

Exploring computing students post-pandemic learning preferences with workshops: A UK institutional case study

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ABSTRACT

The COVID-19 pandemic has caused both significant disruption and catalysed extensive experimentation in how education has been and may be delivered worldwide. The discipline of computing has been part of this experimentation, and significant innovations have been implemented and disseminated. Furthermore, educational provision and learner expectations may have evolved in response to the experiences during the pandemic; whilst still subject to disruption, higher education in many jurisdictions is still returning to a new (ab)normal. In the United Kingdom, whilst there has been a return to traditional face-to-face delivery, one estimate suggest that nearly a third of courses continue to involve some hybrid learning as opposed to c.5% before the pandemic. Learners' preferences for delivery approach remain critical and have been explored in previous work predominately by survey-based approach. This single UK institutional case study explores learner preferences by using workshops (N=45 students across ten workshops) which aspires to co-create an understanding of issues and benefits of the learning, teaching and assessment approaches adopted in the pandemic and identify preferences for future directions. The workshops employed the sailboat retrospective template; they suggest that the preferences are varied but commonly include some face-to-face study and that digital exclusion, social engagement, and motivation/distraction are vital factors to be addressed for further adoption of hybrid or online learning.

CCS CONCEPTS

• **General and reference** → **Empirical studies**; • **Social and professional topics** → **Computing education**.

KEYWORDS

COVID-19, workshops, learner perceptions, undergraduate

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1 INTRODUCTION

1.1 The impact of COVID-19

Across the three academic years of 2019–2020, 2020–2021, and 2021–2022, the COVID-19 pandemic significantly impacted on the delivery of education on a global scale [29], and especially the discipline of computer science [11–13]. In many educational contexts, there was a rapid transition to emergency remote teaching and remote working [10, 57]. The impact of this transition on university staff, both academic and professional services, has been much explored [25, 40, 58–60]. The perceptions of learners regarding the adopted adjustments has also been the topic of significant research [32, 44, 52, 53]. However, whilst COVID-19 continues to be a significant public health challenge globally [41], most countries have returned to a new sense of *normal* in terms of how education is delivered. Indeed, face-to-face education has returned in many, if not most, jurisdictions worldwide. However, not all provision is returning to solely traditional face-to-face delivery. UK media reports suggest that in the autumn term (September to December) 2022, 28% of courses were being taught in a “hybrid” manner, as opposed to 5% from before the pandemic [45].

As the pandemic progressed from 2020 onwards, there has been a profound impact on the education system across all settings and contexts [6, 37, 43, 58, 59]. This has catalysed innovation and experimentation in alternative learning, teaching, and assessment approaches [35, 43, 44, 62]. A literature review compiled by a recent ACM ITiCSE Working Group [44] focusing upon the impact upon students classified previous work into six themes: impacts of technology; experiences of virtual learning, health and wellness; study skills and support; community building and modality preferences. There have been significant challenges to address, including the impact of technology and rapidity of change [9, 12, 43, 44], issues arising from the digital experience of both learners and teachers [10, 50], digital exclusion [6, 8, 16, 43, 44], less personal engagement and interaction than in face-to-face setting [17, 21, 24, 48], lack of motivation and study focus [43, 48, 61], growth in academic misconduct and related adjustments [1, 36, 43, 46, 55], and learner wellbeing (such as social isolation, belonging, loneliness, anxiety related to unexpected change, other mental health issues or learner resilience issues) [6, 8, 14, 15, 27, 30, 34, 43, 44, 48]. The preferred approach for many learners has been reported to be face-to-face due to the social aspects [24].

Given these issues and the choices concerning the future delivery of courses, it is timely to explore and better understand learner preferences. Learners have experienced significant adaptation and experimentation over recent years; by better understanding their views, this allow practitioners to enhance and meaningfully co-create future curricula, assessment and delivery. A number of surveys have been employed to explore learning preferences; these surveys have indicated a variety of things. For example, a preference for hybrid learning rather than solely online or face-to-face study,

admittedly during the height of the pandemic [63]. Or alternatively, a preference for synchronous online delivery rather than asynchronous online delivery, again at the height of the pandemic [2, 31]. Or the importance of interactivity with fellow students and teachers as critical to the process [19]. A recent ACM ITiCSE Working Group reported significantly varied preferences, again with data obtained from a survey [44]. This paper describes the application of workshops rather than surveys and explores learner preferences within a more *normal* setting.

1.2 Post-pandemic learning

There has been considerable exploration and discussion regarding how education has and should continue to evolve following the COVID-19 pandemic and what benefits the adopted approaches provide. The importance of student preferences has been highlighted [44]. How should the curricula taught emphasise competencies and be personalised to an individual learner [62]? Should more active learning be promoted [62]? Perhaps the technologies adopted during the pandemic may help facilitate such changes [4, 33, 38, 62]. Should educators be better trained to employ such technologies [6, 43]? Benefits highlighted growth in the use of learning technologies (include lecture capture, ease of asking questions, the paperless classroom, etc) [47, 48, 58], sustainability or green benefits (such as less travel, paperless and reduced campus energy usage) [28, 47, 48], accelerated modernisation [58], “hyflex” (hybrid/flexible) learning and working (including attending remotely and remote guest lectures) [47] and improved communication within university departments [58]. Much of this work had focused on education or higher education more broadly. However, it has also been considered in computing education more explicitly [12–15, 28, 42, 43, 47, 61].

To date, much of the work has been descriptive research [7], in that it has been intended to describe and interpret the current situation. To this end, surveys [7] have predominantly been used with other mechanisms such as interviews [23] or ebook usage [61] being occasionally explored. Understandably, given the expectations for social distancing that have been in place in many jurisdictions worldwide, online surveys have predominated. The use of online surveys for education research is not without downsides. Specifically, it has been recognised that students can be reluctant to participate in online surveys [22] and also, those who are more comfortable with online working may be more likely to complete such surveys than those less comfortable [44]. This issue has been addressed by the employment of large sample sizes, but there may remain bias differences in perceptions between students who tend to complete online surveys and those who do so less frequently. This suggests that it is timely to consider if alternative data capture techniques to surveys can duplicate the reported survey results or yield new insights.

1.3 Motivation

This research is based on a single university in the UK, a jurisdiction where there has been a return to face-to-face teaching outside specialists in online education programmes. Whilst hybrid teaching continues at some universities in the UK, the university hosting this study has returned to face-to-face delivery for all non-specialist

programmes. In England, this return took place in January 2022, with a phased return in Scotland, Wales and Northern Ireland, and face-to-face teaching fully resumed in September 2022. With a *return to normal*, at pace in the UK, it is timely to explore learners’ perceptions of the efficiency and effectiveness of online and blended learning approaches. These preferences may be the same or different to those reported by other work completed during earlier stages of the pandemic. Such learners are in an informed position to comment upon the benefits and challenges of online/blended education and to co-create the aims for their ideal learning environment. Co-creation can be seen as “*occupying the space in between student engagement and partnership, to suggest a meaningful collaboration between students and staff, with students becoming more active participants in the learning process, constructing understanding and resources with academic staff.*” [3, p. 196]. In this work, focus groups were employed to establish the collective view [7] of groups of students. The use of interviews emphasises knowledge as generated in a conversation between people [20] and is consistent with the co-creation intention. Additionally, the alternative approach was adopted to determine if insights generated by survey-based approaches are reproducible. The work is based on the outcomes of 10 focus groups and the perceptions of 45 students, collected from focus groups that ran as part of scheduled classroom sessions.

1.4 Research questions

Two research questions are considered as part of this study:

RQ1: *From the perspective of computing students, what are the challenges and risks related to the further adoption of online or blended learning?*

RQ2: *From the perspective of computing students, what opportunities are presented by further adoption of online or blended learning?*

2 METHODS

2.1 Sample

The sample analysed in this paper includes 10 focus groups that ran as part of scheduled classroom sessions in November 2022, focusing on the perceptions of 47 students. The participants were all studying a Computing and Information Technology Foundation Year, which provides access to degree study. This programme is an integrated foundation year which provides access to degree-level study for those who have not otherwise met the admission requirements. Such programmes are standard in the UK, with, for example, 19,500 students studying them in 2017-18 [51]. The related syllabus concerns exploring the digital society, including topics on the use of technology in healthcare, politics and governance, manufacturing and education. Thus, exploring the impact of the COVID-19 pandemic and how computing education should be construed in the future is in keeping with the syllabus. Institutional ethics approval was sought and obtained (No.0267) before commencing any research or data collection, and all students have formally provided their consent in writing to participate. The study did not include focus groups in which consent was not forthcoming from any of the students. Furthermore, to ensure homogeneity, the focus groups took place in classes that ran within a single week and were delivered by the same teaching team.

2.2 Workshop Design

The analysis, design, implementation and evaluation cycle is increasingly common within software development and broader computing work [39]. Within these agile cycles, a team will meet to identify improvement opportunities for both product and process [39]. Such meetings are commonly known as retrospectives, and a wide range of alternative templates have been established to support them, for example: *Start, Stop Continue; Glad, Sad, Mad; Sailboat; The 4L's, Quick Retrospective* [26]. The students involved in the study have experienced a variety of learning approaches in recent years. This places them in a position to engage in a retrospective related to this experience, evaluate the experience and co-create a preferred way forward for future educational delivery. The sailboat retrospective was adopted for the workshop. This template adopts the analogy of sailing a boat to an idealised tropical island powered by wind, delayed by anchors and challenged by icebergs. It was felt this is analogous with us all progressing to post-pandemic normality. In this context, the wind is seen as helping promote adoption/make a change, anchors are seen as current issues that prevent change, icebergs are seen as potential risks, and the island is the goal or the idealised situation. The workshop was trial by running with Faculty colleagues and at BLINDED Conference[anonymous]. Each workshop was approximately one hour in duration.

The workshops were introduced by explaining to students the background of the workshop, how it related to their overall studies, and how students could opt-in to the research and complete the workshop as part of their studies. Students were then supplied and requested to read a participant information sheet. They were then offered the opportunity to opt-in to being included in the research. We have only included the focus groups in which all the involved students consented to be involved. The agenda for the workshop was then explained, and instructions for the operation of the workshop tasks were provided. The workshop itself was then run. The workshop began with the idea generation phase. This was to explore students' perceptions of issues and successes of online and hybrid learning. Initially, the students were guided to work individually, adopting a "brainwriting" approach to identify ideas [56]. The students were requested to add virtual stickies/post-it notes to the four quadrants (Wind, Anchors, Islands, and Icebergs). Then, as a team, the SIL Method (Successive Integration of Problem Elements (in the original German language)) was adopted [56]. Each team member explained their ideas in turn. Similar ideas were combined into a compound idea. Additional ideas were added. The problem categorisation section of the workshop was then run. This was to identify the students' perceptions of the most salient issues. Each team then agreed on the top three most significant ideas. A graph was employed with two axes. Difficulty from easy to very challenging to address was plotted in the x-axis. Impact from minimal to very significant impact was plotted on the y-axis. The three most significant ideas were placed on the graph. This serves to help classify the ideas into 'easy wins', 'hopeful investments', 'incremental improvements', 'projects you probably do not want to do' and 'issues to resolve or mitigate or avoid' (i.e. ideas with a negative impact). Finally, each focus group summarised their findings for the wider group.

2.3 Analysis

NVivo version 12 was employed to support the qualitative data analysis process, due to the claimed benefits of managing, querying, searching and visualising data and ideas [18]. The outcomes of the retrospectives completed in the workshops were converted into PDF documents and then imported into NVivo. The workshop retrospectives were analysed using grounded theory [5, 7, 49]. One of the research team read the retrospectives several times. The researcher then applied coding to each individual group of responses. The researcher then re-read the entire data set, and the coding was adjusted as required. This process was repeated with another research team member, reviewing the entire dataset several times and adjusting the coding as required. The two researchers then met to discuss differences and confirm their understanding and to ensure inter-rater reliability (IRR=0.82). The process was then repeated by a third member of the research team and then a meeting of the whole research team to confirm understanding. In the idea generation phase analysis, the codes were identified in each of the four key areas of the retrospective, namely *Wind, Anchors, Icebergs* and *Islands*. In the problem categorisation phase analysis, the four areas were not partitioned. Each identified code is then taken to represent a theme emerging from the workshops. These themes were reviewed rigorously against the data to ensure that they were compatible with the data and accurately represented the comments.

3 RESULTS

The results from the study are presented in three tables. The outcomes from the issue identification phase are considered first. The codes, together with an example of each code, are shown in Table 1. Table 2 shows the distribution of the codes that emerged in *Wind* (promoting change), *Anchors* (current issues that prevent change), *Icebergs* (risks), and *Island* (the idealised situation). The codes identified from the problem prioritisation stage of the workshops, examples illustrating those codes, and the frequency by which each code occurred are shown in Table 3. This table provides a sense of the urgent projects that the workshop participants felt should be addressed.

4 DISCUSSION

Issue identification will be discussed first, with each of the four quadrants considered in turn, i.e. *Wind* (promoting change), *Anchors* (current issues that prevent change), *Icebergs* (risks), and *Island* (the idealised situation). The problem prioritisation will then be discussed. This facilitates the holistic discussion to focus on the students' priorities and supports the co-creation of the vision for educational enhancements.

Wind – promoting change. The evaluations here were quite positive. Students perceive the available and emerging technology promotes alternative learning opportunities, some aspects of learning are better when completed online, and there are some opportunities presented by the resultant increase in flexibility and personal learning and a need to grow the digital literacy of learners and educators. However, it is notable that even in this positively framed section, there is also a sense that some aspects of learning are also worse in an online environment. This preference may vary by individual. However, the option for face-to-face learning remains

Table 1: Examples codes from Issue Identification - key themes

Code	Example
Promoted by available technology	Apps like zoom and teams enabled classes to take place remotely
Some things are better online	Online resources have been developed for extended online learning
Benefits from Hybrid or Hyflex	Classes can still be held without having all students and teachers in the same place.
Flexibility or personal learning	There is more flexibility instead of a strict structures school setting/ environment
Some things are worse online	Online learning is too removed or 'distanced' to be effective full-time
Digital Exclusion/Divide	Laptops and online learning equipment is too expensive for some students and even schools to afford
Digital literacy	Knowledge of technology
Independent learning	Independent learning
Higher motivation required or distractions	This relies on students being proactive learners. In reality this is unrealistic as students misbehave, especially the younger they are.
Unreliable technology	Technical difficulties causing problems such as bandwidth, old tech, broken hardware etc
Preference for face-to-face	Some people (the older generation) are against online learning for whatever reason.
Illness	Forced isolation causing us to miss learning during hybrid learning when we were going back to face-to-face learning to some degree
Hybrid learning	We are headed to more digital learning for people in certain situations in whereas they can't get to school or Uni because of various reasons such as being ill .
Everything face-to-face	Working in classrooms again
More online	A place where face to face learning is not as essential anymore
More focus on personal learning	To create more flexible, accessible, inclusive, and personalised form of education
Widening access to study	Distribute teaching to more isolated areas of the world where face to face teaching is impractical.
Bring your own device	Bring your own devices for learning, instead of relying on the learning establishment's technology.
Missing interaction or social development	Online learning distances students from the social aspect of school and therefore may take a negative toll on their mental health and social skills.
Cybersecurity	Online identity theft/ impersonation
Challenging to engage	When learning remotely students could just join the session and not actually take part.
Pandemic issues	COVID again
Digital badges or credentials as alternatives	Value of degrees vs Value of online credentials
Lowering standards	Learning material being 'watered down' – results in lack of detail and information
Challenges of changing approaches	Some students might find it difficult to transition to online learning after being in strictly a classroom setting for a long time

critical for some. The importance of individual student preferences has been highlighted by other studies [44].

Anchors – current issues that prevent change. Critically, issues related to the digital divide mean access to online and blended resources varies. At the workshops, some students discussed that their access to computing technology and the internet was primarily campus-based. For such students, the potential opportunities presented by alternative approaches are less attractive. These issues have been identified by survey-based work [6, 8, 43, 44]. The experience of online or blended education the workshop participants had experienced was before university at school or college. In this context, digital literacy was highlighted as a concern (as previously identified [10, 50]). This may be partly due to the rapid and enforced move to online learning [9, 12, 43, 44, 57]. Flexibility also appears to be a negative and a positive issue with higher motivation and more issues with distractions related to online/blended learning, which has also been reported elsewhere [43, 48, 61]. Technical issues also appear to have been disruptive. Some of the technical issues may also be linked to digital divide issues, e.g. several users attempting

to share a single domestic broadband connection. Of note also that some groups just preferred face-to-face learning.

Icebergs – risks. The lack of personal interaction and social isolation are perceived as the most frequent future concern. This was a common feature of the literature [17, 21, 24, 48]. Another common concern is digital exclusion and the digital divide. The economic situation in the UK at the time of writing is somewhat challenging for students [16, 54]. These circumstances may be making an impact. Challenges related to motivation and distraction from online/blended learning surface as they did in the previous section. Interesting to see issues related to cybersecurity being highlighted, which parallel with the assessment security issues highlighted in [1, 36, 43, 46, 55].

Island – the idealised situation. The outcomes here were diverse. Some groups seek more hybrid learning, others more face-to-face and others more online learning. This is in the context of a cohort of students who have enrolled on a face-to-face course. To satisfy these varying demands in terms of the idealised future, the workshops suggest variety and customisation around individual

Table 2: Issue Identification Retrospective

Wind – promoting change		Island – the idealised situation	
Theme	Frequency	Theme	Frequency
Promoted by available technology	8	Hybrid learning	6
Some things are better online	8	Everything face-to-face	3
Benefits from hybrid or hyflex	4	More online	2
Flexibility or personal learning	2	More focus on personal learning	2
Some things are worse online	2	Widening access to study	2
Digital literacy	1 each	Bring own devices	1
Independent learning			
Anchors – current issues that prevent change		Icebergs – risks	
Theme	Frequency	Theme	Frequency
Digital Exclusion/Divide	6	Missing interaction or social development	7
Digital literacy	5	Digital Exclusion/Divide	5
Higher motivation required or distractions	5	Cybersecurity	4
Unreliable technology	5	Challenging to engage	4
Preference for face-to-face	3	Pandemic issues	3
illness	2	Digital badges or credentials as alternatives	1 each
Missing interaction or social development	1 each	Lowering standards	
Cybersecurity		Unreliable technology	
		Challenges of changing approaches	

Table 3: Examples of codes from Issue Prioritisation - key projects

Project	Frequency	Example
Digital Exclusion	6	The resources required for online learning are not accessible to everyone
Social Engagement	6	Online learning too remote – removes social aspect of education
Distraction or motivation	5	Motivation is required in a student to learn effectively online – concentration is difficult otherwise
Cybersecurity	3	To be able to go completely digital without the risk of security issues such as data leaks.
Flexibility	3	We are headed to more digital learning for people in certain situations in whereas they can't get to school or Uni because of various reasons such as being ill .
Digital literacy	1	Importance of digital literacy, knowing how to use the technology for a better experience in learning
Face-to-face is best	1	Unwillingness to accept online learning methods
More Hybrid learning	1	We could be see a future of mostly remote learning and less and less face to face teaching.
Unreliable technology	1	The technology we use can still sometimes fail, such as a zoom meeting crashing

learner preferences appear to be desired. This is consistent with the discussion in the wind section in section 4 and other studies [44].

Prioritisation – projects to address. The three most significant projects highlighted were, addressing digital exclusion, ensuring social engagement and thereby reducing isolation, loneliness and reducing related well-being issues, and addressing perceived motivation/ distraction issues that are associated by many with on-line/blended learning. These issues are addressed in part by providing face-to-face learning. Together this suggests the idealised way forward, maybe to supplement face-to-face learning with digital learning opportunities but not to replace the face-to-face learning opportunities with them. For example, at the workshops, when groups were asked regarding the need for the continued provision of online resources created during the pandemic, there was a strong sense that such support should continue, for days students either couldn't or decided not to attend the face-to-face classes.

4.1 Limitations

This study is subject to a number of limitations. Firstly, this is a single institutional study of one UK university. The outcomes in other universities in the UK or other jurisdictions could be different, especially considering varied demographics. Secondly, a larger study could yield different results. The study is based on ten workshops involving 45 students. Thirdly, the workshops were run as part of a taught course. The students were aware academic faculty was reading the outcomes. This may have influenced the content. Fourthly, the students in the workshops were from a single programme of study, namely the foundation year access course. This means their perceptions will be influenced by the school or further education provision they have experienced. Schools may have been less set up to provide an engaging online or hybrid learning experience than universities, as they typically have fewer educational

resources at their disposal. For example, not all schools would have had a virtual learning environment, whereas most UK universities would have at least one. Fifthly, the workshops were completed in a classroom setting, so the perceptions of students' peers may have influenced the outcomes. Additionally, the students had chosen to study a face-to-face programme, possibly due to their preference for face-to-face study. Finally, the workshops were delivered as part of a course exploring digital society more broadly, and some of the themes of that course (for example, security, digital inclusion and exclusion) may have influenced the outcomes.

5 CONCLUSIONS AND FUTURE WORK

As discussed in the previous section, this is a single university study, employing ten workshops and involving 45 students. As such, care needs to be taken before making conclusions regarding the general case. However, the results do highlight specific challenges and preferences for future learning approaches within this cohort, which may apply to other instances; this supports a general recommendation for scaling this work to larger cohorts and across multiple institutions.

In terms of RQ1: *From the perspective of computing students, what are the challenges and risks related to the further adoption of online or blended learning?*, the workshops highlight there are a number of barriers to the extension of online and blended learning. Increased isolation and decreased social engagement with online/blended learning were seen as key blockers. The flexibility offered by blended/online learning is perceived to result in positive and less positive consequences. To some, the flexibility presented more opportunities for procrastination or being distracted. Different learners have significantly different economic circumstances. The educational design of courses needs to factor in digital inclusion and exclusion, or it will not support the needs of all students. Face-to-face teaching is accessible to all students who attend.

In terms of RQ2: *From the perspective of computing students, what opportunities are presented by further adoption of online or blended learning?*, there are many different perceptions and preferences, and going forward, it appears that students desire flexibility and choice. However, it appears that face-to-face tuition is a critical part of the mix for many. Supplementing face-to-face with further support appears welcomed. This could be because of the barriers discussed in relation to RQ1 and Section 4.

Looking ahead, a number of the outcomes highlighted in this study are broadly similar to those in published outcomes based on survey-based work discussed in Section 1.1. However, the situation continues to be a transient one, especially reflecting on the huge corpus of work published in this space over the past couple of years. The learners in this study appear to be anticipating education post-pandemic will be different to education pre-pandemic. While there is an expectation for face-to-face classes, it appears there is an increased demand for that to be supplemented by an enhanced online offering. This creates an increased workload for faculty and professional services staff. Assuming these perceptions are replicated elsewhere, how these learner preferences can be addressed is worthy of further discussion. From the learner's perspective, there is a promise of an enhanced, co-created, more flexible offering that should better support their personal learning preferences. That is

an outcome that should be welcomed. The workshop developed in this research is a potentially effective approach to co-create with students the design of the learning approaches adopted. The next steps will involve running the workshops for other cohorts of students, studying the same and different programmes at the same and other universities. This co-creation would help ensure all parties can learn and benefit from the experiences of learning during the pandemic to formulate enhanced learning experiences.

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