methodology (Caird, Swithenby & Lane, 2012), with its 12 year history, represents the most comprehensive and well-tested approach to understanding the carbon-based environmental impact of teaching and learning in the United Kingdom. This study adapted the SusTEACH methodology for the New Zealand context.

The problem being addressed

This research addressed the following question:

What is the carbon-based environmental impact of the face-to-face and online methods of delivery of higher education at the University of Waikato?

Intuitively, online teaching's reduced dependence on regular travel to campus compared with traditional on-campus delivery should result in a commensurate reduction in carbon emissions. However, the digital technologies that make online learning possible also have their own, less obvious, environmental impact. Just as the geographical boundaries are blurring as a result of digital technologies' affordances, these same technologies have an environmental impact that is widely debated and similarly blurry, and often geographically dislocated from where they are being used. With an emphasis on growing the number of tertiary students being educated, understanding the environmental impact of tertiary education becomes of strategic importance. Fortunately, this imperative for growth aligns with a rising awareness of environmental issues among tertiary education suppliers, as increasingly they monitor their environmental performance at the institutional level.

This study aimed to account for the carbon-based environmental impact of one paper taught at the University of Waikato, using a bottom-up approach. Bottom-up approaches are commonly used to measure the carbon footprint of a process (education) used to produce an individual product (graduate). The criticism of this approach is that it is time-consuming and that inconsistent application of boundaries or scope can lead to incomplete footprints.

The fact that the paper investigated, a compulsory 20 point second year undergraduate paper, is delivered in two different modes allowed comparisons to be made between the environmental impact of the delivery method. In answering the research question a methodology appropriate to the New Zealand context has been made available for others wanting to explore the carbon footprint of their tertiary teaching.

Study design/Approach

This interpretive case-study adapts the SusTEACH methodology of Caird et al. (2012) to deliver an online questionnaire to students designed to solicit travel and energy and material use data

associated with their study of an second year undergraduate paper. Responses were compiled using spreadsheet software and calculations made to estimate the carbon footprint of a student's studying.

The interpretivist position considers reality as subjective and socially constructed by participants. As defined by Yin (2014, p.14), a case-study "investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." In this case, where different cohorts of students are studying under different conditions, the "…contextual conditions… [are] …highly pertinent." (Yin, 2014, p.14).

This study is exploratory in nature, that is, it sets out to investigate the phenomenon of carbon-based environmental impact of teaching and learning in the real-life context of the University of Waikato. While the data are self-reported, the empirical data is being collected from real people in order to understand their environmental impact within a real-life organisational context. The participants' interpretations are in turn being interpreted by the researcher (Walsham, 1995) and in this case the plausibility or trustworthiness of the overall interpretation is more important than the positivist concepts of reliability, validity and generalisability (Myers, 2009).

The choice of methodology provides a rationale for the method used. This limited exploratory study collected quantitative data using a survey method. While most survey questionnaires are based on positivist epistemology and objectivist ontology, the quantitative data they collect "are perfectly valid inputs for an interpretive study" (Walsham, 2006, p.323).

Survey methods are prone to question misinterpretation (a validity issue) and, unlike interviews, do not provide an opportunity for clarification. The survey was piloted to identify potential interpretation difficulties. Confidence in the validity of the survey was also increased because it was based on a tried and tested instrument, the SusTEACH survey developed by Caird et al. (2012). However, surveys rely on participants' interpretations and memories and because of this there may be issues of reliability.

Findings

Online students' total emissions are, on average, 72% fewer than those of on-campus students. When the travel and residential emissions contributed as part of the online students' block course attendance are removed the re-calculated emissions reduction of 87% is in close agreement with the 85% reduction reported by Roy et al. (as cited in Caird et al., 2012).

The area of most significance is that of travel, where on closer inspection it becomes clear that travel to campus has the largest single impact for on-campus students. Perhaps less foreseeable is the large contribution of travel to permanent residences for those students residing in term-time accommodation. Travel home is responsible for one third of on-campus students' travel-related carbon emissions; their second single largest source of carbon emissions.

Campus and residential energy use and the associated carbon emissions are the next most significant contributors to the overall emissions profile for on-campus students. Combined they represent 36% of emissions for on-campus students.

Printing represents a relatively small component of a student's overall impact, and emissions vary little between cohorts. As a proportion of total emissions, however, they are more significant for online students. Likewise ICT-related emissions represent a larger proportion of online students' total emissions. Surprisingly, on-campus students' ICT-related emissions can exceed those of online students' because of the impact of the embodied energy of ICTs on total emissions.

Discussion and conclusion

Student travel to campus associated with a 120 point academic year of study creates, on average, emissions of 360 $kgCO_2e$ per student, or 52 tonnes of carbon annually for the campus-based cohort studied. Therefore strategies that reduce travel will have the greatest effect on reducing the carbon-based environmental footprint of teaching and learning. However, as Williamson (2012) points out, strategies for reducing travel-related (mobile) emissions have traditionally received less attention than those interventions that mitigate (stationary) campus energy-related emissions. In part this is because, as acknowledged by this study, the accurate measurement of travel behaviour is a complex undertaking and the behavioural changes required to reduce that travel are relatively unpalatable to many individuals. However, it is also because there are immediate and significant financial incentives for institutions to reduce their energy use (Williamson, 2012).

From the perspective of travel reduction, ideally campuses should be sited as close as practical to students' permanent residences. Residential housing policies can have a significant effect on emissions profiles of higher education institutions (Williamson, 2012). While existing campuses cannot be easily shifted and any changes to housing policies would manifest change on a longer timeframe, a timelier and more practical consideration might be to encourage the use of public transport. Other potential measures include charging for parking spaces. As at the time of writing, the University of Waikato is in the process of introducing parking charges in line with other New Zealand universities.

Another approach to mitigating the carbon impact of travel is to encourage the use of ICT. If the embodied energy of the device is discounted, the emissions of online students as a result of their ICT use are twice those of their on-campus peers, but they are still a magnitude smaller than the emissions caused by travel. Therefore it is in the substitution of ICT for more carbon-intensive travel that the largest reductions in GHG emissions can be won.

Although the order of the factors influencing the carbon-based environmental impact of teaching and learning is in agreement with the SusTEACH study, that is travel, campus and residential energies, the magnitude of their impact is much smaller (around 60% less). This reduced impact is largely a result of a national energy mix that, as a result of a large proportion of renewable sources, has a much reduced carbon intensity. It is also likely a result of climatic and geographical factors that result in reduced energy demand and shorter commutes respectively. These findings illustrate the importance of the study's context. It seems safe to conclude that, independent of context, travel has the greatest influence on the carbon-based environmental impact of teaching and learning.

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