**Research Article**

## Examining the Impact of the COVID-19 Pandemic on Student Employability Skills - an Employer's Perspective

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**ABSTRACT**

Like most university learners, students in the Department of Pure and Applied Chemistry at the University of Strathclyde, experienced hybrid learning environments from March 2020 transitioning into hybrid approaches for the full academic year 21/22. As students who were in the early years of their programme at this time, and experienced a shift from traditional education practices are soon to graduate, a short research project was undertaken to better understand the perception of employers on the impact of remote and hybrid learning on current, and future, graduate skills, and competencies. Several employers in the chemical industries were surveyed to rate changes in their perception of, and importance of, key graduate skills and competencies after the pandemic. In general, it was shown that the employers responding to this survey did not show concern about the level of personal, professional, and higher-level cognitive skills developed by students working in remote/hybrid environments during the pandemic. A gap in practical skills was acknowledged as indicated by employers' viewing students as being less skilled in this area, however the skills gap was not thought to be important with regards to employability. Additionally, employers indicated an increased importance on a student's ability to develop and demonstrate basic personal and professional skills including communication, collaboration, interpersonal/networking, autonomy, self-management, and resilience. The research suggests programme leaders creating or modifying curricula should place attention on the development of these skills and competencies to ensure students are self-led to successfully transition into the workplace.

*Keywords*: *Chemistry Education Research, Employability skills, Employers, Scholarship*

## Introduction

A significant challenge was faced by students, and staff, when the U.K. university education system was disrupted by the COVID-19 pandemic in March 2020[1,2]. A transition to remote learning impacted a wide range of traditional student experiences such as a loss of community and face to face engagement with educators[3], changes in assessment format, the need to self-learn from lecture videos, virtual attendance at synchronized and non-synchronized lectures and tutorials[4-7]. This led to reports of increased anxiety and mental health issues across the student population[8,9]. For students undertaking degree programmes that contained practical modules, additional challenges included the need to pivot from an extensive hands-on experience of practical work to blended learning environments which involved supplementing reduced practical bench time with simulations, at-home experimental kits, and interrogation of experimental data[5,10].

Whilst the above studies have focused on the impact on students from the point of view of changes in the learning environment and mental health, of particular interest here is the potential impact on the development of employability skills and competency training during remote/hybrid working. Development of personal, professional, and higher-level cognitive skills support the transition of graduates into the employability sector[11] as highlighted in QAA benchmark statements[12]. High quality skills training opportunities need to be relevant, enabling, and flexible to reflect the needs of potential employers and to ensure graduates can navigate the rapidly shifting employability landscape. Education must extend beyond declarative knowledge acquisition in the subject area and include training in competencies such as collaboration and citizenship to cross planetary boundaries[13], critical thinking by active learning scenarios[14], education for sustainable development[15,16], self-awareness and emotional intelligence[17]. A holistic approach to increase an undergraduate student's employability opportunities is found by solving complex problems in real world scenarios. In addition to the need to provide employability skills in a holistic way on campus, employers additionally encourage the development of focused partnerships with industry colleagues to ensure students gain skills in an industrial setting[18]

Students studying undergraduate degree programmes will recognize the development of employability skills through their engagement with bespoke employability skills modules[19] or via embedded skills training across discipline-based modules[20-22]. Previous work, prior to the pandemic has reviewed student[23,24] and employer[25,26] perceptions of employability skills development in relation to how they support the student's transition into employment. Less is known about the employers' perspective of student skills development during the COVID-19 pandemic to determine whether there is a need for educational institutions to upskill current students in key areas prior to graduation.

In our chemistry programmes, prior to the COVID-19 pandemic, students were taught in a face-to-face setting with on campus lectures, tutorials, laboratory sessions and workshops. Supplementary support was provided on-line by use of the Moodle virtual learning platform in the form of material resources, on-line quizzes, videos etc. All laboratory sessions were undertaken at the bench in the form of practical experiments, with students interrogating data, completing reports and/or proformas within a scheduled period. As with all other educational institutions, from March 2020 – May 2021 there was a significant shift in the students' learning experience as teaching and assessment of theoretical modules moved to hybrid/remote settings. In addition to a loss of face-to-face engagement with educators and fellow students in theory-based modules, delivery of practical and laboratory sessions continued but in smaller student groups than in previous years. Due to the significant reduction in student numbers allowed into laboratory areas, the number of practical experiments undertaken by students at the bench were reduced. The reduced bench time was supplemented by providing students with laboratory simulations, provision of raw data to analyze and interpret, videos of laboratory demonstrations and report writing activities. By implementing these new structures, our department, like many others, successfully transformed the learning and education experience to ensure

students were able to meet their intended learning outcomes despite the challenges presented by the COVID-19 pandemic. However, there remained a question about the perception of employers in relation to the development of graduate citizens by the provision of employability skills and competencies during remote/hybrid working, and whether the department would need to address upskilling needs prior to employment.

In this article the findings of a recent research project that sought to investigate the employers' perception of student and graduate employability prospects are presented. As mentioned above, during the COVID-19 period module and programme related intended learning outcomes were met. This project, therefore sought to examine how chemistry employers view current student and graduates in relation to the development of personal, professional, or higher-level cognitive skills as a result of working in remote and hybrid learning environments from March 2020 – May 2021. The department has a vested interest in this area to ensure the continued production of industry-ready graduates. Moreover, like many other institutions, our MChem students undertake a credit-bearing 12-month industrial placement in the penultimate year of study. This project was therefore undertaken to be better informed of employer expectations after COVID-19 in relation to student employability skills and competencies. These research aims led to the following research questions (RQs):

RQ1: To what extent has the transformation in student's learning environments during the COVID-19 pandemic affected the perception of chemical industry employers on graduate preparedness for employment?

RQ2: Is there a need to alter the curricula and provide additional upskilling in specific areas to meet employer expectations of our chemistry students and graduates?

## Methods

Study participants (industrial employers who work with our students and/or graduates) were recruited through email contact which contained an invite to complete a survey, implemented through GoogleForms. The survey was designed for participants to reflect upon their perception of the impact of the pandemic on student and graduate employability skills and competencies. The job roles held by colleagues who participated in the survey ranged from laboratory manager, research team leader through to chief executive officer, as the intention was to canvas the views of a diverse range of staff who currently recruit our students and/or graduates. Survey participants were provided with privacy information and were required to give voluntary informed consent prior to entering the survey. No incentives were offered, and invitations were sent by a student intern to minimize any coercive power dynamics. Ethical approval was granted by the departmental ethics committee prior to release of the survey. Responses were allocated a unique code - EMPX (employer number X) to anonymize data at the point of collection.

A set of questions were designed for the survey to probe the employers' perception of students' skills development during the transition to remote/hybrid learning. Employers were asked to consider a list of employability skills as defined in a Quality Assurance Agency report[27] (skills and short descriptions of each skill are listed in Table 1). The survey was a mix of Likert-scale and free-text questions and was developed from a combination of previously cited literature and consideration of our research questions.

*Table 1. Summary of skills to be evaluated by employers in the GoogleForms survey*

| Type of Skill | Description | Abbreviation* |
|---|---|---|
| **Basic Professional Skills** | | |
| Communication | communicate knowledge, understanding, and skills to a variety of audiences, with a variety of media | Com |
| Collaboration | work in teams and groups, lead where appropriate | Coll |

| Type of Skill | Description | Abbreviation* |
|---|---|---|
| **Basic Professional Skills** | | |
| Interpersonal/networking | listen actively, negotiate effectively, be empathetic, and develop positive connections | IP/Net |
| **Higher Level Cognitive Skills** | | |
| Critical Thinking | a systematic and critical assessment of complex problems | CT |
| Problem Solving | Investigate problems, then formulate and apply evidence-based solutions | PS |
| Information Literacy/Analytical | locate, synthesise, and analyse information and data from a variety of sources, with an attention to detail | IL/A |
| Curiosity to Learn | search for insights and information across a range of situations, challenge assumptions | CtL |
| Innovative/Creative | examine problems from a fresh perspective and develop innovative solutions | I/C |
| **Personal Skills** | | |
| Autonomy | initiative, independent thinking, exercise personal judgement | Aut |
| Self-Management | time management, working under pressure, prioritising tasks | SM |
| Resilience | respond flexibly, adapt skills and knowledge when dealing with change, or unfamiliar and challenging situations | R |
| Reflection/self-awareness | use feedback productively, identify skills, set goals for personal and professional development | R/SA |
| **Laboratory Skills** | | |
| Practical Skills | including synthesis, analysis, and computational work | PrSk |

* abbreviations of each skill set will be used in subsequent tables.

Given that the aim of the study was to assess employer perceptions on skills development impacts during the pandemic, an additional skill was added to the QAA list to consider the impact of practical laboratory skills. The main body of the survey used a Likert item for the employers' evaluation of skills development. More specifically, in relation to each of the 13 skills outlined in Table 1, employers were asked to rate if their perception of a chemistry student and/or recent graduate's proficiency had changed as a result of the pandemic. This evaluation used a Likert item with employers selecting responses between 1 and 5 with the following descriptors: 1 – much less skilled, 2 – slightly less skilled, 3 – no change in skill level, 4 – slightly more skilled, 5 – much more skilled. The same Likert item response was then used to ask employers to rate whether their view on the importance of each skill had changed after the pandemic. Here responses between 1 and 5 were used with 1 being much less important to 5 being much more important. The final two questions in the survey encouraged employers to enter free text comments in response to the following questions:

- Are there any other skills or attributes that you consider to be of importance for students/recent graduates?
- Considering the effects of the pandemic, explain how your expectation of students/recent graduates and their skills when entering the workplace have changed, if at all.

Survey respondents were also given the option to email the research team directly so that a more in-depth interview could be conducted to further explore the general outcomes of the research. In total, 4 employers agreed to be interviewed and were asked to elaborate on the survey questions in more detail. Standardized, open-ended questions were used during interviews to gain further insight into the research questions, to expand on and supplement the data collected from the survey.

The Likert item survey responses were compared for different employer sub-groups using the Mann-Whitney U-test (a = 0.05) to compare median responses. Free text survey and interview responses were qualitatively analysed by thematic analysis, which was used as a method to identify, isolate, and analyse themes within the responses. In this research project thematic analysis was conducted in an inductive way to identify patterns (themes) whilst avoiding potential researcher's bias and prejudices. EDP conducted thematic analysis[28] on free text data, and themes and sub-themes were discussed with FS and LGvM during and after identification as a form of verification. Themes attempted to answer the question 'What feeling, or response does this answer lead to?', by examination of expressions and keywords given in the free text. Themes were identified by the following observational techniques looking for repetitions, metaphors and analogies, similarities and differences, and linguistic connectors. The analysis of the text allowed isolation of specific themes and sub-themes which were reduced to a manageable few, building a hierarchy of codes and linking them to identified themes.

## Results and Discussion
### *Part A: Collection of demographic data*
The employers' perception survey was completed by 23 respondents, although 1 survey was incomplete and was excluded from the research analysis. At the start of the survey, participants were asked to provide information about the chemical sector their company worked within, the number of years they had worked in their current company, their time working in the chemical industry in general, the geographic location of their company headquarters, and the approximate number of employees working in their company, (see Table 2).

*Table 2. Demographic data to assess employers' perceptions of remote/hybrid working on student skills development*

| Participant Number | Employers' working sector | ≥ 10 years in current company | Time in the chemical industries | Company headquarters base | Company Employee Number |
|---|---|---|---|---|---|
| EMP1 | Varied (enviro, pharma, food) | No | 4 | USA | 1000+ |
| EMP2 | Biotechnology | Yes | 10 | Japan | 100-250 |
| EMP3 | Drug discovery (Pharma) | No | 7 | Germany | 250-1000 |
| EMP4 | Fast moving consumer goods | Yes | 30 | UK | 1000+ |
| EMP5 | Surface coatings | Yes | 33 | UK | 250-1000 |
| EMP6 | Printing technology | No | 6 | UK | 1000+ |
| EMP7 | pharmaceutical sciences (Pharma) | No | 9 | Germany | 1000+ |
| EMP8 | Agriculture | No | 10 | Switzerland | 1000+ |
| EMP9 | Coatings/materials | Yes | 29 | Germany | 1000+ |
| EMP10 | Agrochemical | Yes | 14 | Switzerland | 1000+ |
| EMP11 | Chemical | Yes | 17 | USA | 1000+ |
| EMP12 | contract research | Yes | 32 | USA | 1000+ |
| EMP13 | Pharmaceutical (Pharma) | Yes | 23 | UK | 1000+ |
| EMP14 | Pharmaceutical sciences (Pharma) | Yes | 19 | UK | 250-1000 |
| EMP15 | Pharmaceutical sciences (Pharma) | No | 13 | UK | 100-250 |
| EMP16 | Medical devices | No | 1 | UK | 100-250 |

| Participant Number | Employers' working sector | ≥ 10 years in current company | Time in the chemical industries | Company headquarters base | Company Employee Number |
|---|---|---|---|---|---|
| EMP17 | Pharmaceutical (Pharma) | No | 10 | UK | 1000+ |
| EMP18 | Pharmaceutical (Pharma) | No | 6 | UK | 1000+ |
| EMP19 | Pharmaceutical sciences (Pharma) | Yes | 33 | UK | 1000+ |
| EMP20 | Pharmaceutical (Pharma) | Yes | 16 | UK | 1000+ |
| EMP21 | Pharmaceutical sciences (Pharma) | No | 16 | USA | 1000+ |
| EMP22 | Analytical science | Yes | 19 | UK | 1000+ |

The employers had a wide range of experience working in the chemical sector (from 1 – 33 years), with most working for large scale organizations with more than 1000 employees, whilst 3 worked for companies who employed between 250-1000 employees and 3 worked for companies employing between 100 and 250 people. Of the 22 respondents, 20 worked in the UK, with one working in the Netherlands and one working in Belgium.

Reponses given to these demographic questions allowed the creation of 3 employer subgroups, whose Likert item responses were evaluated using calculated median values. The first subgroup was based on the number of years participants had worked in their current company, either < 10 y (n=10) or ≥ 10 y (n=12). A second subgroup was created based on the location of the company HQ, which was either in the U.K. (n=12) or out with the U.K. (n=10). A final subgroup was created to align with the employer's working sector which was split into

'Pharma', which aligned with drug discovery, pharmaceutical or pharmaceutical science sectors (n=10), against 'Other' sectors that included environmental science, biotechnology, fast moving consumer goods, surface coatings, printing technology, arti/agriculture, coatings/materials, chemical, contract research and analytical science (n=12).

The participants were also asked about their interaction or engagement with industrial placement students or graduates, and whilst 2 participants did not have any direct experience of working with students or graduates, more than 25% of participants had worked with more than 10 students or graduates before March 2020 and 90 % worked directly with students or graduates in their own teams since March 2020 (Figure 1). This provided confidence that the data collected would give a reliable indication of the landscape around employer's perceptions of student and graduate employability skills pre- and post-pandemic.
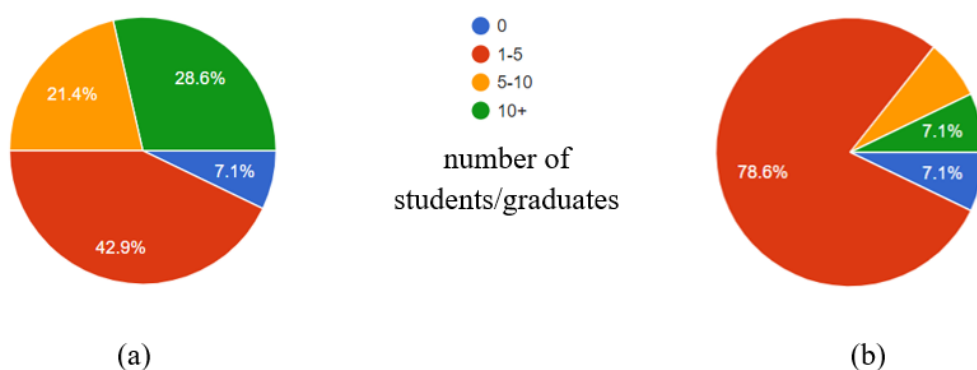


*Figure 1: proportion of participants employing students or graduates before March 2020 (a) and since March 2020 (b).*

**Part B: Participant responses in relation to the perceived change in skills development**

Employer responses to all Likert item questions were first reviewed collectively by calculating median responses from all 22 respondents. The first set of questions asked employers to reflect upon their own perception of student skills, and if they felt that the pandemic had an impact on the development of the 13 listed employability skills. Almost all median values returned as 3 indicating that, in general, employers did not perceive any change in the level of student skills development even whilst working in hybrid or remote environments. There was one exception, with employers rating their perception of student practical skills as being lower than before the pandemic, giving a median value of 2. In the second set of Likert item questions, employers were asked to consider whether they viewed the importance of each skill differently after the pandemic. Median responses were calculated across the 13 skills with 9 returning median values of 3 indicating employers had not altered their view on the level of importance of each skill on a student's employability prospects. The exceptions were for communication, autonomy, self-management, or resilience which received median scores of 4, 3.5, 4 or 3.5, indicating employers viewed these skills as being slightly more important post-pandemic. It is perhaps surprising that even although employers felt students had decreased practical skills due to the pandemic, their view on the importance of a student's practical skill set on their employability prospects had not changed.

The data was then split into subgroups, as outlined in Part A to assess whether an employer's time in their current company, HQ location or chemical sector, had an influence on the returned median values.

*Subgroup Responses: Employers perceived changes in skills development.*

To determine whether employers had a negative perception of skills development they were asked to rate their perception about the development of each skill before and during/after the pandemic. The employers were split into the same subgroups as outlined above. When median values for subgroups across all skills were reported as 3, these values are not given in Table 3. Instead, Table 3 presents median values that differed from 3 indicating that there was a perception by a subgroup of employers that the development of a skill had changed as a result of the pandemic.

The first subgroup compared responses from employers who have worked ≥ 10 years in their current company compared to employers who have worked less than 10 y. When asked to consider their perception of the development of employability skills during the pandemic, most median responses were 3 indicating that employer subgroups felt there was no change in the level of skills demonstrated by students or recent graduates after the transition to remote and/or hybrid learning environments. Employability skills which had median values of 3 for this subgroup included collaboration, interpersonal/networking, critical thinking, problem solving, innovative/creative, autonomy, and self-management. Median values that differed from 3 for any skill across all subgroups are reported in Table 3. Employers with less than 10 years' experience in their current company perceived there to be a change in skill levels for information literacy/analytical skills, curiosity to learn, resilience and reflection/self-awareness which received median responses of 3.5, 3.5, 4 or 3.5, respectively, reflecting a slight increase in these skills after students emerged from the pandemic. Interestingly, the same observations were not reported by employers with ≥ 10 y working in their current company, this subgroup of employers returned a median value of 3 for these four skills. Comparison of the median values using the Mann Whitney U-test confirmed that the different responses returned by the employer subgroups were not statistically significant. In contrast, employers with more years of service in their current company perceived students to be slightly less proficient with their practical skills (returning a median value of 2), an observation that was not shared by the subgroup of employers working less than 10 years in their current company who returned a median value of 3 (differences in median values were not statistically significant).

To determine if there were any cultural differences on the perception of students' skills

development, a second set of employer subgroups was created by comparing employers who had a company headquarters (HQ) based in the U.K. and those whose HQ was out with the U.K. (in Europe, Japan or the U.S.A.). Most employers, regardless of company HQ location, thought that out of the 13 skills listed, 11 had not changed as a result of the pandemic, with both subgroups reporting mean values of 3. There was a slight difference in employer subgroups for the perception of the development of resilience, with one subgroup (company HQ in the U.K.) reflecting a slight increase (median value of 3.5) in this skill. This perception was not reflected by the employer subgroup with company HQ's located out with the U.K., who returned a median score of 3. Both employer subgroups in this category perceived students and recent graduates to be slightly less skilled at practical skills, with both subgroups returning median scores of 2.

Employer subgroups representing 'Pharma' or 'Other' returned median scores of 3 for 11 of the 13 skills indicating that they did not perceive any change in the development of 11 skills during the pandemic, only communication and practical skills did not receive median values of 3. These employer subgroups differed in their assessment of the development of communication and practical skills. Employers from the pharma sector thought that the pandemic led to an increase in the development of communication skills (median score of 4), whereas employers from other sections in the chemical industry did not perceive there to be any change in communication skills. Both subgroups also returned median values less than 3 for practical skills indicating that students were less skilled in this area. Employers in the pharma sector being more concerned than employers working in other sectors as median values of 1 or 2.5 were returned.

*Table 3. Median responses given to assess perceived changes in skill proficiency.*

| Skills | Time (y) in the chemical industries | | Location of company HQ | | Chemical Sector | |
|---|---|---|---|---|---|---|
| | < 10 (n = 10) | ≥ 10 (n = 12) | U.K. (n = 12) | Other (n = 10) | Pharma (n = 10) | Other (n = 12) |
| Basic professional skills | | | | | | |
| Com | 3 | 3 | 3 | 3 | **4** | 3 |
| | | | | | 0.2340 | |
| Higher cognitive skills | | | | | | |
| ILA | **3.5** | 3 | 3 | 3 | 3 | 3 |
| | 0.3173 | | | | | |
| CtL | **3.5** | 3 | 3 | 3 | 3 | 3 |
| | 0.1310 | | | | | |
| Personal skills | | | | | | |
| Res | **4** | 3 | **3.5** | 3 | 3 | 3 |
| | 0.18352 | | 0.6672 | | | |
| Ref/SA | **3.5** | 3 | 3 | 3 | 3 | 3 |
| | 0.0657 | | | | | |
| Laboratory Skills | | | | | | |
| PrSk | 3 | **2** | **2** | **2** | **1** | **2.5** |
| | 0.1971 | | | | 0.4473 | |

Median values greater or lower than 3 are indicated in bold. *p*-values given when median values differ across subgroups indicate no statistically significant differences in comparative mean values (a = 0.05).

*Subgroup Responses: Employers' view on the importance of each skill for employability success*

Employers were also asked to rate whether their views had changed about the importance of each skill for students or recent graduates to be successful in the workplace. The employers were split into the same subgroups as outlined above. When median values for subgroups across all skills were reported as 3, these values are not given in Table 4. Instead, Table 4 presents median values that differed from 3 indicating that there was a perception by a subgroup of employers that a skill was more or less important for a successful transition into the workplace.

Comparing responses from employer subgroups based on the time they had spent in their current company, both subgroups returned median values of 3 for the following skills; collaboration, critical thinking, problem solving, information literacy/analytical, innovative/creative, reflection/self-awareness and practical skills. This indicates that employers do not place any additional levels of importance on these skills in order for students or recent graduates to be successful in the workplace. Median responses greater than 3 were returned for 6 skills for the employer subgroup with < 10 years in their current company compared indicating they place a higher level of importance on communication, interpersonal/networking, curiosity to learn, autonomy, self-management, and resilience. In their view students need to possess a higher level of these skills to be successful in the workplace. The employer subgroup with ≥ 10 y experience in their current company also placed a higher level of importance on communication and self-management skills for workplace success, but otherwise did not feel that there has been a change on the level of importance of other skills after the pandemic.

Looking at employer subgroups with their company HQ located in the U.K. compared to those where the HQ was out with the U.K., both subgroups returned a median value of 3 for 7 skills indicating they did not feel they are any more or less important to employability success post-pandemic. These included interpersonal/networking, critical thinking, problem solving, information literacy/analytical, curiosity to learn, innovative/creative, and practical skills. Both subgroups agreed that there is a higher level of importance on personal skills such as autonomy, self-management and resilience, whereas only the employers from the subgroup with their company HQ in the U.K. also placed a higher level of importance on reflection/self-awareness. There was also a difference in median values for communication and collaboration with only employers in the subgroup having their company HQ in the U.K. returning median values of 4 and 3.5 indicating that in their view these skills are also more/slightly more important for employability success.

When employers were split into subgroups depending on the chemical sector within which they are working, median values of 3 were returned by both subgroups for all higher cognitive skills (critical thinking, problem solving, information literacy/analytical, curiosity to learn, innovative/creative), as well as for reflection/self-awareness and practical skills. This indicates that these employer subgroups do not feel that these skills are any more or less important for workplace success post-pandemic. Employers from the pharma sector gave median values of 4 for communication, collaboration interpersonal/networking, autonomy, self-management, and resilience indicating that they feel these skills are more important for workplace success. In comparison median values returned by employers in other sections were 3, except for self-management which had a median value of 3.5.

*Table 4: Median responses given to assess importance of skills for successful employment*

| Skills | Time (y) in the chemical industries | | Location of company HQ | | Chemical Sector | |
|---|---|---|---|---|---|---|
| | < 10 (n = 10) | ≥ 10 (n = 12) | U.K. (n = 12) | Other (n = 10) | Pharma (n = 10) | Other (n = 12) |
| Basic professional skills | | | | | | |
| Com | **4** | **4** | **4** | 3 | **4** | 3 |
| | | | 0.0801 | | 0.1211 | |
| Coll | 3 | 3 | **3.5** | 3 | **4** | 3 |
| | | | 0.1052 | | 0.1556 | |
| IP/Net | **3.5** | 3 | 3 | 3 | **4** | 3 |
| | 0.6031 | | | | 0.2891 | |
| Higher cognitive skills | | | | | | |
| CtL | **4** | 3 | 3 | 3 | 3 | 3 |
| | 0.0767 | | | | | |
| Personal skills | | | | | | |
| Aut | **4** | 3 | **3.5** | **3.5** | **4** | 3 |
| | 0.0703 | | | | 0.3898 | |
| SM | **4** | **4** | **4** | **4** | **4** | **3.5** |
| | | | | | 0.6241 | |
| Res | **5** | 3 | **3.5** | **3.5** | **4** | 3 |
| | 0.1310 | | | | 0.3371 | |
| Ref/SA | 3 | 3 | **3.5** | 3 | 3 | 3 |
| | | | 0.1052 | | | |

Median values greater or lower than 3 are indicated in bold. *p*-values given when median values differ across subgroups indicate no statistically significant differences in comparative mean values (a = 0.05).

## Part C: Participant responses in relation to free-text questions and qualitative review of the four interviews

At the end of the survey, all employers were asked if there were any other skills or attributes that they consider to be important for students or recent graduates to enter the workplace. Out of all employers, there were only 3 areas highlighted which were the need for students or recent graduates; (i) to display an enthusiasm for chemistry, (ii) to have increased skills in the use of virtual media such as Zoom, Teams etc., and (iii) to have an ability to take ownership/responsibility of tasks so that they are taken to a successful outcome. The final survey question asked employers to expand, if they wished, on any changing expectations of students and recent graduates since the pandemic. Key areas of interest noted by employer responses are given below:

- *Employers expect students or recent graduates to have done less laboratory work at the University, and so they expect a gap in practical skills.*
- *Due to the shift in working environments, resilience and flexibility have become significantly more important for new students entering the workplace.*
- *The expectation is that graduates are more self-directed and have good ability to seek effective collaboration.*
- *There is definitely more emphasis on softer skills.*
- *There is an expectation of students to be more competent in desk-based tools/process than pre-covid students.*

The comments provided above align with the quantitative analysis of the Likert item responses, in particular the low median values returned by most employer subgroups that students or recent graduates would be less skilled

in practical chemistry. Employers expect there to be a gap in this skill, but they did not find this gap important for employability success. Most likely this is because new employees will be expected to undertake a wide range of on-the-job training when securing a new position. Despite the survey responses for the perception of skills development changes as a result of the pandemic being mainly neutral, the free-text comments discussed the increased importance of basic professional and personal skills. This increased importance was also demonstrated in the quantitative analysis (see Table 4), with median values > 3 being returned by employer subgroups for most skills listed in these categories.

In addition to the free text comments returned in the survey interviews were conducted with four employers. The interview scripts were anonymised, reviewed and assessed by thematic inductive analysis to identify overall themes and codes within the transcripts. Three main themes were identified in the transcripts that were of importance for the employer in terms of skills development; 1. the selection/hiring process, 2. the pandemic effect on teaching and learning and 3. future hiring reliance. Within each of these themes, it was possible to identify subthemes and codes that aligned with the list of skills given in the employer survey (see Table 5).

*Table 5: Results of inductive thematic analysis on survey questions and the four interview transcripts*

| **Theme 1: Selection/Hiring Process** | |
|---|---|
| **Sub-Themes** | **Codes** |
| Basic Professional Skills | Communication |
| | Collaboration |
| Higher Level Cognitive Skills | Critical Thinking |
| | Problem-Solving |
| | Information literacy/analytical |
| | Curiosity to Learn |
| | Innovation/ Creativity |
| Personal Skills | Self-Management (Time and Work Management) |
| Practical Skills | Practical Laboratory Skills |
| Additional Skills | Specific Background |
| | CV Design (developing and writing a CV) |
| | Company Values |
| | Interview Management |
| | Leadership Attitude |
| **Theme 2: Pandemic effect on teaching and learning** | |
| **Sub-Themes** | **Codes** |
| Basic Professional Skills | Collaboration |
| Personal Skills | Self-Management (Time and Work Management) |
| Practical Skills | Attainment Gap |
| Additional Skills | Interview Management |
| | Inclusive Approach |
| **Theme 3: Future hiring reliance** | |
| Basic Professional Skills | Collaboration |
| | Networking |
| Higher Level Cognitive Skills | Problem-Solving |
| Personal Skills | Self-Management |
| Practical Skills | Laboratory Skills |
| Additional Skills | Self-Confidence |

Interviewed employers identified with the need for students to demonstrate communication and collaborative skills at the selection stage of the recruitment process; this aligns with the descriptive statistics results where the importance of these skills was identified in the survey results. There was also a strong identification with all of the higher-level cognitive skills included in the employers' survey; critical thinking, problem solving, information literacy/analytical skills, curiosity to learn and innovation/creativity. Despite the perception that there is, in general, little change in a student's level of these skills or any increased perception of importance in relation to success in the workplace, it was clear that applicants need to provide evidence of possessing higher cognitive skills during the recruitment process. Self-management was a key personal skill that employers sought during interview and again the importance of this skill was observed in the survey results. In addition to the survey skills, employers also highlighted additional preparation skills required of students including the need to demonstrate specific type of background, a need to understand the company values, a well designed and well written CV, good interview management skills and a leadership attitude. Within the second theme, codes identified with collaboration, self-management, a gap in practical skills and additionally, a need to demonstrate interview management skills and an inclusive approach. A similar set of codes were identified in the future hiring reliance theme, with an additional skill of self-confidence being exclusively identified. Quotes that provide demonstrable evidence of the codes are given below:

*'Communication, that could be written communication, that can be how you helped change somebody's mind, how you influence and negotiate quality we ask you for'.* – aligned with themes 1 and 2.

*'Communication, that could be written communication, that can be how you helped change somebody's mind, how you influence and negotiate quality we ask you for'.* – aligned with themes 1 and 2.

*'The lab time can act as a good differentiator. The fact that you haven't been given any exposure to labs it doesn't mean that you're not capable with a bit of training.'* – aligned with themes 1 and 3.

*'I don't see the access to laboratory work as being a barrier to hiring what could be a barrier or what could be impactful is the act of working in the lab requires teamwork. It requires negotiation for access. It requires you to be talking to supervisors, requires you to be planning work. All these things are the soft skills that we talked about. And without access to laboratories, or tutorials, or campus, there's the potential that you're not getting exercise to not getting the opportunity to exercise those soft skill muscles'.* – aligned with theme 3.

## Conclusions

In this study the perception of employers' on changing levels of student/graduate employability skills were collected to inform future teaching practice and ensure our graduates continue to be perceived by employers as industry ready. In research question 1 we set out to determine if the transformation in the students' learning environment affected the perception of chemistry employers on the graduates' preparedness for industry. In total 13 skills were reviewed by employers to cover the range of personal, professional, higher level cognitive and laboratory skills. Perhaps reassuringly, when all responses were considered as a collective group, median responses of 3 were returned for 12 of the listed skills indicating a general perception of no change in skills development even after working in remote/hybrid environments during the pandemic. Only one skill was highlighted by the full group of employers as being negatively impacted by the pandemic; the students' practical skills. This was not a surprising result considering the time students could spend on the bench undertaking practical work decreased significantly during the pandemic. It was however interesting to see that employers did not place any higher level of importance on this skill for employability success, this was also observed in the free-text and interview responses, indicating that a skill gap in this area is expected, but the gap can be easily filled by in-company training.

The employers were then broken down into subgroups to identify any trends related to the amount of time the employer had worked in their company, the location of the employers' HQ or their chemical sector. Most employer subgroups had a similar view when asked to rate their perception of skills development during the pandemic. With the exception of practical skills as discussed above, no employer subgroup felt concerned about a lack of skills development during the pandemic. Indeed, there were even a few skills that employers felt had been slightly strengthened as a result of working in a remote or hybrid environment (see Table 3). When comparing the importance that employers placed on the skills in terms of successful employment, perhaps unsurprisingly there were no skills rated less important than before the pandemic (see Table 4). However, many of the employer subgroups rated basic professional skills and personal skills as being more important for students or recent graduates to be successful in the workplace. These responses were confirmed by comments made in the survey and during the interviews. Employers did not place any more or less importance on the development of higher cognitive skills, which in general had Likert median values of 3. In conclusion it was demonstrated that there will be a skills gap in practical chemistry, but employers are aware of this gap and do not feel concerned about the decreased level of skill of current students and recent graduates. In addition, employers confirmed their view that it is more important for students to demonstrate a high level of professional and personal skills for successful employment.

These general conclusions linked to the second research question and the potential need to upskill students and graduates post-pandemic. There was a sense that employers do not perceive there to be a negative impact on the skill level of students and recent graduates as a result of working remotely or in a hybrid environment. Even the practical skills gap was not thought to be of concern with no need for university programmes to upskill students in this area, employers are confident that this gap can be bridged during employment. What was shown to be of increased importance is the de-velopment and demonstration of basic professional skills (communication, collaboration, and interpersonal/networking) and personal skills (autonomy, self-management and resilience) which was seen to be more important for employability success. These findings align with a study[29], which highlight the importance for students to improve self-management skills as they would be required to work in a self-led manner within an industry setting. Moreover, the benefit of human and social capital (personal and professional competencies) on perceived employability has been reported elsewhere[30]. When programme and module leaders are creating or modifying curricula attention needs to be placed upon the development of these skills to ensure graduates are industry-ready to transition successfully into the workplace.

## Conflict of Interest

## Acknowledgments

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