

The Impact of the COVID-19 Pandemic on the Career Preparedness of Chemistry Graduates

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Keywords: *Employability; Careers; Transferable Skills; Chemistry; COVID-19*

Abstract

Recent research has established that the COVID-19 pandemic has resulted in a shift in University student expectations of their graduate prospects due to unavoidable changes in their learning experiences during the pandemic, as well as the decrease in number of available jobs because of the economic impact of measures put in place to reduce COVID-19 transmission. This study used a survey to investigate: (a) the impact of the pandemic on student destinations six months after graduation and (b) the variations in perceptions of personal level of career preparedness between pre-pandemic graduates and graduates at different stages of the pandemic (i.e. the graduating classes of 2020 and 2021). 40 University of Leicester chemistry graduates engaged with the survey and analysis of the data revealed a non-statistically significant negative impact on employment six-months after graduation that appears to only affect graduates in 2020. The data also suggests that increased experience of the blended learning approaches adopted at the University of Leicester during the pandemic studies may better prepare graduates for remote working practices (e.g. using remote video conferencing software).

Introduction

Background

The COVID-19 pandemic transformed the landscape of Higher Education as we entered

the third decade of the 21st Century (Agasisti & Soncin, 2021; Farnell et al., 2021; Zawacki-Richter, 2021). The COVID-19 pandemic has had at least some impact on all aspects of Higher Education. Since 2020 there has been an abundance of literature that has focused on the impact of the pandemic on numerous facets of Higher Education including student learning (Pokhrel & Chhetri, 2021), student and staff wellbeing and mental health (Appleby et al., 2022; Leal Filho et al., 2021; Plakhotnik et al., 2021), student outcomes (Mahdy, 2020), academic research outputs (Carr et al., 2021) and aspects of university governance (Farnell et al., 2021). Studies have also shown that the pandemic has had an unequal impact on academics (Deryugina et al., 2021; Myers et al., 2020) and students in different demographic groups (Haelermans C, 2022). An increasing number of studies (including this one) are now focusing on the impact of the pandemic on recent graduates.

In 2021 the United Kingdom's Higher Education Statistics Agency (HESA) produced a report on the impact of the pandemic on graduate outcomes that demonstrated a measurable increase in the proportion of unemployed recent graduates when compared to statistics for recent graduating cohorts collected before the start of the pandemic (Van Essen-Fishman, 2021). This impact can be justified by the substantial effect of the pandemic and the associated measures put in place by regional and national governments to limit social movement and interactions throughout 2020 and (to a lesser extent) 2021.

During the national lockdowns imposed by the national legislative authorities in the United Kingdom in 2020 and early 2021 the population was instructed to (i) work from home unless the nature of their profession allowed them to be classified as key or critical workers and (ii) remain at home for all but essential activities such as shopping for food and essential items, exercise and medical emergencies. During this time much of the working population of the United Kingdom were placed on paid sabbatical with funding for this scheme provided jointly by employers and the national government. These measures had a significant impact on the number of jobs advertised in the United Kingdom throughout 2020. A decrease in online job vacancies greater than 50% was observed in the early stages of the pandemic, with only a modest recovery observed over the course of the year (Arthur, 2021; OECD, 2021).

The pandemic has had measurable impacts on student expectations of their graduate prospects. Miani *et al.* demonstrated an awareness amongst Australian undergraduate aviation students of the likely impact of the COVID-19 pandemic on their career prospects (Miani *et al.*, 2021). The study revealed a student expectation that the pandemic would result in an oversupply of trained aviation specialists at a time when the industry faced a significant downturn. There is now a need to analyse the evidence of the measured impact of the pandemic on graduate prospects and to use the key lessons learnt to inform decisions on how best to support student career preparations throughout their studies (*vide infra*).

Impact on Teaching and Learning Approaches Used in Higher Education

A range of different specific teaching and learning approaches were adopted by Higher Education Institutions (HEIs) in response to the effects of the pandemic and the social measures put in place by national governments to minimise the transmission of COVID-19 within populations (van Schalkwyk, 2021; Webb *et al.*, 2021). Depending on the nature of the course being delivered, teaching and learning activities may have been converted to an entirely remote format (i.e. all teaching and learning activities and associated support mechanisms are facilitated using online tools

such as the Learning Management System and video conferencing platforms such as Microsoft Teams or Zoom). Alternatively, what we might call a blended approach (i.e. an approach that combines asynchronous online learning activities with some opportunities for students to engage in Face to Face (F2F) activities (Garrison & Kanuka, 2004), especially those that allow students to gain essential practical experience or put their subject-level understanding into practice, may have been adopted. Due to the sudden and unanticipated transition from F2F teaching environments to remote or blended environments, many academic staff felt under supported (e.g. due to a lack of training on the technological platforms used to support learning during the pandemic) and experienced logistical challenges (e.g. a lack of quiet working space or the loss of an appropriate work-life balance) during this time (Erlam *et al.*, 2021).

Subsequent analysis has shown that students have preferences for F2F teaching and learning activities over blended learning approaches under normal circumstances (i.e. outside of the context of the pandemic) but appreciated the important role that blended learning played when F2F activities were perceived to be too high risk throughout much of the first 18 months of the pandemic (Mali & Lim, 2021). It is also known that students have adopted a range of different coping mechanisms (e.g. using relaxation methods or avoiding news related to the pandemic) to deal with the sudden and unexpected transition from F2F learning environments to the types of blended learning experiences that were common throughout much of the pandemic (Baloran, 2020).

Aims and Objectives

In order to gain a deeper understanding of the legacy of the pandemic on graduate prospects, it is essential to investigate the effect of these online approaches to teaching and learning employed throughout the Higher Education sector between 2020 and 2021 on the preparedness of graduates of the classes of 2020 and 2021. For the purpose of this study, graduate preparedness is defined as the development of the skills, outlook and expectations that students need to develop in order to prepare them for their chosen

graduate destination (which may include employment, further study or voluntary/charitable work).

An example of a potential impact of the pandemic on STEM undergraduates is the potentially limited access to practical experiences they may have encountered at times during their studies. A study by Desrochers, et al. revealed that students had a relatively positive outlook on their career prospects but that some were anxious about the lack of F2F practical experience during the pandemic. It is possible that this may have a negative impact on students' perceptions of their preparedness for their preferred graduate destinations (Desrochers et al., 2020).

The purpose of this study is to engage with recent graduating cohorts at the University of Leicester to establish whether the transition to online teaching and learning approaches has had a measurable impact on the graduate outcomes of students and whether students who have graduated during the pandemic believe their university experience adequately prepared them for their graduate destinations.

The research questions for this study are:

1. Did graduating during the COVID-19 pandemic have an impact on student destinations six months after graduation?
2. How do student perceptions of their personal level of career preparedness vary between pre-pandemic graduates and graduates at different stages of the pandemic (i.e. the classes of 2020 and 2021)?

Methodology

Study Context

This study focused on graduates of the chemistry degree programmes provided by the School of Chemistry at the University of Leicester. Before the pandemic the chemistry degree programme included a balance of different teaching and learning approaches built around a core of lectures (including flipped

lectures in some parts of the course (Blackburn, 2018)), small group tutorials, Problem Based Learning activities (Williams, 2017; Williams et al., 2010) and practical classes (see Table 1). The practical classes have incorporated some elements of blended learning for a number of years. Students are required to engage with pre-laboratory reading, simulated versions of experiments (Blackburn et al., 2019; George-Williams et al., 2022) to adequately prepare them for the in-laboratory experience.

The sudden transition to online learning approaches in March 2020 resulted in the development of an entirely remote mode of delivery that was used for the closing weeks of the 2019-20 academic year. Due to the timing of the pandemic only the final two weeks of academic teaching (plus an additional week used for pre-examination revision activities) were affected by this transition at the University of Leicester. In the summer of 2020-21 the School of Chemistry developed a blended learning strategy as it became apparent that the disruption of the pandemic would last well into that academic year (see Table 1).

This strategy created a new structure and style for each type of learning experience. For example, lectures were replaced by a combination of short, focused videos delivered asynchronously together with weekly synchronous video conference sessions that gave students opportunities to apply what they had learnt from the asynchronous videos and to also interact with their instructors.

For the purposes of this study, the respondents were divided into three cohorts: (a) pre-pandemic graduates; (b) summer 2020 graduates and (c) summer 2021 graduates. The decision to divide the 2020 and 2021 graduates into two cohorts was based on the fact that these cohorts faced very different challenges. The graduating class of 2020 only experienced disruption in the closing weeks of their studies.

Type of learning experience	Pre-pandemic	2019-20 (closing two weeks of teaching only)	2020-21
Learning the core theoretical principles of subject	F2F lectures that often incorporate interactive elements	Students given access to recorded lectures from previous year with a synchronous video conference provided at end of term (Microsoft Teams).	Bespoke asynchronous video content prepared (short, focused videos) with synchronous video conference provided each week (Microsoft Teams).
Development of core practical skills	Blended practical course with significant amount of in-laboratory experience	Laboratory closed. Practical marks generated from practicals completed before pandemic	Blended practical course with limited amount of in-laboratory-experience (reduced capacity to allow social distancing). Introduction of some dry experiments that could be delivered remotely
Independent research skills for finalists	Independent research projects with students joining one of the School's research groups	Independent research projects had finished before the pandemic started. Some assessment (e.g. <i>viva voce</i> examinations) carried out online.	Blended approach to projects developed that maximised available time for F2F work while providing relevant "dry" activities when this wasn't possible
Transferable skills development	F2F team projects based around Problem Based Learning (PBL) pedagogy	PBL activities had finished before the start of the pandemic. No impact	Virtual PBL (vPBL) model developed to allow team projects to run remotely (Williams, 2022)
Consolidating learning of the theoretical principles	Weekly small group tutorials aligned with theory modules	Tutorials adapted to run as weekly synchronous online activities (Microsoft Teams)	Tutorials adapted to run as weekly synchronous online activities (Microsoft Teams)

Table 1. Overview of Teaching and Learning approaches before and during the pandemic in the Chemistry programmes at the University of Leicester.

While this undoubtedly had some impact on student experience at the end of the degree, it is a different scale of disruption to that experienced by the graduating class of 2021 who had to study their entire final year by blended learning. It is also worth noting that some of the challenges associated with

securing graduate opportunities (e.g. employment, further study or opportunities to do voluntary/charitable work) may have varied significantly between summer 2020 and summer 2021 (e.g. the level of UK government restrictions on social movement varied significantly between these two periods).

The rationale for grouping all pre-pandemic graduating classes together was the fact that these graduates had not experienced any pandemic-related disruption during their degree or during their first six months after graduation. It is worth noting that the post-graduation experience of members of this group may have varied significantly (e.g. as a consequence of the national economy and employment rate in their year of graduation) but this falls beyond the scope of this study.

Survey Instrument

This study made use of a survey created and distributed in Google Forms. This platform was chosen as it provided all the functionality required by this study (e.g. the ability to set multiple choice, Likert and text response questions), allowed easy access to data (responses could be downloaded as a Microsoft Excel spreadsheet), was free-to-use and was a tool that all members of the research team had experience of using.

The survey was divided into three sections. Section 1 focused on demographic information (year of graduation and type of course), Section 2 included multiple choice questions on employment status (complemented with a single text response question for additional detail where required) and Section 3 took the form of a series of five-point (strongly agree, agree, neutral, disagree and strongly disagree) Likert statements based on student perceptions of how effectively the respondent's course had prepared them for their graduate destinations.

The survey was promoted to recent graduates via personal connections and alumni groups. In order to maximise the response rate information about the study was circulated on the social media network LinkedIn.

Results and Discussion

A total of 40 responses were received to the survey. To put this in context, in a typical academic year between 80 and 90 students would graduate from the University of Leicester's Chemistry programmes. 22 (55%) of the respondents belonged to the pre-pandemic cohort, 8 (20%) respondents belonged to the graduating class of 2020

cohort and 10 (25%) respondents belonged to the graduating class of 2021 cohort.

Graduate Destinations

Respondents were asked to state which of the following best described their situation six months on from their graduation: *Employed*, *Undertaking further study*, *Unemployed and due to start work*, *Unemployed and due to undertake further study* or *Unemployed with no commitment to start work or undertake further study*. An overview of the proportion of respondents stating they were employed or undertaking further study is shown in Figure 1.

Despite the dramatic impact of the pandemic on job advertisements in the UK (with a greater than 50% reduction of jobs being advertised online in Spring 2020 (Arthur, 2021)), the proportion of 2020 graduate respondents who secured employment or a place in further study within six months was as high as 75%. There was no statistically significant difference between the reported rates from different graduate cohorts (2020 vs 2021: $\chi^2(1, n = 18) = 2.81, p > 0.05$, 2020 vs pre-COVID: $\chi^2(1, n = 30) = 0.55, p > 0.05$). It is also interesting to note that 100% of the respondents from the graduating class of 2021 reported that they had secured employment or further study positions within six months of graduation, a 14% higher proportion than the pre-COVID cohort. Another interesting observation is that all respondents in each of the three cohorts reported that they had secured employment or further study opportunities by the time they had completed the survey (February 2022). This evidence may suggest that the pandemic may have only had a time-limited impact on the graduate prospects of chemistry students in the UK and that a recovery may have been evident by 2021. It is important to remember that the sample sizes in each of these cohorts is very small which means these conclusions are not necessarily "robust". Another potential limitation is the fact that many respondents were recruited by posts on the LinkedIn social media platform. It is known that many students and graduates use LinkedIn for career planning and development purposes (Davis et al., 2020).

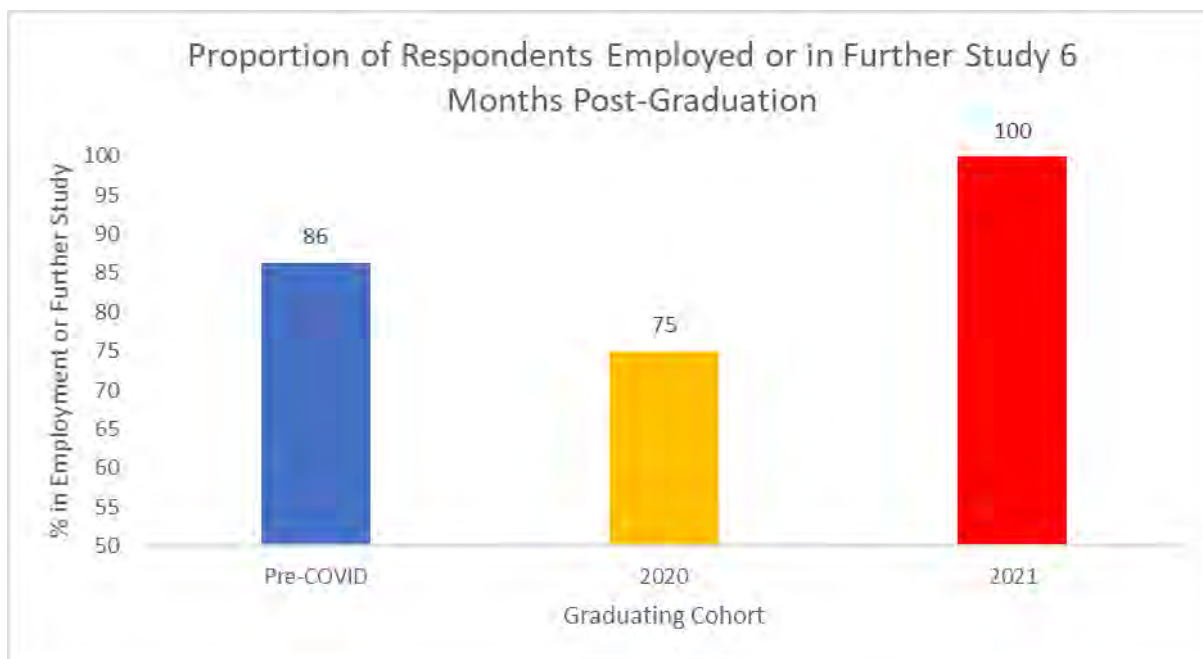


Figure 1. Proportions of respondents from each cohort who reported they were in employment or further study within six months of graduating. Numbers of respondents: Pre-COVID = 22, 2020 = 8, 2021 = 10

It is possible that LinkedIn membership is an attribute that is more common amongst graduates with more advanced career plans.

Level of Preparedness for Graduate Destinations

Respondents were asked to state their level of agreement with the statement *The use of online learning in my Chemistry degree prepared me for a remote working environment* (e.g. undertaking professional meetings online, having the necessary IT skills, knowing how to effectively work with others remotely, etc) on a five-point Likert scale. The proportions of each of the three cohorts who agreed or strongly agreed with the statement are presented in Figure 2. There were no statistically significant differences between the responses to this statement from the Pre-COVID graduates and the graduates of 2020 ($\chi^2(5, n = 29) = 0.84, p > 0.05$) or 2021 ($\chi^2(5, n = 31) = 2.26, p > 0.05$).

As the use of online teaching and learning activities increased (i.e. from the start of the pandemic), the proportion of students agreeing that they felt prepared for a remote working environment also increased. This may reflect the extensive use of, and subsequent proficiency with, software that facilitated video

communication and remote peer collaboration (e.g. Microsoft Teams). It is interesting to note that almost one third of pre-COVID graduate respondents agreed that their “in-degree” experience of online learning helped prepare them for remote working environments in spite of the fact they had no experience of using video communication software during their studies. This may be due to the extensive use of online elements that have supported student learning for a number of years (e.g. the use of cloud-based systems such as Microsoft Office 365 for producing, sharing and collaborating on assessed outputs).

One of the most significant impacts on chemistry degree programmes during the pandemic was the reduction in opportunities to run Face to Face laboratory sessions. As discussed earlier (*vide supra*) the University of Leicester adopted an approach where socially distanced laboratories sessions were run. The safe operating capacity of the laboratory (at Leicester) during these sessions was less than half the normal capacity and sharing of common resources was no longer possible in some cases (e.g. each fume cupboard had to be assigned to a single student per session).

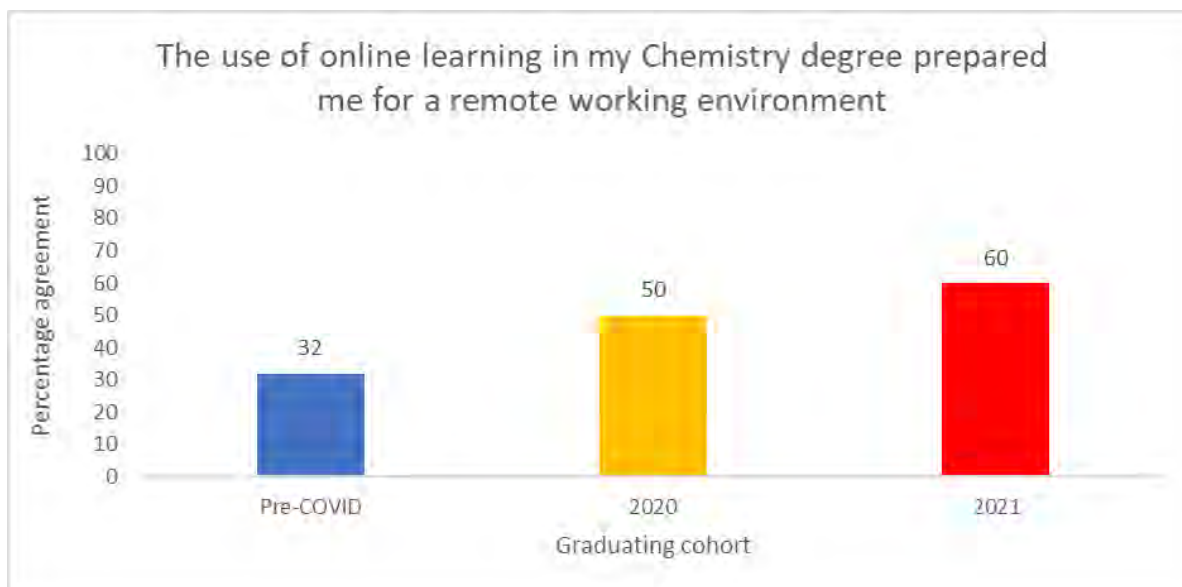


Figure 2. Proportions of respondents from each cohort who agreed or strongly agreed with the statement: *The use of online learning in my Chemistry degree prepared me for a remote working environment.* Numbers of respondents: Pre-COVID = 22, 2020 = 8, 2021 = 10.

F2F sessions were supplemented by “dry-practical” activities that could be delivered remotely with demonstrator support provided via a synchronous online platform (Blackboard Collaborate Ultra).

Due to the extent of the impact on such an integral part of any chemistry programme, this study set out to measure the perceived impact of this reduction of Face to Face practical experience on graduate perceptions of their preparedness for their graduate destinations (see Figure 3). It is worth noting that at least 50% of respondents in each cohort either agreed or strongly agreed with the statement *The impact of the COVID-19 pandemic on the amount of practical chemistry taught in your degree had no detrimental impact on how well prepared you were for a job, graduate scheme or further study opportunity.* There was no statistically significant difference between the responses from the two cohorts to this statement $\chi^2(5, N = 18) = 0.28, p > 0.05$. As a result of the relatively large proportions of respondents that didn't agree with this statement, the authors strongly recommend that instructors of degree programmes that contain significant amounts of laboratory learning create contingency plans that minimise the impact of laboratory closure in the

event of future events that limit access to the laboratory environment (e.g. another pandemic)

When asked about how effectively their studies had equipped them for the transferable skills needed for their graduate destination, there were no significant differences between the responses from different cohorts (2020 vs 2021: $\chi^2(5, n = 18) = 3.29, p > 0.05$, 2020 vs pre-COVID: $\chi^2(5, N = 30) = 2.38, p > 0.05$). The proportion of respondents agreeing with this statement were consistently high (82% or greater for all three cohorts, see Figure 4) suggesting that the programme-level response to adapting teaching of these skills in a blended learning environment was particularly effective. The virtual PBL (vPBL) model was adopted for the majority of skills focused activities (Williams, 2022). A separate study has already demonstrated that this approach has no detrimental effect on student learning when compared to analogous classroom-based approaches. It is also known that the vPBL model is a particularly effective way of encouraging students to make use of the types of collaborative digital tools that they might encounter in the workplace during and beyond the pandemic

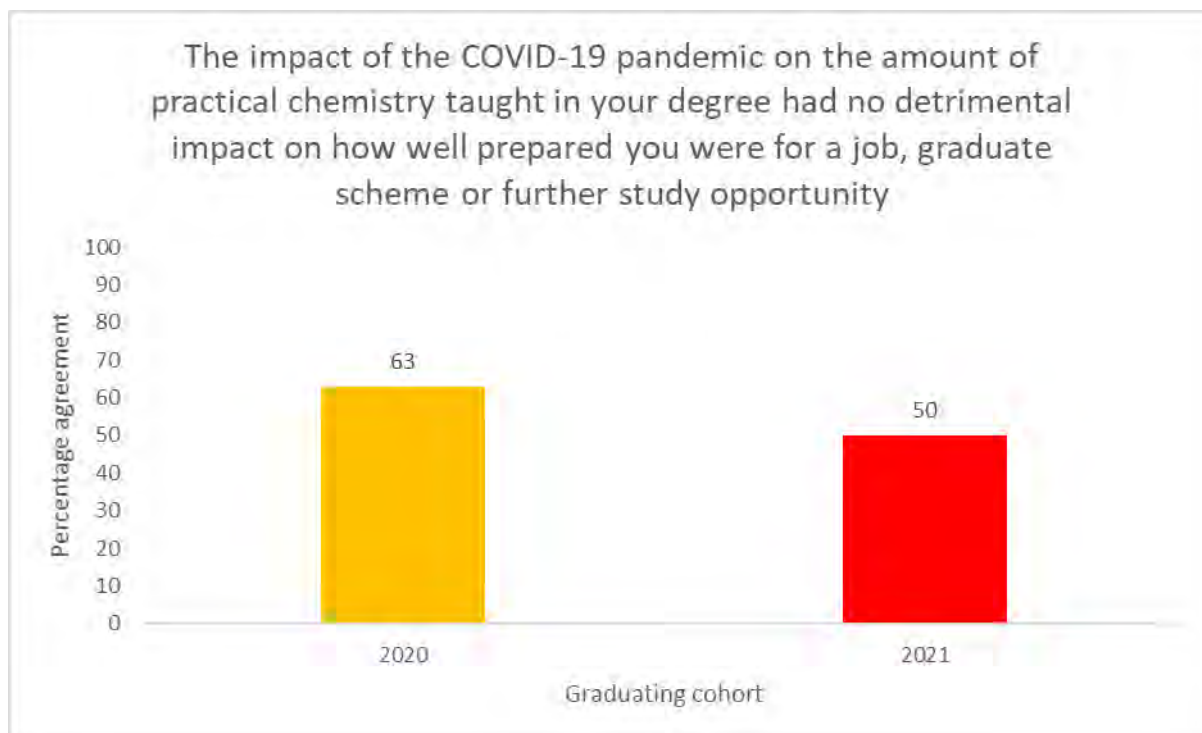


Figure 3. Proportions of respondents from each cohort who agreed or strongly agreed with the statement: *The impact of the COVID-19 pandemic on the amount of practical chemistry taught in your degree had no detrimental impact on how well prepared you were for a job, graduate scheme or further study opportunity.* Numbers of respondents: 2020 = 8, 2021 = 10. Note this question was not asked to graduates from before the pandemic as it did not apply.

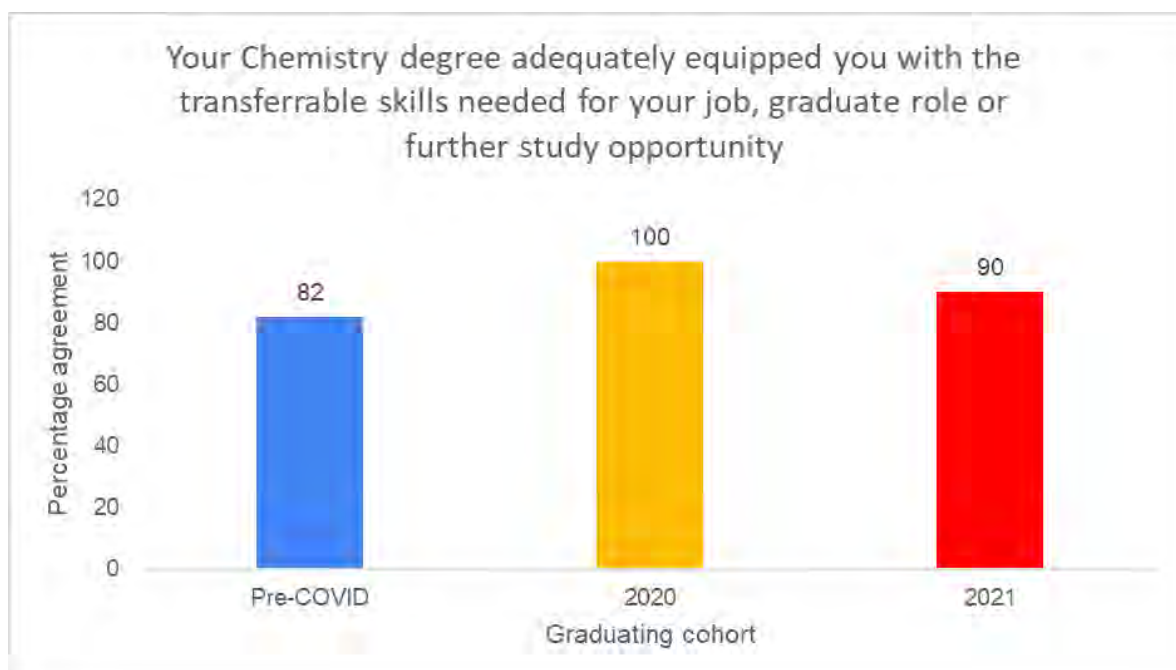


Figure 4. Proportions of respondents from each cohort who agreed or strongly agreed with the statement: *Your Chemistry degree adequately equipped you with the transferrable skills needed for your job, graduate role or further study opportunity.* Numbers of respondents: Pre-COVID = 22, 2020 = 8, 2021 = 10.

Conclusions

This study has demonstrated a non-statistically significant drop in employment of University of Leicester chemistry graduates six-months after graduation during 2020. The data suggests that any impact on graduate employment was limited to the opening stages of the pandemic as employment rates recovered in 2021. The level of preparedness of graduates for using remote working technologies in the workplace appeared to increase with increasing exposure to the blended learning approaches during the COVID-19 pandemic. A high proportion (82% or higher) of graduates from each cohort agreed that their undergraduate experience had equipped them with the transferable skills needed for their graduate destinations. These consistently high levels of agreement (with no statistically significant differences between cohorts) suggest that the blended approaches to developing transferable skills at the University of Leicester were as effective as the in-person approaches used before the pandemic. In spite of the fact at least 50% of the respondents from each affected cohort reported the reduction of practical chemistry in their programmes had no detrimental impact on their graduate preparedness, the authors recommend that educators still prepare contingency plans for laboratory teaching in the event of future pandemics or other events that disrupt regular teaching activities.

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