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# Evaluation of Higher-Order Skills Development in an Asynchronous Online Poster Session for Final Year Science Undergraduates

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## Abstract

Preparing a scientific poster and presenting it at a conference supports the development of a range of skills in undergraduates that are relevant to further study and the workplace. This investigation focused on an asynchronous online poster session in a final year undergraduate science module at a UK university to assess evidence of higher-order skills development and determine student perceptions of the benefits and challenges of participating in the session.

The study analysed 100 randomly selected posters from the 2020 session for evidence of scientific understanding, application, and critical evaluation, together with the feedback received on them. While 73% of the posters demonstrated understanding and 70% application, a lower proportion (42%) demonstrated critical evaluation skills. Seventy-eight percent of posters were considered to have received feedback from peers that gave an effective or partially effective evaluation of scientific content.

Focus group discussions involving nine students led to the identification of themes relating to constraints, academic challenges, skills and experience, and personal development. Students recognized the value of the conference for skills development and the experience it gave of “real” science, while acknowledging the challenges involved in producing posters, giving feedback to peers, and managing their time.

The asynchronous online poster session enabled students to develop higher-order cognitive and communication skills that are valued by employers. This format provides a pragmatic and easy to implement alternative to synchronous online conferences, which is relevant to the shift toward online learning in higher education, due to the COVID-19 pandemic and increase in distance learning and international students.

*Keywords:* online poster session, asynchronous, student perceptions, higher-order skills

## Introduction

Participation in academic conferences provides an opportunity for undergraduate students to expand their knowledge while developing skills in networking and communication, both of which are increasingly valued by employers (Kneale et al., 2016). Poster sessions in conferences enable students to present their work and receive feedback but can feel less intimidating than oral presentations. Hence, they may be particularly suitable for novice presenters (Halligan, 2008). Preparing and presenting a poster enables “situated **learning**” to take place (Lave & Wenger, 1991), providing a safe environment for the novice, supported by collaboration with peers and more experienced members of the academic community (Kneale et al., 2016).

The process of preparing a poster and presenting it at a conference supports the development of creative, scientific, and communication skills (Holt et al., 2020). Through communicating their research to others, students can apply their knowledge and demonstrate a deeper understanding of the subject (Spronken-Smith et al., 2013). The ability to review, synthesise, and clearly articulate ideas can be considered an essential skill to help graduates transition into careers and be successful life-long learners (Jewell et al., 2020). Giving and receiving feedback engages students actively, which enhances their learning (Liu & Carless, 2007) and can develop critical evaluation and reflection skills (Little, 2020). Careful thought is needed to construct explanations when giving feedback, which helps consolidate the **giver’s own knowledge and understanding** (Van Popta et al., 2017). Both preparing a poster and giving and receiving feedback can therefore support deeper learning, with a greater focus on understanding and constructing meaning (Mathieson, 2014). Previous studies report that students value poster sessions (Kinikin & Hench, 2012; Kneale et al., 2016; Mabrouk, 2009), recognising their benefits, including developing science communication skills and interacting with others at the poster session (Holt et al., 2020).

**Bloom’s taxonomy (Bloom, 1956) provides a hierarchical framework to assess skills development in** producing posters and giving feedback on them. Students need to know and understand concepts to be able to apply that knowledge, for example in considering the wider implications of research findings and critically evaluating study methodologies. Thus, application and evaluation can be considered higher-order skills than knowledge and understanding (Zheng et al. 2008). While some studies have evaluated student academic performance in posters (e.g., Gosselin & Golick, 2020), few have focused on student posters in terms of higher-order cognitive skills, such as critical evaluation and the application of knowledge. These higher-order skills will be the focus of this study, together with the understanding and explanation of the ideas and concepts that underpins them (Zheng et al., 2008).

Student poster sessions can take place online and have increasingly done so because of the COVID-19 pandemic, which necessitated a rapid shift to “virtual” delivery of higher education (HE) tuition throughout the world. This shift has accelerated the removal of boundaries between traditional and online education, which were already becoming blurred prior to the pandemic (Lockee, 2021). While the online format has some advantages, such as lower costs (Freeze et al., 2020; Holt et al., 2020) and increased accessibility and equity (Saribipour et al., 2021), the lack of in-person interaction can make it more difficult to discuss the research outlined in posters. This lack of interaction can be particularly challenging for distance learners, who can already feel somewhat isolated (Gillett-Swan, 2017). Despite the challenges of delivering online learning, it is likely that it will continue to be offered throughout the HE sector as a delivery mode (Lockee, 2021).

Several online poster sessions that have taken place since the start of the pandemic have been wholly or partly synchronous. For example, Freeze et al. (2020) report on a student poster session involving a combination of pre-recorded video presentations on YouTube and a live session using Zoom breakout rooms, while Holt et al. (2020) describe a synchronous poster session hosted on Mozilla Hubs involving a virtual poster hall, with students using avatars to stand by their posters and interact with viewers. Synchronous online sessions provide a degree of social presence and can give a sense of community (Holt et al., 2020), but there can be issues with connectivity and Internet speed (Basaran & Yalman, 2020; Freeze et al., 2020).

Online poster sessions can also take place in an asynchronous format. Although they may feel less personal and interactive and lack the immediate feedback that can reduce miscommunication (Wang & Wang, 2021), asynchronous platforms can be more convenient for distance learning (Kear et al., 2012). They give students from different time zones or with other commitments an opportunity to participate that might not be possible with synchronous sessions. Furthermore, the flexibility of asynchronous platforms can make for a more comfortable learning environment for students with disabilities (Terras et al., 2015) and give more time and space for participation (Wang & Wang, 2021).

The Open University (OU) is one of the largest universities in Europe, with over 150,000 students (Open University, 2021). It is an established and respected provider of online HE, which it delivers through a combination of synchronous and asynchronous platforms. OU students have an average age of 27 when commencing their degrees and are often employed in full or part-time work or have family and caring responsibilities. They study at a flexible intensity, ranging from 8 to 36 hours per week depending on the number of modules studied. Here, we focus on an asynchronous online student poster session that is a core component of a third-year multidisciplinary science module. Through analysis of poster content and student perceptions of the poster session we will address the following questions:

- How can an asynchronous online poster session help develop science **students' understanding**, application, and critical evaluation skills?
- What do students consider to be the key benefits and challenges of participating in the asynchronous online poster session and how does this relate to the skills evidenced in their posters?

These questions will be relevant in terms of planning and improving online activities for distance-learning students. They are also more widely relevant as HE institutions expand their online tuition in response both to the COVID-19 pandemic and to increasing numbers of international and distance-learning students, for whom participation in face-to-face activities is not always feasible.

### **The Online Student Poster Session**

The OU runs an online student poster session as part of the third-year undergraduate multidisciplinary “Evaluating Contemporary Science” module, which has up to 250 students in each cohort. The module is recommended to be studied for 8 to 10 hours per week, with three study weeks allocated for researching and preparing the poster and accompanying materials. Each student prepares a poster on a subject of their choosing within one of five topics (antibiotic resistance, diesel vehicles, nuclear legacy, moons and asteroids, and rare earth elements), through which they compare the scientific approaches and research findings in two recent primary research papers of their choice. They also produce a four-minute audio commentary of the poster, key words, and an image that is used to promote their poster.

A series of live online tutorials are offered prior to the poster session on each of the topics, which are recorded so that students can review them as required. These provide instruction on how to search for relevant literature and emphasise the science aspect, which complements the written guidance the students are given on what to include in their posters. Students are instructed to produce their poster in portrait mode and in a font size that is legible, but they are otherwise encouraged to develop their own style and format.

The poster and accompanying material are uploaded onto OpenStudio. This is an online platform where artefacts (e.g., posters and images) are shared and students can add feedback comments, together with more immediate feedback in the form of icons such as “smile” and “favourite.” In this way, OpenStudio supports a form of social learning (Jones et al., 2017).

The poster session takes place over a two-week period. During this time, students select at least two other posters through browsing titles and thumbnail images or through a keyword search, and they provide feedback as comments in OpenStudio. They are given a set of structured questions and are encouraged to use the CORBS (clear, owned, regular, balanced, specific) approach when giving feedback (Hawkins & Shohet, 2012).

The student poster and feedback given on other posters contribute to approximately 10 percent of the assessment score for the module. Following the poster session, students develop the research carried out for their poster over an eight-week period, leading to the production of a briefing document and research proposal that forms a major component of their final examined assessment.

## Methodology

The research used a mixed-methods approach involving two phases. In the first phase, we analysed student poster content for evidence of scientific understanding, application, and critical evaluation. In the second phase we considered student perceptions of the benefits and challenges of participating in the poster session through synchronous online focus group discussions. Ethical approval for both **phases of the research was gained from the OU’s Human Research and Ethics Committee prior to commencement.**

### Analysis of Poster Content and Feedback

We randomly selected 100 posters from the 198 that were uploaded by the 2020 student cohort. This was considered a sufficiently large sample size to capture the variation in the posters while being pragmatic to analyse within the time and resources available for the study. Following anonymisation, they were assessed using eight criteria (Table 1) covering scientific understanding (understanding), application (application), and critical evaluation (evaluation). Each criterion was assigned a score on a Likert scale from 1 (very poor / no attempt) to 5 (excellent). For example, for “use of language,” a score of 3 indicated it was satisfactory in meeting the criteria of being clear, concise, and having appropriate use of terminology. **“Use of language” that scored 4 (good) and 5 (excellent) also recognised which terms needed to be explained to students from outside their discipline in a manner appropriate to a generally scientifically educated audience.**

Table 1

*Summary of Criteria Used to Assess Poster Content*

<i>Criterion</i>
Understanding <ul style="list-style-type: none"><li>• Use of language</li><li>• Use and amendment of figures</li></ul>
Application <ul style="list-style-type: none"><li>• Interpretation of results</li><li>• Drawing of conclusions</li><li>• Suggestions for further research</li><li>• Contextualisation</li></ul>
Evaluation <ul style="list-style-type: none"><li>• Evaluation of individual studies</li><li>• Comparative evaluation of both studies</li></ul>

The criteria were grouped into overarching criteria for understanding, application, and evaluation, and the individual criterion scores totalled for each of the three overarching groups. These overarching **criteria are hierarchical and reflect elements of Bloom’s taxonomy (Bloom, 1956)**, with understanding (Bloom’s “comprehension”) underpinning application, above which sits evaluation.

Scientific understanding can be **demonstrated through the students’ use of language**; if they conveyed the key points from the studies in concise and non-technical language, this indicated that they understood them. The presentation of data from the studies can also indicate understanding, with students who successfully produced their own figures and/or annotated figures to indicate key points considered to show a greater understanding than those who simply copied figures from the original papers.

**In terms of Bloom’s taxonomy, interpretation has been** treated as part of both “understanding” or “application” in previous studies (Stanny, 2016), but we considered it a measure of “application” for the purpose of this study. **Students’** application of knowledge and understanding was evaluated through how they interpreted the research findings from the two papers they compared and drew conclusions from them. They were also required to suggest future research based on their interpretation of the research findings and apply their understanding to contextualise the research. They can demonstrate evaluation skills both through evaluating each study, for example in terms of their limitations, and comparing the two studies.

We assessed the feedback received on each poster in terms of (i) whether the feedback focused on appearance or scientific content (assigned to one of three categories: appearance, content, or equally) and (ii) whether the feedback was considered to give an effective evaluation of the **poster’s** scientific content. This was also assigned to one of three categories: yes (constructive criticism and engagement with points made in the poster), partially (some attempt to give feedback on scientific content) or no (lack of feedback on scientific content).

Each of the study authors assessed approximately half the posters, with a standardisation exercise undertaken prior to analysis to ensure consistency. This involved both study authors, together with a

third, independent researcher, analysing the same 10 posters and comparing criteria scores and assessment of the feedback. This showed there were minimal differences between the researchers in their assessment of the posters.

## **Student Perceptions**

Student participants were recruited by contacting all those studying the module in 2020, of whom nine volunteered for the focus group discussions. Two one-hour discussions took place via an online platform (Adobe Connect), with four students in one group and five in the other. The discussions were held after the final module assignment was submitted but before the results were released, to avoid this influencing student views in the discussions.

The focus groups were facilitated by two student volunteers. The volunteers were experienced in using the Adobe Connect platform so they could assist with any technical problems, but they were not part of the student cohort for the module. Prompts for discussion related to:

- how students prepared for the poster session
- how students experienced the poster session
- what students thought they gained from the poster session

Thematic analysis was undertaken on the transcripts from the discussion recordings, which were coded using NVivo software. This helped identify groupings within the initial codes and led to the identification of key themes and subthemes (Braun & Clarke, 2006).

## **Findings**

### **Poster Content and Feedback**

Table 2 shows the percentage of posters gaining each score for the three overarching criteria (understanding, application, evaluation). Posters generally scored highly in terms of the understanding and application criteria, with 73 percent and 70 percent of the posters scoring in the 3 to 5 range (i.e., considered satisfactory, good, or excellent) and both criteria having a mean Likert score of 3.1. Scores for the evaluation criteria were somewhat lower, with 42% of posters scoring in the 3 to 5 range and with a mean Likert score of 2.3.

Table 2

*Percentage of Scores Awarded and Mean Likert Score for the Overarching Criteria*

Overarching criterion	Score					Mean score
	1	2	3	4	5	
Understanding	4%	23%	42%	20%	11%	3.1
Application	5%	25%	37%	25%	8%	3.1
Evaluation	33%	26%	27%	13%	2%	2.3

*Note.* A score of 1 = very poor/no attempt; 2 = poor; 3 = satisfactory; 4 = good; 5 = excellent.

Nearly three-quarters of posters received feedback that focused mainly on scientific content (19%) or had an equal focus on content and appearance (53%). Over three-quarters of posters were considered to provide an effective evaluation of scientific content (53%) or at least partially so (25%).

### Student Perceptions

Four main themes emerged from the student focus group discussions: constraints, academic challenges, skills and experience, and personal development. These themes and the underlying subthemes (Table 3) are discussed below, illustrated by anonymised quotations from focus group participants.

Table 3

*Themes and Subthemes Identified from Focus Group Discussions*

Constraints
<ul style="list-style-type: none"> <li>• Time pressure</li> <li>• Assessment</li> </ul>
Academic challenges
<ul style="list-style-type: none"> <li>• Researching and preparing poster</li> <li>• Selecting posters and giving feedback</li> </ul>
Skills and experience
<ul style="list-style-type: none"> <li>• Appreciation of value of feedback</li> <li>• Skills development</li> <li>• Experience of “real” science</li> </ul>
Personal development
<ul style="list-style-type: none"> <li>• Interest and enjoyment</li> <li>• Building confidence</li> <li>• Social learning</li> </ul>

### Constraints

Several participants experienced time pressures, particularly those who were studying other modules with competing deadlines or had other commitments that limited the time they could devote to preparing their poster and participating in the poster session. To add to these pressures, the 2020 poster session took place between March 21 and April 3, which coincided with the start of the first COVID-19 lockdown in the United Kingdom. The run up to the March 20 deadline for uploading posters to

OpenStudio involved a period of considerable uncertainty, with schools and workplaces shutting in the week preceding the lockdown.

Some participants felt somewhat constrained by the fact that their poster and the feedback they gave on others was assessed. For example, one **participant noted that “you were being graded based on how you presented what was said” and that “you were pandering to what you felt was required some of the time as well.”**

### ***Academic Challenges***

The participants had some experience searching for suitable papers from previous study, including earlier on in the module, but some found it challenging to choose suitable papers to base their poster on. The large number of potentially suitable papers available in the literature made it difficult for students to know when to stop searching and finalise their choice of papers. Another challenge was synthesising and comparing the two papers and communicating the findings to a wider audience within the limited space available. **One participant noted that “a lot of it was down to how much detail to include ... you don’t want to give too much but you don’t want to give too little – so it’s getting the balance right.”**

Choosing posters to give feedback on was sometimes challenging, as there were numerous posters to choose from. The participants wanted to choose posters for which they could provide constructive feedback. **One commented that they “wanted one I could actually provide feedback for” and not one which they looked at and thought “I don’t really know what to say about this.”**

Giving feedback on posters that were weaker overall was particularly challenging as the participants were aware how much work had gone into each poster and did not want to cause offence. As one **participant put it “it was a good exercise in how to be tactful – knowing how to tell somebody that they can improve an aspect not in a way to cause offence but that could actually help them.”**

**It was considered more challenging to give feedback on a poster’s scientific content than its appearance.** However, the importance of giving feedback on content was recognised, with one participant noting that **“you’ve got to try and concentrate on the actual science – obviously the display is part of the process but it’s looking at the science – that’s the main focus.”**

### ***Skills and Experience***

The participants appreciated the value of giving and receiving feedback and recognised where this fitted into their studies and how this could help improve their work. **One participant observed that “it’s difficult when people are giving you constructive criticism, but you’ve just got to take it on board and actually give it some reflection ... and try to move forward and incorporate that into your future work.”**

They also recognised the role of the conference in developing skills, including those needed for further study, dissertations, and work-related projects. According to one participant, **“You are learning or improving the [skills] you’ve already got—things like evaluating, making sure work is concise, making sure you are doing it to the right audiences—lots and lots of skills to get your teeth into.”**

The participants appreciated the role of conference poster sessions and the feedback process in real science. As one participant noted, **“It’s how they learn as well, doing a poster, because they are getting**



feedback from other scientists, which helps to build and develop whatever you are talking about at **conferences and that's how they learn and progress.**"

Linked to this was a more general feeling that they were experiencing how real science operates, for example that **"people really do just talk to each other and that's how they develop their ideas."**

### ***Personal Development***

Recurring themes throughout the discussions were those of interest and enjoyment, with one **participant stating that they "enjoyed the creative side" of making a poster as well**, while others commented on the interesting science that was presented and how they enjoyed the opportunity to **broaden their knowledge. As one participant put it, "It was really interesting to learn about other subjects ... I never expected to be reading a poster about volcanoes and satellites, for instance."**

While the poster session was challenging and took some participants out of their comfort zones, it also helped build confidence. One participant noted that they **"gained confidence, otherwise I wouldn't be contributing to this focus group now, so I think it is certainly going to help me in the future."**

The participants also appreciated the social aspect of the session through interacting with fellow students with similar interests and learning from them:

**One of the nicest things for me was actually getting to see other students' work because you never normally get to see something another student [has produced] and I think it's quite beneficial to see how other students approach things.**

Some participants mentioned that they would have liked to have had the opportunity to discuss each **other's posters in real time**: that is, for there to have been a synchronous element to the poster session. However, another **noted that "because everybody has different timetables, I don't know how it would have been possible to bring everybody together."** Furthermore, the **asynchronous** format meant that students could take their time to look at the posters, which remained accessible in the weeks after the poster session had finished. One participant stated that **"you do what you need to do at the time and then you can go back at your leisure which is really nice to have a look through them all."**

## **Discussion**

Analysis of the poster content showed that nearly three-quarters (73%) of students demonstrated their understanding through use of language and use and/or adaptation of figures. A slightly lower proportion (70%) demonstrated their application skills through interpreting results, drawing conclusions, proposing further research and contextualising the research. A lower proportion (42%) critically evaluated the studies they investigated, which was also evidenced in the focus group discussions, where the academic challenges in producing posters was highlighted. Understanding provides the foundation for the application of higher-order cognitive skills such as application and evaluation, with a solid understanding of the material needed to apply these skills (Zheng et al., 2008). It is therefore not surprising that evaluation—the highest-order skill out of those assessed according to **Bloom's taxonomy**—was the least well demonstrated skill, and that the converse was the case with understanding. However, the abilities to apply knowledge and understanding, evaluate information,

and think critically are needed for the workplace (Gasper & Gardner, 2013), so development of these skills is particularly important for students.

From the focus group discussions, it was clear that students recognised the role of the poster session in developing key skills such as communication and critical evaluation, which is supported by the wider literature on student conferences (Kneale et al., 2016; Little, 2020; Walkington et al., 2017). They also recognised the relevance of these skills to their future study and work, which also emerged as a key theme in another study investigating the value of student poster presentations (Kneale et al., 2016). The students appreciated the insight the poster session gave them into real science, for example, by experiencing the types of discussion that take place at conferences. This can act as a motivator through enabling them to see themselves as part of an academic community (Little, 2020).

Several academic challenges were mentioned in the focus group discussions, such as choosing suitable papers to base the poster on and communicating findings in the limited space afforded by the poster format. The limited space and time available might have contributed to the poorer performance overall in terms of evaluation, which may have been considered less of a priority by students when having to cover several elements in their posters. The investigation focused on a final year module, where a higher level of learner autonomy and discipline knowledge was expected. Students were therefore provided with less comprehensive guidance than they would be at an earlier stage of study, but we nevertheless recommend this is consolidated and made more prominent for future poster sessions. Some focus group participants commented on the difficulties in selecting posters to give feedback on. Students might not necessarily select the highest quality posters to comment on, instead being drawn to “middling” posters where there is more of an opportunity to give constructive, critical feedback (Lotz et al., 2018).

Over three-quarters of the posters received feedback that was considered to make at least some attempt to effectively evaluate their scientific content. In addition, the majority of posters received feedback that either focused on scientific content, or had an equal focus on content and appearance. However, nearly **30 percent received feedback that focused on the poster’s appearance rather than** its content, which could be considered an “easier” option to give. Possible reasons for this were not explored in the current study but could be the result of a reluctance to give critical feedback (McMahon, 2010) and risk causing offence, as noted in the focus group discussions. Students might be more comfortable giving critical feedback on poster appearance, such as font size or layout, than on the scientific content when they are aware how much effort went into researching and creating it. Given the challenges students faced producing their posters and their weaker performance in terms of evaluation, it is unsurprising that they found it difficult to give feedback on the scientific content of other posters, whose contents they were not familiar with and might not have felt qualified to judge. Furthermore, some students might have adopted a “surface” approach (Mathieson, 2014) to giving feedback through finding something to say to “tick a box” rather than engaging more deeply with the poster content. Workloads and their perception can influence student approaches to learning, with heavy workloads associated with the adoption of a surface approach (Scully & Kerr, 2014). Some focus group participants commented on the time pressures they were under, and it is possible that students with less time available might have engaged less deeply with poster content when giving feedback.

The focus group participants appreciated the value of receiving critical feedback in terms of improving their future work. The benefits of receiving feedback are widely recognised, both in terms of improving **students’ research work** (Van Popta et al., 2017) and preparing them for developing academic careers: for example, through exposure to the peer review process (Kneale et al., 2016). However, the benefits

of giving feedback are less widely recognised, despite contributing to improved understanding (Van Popta et al., 2017) and improving **students'** self-assessment skills when evaluating their own work in the future (Yucel et al., 2014).

The student posters and the feedback students gave were assessed as part of the module. This was considered a constraint by some focus group participants in that they did not feel they could take any risks in producing their posters, and the feedback format they were expected to use was rather formal. This contrasts with optional, non-assessed student conferences, described by Little (2020) as a “**risk-free space, away from the determinants and pressures of summative assessments,**” which enable research to be reported in an interesting and engaging manner (Walkington et al., 2017). A non-assessed poster session may also give space for students to undertake more challenging conversations with each other, which could support the development of critical thinking skills (Little, 2020). However, such non-assessed activities might involve lower levels of participation, particularly from students experiencing time pressures.

The poster session provided a confidence boost for some participants, which could help reduce anxiety with any future presentations, both in their studies and employment (Little, 2020) and improve their sense of self-worth. Producing a poster and participating in a conference can be an enjoyable experience and give students a feeling of ownership and achievement (Kinikin & Hench, 2012). It can also enable students to gain ideas and inspiration (Kneale et al., 2016), as shown in the focus group discussions where one student described a “lightbulb moment” as to how real science operates. Indeed, some researchers have described student experience of a research conference as being “transformative,” both in the short and longer term (Little, 2020; Walkington et al., 2017).

The poster session used an asynchronous format. Although there were a few reported issues with the OpenStudio interface, such as the need to download the audio commentary before listening, the session ran smoothly, with the asynchronous format less reliant on Internet connectivity than a synchronous format (Holt et al., 2020). An asynchronous poster session may lack the informal and spontaneous conversations that may take place in real time, with immediate feedback including from social cues such as facial expressions (Walkington et al., 2017). However, there is some evidence for text-based non-verbal communication through electronic cues such as the frequency and tone of postings and use of emoticons, which could have a positive influence on student engagement (Al Tawil, 2019). Such peer interaction was commented on positively in the focus groups and can help combat feelings of isolation among students (Al Tawil, 2019), particularly those studying at a distance. Asynchronous poster sessions can therefore provide a pragmatic and flexible alternative to synchronous online sessions, which is relevant not just in times of pandemics, but more widely with the increase in distance learning and international students in HE.

The study had some limitations. Firstly, the audio commentaries that students submitted to accompany their posters were not analysed due to time constraints. This may have influenced the findings regarding evidence for skills development, as it is possible the audio might have provided additional evidence, such as for critical evaluation. Analysing the audio commentaries would be a worthwhile follow up to gain a further insight, while recognising that oral communication is a key employability skill. Secondly, although the sample size was large, representing just over half the posters from the 2020 student cohort, it represented a snapshot from a single, perhaps somewhat atypical, year as the conference coincided with the start of the COVID-19 pandemic and first UK lockdown. This meant that students were experiencing considerable stress and uncertainty, both when producing and uploading their posters and

during the two-week poster session, which might have compromised their efforts. A longitudinal study following the same approach, but in a more “normal” year would be a worthwhile follow up to this investigation. Thirdly, the number of focus group participants was low, and students volunteered to participate in them. The focus group participants might therefore not have been representative of the wider student population for the module and are likely to have been those that are more actively engaged to start with.

## Conclusions

The HE landscape is rapidly changing, with online tuition and learning no longer an exception. This study demonstrated that an asynchronous online format could provide an effective, pragmatic, and flexible alternative to synchronous online poster sessions. The study showed that an asynchronous poster session enabled students to develop and demonstrate a range of higher-order skills relating to understanding, application, and critical evaluation. Students recognised the role of the poster session in developing these skills while being aware of the challenges involved in producing the poster and giving feedback. They appreciated the insight it gave them into real science, together with the personal benefits they gained in the form of enjoyment and increased confidence. Such confidence, together with the skills developed, will be of key importance as they complete their degrees and enter the future workplace.

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