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BRIEF REPORT

REVISED Comparing carbon emissions between online and in-person study for a cohort of overseas students: A retrospective cohort study [version 2; peer review: 2 approved with reservations]

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Abstract

Background: One of the benefits of online education is the potential reduction in carbon emissions through the decrease in travel to attend a university in person. We estimated the savings in CO₂ emissions of an international cohort of master's students who studied fully online from their home countries, rather than travelling to the UK and living there while attending university.

Methods: The city and country of residence of a cohort of students who first enrolled in the fully online Peoples-uni/Manchester Metropolitan University MPH programme between the second semester of 2011 and the first semester 2013 were recorded. We estimated the aviation emissions between Manchester, UK and the cities where students reside, and subtracted the per capita emissions for the country of origin from the per capita emissions for the UK over the time that the student would have spent in Manchester as a full-time student, based on the semester in which they first enrolled.

Results: 128 students enrolled from 55 cities in 31 countries. 93 students were from a range of African countries and 18 from the Indian sub-continent. Flights to and from Manchester were estimated to have accounted for 114,553kg of CO₂ and living in Manchester for the duration of their course compared with staying in the home country would have been equivalent to 854,904kg of CO₂.

Open Peer Review

Approval Status

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version 5 (revision) 14 Feb 2022			
version 4 (revision) 04 Feb 2022			
version 3 (revision) 24 Sep 2021	 view	 view	 view
version 2 (revision) 07 Sep 2021	 view	 view	
version 1 25 Aug 2021			

1. **Vincent Tawiah** , Dublin City University, Dublin, Ireland

2. **Andy Lane** , The Open University, Milton Keynes, UK

Sally Caird, The Open University, Milton

The combined net savings was 969,457kg of CO₂.

Conclusions: A small cohort of overseas students, largely from Africa and India, studied online rather than attending university in the UK. The saving by this small cohort of nearly a million kg of CO₂ emissions through not attending university in-person offers an indication of the potential environmental benefits of offering university education online to overseas students.

Keywords

Online learning, carbon emissions, airline travel, overseas students

Keynes, UK

3. **Geoffrey R Browne** , University of Melbourne, Melbourne, Australia

Any reports and responses or comments on the article can be found at the end of the article.

Corresponding author: Richard F Heller (rfheller4@gmail.com)

Author roles: **Heller RF:** Conceptualization, Data Curation, Methodology, Project Administration, Writing – Original Draft Preparation, Writing – Review & Editing; **Sun YY:** Conceptualization, Data Curation, Formal Analysis, Methodology, Writing – Review & Editing; **Guo Z:** Formal Analysis, Visualization, Writing – Review & Editing; **Malik A:** Conceptualization, Data Curation, Formal Analysis, Methodology, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: The author(s) declared that no grants were involved in supporting this work.

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REVISED Amendments from Version 1

In the previous version 1 we had quoted the wrong data source for CO₂ emissions. We have updated the references to the data source we actually used (<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>) in the Methods, Data availability and References sections. We can confirm that our calculations were already accurate in the v1, and they are unchanged in this v2. We have also amended the number of students whose country emissions were higher than in the UK from three to seven in the Results section.

Any further responses from the reviewers can be found at the end of the article

Background

One of the benefits of online education is the potential reduction in carbon emissions through decreasing travel to attend university in person. However, there is little evidence in the existing literature that quantifies this potential for overseas students, but one study concludes: “The introduction of online education allows [...] a huge reduction in carbon emissions and could thus help HEIs [Higher Education Institutions] to achieve their energy efficiency and sustainability goals”¹. Other studies have examined the carbon footprint of universities, with one finding that travel by overseas students to the university accounted for 6% of total emissions² and another, while describing a large variation in estimated carbon emissions between different universities in Texas, also estimated the carbon emissions from travel through a ‘study abroad’ programme in one university³.

Peoples-uni, a volunteer led educational charity, provided fully online master’s level courses to health professionals in low- to middle-income countries (LMICs) from 2008 to 2021⁴. For four semesters between 2011 and 2013, a partnership allowed students to enrol in the Master of Public Health (MPH) offered by Manchester Metropolitan University (MMU) by solely online study through the Peoples-uni without travel to the UK.

This paper estimates the savings in CO₂ emissions by this cohort of students who studied fully online from their home countries rather than travelling to and living in Manchester to attend the University in-person.

Methods

A retrospective cohort study explored the records in the Peoples-uni database of each of the students who first enrolled through Peoples-uni in the MMU MPH award programme between the second semester of 2011 and the first semester of 2013. The city and country of residence were recorded, as was the final award gained. Even though the course was part-time, we assume that students would have been living in Manchester full-time and would have travelled by air from their home city. We assumed that they would have lived in Manchester for 18 months to complete a full 180 credit MPH, 12 months for those exiting with a 120 credit Graduate Diploma (passing all coursework except for the Dissertation) or 6 months for those exiting with a 60 credit Graduate Certificate (passing half the

number of modules required for the Graduate Diploma). For students who passed some modules, but not enough to earn a Graduate Certificate, we assumed they would have spent 3 months in Manchester, and for those who passed no modules we assumed they would have withdrawn before travelling to Manchester. The dataset for this report can be found here⁵.

The differences of carbon emissions during participation in the MMU MPH programme are calculated as the following:

$$\text{Net emissions} = (\text{emissions of living in Manchester}) - (\text{emissions of living at home country}) + \text{round trip air transport emissions}$$

If net emissions are larger than zero, this implies the online MMU MPH programme creates an environmental benefit - with a carbon footprint at home smaller than the footprint when living in Manchester combined with the air travel.

To calculate the difference, we first used the International Civil Aviation Organization (ICAO) carbon emissions calculator⁶. The ICAO provides the comprehensive city-pair carbon dioxide emissions from air travel by taking into account aircraft types, route specific data, passenger load factors and cargo carried. We estimated the aviation emissions between Manchester, UK and the city where students resided. To avoid overestimating the environmental impact of the travel, we took a conservative approach by choosing the route with fewest number of stops and lowest flight time or miles where this was an option, even though these may not have been the cheapest options, nor the actual flights used by the students. Road travel from a city without an international airport was recorded but not included in a calculation of emissions as the mode of travel was unknown and the estimates would have been imprecise.

To calculate the emissions of students living in the UK compared with their home country, the annual per capita CO₂ emissions for each country were taken for the relevant years from data collected by the Carbon Dioxide Information Analysis Center and reported in OurWorldInData.org⁷. The per capita emissions for the country of origin were subtracted from the per capita emissions for the UK over the time that the student would have spent in Manchester as a full-time student, starting with the semester in which they first enrolled.

Ethics statement

As part of the application process for entry to Peoples-uni courses, students were informed that their anonymised information might be used for research into the outcomes of the education programme. Data from the Peoples-uni database were extracted by one of the researchers (RFH) and de-identified by deleting the names of the students from the resulting spreadsheet shared for analysis with the other authors, and for the resulting publication. No ethical approval was sought due to the low-risk nature of the study.

Results

From 2011 to 2013, 128 students enrolled in the MMU MPH programme from 55 cities in 31 countries, 93 students were from Africa and 18 from the Indian sub-continent.

94 students gained an MPH, from which we recorded an assumed 18 months living in Manchester, 9 gained a Graduate Diploma, equating to 12 months in Manchester, and 16 students gained a Graduate Certificate, equating to 6 months in Manchester. 5 students passed two modules, corresponding to 3 months in Manchester, and 4 students gained no passes and are assumed not to have travelled to Manchester at all.

35 students started in the second semester of 2011, 24 and 22 respectively in the first and second semesters 2012, and 47 in the first semester of 2013. Although all students were from LMICs, some were living in high-income countries at the start of their studies.

Transport emissions

Two students started the MPH programme in the UK, so were not counted in the calculation of transport emissions. Flights to and from Manchester were estimated to have accounted for 114, 553 kg of CO₂ emissions, with an average of 924 kg per student. Transport emissions are largely determined by distance, and the largest emissions on flights were those flying intercontinental from Fiji (2,133 kg), Papua New Guinea (1,635 kg) and Zimbabwe (1,495 kg) to Manchester. **Figure 1** shows the emissions for each country – where students came from more than one city in a country these were averaged to show country data.

Emissions from living in Manchester

The two students who enrolled from the UK had no change in emissions, and seven students came from countries (South Africa, USA, Canada and United Arab Emirates) with higher emissions than in the UK, so contributed negative counts. Overall, the emissions per capita are linked strongly to national economic development status – the higher the wealth the larger the emission footprint. Because the MMU MPH programme was mainly offered to students from LMICs, students' carbon footprint in their home country is generally lower than it would be living in Manchester, although this will vary over time. As examples, the net CO₂ emission estimates used

for 2013 were 7,354 kg for Manchester, 103 kg for Ethiopia and 72 for Rwanda. For the group as a whole, living in Manchester for the duration of their course compared with staying in the home country would have been equivalent to a net excess of 854,904 kg of CO₂.

Combining transport and living gives an estimate of total excess net emissions of 969,457 kg of CO₂. **Figure 2** shows the total net emissions per country.

Discussion

This cohort of 128 master's students was estimated to have saved 969,457 kg of CO₂ through studying online from their home country rather than travelling to and living in Manchester, UK to attend in person.

We used conservative assumptions for flight estimations in terms of number of stops and routes taken, and also assumed that the students travelled alone without family and did not return home during the programme. Flight emissions may reduce over time with increasing global attention to the climate change issue. Per capita emissions will also change over time in different ways across countries.

We have assumed that a student living in Manchester would have the same consumption patterns as the general population, and so created our method of calculating their consumption by subtracting the per capita CO₂ emissions of their own country from that of the UK. It may be that students have lower consumption patterns than the general population, although the university campus has a high carbon footprint⁸. Future research could consider specific supply chain aspects for quantifying reductions in emissions from online learning. To this end, a global multi-regional input-output model could be integrated with detailed information on expenditure patterns of students on a country-by-country basis for quantifying their at-home carbon footprint, and the footprint if they travelled to the UK. Such an analysis could be performed at a sector-level, enabling the quantification of hotspots. Future work could also

Figure 1. Mean emissions (in kg CO₂) per country from air travel to Manchester and return. X axis shows the country from which the students come – where students come from more than one city in the country, the mean has been calculated to characterise the country. Y axis shows kg CO₂.

Figure 2. Difference in net emissions (kg CO₂) between physical attendance in Manchester and studying online at home. X axis shows the country from which the students come. Y axis shows the net difference in emissions between the UK and each country in kg CO₂.

focus on expanding such an assessment to university-wide quantification of emission savings from online learning, beyond the assessed master's programme in this work. A university-wide assessment could also include savings through online working of the teaching staff, a possible decrease in electricity consumption in lecture theatres (and possible increase from students' perspective). Future research could also consider the costs associated with the sourcing of equipment for accessing online material, such as laptops, internet plans, and associated carbon emissions.

Conclusion

Although there have been a number of studies discussing the benefits of online learning on carbon emissions, the full contributions of overseas students to emissions have not yet been explored. Caird *et al.*⁹ calculated that among 15 higher education institutions in the UK, distance-based education models achieved an 83% reduction in carbon emissions, with the fully online model achieving the lowest carbon emissions. Similarly, Perales Jarillo *et al.*¹⁰ have set the benefits of online education in the context of Sustainability Development Goals.

Project Atlas, quoting UNESCO data, estimated in their 2020 report that there were more than 5.6 million higher education students globally that were studying abroad¹¹. In each of the top three countries receiving overseas students, the United States, the United Kingdom and Canada, more than 20% of all students were international. In the UK in 2019/20 there were more than 250,000 postgraduate non-UK students, the majority from outside the EU¹². Considering that the countries

from which most overseas students come from have lower emissions per capita, having international students enrolled in in-person programmes will create a net emission increase compared with online-study. Given the large number of overseas students globally, their impact on carbon emissions is considerable.

That even a small cohort of international students, largely from Africa and India, studying online rather than travelling to the UK likely saved nearly a million kg of CO₂ provides an indication of the extent of the savings that could be made through the development of online education for overseas students.

Data availability

Underlying data

Data come from International Civil Aviation Organization (ICAO) carbon emissions calculator⁶ <https://www.icao.int/environmental-protection/CarbonOffset/Pages/default.aspx>; and CO₂ and Greenhouse Gas Emissions⁷ <https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>

Zenodo: Saving carbon emissions through online learning for overseas students [Data set] <https://doi.org/10.5281/zenodo.5335865>

This project contains the following underlying data:

- Student data and calculations, and World Bank emissions data

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

References

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1. Versteijlen M, Salgado FP, Groesbeek MJ, *et al.*: **Pros and cons of online education as a measure to reduce carbon emissions in higher education in the Netherlands.** *Curr Opin Environ Sustain.* 2017; **28**: 80–89.
[Publisher Full Text](#)
2. Ozawa-Meida L, Brockway P, Letten K, *et al.*: **Measuring carbon performance in a UK University through a consumption-based carbon footprint: De Montfort University case study.** *J Clean Prod.* 2013; **56**: 185–198.
[Publisher Full Text](#)
3. Bailey G, LaPoint T: **Comparing Greenhouse Gas Emissions across Texas Universities.** *Sustainability.* 2016; **8**(1): 80.
[Publisher Full Text](#)
4. Heller RF, Strobl J, Madhok R: **Online Education for Public Health Capacity Building in Low- to Middle-Income Countries: The Peoples-uni Experience.** *IRRODL.* 2019; **20**(1).
[Publisher Full Text](#)
5. Heller RF: **Saving carbon emissions through online learning for overseas students [Data set].** *Zenodo.*
<http://www.doi.org/10.5281/zenodo.5335866>
6. International Civil Aviation Organization (ICAO) carbon emissions calculator.
[Reference Source](#)
7. Ritchie H, Roser M: **CO₂ and Greenhouse Gas Emissions.** 2020.
[Reference Source](#)
8. Yañez P, Sinha A, Vázquez M: **Carbon Footprint Estimation in a University Campus: Evaluation and Insights.** *Sustainability.* 2020; **12**(1): 181.
[Publisher Full Text](#)
9. Caird S, Lane A, Swithenby E, *et al.*: **Design of higher education teaching models and carbon impacts.** *Int J Sust Higher Ed.* 2015; **16**(1): 96–111.
[Publisher Full Text](#)
10. Perales Jarillo M, Pedraza L, Moreno Ger P, *et al.*: **Challenges of Online Higher Education in the Face of the Sustainability Objectives of the United Nations: Carbon Footprint, Accessibility and Social Inclusion.** *Sustainability.* 2019; **11**(20): 5580.
[Publisher Full Text](#)
11. Institute of International Education: **Project Atlas.** 2021.
[Reference Source](#)
12. HESA, the Higher Education Statistics Agency: **Higher Education Student Statistics: UK, 2019/20 - Where students come from and go to study.**
[Reference Source](#)

Open Peer Review

Current Peer Review Status: ? ?

Version 2

Reviewer Report 15 September 2021

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Andy Lane

The Open University, Milton Keynes, UK

Sally Caird

School of Engineering and Innovation, Faculty of Science, Technology, Engineering and Maths, The Open University, Milton Keynes, UK

The introduction is quite poor in setting the context. Some material in the conclusions should be in the introduction, for example, the discussion of Caird S, Lane A, Swithenby E, *et al.*: Design of higher education teaching models and carbon impacts. Int J Sust Higher Ed. 2015; 16(1): 96–111¹ would help with that context rather than being an afterthought in the conclusions.

The method used in this study is very high level and crude. It ignores the HE context (in terms of HE systems, climate action and sustainability policies and GHG emissions data) and does not describe the two teaching models compared; so consequently, it offers no insights into systemic aspects of HE institutional systems and teaching models. In other words, the method would be no different if it were calculating the effects of visiting the UK on holidays or for work for the same duration, and so it offers limited insight from a HE perspective. The title is therefore misleading because it does not look at the impacts of 'online and in-person study', instead, it estimates the impact of air travel of overseas students.

As far as we can tell, limited primary data was collected, other than on the number of students on a programme, their nationality, and their qualification programme. The method does not take student or staff activities related to teaching and learning into account, other than to make assumptions on average behaviours rather than any self-reporting of 'actual' behaviours. The study assumes:

- students living in Manchester would have the same consumption patterns as the general population in the UK (is there no variation in consumption within countries?);
- students would have been living in Manchester full-time;
- the length of time students would have lived in Manchester, based on the time needed to

complete their qualification programmes;

- students would have travelled by air from their home city;
- flight impacts in terms of the number of stops and routes taken;
- students travelled alone without family and did not return home during the programme.

These limitations should be acknowledged, i.e. the study does not consider HE systems nor students specifically, and so the study is just an estimation of travel emissions related to visitors to the UK for a specific period of time.

References

1. Caird S, Lane A, Swithenby E, Roy R, et al.: Design of higher education teaching models and carbon impacts. *International Journal of Sustainability in Higher Education*. 2015; **16** (1): 96-111
[Publisher Full Text](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Environmental systems, innovation

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

Author Response 21 Sep 2021

Richard F Heller, University of Newcastle, Newcastle, Australia

Reviewer Report

Andy Lane, The Open University, Milton Keynes, UK
Sally Caird, The Open University, Milton Keynes, UK

The introduction is quite poor in setting the context. Some material in the conclusions should be in the introduction, for example, the discussion of Caird S, Lane A, Swithenby E, et al.: Design of higher education teaching models and carbon impacts. Int J Sust Higher Ed. 2015; 16(1): 96–111¹ would help with that context rather than being an afterthought in the conclusions.

Author response: We have quoted this paper at the start of the Background which now reads as follows: "One of the benefits of online education is the potential reduction in carbon emissions through decreasing travel to attend university in person. Caird et al. 1 calculated that among 15 higher education institutions in the UK, distance-based education models achieved an 83% reduction in carbon emissions, with the fully online model achieving the lowest carbon emissions. Estimates included travel, purchase and use of ICT devices, purchase of books and publications and use of paper for printing, residential and home energy use and campus site operations. Versteijlen et al. conclude: "The introduction of online education allows [...] a huge reduction in carbon emissions and could thus help HEIs [Higher Education Institutions] to achieve their energy efficiency and sustainability goals" 2"

The method used in this study is very high level and crude. It ignores the HE context (in terms of HE systems, climate action and sustainability policies and GHG emissions data) and does not describe the two teaching models compared; so consequently, it offers no insights into systemic aspects of HE institutional systems and teaching models. In other words, the method would be no different if it were calculating the effects of visiting the UK on holidays or for work for the same duration, and so it offers limited insight from a HE perspective. The title is therefore misleading because it does not look at the impacts of 'online and in-person study', instead, it estimates the impact of air travel of overseas students.

Author response: To reflect this comment we have changed the title as follows: "Impact on carbon emissions of online study for a cohort of overseas students: A retrospective cohort study".

We have also added to the Methods the following: "We did not estimate the carbon emissions associated with different educational processes themselves."

We have also added the following to the Discussion: "Caird et al. 1 estimate 36kg CO₂ per 100 study hours for UK based fully online courses (compared with 278kg for face-to-face teaching). Applying this estimate for online teaching to our cohort would equate to 648kg over the course of the master's degree, and 68,796kg for the whole cohort. However, it is difficult to apply this to Peoples-uni which did not have a campus, used Open Educational Resources and whose students live in LMICs."

We have also added to our original sentence in the Discussion "Future work could also focus on expanding such an assessment to university-wide quantification of emission savings from online learning, beyond the assessed master's programme in this work." which now reads: "Future work could also focus on expanding such an assessment to university-wide quantification of emission savings from online learning, beyond the assessed master's programme in this work, to provide a

n accurate estimate of the emissions from different teaching models related to the 'export' of higher education to LMIC populations."

We have also changed the final sentence in the Abstract from "The saving by this small cohort of nearly a million kg of CO₂ emissions through not attending university in person offers an indication of the potential environmental benefits of offering university education online to overseas students." to "The likely saving by this small cohort of nearly a million kg of CO₂ emissions offers an indication of the potential environmental benefits of offering university education online to overseas students."

As far as we can tell, limited primary data was collected, other than on the number of students on a programme, their nationality, and their qualification programme. The method does not take student or staff activities related to teaching and learning into account, other than to make assumptions on average behaviours rather than any self-reporting of 'actual' behaviours. The study assumes:

- students living in Manchester would have the same consumption patterns as the general population in the UK (is there no variation in consumption within countries?);
- students would have been living in Manchester full-time;
- the length of time students would have lived in Manchester, based on the time needed to complete their qualification programmes;
- students would have travelled by air from their home city;
- flight impacts in terms of the number of stops and routes taken;
- students travelled alone without family and did not return home during the programme.

These limitations should be acknowledged, i.e. the study does not consider HE systems nor students specifically, and so the study is just an estimation of travel emissions related to visitors to the UK for a specific period of time.

Author response: *We thank the Reviewers for these suggestions which clarify the nature of the study. As indicated above, we have now acknowledged the limitations of the study at various points in the paper, including in the title, and feel that the changes more accurately reflect the nature of the study and any implications.*

Competing Interests: No competing interests were disclosed.

Reviewer Report 14 September 2021

<https://doi.org/10.5256/f1000research.77395.r93064>

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Vincent Tawiah

DCU Business School, Dublin City University, Dublin, Ireland

This paper addresses an interesting and relevant topic on how online education could solve environmental problems. I suggest the authors improve the paper by considering the following points:

- Given that online education covers international activity, I suggest that the authors provide more literature on how international activities affect the environment and then narrow it down to online education. The authors could consider the following papers:
  - The environmental footprint of China-Africa engagement by Tawiah *et al.* (2020)¹;
  - Energy resource melioration and CO2 emissions in China and Nigeria; Efficiency and trade perspective by Li *et al.* (2020)².
- Policy implication: COVID-19 has forced many HEI to move online; hence, I expect the authors to provide some policy implications on findings nested with the COVID-19 situation. One way is to articulate how online education could reduce emissions and make your studies more relevant in this COVID era.

All the best.

References

1. Tawiah VK, Zakari A, Khan I: The environmental footprint of China-Africa engagement: An analysis of the effect of China - Africa partnership on carbon emissions. *Sci Total Environ.* 2021; **756**: 143603 [PubMed Abstract](#) | [Publisher Full Text](#)
2. Li G, Zakari A, Tawiah V: Energy resource melioration and CO2 emissions in China and Nigeria: Efficiency and trade perspectives. *Resources Policy.* 2020; **68**. [Publisher Full Text](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Environment

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 21 Sep 2021

Richard F Heller, University of Newcastle, Newcastle, Australia

Reviewer Report

Vincent Tawiah, DCU Business School, Dublin City University, Dublin, Ireland

This paper addresses an interesting and relevant topic on how online education could solve environmental problems. I suggest the authors improve the paper by considering the following points:

- Given that online education covers international activity, I suggest that the authors provide more literature on how international activities affect the environment and then narrow it down to online education. The authors could consider the following papers:
  - The environmental footprint of China-Africa engagement by Tawiah *et al.* (2020)¹;
  - Energy resource melioration and CO2 emissions in China and Nigeria; Efficiency and trade perspective by Li *et al.* (2020)².

Author response: *We have added both of these references, and added the following to the Conclusion: "There is a literature on the way in which numerous international economic activities affect the environment 13,14 and the importance of international education to the economy of many countries demonstrates the value of considering how online education might contribute to a reduction in global CO2 emissions. "*

- Policy implication: COVID-19 has forced many HEI to move online; hence, I expect the authors to provide some policy implications on findings nested with the COVID-19 situation. One way is to articulate how online education could reduce emissions and make your studies more relevant in this COVID era.

Author response: *We have added the following to the Conclusion: "The benefits of reducing CO2 emissions through online education for international students should be seen in the context of the COVID era, which has demonstrated the importance of online education and the limits to international travel."*

All the best.

Author response: *Many thanks for your helpful suggestions. We hope that the corrections we have made capture your points.*

Competing Interests: No competing interests were disclosed.

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