Will university students return to campus after COVID-19?

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SHORT SUMMARY

The COVID-19 pandemic introduced major challenges to higher education. Many students had to partake in a predominantly virtual educational and social university experience, which inevitably affected travel behaviour around university campuses. The purpose of this study was to explore how student travel behaviour may shape post-COVID-19. Using the University of Southampton as an example, a survey combining stated and revealed preference methods with students was carried out. The responses were analysed using binary logistic regression and the results suggested that students were most inclined to travel to campus for learning and assessment activities, extracurricular activities, individual/group studying and events. A particularly interesting finding was that even if virtual alternatives to several of these activities were offered, they were unlikely to deter students from travelling to campus. This suggests that despite changes in the delivery of higher education activities, university campuses are likely to remain focal points of student life post-COVID-19.

Keywords: travel behaviour, COVID-19, university students

1 INTRODUCTION

The COVID-19 pandemic brought about major travel behaviour changes at a scale never seen before. As social distancing measures were introduced in different countries worldwide, key assumptions on travel behaviour trends that were challenged and invalidated overnight. However, despite the major disruption to society and lifestyles, which came on top of the public health and economic impacts, the COVID-19 pandemic is also often seen as a catalyst to more efficient and sustainable mobility, in what some of the measures implemented out of necessity may prove beneficial to remain in place even after widespread in-person social interaction resumes. Some degree of remote working, for example, may be normalised across workplaces and educational establishments.

Universities are of particular interest in this respect; a university is a hub of educational, social and economic activity, and is therefore usually a major generator and attractor of trips in a city, so a change in student mobility habits due to, for instance, more remote learning activities could have significant implications for urban transport planning. Still, while there is extensive literature on how the pandemic has affected travel behaviour on national and international scales (e.g. [*1-7*]) and what, given the ongoing mass vaccination campaigns and evolution of the disease, the new "normal" may look like, the specific case of higher education institutions has so far received only limited coverage.

The aim of this study is, therefore, to investigate how changes in the travel behaviour of university students during the COVID-19 outbreak could be integrated in transport planning and to identify the circumstances under which this could happen. Using the University of Southampton (UoS) as a case study, an online survey with students was carried out in order to explore how travel behaviours changed since the onset of COVID-19 and how they are likely to shape after the pandemic. It is expected that the results will provide an insight into the most important factors that attract students to campuses and into how universities may prepare for changing mobility habits post-pandemic.

2 METHODOLOGY

2.1 Survey design

The first step of the survey design entailed the initial compilation of a list of factors that could potentially influence the decision of a student to travel to campus. These were based on available literature (e.g. [*7-13*]), as well as on the authors' personal judgement. Two categories of factors were identified: internal factors, which referred to the characteristics and habits of students themselves; and external factors, which were features relating to usual campus activities and available infrastructure. The full list of factors is provided in Table 1.

Table 1: Factors potentially influencing a student's decision to travel to campus

Internal	**External**
Gender	Teaching and learning activities
Level of study (undergraduate, masters, …)	Assessment activities (e.g. exams)
Course (or faculty/department) of study	Group projects
Student status (UK or overseas/international)	Individual studying
Travel frequency pre-COVID-19	Sports and fitness activities
Usual/preferred transport mode pre-COVID-19	Club and society related activities
Travel frequency during COVID-19	Leisure activities
Usual/preferred transport mode during COVID-19	Catering availability and quality
	Bus facilities
	Cycling facilities
	Walking routes
	Parking availability

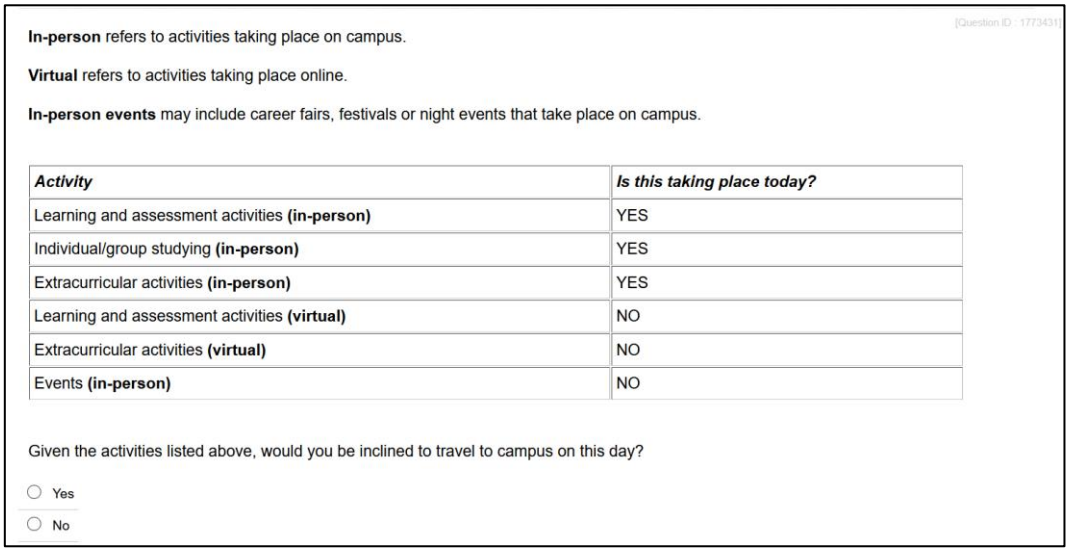
The next step comprised the formulation of the survey questions. Both revealed preference (RP) and stated preference (SP) techniques were used, and the survey was structured in three main sections: demographic information; travel behaviour pre- and during COVID-19 (RP); and post-pandemic scenarios (SP).

The demographic section included questions on the respondent's gender, level of study (undergraduate or taught postgraduate), student origin/status (UK or international), and the faculty that they were primarily based in. The travel behaviour section enquired about the students' travel frequency pre- and during COVID-19, the transport mode of the last leg of their usual journey to campus pre- and during COVID-19, and their preferred transport mode post-COVID-19. This provided a basis for comparison of the results of the SP section. The attributes used in both sections were compiled as the internal factors that may affect students' travel behaviours on campus, as listed in Table 1.

Table 2: Bi-level (yes/no) attributes

Attribute	**Code**	**Description**
Learning & assessment activities (in-person)	LA-ip	Occurrence of learning/assessment activities on campus
Individual/group studying (in-person)	ST-ip	Occurrence of individual/group studying on campus
Extracurricular activities (in-person)	EX-ip	Occurrence of extracurricular activities on campus
Learning and assessment activities (virtual)	LA-v	Occurrence of virtual learning/assessment activities
Extracurricular activities (virtual)	EX-v	Occurrence of virtual extracurricular activities
Events (in-person)	EV-ip	Occurrence of events on campus

The third section consisted of a set of scenarios, i.e. combinations of selected attributes, whereby participants were asked whether they would be inclined to travel to campus under the conditions described. Six bi-level attributes were selected following a focus group with experts, and each scenario consisted of all six with a specific level for each one. The six attributes are shown in Table 2, while an example of a scenario question is shown in Figure 1.



In-person refers to activities taking place on campus.

Virtual refers to activities taking place online.

In-person events may include career fairs, festivals or night events that take place on campus.

Activity	*Is this taking place today?*
Learning and assessment activities **(in-person)**	YES
Individual/group studying **(in-person)**	YES
Extracurricular activities **(in-person)**	YES
Learning and assessment activities **(virtual)**	NO
Extracurricular activities **(virtual)**	NO
Events **(in-person)**	NO

Given the activities listed above, would you be inclined to travel to campus on this day?

○ Yes

○ No

Figure 1: An example scenario

Fractional factorial design was used to create the SP part of the survey, as opposed to full factorial design. This was because there were six scenarios with two levels each, leading to $2^6 = 64$ scenarios for the participants to answer for a full factorial design, which would have been impractical. For this survey, a 1/8 fractional factorial design was used, which resulted in 64/8 = 8 questions. This was done following the method described in [*14*], which involves obtaining the full factorial (all combinations) for the first three most important factors and then selecting certain levels for the remaining three factors by simple multiplication of the levels for the initial three factors, so as to confound some main effects' estimates with the estimates of the interaction effects of the initial three factors. The three factors chosen as most important were: "Learning and assessment activities (in-person)", "Individual/group studying (in-person)" and "Extracurricular activities (in-person)". A Resolution III design was sought, i.e. one where main effects were not confounded with each other.

Table 3: The set of eight scenarios used in the survey in binary format

Factor	**1**	**2**	**3**	**4**	**5**	**6**
Label	**LA-ip**	**ST-ip**	**EX-ip**	**LA-v**	**EX-v**	**EV-ip**
Definition	***1***	***2***	***3***	***1*2***	***1*3***	***2*3***
Scenario 1	-1	-1	-1	+1	+1	+1
Scenario 2	+1	-1	-1	-1	-1	+1
Scenario 3	-1	+1	-1	-1	+1	-1
Scenario 4	+1	+1	-1	+1	-1	-1
Scenario 5	-1	-1	+1	+1	-1	-1
Scenario 6	+1	-1	+1	-1	+1	-1
Scenario 7	-1	+1	+1	-1	-1	+1
Scenario 8	+1	+1	+1	+1	+1	+1

The procedure of factorial design used (Table 3) was adapted from suggested summary tables in the literature [*15-16*]. As such, the levels chosen for Factor 4 for each scenario were determined by

multiplying the levels of Factors 1 and 2; similarly Factor 5 was formed using Factors 1 and 3, and Factor 6 was formed using Factors 2 and 3 ('+1' denoted the 'No' level for each attribute, while '-1' denoted the 'Yes' one).

Finally, the order in which the scenarios appeared to the respondent was randomised in order to reduce the occurrence of biases towards particular factor combinations.

2.2 Survey distribution and response

The survey was setup on UoS's "iSurvey" tool (https://www.isurvey.soton.ac.uk) and was circulated to potential respondents through email lists and word of mouth. The target group was narrowed down from all UoS students to only undergraduate and taught postgraduate ones, based on the fact that these two student types amass the majority of the university population and that they are also most active on campus during term-time (when the campus is busiest).

A medium-sized sample was obtained, comprising 88 usable responses and corresponding to 696 individual scenarios used in the analysis, out of which 484 (69%) were 'Yes' responses. With respect to the demographics of the sample:

- 46 of the 88 respondents were male, while 42 were female;
- 74 respondents were undergraduate students, while 14 were taught postgraduates (masters);
- 73 respondents were based in the Faculty of Engineering & Physical Sciences, while 15 were based in other faculties;
- 51 respondents were UK students, while 37 were international ones;
- 64 respondents stated that they travelled to campus almost daily pre-COVID-19, and another 12 said they travelled a few times a week, while only 8 stated that they travelled less frequently;
- 63 respondents stated that they travelled to campus a few times a month, occasionally or never during COVID-19, while 15 said that they travelled more frequently;
- 46 respondents stated that they usually walked to campus pre-COVID-19, and another 24 said they took the bus, with only a handful saying that they cycled (3) or drove (2), and the remainder (13) not being at the university before COVID-19;
- 56 respondents stated that they walked to campus during COVID-19, 16 said they took the bus, 2 cycled and 4 drove, with the remainder (10) not travelling to campus at all; and
- 53 respondents said that walking would be their preferred mode of travel to campus post-COVID-19, 19 said that they would take the bus, while 8 would cycle, 6 would drive, 1 would ride a motorcycle and 1 would travel by scooter.

3 RESULTS

3.1 Analysis

Binary logistic regression was used to fit a model to determine students' post-COVID-19 travel behaviour, as expressed by their willingness to travel to campus in relation to the activities taking place. The outcome of the model was the probability of a student willing to travel to campus (TRAVEL, yes = 1, no = 0). The set of model attributes included those relating to each scenario, as well as those relating to the respondent's characteristics, as obtained from the RP questions.

Namely, the scenario-specific (external) attributes were the ones shown in Table 2, i.e.: "learning and assessment activities (in-person)" (LA-ip), "individual/group studying (in-person)" (ST-ip), "extracurricular activities (in-person)" (EX-ip), "learning and assessment activities (virtual)" (LA-v), "extracurricular activities (virtual)" (EX-v), and "events (in-person)" (EV-ip); all seven attributes were

bi-level, with '1' denoting their presence (i.e. that the activity was taking place) and '0' indicating their absence (i.e. that the activity was not taking place).

Similarly, the respondent-specific (internal) variables were: "gender" (GEN, female = 1, male = 0,), "level of study" (LEV, undergraduate = 1, taught postgraduate = 0), "student status" (SS, UK = 1, international = 0), "faculty of study" (FAC, Engineering & Physical Sciences = 1, other faculties = 0), "travel frequency to campus before COVID-19" (FQ-bef, daily = 1, a few times a week or less = 0), "usual mode of travel to campus before COVID-19" (TM-bef, active (walking/cycling) = 1, motorised = 0), "travel frequency to campus during COVID-19" (FQ-dur, daily = 1, a few times a week or less = 0), "usual mode of travel to campus during COVID-19" (TM-dur, active = 1, motorised = 0), and "preferred mode of travel to campus after COVID-19" (TM-aft, active = 1, motorised = 0).

SPSS 26 was used to perform the binary logistic regression and estimate the coefficients of the resulting model. All of the independent variables were binary, and therefore each attribute had one variable in the model. Hence, the following binary variables were generated: the dependent variable Y_{TRAVEL_1}, which was equal to the logit transformation of the probability of the student willing to travel to campus (i.e. TRAVEL = 1), P_{TRAVEL_1}, and the independent variables *GEN*_1, *LEV*_1, *SS*_1, *FAC*_1, *FQ-bef*_1, *TM-bef*_1, *FQ-dur*_1, *TM-dur*_1, *TM-aft*_1, *LA-ip*_1, *ST-ip*_1, *EX-ip*_1, *LA-v*_1, *EX-v*_1 and *EV-ip*_1 (for GEN = 1, LEV = 1, etc.). The model was thus of the form:

$$Y_{TRAVEL\_1} = \ln(P_{TRAVEL\_1}/(1- P_{TRAVEL\_1})) = \beta_0 + \beta_1\cdot(GEN\_1) + \beta_2\cdot(LEV\_1) + \beta_3\cdot(SS\_1) + \beta_4\cdot(FAC\_1) + \beta_5\cdot(FQ\text{-}bef\_1) + \beta_6\cdot(TM\text{-}bef\_1) + \beta_7\cdot(FQ\text{-}dur\_1) + \beta_8\cdot(TM\text{-}dur\_1) + \beta_9\cdot(TM\text{-}aft\_1) + \beta_{10}\cdot(LA\text{-}ip\_1) + \beta_{11}\cdot(ST\text{-}ip\_1) + \beta_{12}\cdot(EX\text{-}ip\_1) + \beta_{13}\cdot(LA\text{-}v\_1) + \beta_{14}\cdot(EX\text{-}v\_1) + \beta_{15}\cdot(EV\text{-}ip\_1).$$

The results of the binary logistic regression are shown in Table 4. As can be seen, the model was a good fit, as the null hypothesis that it did not fit the data accurately was rejected at the 5% level in the Hosmer–Lemeshow test.

Table 4: Results of binary logistic regression for students' willingness to travel to campus

Attribute	**Variable**	**Coefficient (β)**	**Std. error**	**Significance**
Female	*GEN*_1	0.180	0.241	.456
Undergraduate	*LEV*_1	0.043	0.298	.885
UK (home) student	*SS*_1	0.567	0.220	.010
Fac. of Eng. & Phys. Sciences	*FAC*_1	0.288	0.302	.341
Daily travel pre-COVID-19	*FQ-bef*_1	-0.217	0.346	.531
Active travel pre-COVID-19	*TM-bef*_1	0.391	0.293	.182
Daily travel during COVID-19	*FQ-dur*_1	0.653	0.247	.008
Active travel during COVID-19	*TM-dur*_1	-0.570	0.301	.058
Active travel after COVID-19	*TM-aft*_1	0.370	0.323	.253
Learning and assessment (in-person)	*LA-ip*_1	2.578	0.257	.000
Individual/group study (in-person)	*ST-ip*_1	1.579	0.258	.000
Extracurricular activities (in-person)	*EX-ip*_1	0.845	0.235	.000
Learning and assessment (virtual)	*LA-v*_1	0.244	0.252	.332
Extracurricular activities (virtual)	*EX-v*_1	0.777	0.248	.002
Events (in-person)	*EV-ip*_1	0.976	0.232	.000
Constant		-3.135	0.595	.000

Number of observations = 696; Pseudo-R^2 (Nagelkerke) = 0.452
Hosmer-Lemeshow goodness-of-fit test: chi^2 = 6.402; Sig. = .602

Considering the model coefficients, it can be first observed that the constant term of the model was statistically significant at the 0.05 level, and that it had a negative value. This indicates that student respondents had an initial unfavourable view towards travelling to campus, and that it remained to be seen how, according to the survey, the presence of certain activities, in-person or virtual, could "swing" their opinion towards deciding to travel.

Looking at the remaining coefficients, the ones with the highest magnitude were the in-person activities. The most important influencing factor on whether a student would travel or not was in-person learning and assessment. This is a logical finding, as the main purpose of universities is education. In the same vein, individual and group studying on campus was the second most important incentive for students. There were also positive relationships between in-person events and extracurricular activities and student inclination to travel to campus.

From the respondent-specific attributes, it could be observed that UK students were more likely to visit campus than international students; this was another expected result, as the survey was carried out during a period of predominantly online learning and some international students would have likely stayed in their home countries (and so travelling to campus for them would not have been feasible). Moreover, along the same lines, frequent (daily) visitors to campus during the COVID-19 pandemic were also more likely to visit after the pandemic, which is understandable as these participants may be more accustomed to travelling to campus.

Unexpectedly, virtual extracurricular activities had a positive effect on students' inclination to travel to campus, despite these activities being designed to provide a substitute for those unable or unwilling to go to campus. Another unexpected observation was the statically insignificant effect of virtual learning and assessment activities, i.e. the lack of influence on the decision to travel to campus (as opposed to having a negative effect, i.e. being a deterrent).

3.2 Discussion and interpretation

The analysis found that in-person learning and assessment activities were the main reason why students would visit their university campus, and that virtual equivalents would unlikely be a sufficient disincentive for this journey. It should be noted, however, that education and social activities were compartmentalised in this study, when in reality their effects are often combined. There is a significant social aspect to education, in what it is not purely the learning activity that attracts students to lessons, but rather the social setting allowing students to interact with one another – a feature that is difficult to replicate virtually. Discussions and collaborations are essential learning components that are easier to facilitate in a physical setting. Therefore, it can be inferred that as long as in-person learning and assessment activities occur, students will continue to travel to campus to attend them.

However, this does not necessarily invalidate the effect of online learning on student travel behaviour. Despite virtual learning and assessment activities appearing to have no impact on campus attendance, the derived model treats in-person and virtual learning separately, when in reality the two elements may likely be combined post-COVID-19 through the so-called "flipped classroom model" (a blended learning approach in which students consume their reading materials individually in advance and classroom time is used as an interactive learning environment). As such, a typical timetable might find fewer scheduled in-person learning activities, and this may consequently reduce the frequency of student travel to campus.

Besides learning activities, though, university campuses also offer the intangible element of a stimulating environment that improves student focus. The often centralised locations of campuses relative to student accommodation allows them to become easier rendezvous points for group studying. Also, campuses usually offer a range of technical facilities and specialised software that cannot be

accessed remotely, as well as ample quiet study space. These are further incentives why students may choose to travel to campus and why an online learning offer would not deter them.

Furthermore, extracurricular activities is often a crucial feature of universities, which inevitably attracts students to campus. Since many physical activities (e.g. sports) do not have a virtual counterpart, the number of students travelling to campus for such activities post-COVID-19 is unlikely to change. On the other hand, discussion-based societies may continue to take advantage of the virtual element after the pandemic for part of their activities, such as hosting guest speakers. However, this will likely only cause minor changes to student travel habits.

Moreover, campuses usually host a broad spectrum of events (e.g. parties, career fairs, etc.) offering a unique social experience for students that is difficult to replicate virtually. An event would, therefore, in most cases be held on campus and would be a significant travel incentive for students. The one-off nature of events, however, means that the relevant travel demand can be managed on an ad-hoc basis, so even though events will create demand "spikes", they are unlikely to play a significant part in long-term transport planning.

Finally, in order to promote sustainable travel to campus, infrastructure will need to be developed to allow for easier access. The survey showed that walking was and remained the most popular travel mode for students, so university (and city) transport planners should reinforce this habit by improving walking routes and cycling facilities to and at the campus. Policies should also focus on removing the lingering stigma of public transport after the pandemic through relevant incentives, such as subsidised bus fares and sustained disinfection of vehicles.

4 CONCLUSIONS

This study provided an insight into how student travel behaviour may shape in the post-COVID-19 era, which of the changes observed during COVID-19 would likely stay, and how transport policy-makers and planners may respond. Using UoS as an example, an online survey with students was carried out. The responses were analysed using binary logistic regression and the results suggested that students would be most inclined to travel to campus for in-person learning and assessment activities, extracurricular activities, individual/group studying and other events. An interesting finding, however, was that even if virtual alternatives continued to be offered in the post-COVID-19 period, they would be unlikely to deter large numbers of students from travelling to campus. This suggests that despite changes in the delivery of higher education activities, university campuses are likely to remain focal points of student life post-COVID-19.

But while the study has shed some light onto the previously largely unexplored topic of university student travel habits post-COVID-19, work in this direction continues. Future research will concentrate on expanding and diversifying the sample of respondents for the online survey in order to achieve greater participation from UoS faculties other than Engineering & Physical Sciences. This will likely identify additional trends, as per the requirements and habits of students studying on different courses. Moreover, it is planned for the current study to be complemented by a similar investigation of the travel behaviour changes of other groups of the UoS community, such as PhD researchers, research, technical and academic staff, as well as professional services staff. Finally, it is intended to extend the remit of the study beyond UoS, and in particular to universities whose facilities are spread across a city or even multiple cities rather than being concentrated on a centralised campus.

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