Horizons in STEM Higher Education Conference Proceedings

Making Connections, Innovating and Sharing Pedagogy

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Contents

Plenary 1, Opening Keynote (Wednesday 29th, 10.00)

Active learning as a means of making STEM education fun!

Dr Richard Blackburn, Associate Professor and Director of Education in Chemistry, University of Leicester.

My work at Leicester has focussed on designing activities and instructional methods centred upon not only better equipping our students for their progression (academic + career), but also ensuring their learning is fun and engaging . In this talk I look forward to highlighting two key activity themes, the methods and tools we used to implement them, and the outcomes they have had.

Theme 1 (Research Inspired Communication):

Activities have been created that refocus communication assessment on tasks that allow students to engage with research and their passions, whilst also making the task fun through reduction in anxiety levels. First year students were asked to each create an infographic based on one of their host department's research articles as a new exercise for the "science communication" aspect of the degree. For Batchelor level-research projects, viva voce examinations have made way for a conference-like poster session, with academics judging the design of their poster and the student's competence at presenting and defending the science on that poster.

Theme 2 (Problem Solving):

To improve student's ability to problem solve and retain complex information, we have tried to embed recognition, design and critique throughout our theory modules at Leicester. For entry-level courses we have traditionally used student developed puzzles and card-games to break the ice, help cement core concepts and establish friendships. For mid-level courses, a daunting and difficult topic was revitalised through the creation and embedment of a 3D workflow in class time. For an advanced-level module students were set fun homework tasks (akin to flipped problem classes) as a means to encourage participation and discussion in class.

I very much look forward to sharing these with you all, and in a way that is translatable to the many disciplines covered by this conference.

Active Learning 1 (Wednesday 29th, 10.40)

Revisiting the research-teaching nexus framework: a case study introducing research into programme level, undergraduate teaching

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Internal and external drivers have seen Higher Education Institutions (HEIs) place increasing emphasis on the links in their curricula between teaching and research. It is widely accepted that HEIs endeavour to develop such links between teaching and research, and many institutions advertise their curricula as research-led (Brown & Smith, 2013; Hattie & Marsh, 1996). Despite the apparent positive trend towards research-oriented undergraduate programmes, there are a number of documented challenges or risks to incorporating research into teaching and learning (Gresty, Pan, Heffernan, & Edwards-Jones, 2013; Pan, Murray, & Cotton, 2011). In this talk we will present the theory and implementation of a programme-level framework (adapted from Griffiths (2004), Healey (2005), and Levy (2009)), supporting a student developmental journey from resource consumers to research generators. We provide examples of implementation from the Natural Sciences programme at the University of Leicester where we have used this framework to implement a degree curriculum which scaffolds the development of research skills. This framework allows students to get more value from research-apprenticed tasks by having previously experienced the research-based and research-oriented activities. Although much has been reported on how to integrate teaching and research at an institutional level, little has been reported on how this can be achieved in a holistic way at a programme level. The aim of this iteration of the research-teaching nexus is to provide a framework that can be used to facilitate the design or review of a programme level curriculum.

Brown, S., & Smith, B. (2013*). Research, teaching and learning in higher education* Routledge.

Gresty, K. A., Pan, W., Heffernan, T., & Edwards-Jones, A. (2013). Informed teaching from a risk perspective. *Teaching in Higher Education*, 18(5), 570-585.

Griffiths , R. (2004). Knowledge production and the research–teaching nexus: The case of the built environment disciplines. *Studies in Higher Education*, 29(6), 709-726. doi:10.1080/0307507042000287212

Hattie, J., & Marsh, H. W. (1996). The relationship between research and teaching: A meta-analysis. *Review of Educational Research*, 66(4), 507-542.

Healey, M. (2005). Linking research and teaching to benefit student learning. *Journal of Geography in Higher Education*, 29(2), 183-201.

Levy, P. (2009). Inquiry-based learning: *A conceptual framework. Centre for Inquiry-Based Learning in the Arts and Social Sciences. University of Sheffield.* *http://Www.Sheffield.Ac.Uk/Content/1/C6/09/37/83/CILASS% 20IBL% 20Framework, 20*

Pan, W., Murray, P., & Cotton, D. (2011). (2011). Drivers, barriers and strategies for implementing research-informed teaching: A case study of the environmental building discipline. Paper presented at the *International Conference in Engineering Education (ICEE), 2226.*

vPBL: developing a facilitated remote approach to problem based learning

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An existing classroom-based Problem Based Learning (PBL) activity was transformed to run as a remote activity during the COVID-19 pandemic using an approach described as virtual Problem Based Learning (vPBL). PBL is an active-learning approach that requires students to work in small teams on open-ended problems with real-world scenarios.[1] It was important that vPBL approach was designed in a way that provided teams with the tools and support required to collaborate effectively while students were physically separated. The vPBL approach is based on: (i) identification of suitable technologies that support collaborative working in a way that mimics classroom based activities and provides additional flexibility for teams to work together, and (ii) adaptation of the problem structure to provide additional time for students to work together and additional facilitated support where needed. The activity chosen for the initial PBL to vPBL transformation took place in the first year of the chemistry degree programme at the University of Leicester.[2, 3]

Student use of technology was measured using an anonymous online questionnaire. Anonymised student performance in the vPBL activity was analysed and compared with analogous data from the pre-pandemic PBL version of the activity. Student performance and self-reported levels of transferable skills development in the vPBL activity were at least as good or better than they were in the PBL version of the same activity. Furthermore, the transition to vPBL appears to have no negative impact on student learning and development. There was evidence that suggested that greater students made more use of some collaborative digital learning tools (Audio and video chat and desktop and file sharing) in the vPBL cohort compared to their colleagues who learnt primarily through interactive online lectures. It is worth noting that the same approach may be used to scale-up existing PBL approaches where logistical limitations (e.g. availability of suitably large rooms) prevent scale-up in a classroom setting. The vPBL approach may also potentially allow for new multi-institutional or even international collaborative activities based on the pedagogy of Problem Based Learning.

This presentation will provide an overview of the process used to modify a classroom-based PBL activity to work in the vPBL format including guidance on how to successfully organise and facilitate vPBL sessions.

1. Savery, J. R.; Duffy, T. M., Problem Based Learning: An Instructional Model and Its Constructivist Framework. *Educational Technology* **1995,** *35* (5), 31-38.

2. Williams, D. P., Learn on the Move: A Problem-Based Induction Activity for New University Chemistry Students. *Journal of Chemical Education* **2017,** *94* (12), 1925-1928.

3. Williams, D. P.; Woodward, J. R.; Symons, S. L.; Davies, D. L., A Tiny Adventure: the introduction of problem based learning in an undergraduate chemistry course. *Chemistry Education Research and Practice* **2010,** *11* (1), 33-42.

Assessment 1 (Wednesday 29th, 10.40)

Assignment extensions – use, impact and policy

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The sector move towards more personalised, adaptive learning has led to research into the importance of completion deadlines and their impact on student performance. Ariely and Wertenboch (2002) recommended that evenly spaced deadlines promoted completion of tasks, but Koch et al. (2015) found that while extrinsic motivators, such as assignment deadlines, can increase engagement, effects on performance were mixed. The timing and flexibility of deadlines has been explored; Burger et al (2011) found that what they had considered to be well-chosen deadlines to help people overcome procrastination and make people more likely to complete had the opposite effect, and could indeed impose additional hurdles to completion. Miller et al (2019) found that rigid deadlines had a negative relationship with participation.

The Open University has a more flexible approach to deadlines than is typical for the sector. This work was motivated by the apparent increased demand for assignment extensions, potentially driven by the increase in number of students studying at high intensity, and concerns that this could be adversely impacting student performance.

A mixed methods approach was used to investigate how students use extensions, whether this depended on variables such as module choice, study intensity, qualification, disability, and the impact on success metrics such as assignment scores and overall module outcomes. The modules considered comprise the Level 5 Biology / Health Sciences curriculum.

The key findings were:

- proportionally twice as many extensions were granted to disabled students;
- students studying a largely vocational qualification (Health Sciences) required more extensions than Biology/Natural Sciences students;
- requests for long requests on an early assignment can be an indiactor of struggle;
- extensions were not confined to low attainers;
- for a content-heavy module there was evidence of an adverse impact of multiple extensions on final (exam) outcome, but this was not evident on more skills-based modules.
- no evidence of tactical use of extensions to spread workload; they were requested on an immediate need basis.

Based on the findings, recommendations have been formulated on policy on assignment extensions, assessment design and use of extensions diagnostically. Further research on the impact of assessment policy on disabled students is strongly recommended.

Ariely, D. and Wertenbroch, K. (2002) 'Procrastination, Deadlines, and Performance: Self-Control by Precommitment', *Psychological science*, 13(3), pp. 219–224. doi:10.1111/1467-9280.00441.

Burger, N., Charness, G., & Lynham, J. (2011). Field and online experiments on self-control. Journal of Economic Behavior & Organization, 77, 393–404. doi:10.1016/j.jebo.2010.11.010

Koch, A., Nafziger, J., & Nielsen, H. S. (2015). Behavioral economics of education. *Journal of Economic Behavior & Organization*, 115, 3–17 https://doi.org/10.1016/j.jebo.2014.09.005

Miller, L. A., Asarta, C. J. and Schmidt, J. R. (2019) Completion deadlines, adaptive learning assignments, and student performance, *Journal of Education for Business*, 94:3, 185-194, DOI: 10.1080/08832323.2018.1507988.

Investigating barriers that prevent students attaining their full potential during their degree

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Social and economic barriers that students face during their course can impact severely on their attainment and can be due to many factors. This student led SADRAS project investigated how different socio-economic factors affected students' attainment potential at university. Prior to the Covid-19 pandemic, at Kingston University, most of the lectures, within the School of Life Science (SoLS) ran at a 50 to 60% attendance capacity. It was thought that moving lectures into the online environment would result in higher attendance and attainment by students, however, the complete opposite occurred, with lower attendance rates than seen previously. Aucejo and colleagues (2002) previously demonstrated that students from a lower socio-economic background were 55% more likely to delay their graduation compared to peers coming from higher socio-economic backgrounds. Many of the students within the SoLS are commuting students and have to work to support themselves and their family whilst studying, with some even being the sole breadwinner. It has been reported in literature that long commutes can also impact upon student attainment (Martijn B, et al. 2015). Further, students from low socio-economic backgrounds and students who live far away due to housing costs have been shown to have low levels of self-confidence that can span many generations and thus impact on their career progression and this negative impact could subsequently affect their capacity of achieving their full potential, with the COVID-19 pandemic exacerbating this effect (Crawford et al., 2014, Domina et al., 2021, Filippin & Paccagnella 2012). Using questionnaires and small group interviews to assess the potential issues students may have experienced during their degree, this current study aims to identify the possible barriers that prevent students in fulfilling their full potential. The project's preliminary data suggests that over 35% of students came from a working-class background and 35% are the first generation to attend university in their family. Common preliminary barriers seem to be long commuting time (over 50% of students have a minimum 60 minute journey), and a second barrier seems to be the requirement to work alongside their degree (80% students have to work to supplement their studies). Furthermore, students who received less support from their personal tutor seemed not to thrive academically as students who had regular meetings with their personal tutor. This data will be further analysed thematically to give a conclusive outcome on the identified barriers, but also to report the findings of small group interviews which will facilitate the in-depth understanding of the potential barriers and exploration of possible interventions to allow students to obtain their full potential during their degree course.

Aucejo, E. M, French, J., Arya, M. P. U., Zafar, B., (2020) The impact of COVID-19 on student experiences and expectations: Evidence form a survey. *Journal of Public Economics.* 191, 104271

Antonio Filippin, Marco Paccagnella., (2012) Family background, self-confidence and economic outcomes. Economics of Education Review. Volume 31, Issue 5. Pages 824-834

Claire Crawford, 2014. "Socio-economic differences in university outcomes in the UK: drop-out, degree completion and degree class," IFS Working Papers W14/31, Institute for Fiscal Studies.

Domina T, Renzulli L, Murray B, Garza AN, Perez L. Remote or Removed: Predicting Successful Engagement with Online Learning during COVID-19. *Socius*. January 2021.

Martijn B.W. Kobus, Jos N. Van Ommeren, Piet Rietveld. (2015). Student commute time, university presence and academic achievement, Regional Science and Urban Economics, Volume 52. Pages 129-140.

Blended Learning 1 (Wednesday 29th, 10.40)

Exploring post-pandemic fieldwork challenges and opportunities

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Fieldwork is an important part of higher education learning in a range of disciplines and helps to prepare graduates for a range of discipline-related employment opportunities. A number of studies have demonstrated the effectiveness of fieldwork for developing a wide range of generic skills (Fuller et al 2006; Maskall & Stokes, 2008), providing a learning space for active and collaborative learning (France et al., 2019) and helping to narrow the demographic achievement gap (Beltran et al., 2020). Building on a range of previous research on the provision of fieldwork in HE curricula (Maw et al., 2011) and student views of fieldwork (Welsh et al., 2015, 2018) the Enhancing Fieldwork Learning [EFL] team undertook a snapshot of students' perceptions of fieldwork in Autumn 2021 to understand which aspects they most value from this part of their learning experience and to evaluate whether the their experiences during the pandemic had altered their views on fieldwork provision and delivery. Additional perspectives on inclusive provision and sustainability were explored.

A short, online questionnaire was prepared in Qualtrics and distributed to HE students via the EFL website, social media and via a key contact list of fieldwork educators. 25 undergraduate students completed the questionnaire, across all year groups and covering a wide range of subjects.

Quantitative and qualitative data were collected on a range of topics including the desired mode of delivery going forward, the need for in-person fieldwork and skills that students believed to be important. Students were asked whether sustainability and carbon footprint issues related particularly to international fieldwork required further consideration.

Our respondents felt that whilst the virtual fieldwork alternatives that had been offered during the pandemic had aided learning, there was a strong desire across all disciplines to get back in the field for in-person learning, although some recognised the potential benefits of a blended offering in which in-field activities were supported and scaffolded by online and virtual activity. Nearly half of the sample had felt excluded from fieldwork at some point, some because of disability and many because they could not afford some of the more exotic fieldwork destinations offered as options.

In relation to sustainability issues, there were a range of responses with some students suggesting activities should take place as close to campus as possible, whilst others suggested the carbon footprint of a number of relatively small field courses was negligible in the wider context and should not necessarily be considered.

Overall, this snapshot suggests that any shift to the use of virtual fieldwork as a more permanent option for student learning needs careful consideration. Further, there are clear issues associated with inclusion [particularly related disability and financial issues] and the environmental sustainability of fieldwork options that require further exploration. From the conversations in 2021 it seems that fieldwork educators are starting to adjust fieldwork provision and barriers to access (Giles et al.,2020) are starting to be removed.

Beltran, R.S., Marnocha, E., Race, A., Croll, D.A., Dayton, G.H. & Zavaleta, E.S. (2020) Field courses narrow demographic achievement gaps in ecology and evolutionary biology. Ecology and Evolution, 10(12), pp.5184-5196.

France, D., Mauchline, A., Whalley, W. B., Doolan, M. A. & Bilham, T. (2019) Authentic learning through place-based education. In: Bilham, T., Hamshire, C., Hartog, M. and Doolan, M. A. (eds.)

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Fuller, I.A.N., Edmondson, S., France, D., Higgitt, D. & Ratinen, I., (2006) International perspectives on the effectiveness of geography fieldwork for learning. Journal of Geography in Higher Education, 30 (1), pp.89-101.

Giles, S., Jackson, C. & Stephen, N. (2020) Barriers to fieldwork in undergraduate geoscience degrees. Nature Reviews Earth & Environment 1, 77–78.

Maskall, J. & Stokes, A. (2008) Designing Effective Fieldwork for the Environmental and Natural Sciences, Plymouth: GEES Teaching and Learning Guide.

Maw, S. J., Mauchline, A. L., & Park, J. R. (2011). Biological fieldwork provision in higher education. Bioscience Education, 17(1), 1-14.Welsh, K.E., Mauchline, A.L., Powell, V., France, D., Park, J.R. & Whalley, W.B., (2015) Student perceptions of iPads as mobile learning devices for fieldwork. Journal of Geography in Higher Education, 39(3), pp.450-469.

Welsh, K. E., Mauchline, A. L., France, D., Powell, V., Whalley, W. B., & Park, J. (2018). Would Bring Your Own Device (BYOD) be welcomed by undergraduate students to support.

Blended learning field trips and their role in a post-COVID-19 world: evaluating digital education technologies used to enhance student field trips

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Taught field courses are a critical component of most geoscience degree programs, allowing students to gain and improve practical field skills, and appreciate the context, scale, and three-dimensionality of geological features. Traditionally, field teaching includes lecturing in the field, practical skills demonstration and practice, class and small group discussion, and formative and summative assessment and feedback (Butler, 2008). During the COVID-19 pandemic when in-person field teaching was not possible, many educators created and used virtual resources to achieve similar learning objectives to traditional field courses. These resources utilised new technologies and innovative techniques borrowed from other disciplines, such as videos describing key localities, instructional videos explaining and demonstrating practical skills, and 3D virtual outcrop models which allow students to make primary observations from virtual material.

While virtual resources are unable to wholly reproduce the learning experience of in-person fieldwork, they do present some educational and logistical advantages (Granshaw and Duggan-Haas, 2012). Videos allow discussion of localities in an order which best fits the educational narrative, regardless of geography, and allow students' gaze to be precisely directed to key features (e.g. Hata et al., 2016). 3D models allow observations at scales broader than can be seen in the field. Virtual material is also more accessible to students with disabilities and allows all students the same opportunities to see key features.

Here, we explore the ongoing role of virtual field material as we transition beyond the COVID-19 pandemic and present a case study of a blended learning fieldtrip to Bradgate Park, Leicestershire, UK for 59 second-year undergraduates aimed at teaching geological mapping and field structural geology skills. We created virtual materials to be used before, during, and after the fieldtrip to provide the educator-led elements of this exercise. This supplemented the student-led in-person fieldtrips, which allowed students to practice field skills and complete summative assessments. The virtual material consisted of (1) an overview video on the theoretical background, (2) an instructional video explaining and demonstrating the skills needed to complete the exercise, (3) ten videos

describing each of the key localities, (4) fourteen 3D virtual outcrop models of each of the key localities, and (5) a Google Earth Tour showing the spatial context of the other virtual material.

We assess the usage and effectiveness of each set of virtual resources using view analytics and a feedback survey. Preliminary data show that the overview and skills videos received the most engagement, while the outcrop description videos received the least. We also found that students engaged most with the virtual material after the fieldtrip, despite it being available in advance. This suggests that students favour virtual material that offers an additional perspective on the field area over material that describes field observations.

Based on our case study, we recommend a blended learning approach to field courses where virtual material supplements, but does not replace, student observations. We also advise additional attention be given to formative assessments during the fieldwork to confirm that students have engaged with, and correctly understood, the prerequisite virtual content.

Butler, R., 2008. Teaching Geoscience through Fieldwork. University of Plymouth, Plymouth, United Kingdom.

Granshaw, F.D., Duggan-Haas, D., 2012. Virtual fieldwork in geoscience teacher education: Issues, techniques, and models, in: Google Earth and Virtual Visualizations in Geoscience Education and Research. Geological Society of America. https://doi.org/10.1130/2012.2492(20)

Hata, H., Koike, H., Sato, Y., 2016. Visual Guidance with Unnoticed Blur Effect, in: Proceedings of the International Working Conference on Advanced Visual Interfaces. Presented at the AVI '16: International Working Conference on Advanced Visual Interfaces, ACM, Bari Italy, pp. 28–35. https://doi.org/10.1145/2909132.2909254.

Equality, Diversity and Inclusion 1 (Wednesday 29th, 10.40)

Award gaps in "The Physics Degree": preliminary results from a large dataset of all UK undergraduates 2012–2020

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It is a pressing concern that undergraduates from different backgrounds are awarded "good degrees" (2:1/1st) at differing rates; for example, the Black–White and Disabled–Non-Disabled award gaps, both of which the Office for Students aims to close over the next decade (OfS, 2021). Advance HE routinely reports award gap data for age, disability, ethnicity, and gender down to the level of broad subject areas (e.g., Advance HE 2020). Previously, we have used these data to analyse award gaps in physical sciences—a broad subject area including physics, etc.—finding that the award gaps for disability, ethnicity and gender have remained remarkably consistent over the past two decades, while the award gap across age has reversed (Stirton, 2021).

However, Simson's Paradox (Simson, 1951), in this context, shows that where participation rates vary between subjects it is possible for each subject to exhibit an award gap opposite to that found in the subject area overall. As a result, while these summary statistics may be useful for checking the 'health' of diversity in physical sciences, they ultimately tell us very little about the diversity situation for on-the-ground teaching within individual subjects—or even within specific degree programmes.

In the present work, we explore demographic gaps in a broadly similar class of degree programmes: those that match "The Physics Degree" (IOP, 2011) as determined by Institute of Physics' accreditation process (IOP, 2021). We compare these to award gaps found in degree programmes as grouped by JACS subject code, including comparing accredited physics degrees with all degrees coded as physics under JACS.

This work forms a preliminary analysis of a large demographic and degree outcome dataset. The dataset consists of 13 million records, comprising yearly snapshots of all undergraduates at UK HEIs between the years 2012/13 and 2019/20. In addition to degree programme data, the dataset includes variables describing students' age, disability status, ethnicity, gender, and socioeconomic status along with 13 other demographic variables. Outcome variables include class of first degree, level of qualification obtained, and the reason for ending study (successful qualification or otherwise).

In our analysis, we quantify first-order award gaps across the noted demographic groups; construct lower-bound estimates of the corresponding confidence intervals; and use the odds ratio form of the award gap for comparison between years and subject areas. We discuss the ethical implications of reporting these gaps along with the statistical challenges of calculating them, including: Simson's paradox, overdispersion, and the role of causal inference.

Advance HE. 'Equality + Higher Education: Students Statistical Report 2020'. Advance HE, 2020.

Institute of Physics. 'Register of Accredited Courses: Issue 37'. Degree Accreditation Registers, June 2021.

Institute of Physics. 'The Physics Degree: Graduate Skills Base and the Core of Physics', September 2011.

Office for Students. 'Participation Performance Measures - Office for Students'. Office for Students, 11 March 2021. Worldwide. https://www.officeforstudents.org.uk/about/measures-of-our-success/participation-performance-measures/.

Simpson, E. H. 'The Interpretation of Interaction in Contingency Tables'. *Journal of the Royal Statistical Society: Series B (Methodological)* 13, no. 2 (July 1951): 238–41. https://doi.org/10.1111/j.2517-6161.1951.tb00088.x.

Stirton, A., Hedgeland, H., Lohstroh, A. and Jordan, S.'Demographic Gaps in Physics Attainment and Degree Outcomes'. Presented at the Horizons in STEM Higher Education Conference, 30 June 2021.

The impact of commuting and COVID-19 on assessment gaps at a London university

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The reasons for the observed national awarding gaps in HE are complex with numerous causes having been proposed. Some of the largest HE awarding gaps are seen in London (Closingthegap, 2019), where paradoxically there is higher attainment in secondary education amongst pupils from ethnic disadvantaged backgrounds (Ross et al, 2020). Post-92 London institutions such as Kingston University attract a high percentage of these ethnic disadvantaged students from across London, where many choose to remain in the same home environment as at school. Nonetheless, these students once at university seem to fair less academically well than their white counterparts. Previously, we have identified significant differences between our ethnically diverse and white students in their commuting habits, where 75% of white students lived locally within 30 minutes of the campus compared to 40% ethnic students (Page et al. 2021). This leads to significantly longer and complex journeys for those commuting students creating significant time spent on travel adding extra stress and dissatisfaction. There has been little research to demonstrate the direct impact of commuting on individual attainment, BME awarding gaps and the impact of COVID-19 (when essentially most students could no longer commute to study). In our faculty of Science, Computing, and Engineering (n≈4000), we found pre-pandemic awarding gaps for both commuting and BME students (Asian, Black and mixed race). Commuting added its own premium irrespective of white or ethnic group suggesting commuting by itself had only marginal impact in contributing to existing BME awarding gaps. Nonetheless, by virtue of 70% of our students being BME, of which two thirds commute compared with 30% white of which only half commute, this contributed to nearly 10% of the existing BME awarding gap by simple virtual of the greater number of commuting BME students. The significant reduction in commuting through the COVID-19 pandemic led to convergence/alignment of attainment between commuting and non-commuting students in each ethnic group effectively removing or reducing the commuting attainment gap. However, this did not lead to any corresponding reduction in BME awarding gaps. A closer analysis of bioscience students using three-way intersectionality revealed lockdown benefitted white commuters (especially male) irrespective of index of mean deprivation (IMD) or age and young commuting Asian males. Whilst attainment for commuting ethnic groups was relatively unaffected by lockdown those classified previously as non-commuters were significantly affected especially Black students irrespective of gender, IMD or age. In conclusion, this study found commuting itself contributed marginally to the BME awarding gap excepting by virtue of having an overrepresented BME group, who were more likely to live at home and commute. There are clear benefits for non-commuting BME students in normal circumstances that were lost during lockdown as their performance became more closely aligned with their commuting counterparts. Irrespective of commuting or COVID-19, a substantive awarding gap still exists that remains complicated and likely impacted by a host of factors such as subject area and ratios of different ethnic groups on each course.

Active learning 2 (Wednesday 29th, 11.50)

A new model for mathematics teaching and learning for engineers

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NMITE is a new UK HEI delivering engineering and technology programmes with a fundamentally different approach: engineering "as an integrated discipline which is intrinsically embedded in society and whose purpose is primarily to improve the human condition" (Goodhew, 2020). This approach is underpinned by a "learning-by-doing" model, learning driven by real-world challenges to the learner engineers. NMITE aims to produce work-ready world conscious engineers.

Early in its inception, NMITE identified it was important to reduce barriers to entry to engineering programmes so as to attract a much more diverse group of candidates. The first cohorts, September 2021 and January 2022, come from a diversity of backgrounds: approximately a third were mature candidates accepted through a 'recognised prior experiential learning' route, another third are recent school leavers with maths and physics A Levels, and there is also a group with only GCSEs in maths and the sciences. In the UK, it is recognised that the standard requirement of maths and physics A levels for most engineering programmes is one of those barriers (Engineering UK, 2020). A minority of young people take mathematics or physics beyond age 16+, and the gender, socio-economic and BAME balance in maths and physics in the 16-18 cohorts is skewed in favour of white middle class boys. NMITE has reduced the usual entry requirements related to maths and other science qualifications, instead focussing on behaviours and values that drive intrinsic motivation. This has an impact on the expected mathematical skills of our new learners and the need to develop those skills as and when needed, and importantly in a just-in-time mode, during the programme.

The ASK (Academic Skills & Knowhow) Centre is a core element of NMITE's strategy to allow learners with fewer qualifications in maths to succeed at NMITE. The ASK supports learners with skills gaps, in particular mathematics, at the initial stages of their programme. ASK encourages self-driven learning: the ASK services are optional, and learners choose to take part. This means that maths at the ASK has to feel relevant and important to students.

This paper will present the early experiences of delivering mathematics learning through the ASK Centre. The aspects considered here are:

- practical issues of having a diversity of learners with different mathematical backgrounds: including transition and supportdifferent delivery methods: comparing uptake and progress with self-directed learning versus face-to-face delivery, and the use of interactive tools
- mapping of mathematical skills to the curriculum: how to find where and when needed, and to what level
- learner engagement in the process of designing materials
- and the use of diagnostics and assessment of learning.

We are not just concerned with the maths for the curriculum: we wish to ensure NMITE graduates have real-world maths competencies. Practicing engineers report quite different and disparate views of the use of maths in their everyday working life. The paper will also consider

- re-thinking maths: what mathematical competencies will NMITE engineers need beyond their first months as learners?

Engineering UK. (2020). *Engineering UK 2020: Educational pathways into engineering.* Retrieved from https://www.engineeringuk.com/media/232298/engineering-uk-report-2020.pdf

Goodhew, P. (2020). *Idea to Inauguration - founding a university in the UK.* Retrieved from http://www.goodhew.co.uk/Hereford%20ItoI%20draft%20V2.11.pdf.

Online video content with embed active learning enhances students' learning experience

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Teaching in higher education can be seen as didactic and passive, with approaches such as flipped classrooms, active and blended learning being championed as methods to rejuvenate teaching practice. The arrival of Covid-19 in the UK in Spring 2020 led to the swift transition from face-to-face to online learning, often with face-to-face materials being replaced with pre-recorded videos. These videos on their own are a passive experience more akin to the traditional didactic lecture whereby content rich information is delivered to a mass audience (Veletsianos & Houlden, 2020, Mayer et al 2020).

Here, the use of decision based, branched online learning videos were utilised as a tool to bridge active learning within asynchronous content (Allsop et al., 2020). Through the use of the YouTube end screen template each video included a choice at the end allowing the students to respond to questions or pick what is covered next. This branch approached allowed subsequent videos to give instant feedback to the student on the question or direct them to content relevant to them. The impact on student learning was determined by embedding the video content within a digital workbook containing a questionnaire on experience. Pre and post content related questions were included to determine learning gain, followed by questions to elucidate the students learning experience were conducted both as the primary learning material and as additional content.

Student found the overall learning experience positive, although when material was presented to the students for the first time as the main means of delivery, they reported that they were anxious about the content as they were unaware of which material to concentrate on as it was presented in a non-traditional manner. When students were presented with active learning materials as consolidation or revision material feedback was positive and around reenforcing content.

In conclusion, active learning videos offers an additional tool within the higher education blended learning toolkit and are most effective when used to allow students to interact with and explore information they already have a basic understanding of. This places their use as a revision or consolidation tool ideally suited to supplement a recorded lecture.

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From individual support to small-group problem-solving: encouraging speech online.

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A sequence of studies (Kear et al, 2012 and others) suggests that few students speak in OU STEM online tutorials. However, students do speak in online individual support sessions (ISS), and hence small-group sessions informed by the interaction in ISS have been designed and run.

Data was gathered from tutors of pure mathematics modules who provide ISS for some students. A survey asked what tutors thought encouraged speech in online ISS, and how to do this in group sessions. Three tutors compiled descriptive Logs of ISS, documenting the speech and interaction. These provided rich data, which was analysed thematically.

A major emergent theme was anxiety about exposing vulnerabilities, which students might overcome if they felt their needs were being met, if content were familiar, or they could work within a structure. Students would talk if they saw benefit to them through expressing needs or discussing actively. Other themes were: shared visual content, enabling 'joint attention'; gaps for thought or interjection; roles played; and handling of errors.

These ideas were built into the design for online small-group problem-solving sessions. In addition a study on language tutorials (Heins et al, 2007) suggested structured activities with defined roles. Sources on small-group sessions during the pandemic (Bailey et al, 2021 and others) contributed additional ideas.

The design begins with a quiz to establish needs and preferences, then an icebreaker involving identifying errors in a solution. It continues with four problem-solving styles involving: displaying solutions produced alone on camera and discussing; breakout sessions where one student wrote, one decided what to write and another calculated; a consequences game in break-out rooms, with students continuing each other's solutions; a full-group discussion with the tutor suggesting the method and giving pointers, and students taking turns to talk through parts. Solutions from break-outs would be discussed in plenary.

Two sessions were run for nine students on the third year module Complex Analysis. They ran in Adobe Connect in conjunction with OneNote. The students had a session overview and the problems in advance. Some styles had to be adapted during the sessions.

Participants were surveyed about effectiveness and suggested improvements, which will inform adjustments to the design. Sections were documented by observers and researcher. Types of interaction in the transcripts and notes are being categorised in terms of who took part; whether tutor-led or spontaneous; creating or presenting content; whether writing and speaking simultaneously. The occurrences of these categories in each Style will be quantified, to compare effectiveness.

Bailey, T., Kinnear, G., O'Hagan, S., Reynolds, R., and Wheeler, R. (2021). A Model for Focussed Small-group Workshops in Mathematics. OSF Preprints. January 5. doi:10.31219/osf.io/s932g. Retrieved 30th March 2021.

Heins, B., Duensing, A., Stickler, U., & Batstone, C. (2007). Spoken interaction in online and face-to-face language tutorials, Computer Assisted Language Learning, 20:3, 279-295, DOI: 10.1080/09588220701489440

Kear, K., Chetwynd, F., Williams, J., Donelan, H. (2012). Web conferencing for synchronous online tutorials: Perspectives of tutors using a new medium, Computers & Education, 58(2021), 953 – 963.

Assessment 2 (Wednesday 29th, 11.50)

What does it all mean? Tutor and student experiences of marking grids for assessment on a final year module

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Effective assessment drives learning and is essential to student success (Gibbs, 2006). There is a need for assessment criteria to be clear so that they can be applied consistently by markers and interpreted by students. Whilst the provision of feedback (e.g Hattie and Clarke, 2018) and grading of assessment (e.g. Bloxham et. al. 2016) are relatively well studied, there have been few comparative studies on tutor experience of applying assessment criteria to written assignments and student experience of interpreting them.

Here we focus on the Open University final year interdisciplinary module 'Environment: responding to change', which uses criterion-based marking according to learning outcomes (LOs). Tutors provide assessment feedback using rubrics in the form of marking grids containing a detailed breakdown of the criteria relevant for each LO. The grids are designed to facilitate application of LO grading scales and to enable parity between tutor mark allocations, whilst giving constructive feedback to students around LOs. However, tutors have reported challenges in applying the criteria consistently, whilst student perception of the grids is unknown, hence our research question: "How do students and tutors use the marking grids on this module and what is their experience of this approach?"

We used a mixed methods approach to collect quantitative and qualitative data on how tutors use the marking grids to apply criteria and award marks, and how students interpret the grids and apply them to their learning. Online surveys involving Likert scale and free text questions were completed by students from the current module cohort and tutors supporting them. These were followed up by more detailed interviews with a subset of students and tutors, with thematic analysis undertaken on the transcripts.

In this presentation we will outline our approach, report on the preliminary findings from our data analysis and discuss their implications. This analysis will give an insight into student and tutor perspectives on the use and interpretation of marking grids, which will enable the approach to be tailored for the module to give greater clarity and ease of use and interpretation.

The study concerns an interdisciplinary module that sits at the interface of science and policy. Such interdisciplinary modules present a unique assessment challenge as they represent the coming together of different disciplinary cultures (Jessop & Maleckar, 2016). Thus, in addition to informing future assessment on the module, our findings will have wider applicability to modules using criterion based marking in many STEM disciplines.

Bloxham, S., den-Outer, B., Hudson, J. and Price, M. (2016) 'Let's stop the pretence of consistent marking: exploring the multiple limitations of assessment criteria', *Assessment & Evaluation in Higher Education,* 41(3), pp. 466-481. doi: 10.1080/02602938.2015.1024607.

Gibbs, G. (2006) 'How assessment frames student learning' pp. 23-27 in Bryan, C. and Clegg, K. (eds) *Innovative Assessment in Higher Education,* London, Routledge.

Hattie, J. & Clarke, S. (2018) '*Visible Learning: Feedback*' London, Routledge.

Jessop, T. and Maleckar, B. (2016) 'The influence of disciplinary assessment patterns on student learning: a comparative study', *Studies in Higher Education* 41(4), pp. 696-711. doi: 10.1080/03075079.2014.943170.

Have open-book open-Web exams reformed assessment in STEM?

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STEM disciplines are critical for creating graduates that eventually lead global technical, digital and environmental innovations. Necessities for alignment with, and preparing graduates for, work-force demands translates into authentic, applied, dynamic curriculums that embrace pedagogic advances in enquiry-based, blended and flipped learning. Despite creativity in teaching methods, this has not always translated into innovations in assessment strategies, with many STEM disciplines relying heavily on traditional, closed book, invigilated examinations. While this approach ensures academic integrity and promotes long-term memory, opposers suggest this strategy promotes rote short-term learning, tests a restricted skills set, is non-inclusive, negatively impacts well-being and does not replicate real-world applications.

The global pandemic has forced STEM academics to develop diverse and remote approaches to assessment. A multitude of approaches have been fostered which have led to new, creative more inclusive, real-world authentic assessments *for* learning. However, some modes have also exacerbated social inequalities, depleted long-term knowledge retention and expanded cases of academic misconduct. Within STEM, closed-book, invigilated exams were largely replaced with open book open-web (OBOW) assessments. As we emerge from the pandemic and begin a return to business as usual, evaluating this generally novel approach to assessing STEM is critical to ensure assessment strategies are correctly applied across disciplines to maximise student learning. The benefits and limitations of OBOW assessments are now well reviewed in the pedagogic literature, however, here we provide a more detailed evaluation of this strategy across STEM, where the analytical and quantitative nature of many of these disciplines challenges the boundaries and relevance of this approach.

In 2021, following two semesters of OBOW assessment (June 2020 and January 2021) we evaluated the student experience of this approach across six STEM disciplines (Maths, Physics, Chemistry, Computer Sciences, Biosciences, and Geography). We used a questionnaire to assess students experience, learning and revisions strategy and overall perception of OBOW on developing higher-order cognitive skills (HOCS) and employability.

Our findings highlight significant differences between disciplines in how students perceive and experience OBOW assessments. In disciplines such as Biosciences and Geography, where more discursive questions were applied, students were better able to adapt their revision strategy, develop HOCS and appreciated the authentic value of OBOW assessments in comparison to disciplines that applied more qualitative analytical questions (Computer Sciences, Maths, Chemistry and Physics). In these more analytical disciplines, more students demonstrated dissatisfaction with the approach, highlighting concerns over disjointed revision and teaching strategies, greater assessment anxiety and seeing the employer value. All disciplines identified the limited requirement for rote learning.

The findings of this research offer unique insight into an original, mass pedagogic shift in assessment practice at an incomparable scale. The findings strongly recommend that though OBOW assessments provide a beneficial additional tool to the assessment toolkit that can develop critical HOCS, they should be applied cautiously across STEM disciplines and careful consideration should be given to ensure the question styles are appropriate to robustly assessing the discipline.

Teaching and assessing programming at scale: the use of objective rubrics and structured feedback

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It is widely recognised that feedback is an important part of learning: effective feedback should result in a meaningful change in student behaviour (Morris et al, 2021). However, individual feedback takes time to produce, and for large cohorts – typified by the North of 300 challenge in computing (CPHC, 2019) - it can be difficult to do so in a timely manner. On occasion it seems that many academics lose sight of the purpose of feedback, and instead view it to justify a mark, rather than an opportunity to provide meaningful tuition. One strategy to provide feedback at scale is to share the workload across multiple staff, but this introduces an additional problem in ensuring that the feedback and marking are equitable and consistent. In this paper we present a case study that attempts to address two distinct, but related issues.

The first issue is to make feedback more meaningful. We attempt to achieve this by providing detailed feedback on a draft submission of programming coursework allowing students time to make changes to their work prior to the final submission date. We present an analysis of the data generated from this approach, and its potential impact on student behaviour.

The second issue is that of scalability. This feedforward approach creates a significant pressure on marking and on the necessity to provide feedback on a draft submission to large numbers of students in good time so that students are able to act upon it. To achieve this we consider an approach based on creating an objective, reusable marking rubric so that the work can be reasonably spread across multiple members of staff. We present an analysis of the data generated from this approach to determine whether we consider the rubric to be objective enough to remove individual interpretations and biases, and where discrepancies exist attempt to determine where those discrepancies arise.

This work was carried out through an analysis of impact on student assessment, as well as from the academic staff involved in using the rubrics. Preliminary results from this work show that the more objective rubric used by several did enable a scalable solution for rapid feedback on submissions, and this did indicate some improvement in student outcomes. However, the work also illustrated the problems of subjective interpretations and some variation in outcomes by marker.

CPHC (2019) North of 300: Dealing with Significant Growth. Retrieved 8th July 2020, from https://cphc.ac.uk/2019/01/08/north-of-300-dealing-withsignificant-growth/

Morris, R., Perry, T. and Wardle, L., 2021. Formative assessment and feedback for learning in higher education: A systematic review. Review of Education, 9(3), p.e3292.

Blended Learning 2 (Wednesday 29th, 11.50)

A study into engineering students' perceptions towards blended learning

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As we are embracing a new post-pandemic educational landscape, online education has become a primary focus for the Education community. Undoubtedly, one's perceptions towards it is influenced by where they stand and what they value (Van Wart et al, 2020). Online success can be measured on many levels (Al-Fraihat et al, 2020) and since the start of the pandemic, a plethora of research into the impact of online learning and teaching on students and academics (Dhawan, 2020) has been conducted, some of which has focused specifically on the experiences of engineering students (for example, Warfvinge et al., 2021 and Asgari et al, 2021). What the authors of this paper propose is a collaborative study carried out by students and staff, with students as research partners and content creators. The authors embarked on a four-year long research programme, aimed at improving our blended learning offering, in close partnership with a cohort of students who started their degrees in the 2020/21 academic year. We will collaborate with them throughout their degree towards co-creating a blended learning framework of good practice.

This paper presents an in-depth study focused on understanding and capitalising on student perceptions and experiences of blended learning during as experienced during their first year of study. This stage of the project was guided by three research questions:

1. How do first year students perceive the way in which their university experience unfolded?
2. What is the students' perception towards online delivery and their ability to learn and assimilate information in a new environment?
3. What are the key drivers or factors that would enable students to perceive online learning as high quality and to become more confident learners?

We performed a quantitative analysis of data collected using an anonymous online questionnaire consisting of Likert scale type and open questions and designed semi-structured one-to-one interviews. The baseline interview questions were based on the survey results with new questions emerging from the interview itself. Five emerging themes were identified: the use of break out rooms and interactive tools in blended learning, assessment and feedback, social interaction, learning about oneself as a learner and the wider appreciation of the advantages and disadvantages of blended learning compared to traditional on-campus delivery, all through the student's lens.

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Dhawan, S. (2020). Online Learning: A panacea in the Time of COVIS-19 Crisis *Journal of Educational Technology Systems.* 49(1): 5-22.

Van Wart, M., Ni, A., Medina, P., Canelon, J., Kordrostami, M., Zhang, J. and Liu, Y. (2020) Integrating students' perspectives about online learning: a hierarchy of factors. International Journal of Educational Technology in Higher Education. 17:1-22.

Warfvinge, P., Löfgreen, J., Andersson, K., Roxa, T. and Akerman, C. (2021) The rapid transition from campus to online teaching – how are students' perception of learning experiences affected?. European Journal of Engineering Education. https://doi.org/10.1080/03043797.2021.1942794.

Perceptions, expectations and experience of group tuition: the pandemic effect

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While group tuition plays an important role in teaching in higher education, it is not clear that students and staff always have a shared understanding about the purpose and expectations of tutorials. In our earlier work (Campbell et al. 2019) at The Open University we found that despite areas of overlap between staff and students around the efficacy of face-to-face tuition in terms of social interactions and community, there were identifiable disconnects around the role of assessment in driving tuition, the balance of didactic versus active learning and, interestingly, the role of online interactions in socialising. To gain deeper insights into student perceptions, in 2019 we conducted a survey of 3000 University entry-level STEM students, followed up with a set of semi-structured interviews. We identified common themes from these interviews and began to see patterns around shared experience and social interactions. This work also revealed differences between students new to study and those continuing on their chosen STEM study pathways. These differences were especially marked between online versus face to face tuition.

Then, from March 2020, the global pandemic changed everything. For the first time in the Open University's history, all tuition was moved online. Students no longer had an expectation of face-to-face tuition and the blended approach often used across the University was not available. In early 2022, we decided to run our online survey a second time, using the same pool of entry-level STEM students, but this time focusing exclusively on online tuition. We believe this provides us with a unique perspective on how these expectations and perceptions have changed following the forced move away from blended learning, perhaps reflecting a changed relationship to online working because of the societal impact of the pandemic. In this presentation we use the pre- and post-pandemic data explore changes in student expectations of tutorials following the enforced move to online tuition. 310 words

Campbell, Anne; Gallen, Anne-Marie; Jones, Mark H. and Walshe, Ann (2019). **The perceptions of STEM Tutors on the role of tutorials in distance learning.** *Open Learning: The Journal of Open, Distance and e-learning*, 34(1) pp. 89–102

A blockchain framework to incentivise engagement in online learning

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Online learning technologies have changed the learning environment for students across Higher Education and provided a platform for new digital learning technologies that promote more diverse models for engagement. Our talk describes a new educational framework that provides an infrastructure to support direct incentives for engagement in online learning and verifiable accreditation of education awards. The system is built on blockchain and Web technologies and provides decentralised and verifiable accreditation, traceable engagement in online learning and a reward ecosystem that provides incentives for educators based on engagement and incentives for learners based on course completion.

Blockchain is an established mechanism to publish a decentralised, open-access, verifiable ledger of interactions between parties. Complementary to this, smart contracts and mining applications are established tools for secure operations of financial and transactional ecosystems based on the public ledgers. This project applies these technologies to extend the facilities of online learning and reverse

the way funding is currently linked to education and learning by providing a framework to incentivise engagement.

There are three key components to our educational framework:

- a new dedicated decentralised permissioned cryptocurrency.
- a client-side browser mining dependency.
- a server-side mining pool application with authentication.

The client-side browser mining dependency performs proof-of-work mining of the permissioned cryptocurrency while the user is engaging with online learning. The permissioned pool provides an authenticated gateway to this mining process and is responsible for constraining the effective mining rate which reduces the hardware requirements, making the framework practical for users to interact with on any device, including mobile devices. Finally, the dedicated permissioned cryptocurrency supports and secures the economic incentives of the ecosystem where the rewards of mining (engaging with online learning) are attributed to learners and educators and can be publicly traded and used for purchasing transactions.

The proposed framework is compatible with all online learning. The requirement for educators to integrate this framework is simply embedding a JavaScript dependency in their webpage or virtual learning environment. The only requirement of the learner would be that they are authenticated, which is an existing requirement in most online learning environments. The benefits for learners and educators are verification for all education awards and economic incentives that directly link to the levels of learner engagement.

Sustainability (Wednesday 29th, 11.50)

Will future chemical engineers save us from climate change?

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Mitigating the effects of climate change is an urgent priority across all walks of life. Alongside the major economic, political and social aspects of climate change there is also a clear responsibility on the scientific and engineering professions and industries to develop and improve technical solutions (Orr, 2004; Scott Cato, 2021). Whether these industries can achieve this will depend on the ingenuity, skills and commitment of the people who do science and engineering, ie graduates of STEM higher education: therefore an equally significant responsibility lies with the educational sector. Whether we are meeting this responsibility is the research question we address here: are current engineering students ready to take up their role in mitigating climate change?

We focus on one particular discipline, chemical engineering, at the University of Strathclyde, which graduates typically 100 students per year at BEng Hons and MEng. Chemical engineering is critical to many potential climate change mitigation solutions ranging from renewable energy sources and storage to circular-economy based manufacturing. Using questionnaire methodology, in the first part of the work we explore current students' attitudes to climate change and their sense of their own readiness and commitment to making mitigation of climate change a key part of their future careers.

While exploring these factors across the whole 5-year cohort, we also pay particular attention to mid-course BEng/MEng students to enable a 'bi-directional' perspective: at mid-course, 'looking back', how do students perceive the relevance of their learning experience so far to the climate change problem; and 'looking forward', where they feel they should be by the end of their course. Thus we ask whether the current portfolio of learning activities at Strathclyde is sufficiently highlighting climate change and sustainability, whether we are providing sufficient knowledge and skills, and where do students perceive existing gaps and future goals in their education related to these topics.

In the second part of the work we consider in further detail one specific learning activity directly focussed on mitigation of climate change, where students are given an open-ended task to consider and choose the best mitigation strategies, from both technical and wider points of view (eg economic, political). We explore whether such a 'high agency' (ie open-ended) task may bring specific benefits in preparing students to face the very much open-ended global challenge of climate change. 'Teaching' of sustainability and mitigation of climate change are challenging topics, since ultimately it is not enough to 'convey existing knowledge' in the way we might teach, for example, Maxwell's equations or techniques for distillation column design: rather we must prepare graduates with the flexible skills, confidence and commitment that will be required to enable them to contribute to mitigating climate change over the next decades (Maxwell 2021). Whether the next generations of STEM graduates can rise to this challenge has existential consequences for all of us.

Maxwell, N. (2021). Human Affairs 31, 21–39.

Orr, D. W. (2004). Earth in Mind. Island Press (London).

Scott Cato, M. (2021). Environment and economy. Routledge (Abingdon).

A template for sustainability education in chemistry

Victoria Hilborne and Martha Neugarten

Solving sustainability as described by the United Nations Sustainable Development Goals, is an important focus of chemistry research. Sustainability education must encompass the complexity and interdisciplinary nature of sustainability problem solving and its impact. Tools of systems thinking, network science, and graph theory are ideal for developing sustainability education exercises and delivering transformative learning, which in turn is essential for advising policy and law makers. [1] A template for sustainability education in chemistry that readily fits into any part of the core chemistry curricula and wider STEM subjects, makes it easy for educators to include sustainability in their courses.

In new STEM degree courses, the meaning of sustainability should be covered before the core subject material. [2] Education activities should therefore start by addressing students understanding of sustainability. Current practice in sustainability education and surveys of student, researcher and academic staff understanding of sustainability guide activity development. In groups, students iteratively create concept and system maps alongside discussions led by both the students and educators. Templates of network models and graphics, then show students how to effectively focus problem definitions and form simpler paths through complex information. The models and graphics with summary descriptions directly link specific core chemistry principles to sustainability problem solving. They can be applied at any level of an undergraduate and post graduate degree programme. The sustainability education in chemistry template is presented through examples of (i) first year undergraduate physical chemistry of gas diffusion and (ii) third year undergraduate interdisciplinary chemistry of carbon capture, utilisation and storage (CCUS).

Samples of undergraduate, postgraduate, researcher and academic staff review the activities, providing early feedback on how these might enable future generations to play a crucial role in transforming sustainable use of resources.

[1] Flynn, A.B., Orgill M. K., Ho F.M., York S., Matlin S.A., Constable D.J.C and Mahaffy P.G. 2019, Future Directions for Systems thinking, *J.Chem. Ed*., 96, 3000 – 3005.

[2] Zuin V.G., Eilks I., Elschami Myriam and Kummerer, 2021, Education in green chemistry and in sustainable chemistry: perspectives toward sustainability.

Exploring policies to adopt STEM education in Bangladesh

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Unemployment is an alarming problem especially in developing countries like Bangladesh due to inadequate supply of skill sets required by employers. Recent global initiatives and reforms require technology centric set of skills; therefore, Science, Technology, Engineering, and Mathematics (STEM) has gained momentum in global education systems. Unfortunately, Bangladesh as a country is yet to be on board with this ever-growing education system. Very few studies have been published related to STEM education in Bangladesh context. This study is in line with the country's mission to produce skilled human capital to compete with the global standard education system. The study followed a qualitative research approach. Data was collected from 12 schoolteachers (K-12) of Dhaka city through an interview schedule and via 3 Key Informant Interviews. According to the findings, most of the teachers emphasized an upgradation of the existing curriculum by shifting towards Problem-Centered Learning (PCL), Inquiry-Based Learning (IBL), and Collaborative Learning (CL). In addition, most of the participants opined that teachers need in-service training, infrastructural support, and guidance from the government to implement STEM teaching-learning and assessment approaches effectively and efficiently. Furthermore, they emphasized on continuing professional development through Peer Learning Community (PLC) to improve STEM pedagogical content

knowledge across the four disciplines. Hence, this study can help policy makers, educationists, and other stakeholders to move forward in implementing STEM education in Bangladesh context. Nonetheless, further research may be conducted to explore the consequences of STEM education in classroom settings in terms of cognitive and affective learning outcomes.

Active learning 3 (Wednesday 29th, 13.50)

Workshop: are you SERIOUS?! – teaching operations management through serious games

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The open-source platform INSYSTED (Integrated System for European Digital Learning) is currently being developed in a consortium of Technische Universität Berlin, University College London, Politecnico di Milano, and CentraleSupélec in Paris. The INSYSTED platform supports lecturers in creating, playing, and sharing serious games. In this workshop, we want to introduce the INSYSTED framework and illustrate its application, using a serious game focusing on Operations Management.

Operations management is a quantitative core area of Industrial Engineering and Management education where students need to tackle the stochastic-dynamic interdependencies of processes within a supply network. In order to do so, students need to acquire a deep understanding of the underlying theoretical concepts, methods, and tools. This is especially challenging for students at an introductory level. The heterogeneous knowledge and interests as well as the sheer number of participants in typical introductory courses urgently require new solutions for personalized learning.

Against this background, a serious game was developed at Technische Universität Berlin. Here, problem-oriented, quantitative methods of operations management are taught – using a virtual learning factory. In subsequent game levels, students are confronted with the challenges of everyday production, experience system dynamics, and improve their analytical skills.

In this workshop we want to introduce the simulation game, user management and learning management system integration, as well as discuss with teachers how they can adapt the game to their individual needs. Teachers will gain access to the platform and will be able to setup their own games.

Enabling foundation students during transition: a study on the impact of the self-empowerment journey on student wellbeing

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Foundation courses at Level 3 tend to attract students from non-traditional backgrounds who find transitioning to Higher Education difficult and challenging. It has been reported that the transition into university can induce stress, caused by a variety of factors including moving away from home, financial strains, social change and increasing workloads (Hernamdeztorrano, *et al,* 2020). Traditionally students who are “struggling” are encouraged to seek support through university services, although these are often generic and unable to offer individual support. Research has also shown that a large population of students, despite being aware of these services, will still hesitate to take advantage of this support due to the fear of stigma (Pereira et al 2019).

Many universities are now working towards providing more mental health and wellbeing services such as counselling, drop-in sessions, and stress management. Additionally, teaching coping mechanisms/self-supporting tools for stress and anxiety or providing mental health services during these crucial times, can significantly avoid the consequential emotional effects it would have on the community and improve academic success (O’Driscoll *et al* 2019, Galante *et al*, 2018).

This presentation aims to explore the experiences of Foundation Year students, whilst integrating the Self Empowerment Journey (SEJ) Process into the professional and academic skills module, enabling a successful academic career and improving mental health. During the presentation we will share the research findings exploring the data collected of how practicing the SEJ process has impacted the Level 3 cohort.

As part of the study on Foundation year students within the Faculty of Science, Engineering and Computing (SEC) at Kingston University, data was collected from both a final year project in 2019 and in 2020. Later in 2021, a larger study was carried out, to understand the impact of the SEJ. The students were asked to complete a questionnaire three times, during the study (Ethic approved, students were also asked to provide consent), which measured the scale of their concerns relating to their studies and general wellbeing.

The survey responses from the Microsoft Teams Forms, were exported as an Excel spreadsheet. The survey data of the participants who gave consent were anonymised and coded numerically to maintain the confidentiality of the respondents, and all those who had agreed to participate were incorporated in this study.

In this study the SEJ has shown to improve students' wellbeing, in all the 10 questions being investigated; of those who returned the surveys there was a 100% improvement evidenced in the qualitative comments. This study found that the SEJ was highly effective, particularly in addressing students' stressful thoughts and fears regarding starting university and progression to further study. What is of interest to students, is that this process does not detract from their studies, but rather enhances them and all aspects of student life, as the process is done in real-time. Results obtained offered an insight into the effectiveness of this unique solution as a preventative measure, empowering the individual to better self-manage themselves and thrive, rather than survive during their academic journey.

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Supporting students' transition to research methods and statistics modules in a psychology undergraduate course

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Research suggests that studying statistics as part of a non-mathematical course is often associated with increased anxiety (Hanna, Shevlin, & Dempster, 2008; Macher, Papousek, Ruggeri, & Paechter, 2015) and lower levels of self-efficacy among learners. Whilst cognitive or dispositional factors may

influence statistics anxiety, situational antecedents such as prior knowledge may also have an effect. Despite containing a statistical element, some degree subjects such as Psychology may not require specific mathematics or statistics prerequisites beyond GCSE level. We report findings from a questionnaire-based study conducted with two psychology student cohorts, investigating the prevalence and nature of statistics anxiety, and whether this is influenced by the nature of students' prior experiences with the subject in secondary education. Understanding students' perceptions and attitudes at the start of their studies can provide important insights for educators on how best to support their transition to university.

First year students on an undergraduate psychology course filled in a survey at the beginning of their undergraduate course, capturing prior experiences in studying mathematics or statistics (nature of subjects studied at A-level of equivalent and grades achieved), statistics anxiety measured through the Statistics Anxiety Rating Scale (Cruise, Cash, & Bolton, 1985) and open-ended questions, and levels of confidence around completing the statistical methods component of their course. Findings suggest that studying mathematics at A-level is associated with reduced levels of statistics anxiety. Furthermore, studying a greater number of science subjects at A-Level was associated with lower levels of interpretation anxiety and assessment anxiety, and increased levels of self-concept and worth of statistics. There was further evidence of this in the qualitative data, with findings suggesting that students often compare themselves with others on their course on prior experiences, and view their lack of substantial experience and skills in the subject at the start of their studies as potentially leading to increased workload and hindered progress and performance. Findings will be discussed within the context of curriculum development and practical steps in supporting students' transition to the research methods and statistics component of their undergraduate course.

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Assessment 3 (Wednesday 29th, 13.50)

Workshop: towards Utopia: training teaching assistants to mark consistently

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This workshop aims to share learning around some of the challenges associated with the changing environment of higher education and the increase in use of inexperienced postgraduate teaching assistants for marking. The increased fiscal pressure in higher education has in turn led to large cohorts and an increased load on the provision of marking and feedback. The current solution explored by the authors' engineering faculty is to utilise Teaching Assistants (TAs) to provide the required capacity where the problem is most acute, early in the degree programme where student numbers are high and iterative report writing supports learning.

Whilst the approach does redistribute workload from academics, ensuring quality and consistency of marks and feedback becomes a significant challenge. Through utilising a new digital interactive suite and a reflective marking exercise the authors were able to bring down inconsistencies between TA and academic marking agreement from up to 5 grade boundaries down to less than 1 grade boundary.

Workshop structure

- Introduction and scene setting
- Participate in a blind marking cycle
- Participate in a group marking cycle with further instruction
- Participate in a final marking cycle
- Feedback to the workshop personal experiences
- Authors to share the experience of running a training programme for 8 TAs to mark ~800 lab reports.

ILOs

- Assess the current fallibility of marking and grading
- Develop strategies to improve consistency amongst TAs
- Reflect on current practice.

Recognition of Prior Experiential Learning (RPEL) on entry to STEM degree apprenticeship programmes at the Open University: challenges and opportunities

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Recent legislation demands that Recognition of Prior Experiential Learning (RPEL) is available for apprentices (IfATE,2020), and the starting premise is that RPEL offers an opportunity to bridge the gap between what has already been learned in the workplace prior to applying for a degree apprenticeship, and what is required for accreditation. However, evidence suggests that offering RPEL has enduring and ongoing issues across HE (Higher Education) and is far from simple to accomplish (Peters, 2006; Singh and Ehlers, 2019), especially when compared to Recognition of Prior Credited Learning (RPCL). The promise of RPEL is not fulfilling expectations in terms offering recognition for work-based skills. As higher education institutions have an enduring tradition relating

to established definitions of knowledge, and what is valued in learning (Valk, 2009), questions arise regarding how RPEL is offered, and whether there is sufficient incentive and support for apprentices to consider an RPEL route.

This research examined the process of RPEL for STEM apprentices at the Open University (OU). The approach taken to the research was an ethnographic case study, focusing on the OU as a large degree apprentice provider in the UK, with the researcher central to the process. Initial data collection took the form of review of UK-wide policy documentation, and RPEL guides produced by the institution, alongside those from other universities who offer RPEL. The following data collection phase comprised of interviews with academic and academic-related staff in order to give an insight into their perceptions of the opportunities and challenges that RPEL offers.

Data were analysed using thematic analysis, to build a rich narrative from multiple perspectives. Initial findings suggest that there are concerns, as RPEL can be more problematic than RPCL to implement. Verification for RPEL can be a challenge and it is also difficult to determine the most appropriate module/s for RPEL to be accredited against due to potential mismatches between theory-based and work-based learning. Considering benefits of RPEL, there are opportunities to build in RPEL from the start of module design, as adding on retrospectively can create additional work. RPEL has the potential to save apprentices, and other HE students, time, money and effort by appreciating the skills they have already developed in the workplace. The next stage of research will be to interview apprentices, in order to gather their views of the opportunities and challenges relating to RPEL.

Ultimately, the aim is to create opportunities to move towards an inclusive model of recognising prior experiential learning in the arena of degree apprenticeships.

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Gamifying post COVID STEM classroom for better student engagement

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Teaching in post covid 19 pandemic is challenging. Students are still trying to adjust to inperson mode and many of them are suffering from pandemic related issues such as depression, locked down anxiety etc. Teachers around the world are adjusting to now this new normal. Engaging students in STEM classrooms will be challenging. A study has indicated a significant decrease in emotional engagement, with students reporting a drastic decline in positive attitudes toward science (Wester et al, 2021). The need is to devise and employ tools to make learning more engaging and classroom more vibrant. The author has used gamification in one of her classrooms to make the learning more engaging. Gamification means using the philosophy and science of game elements and game design techniques in non-game contexts. In the context of education, it means integrating game dynamics into teaching content, pedagogy, and assessment to spur participation. Thus it involves using principles, procedures and systems of game designs and using it to motivate, engage

and inspire individuals, groups and communities, and alter their actions and result in desired results (Ray wang).

The motivation behind using the philosophy and science of gamification was its addiction and popularity among students. The insatiable appetite for the games and quantum of playtime by avid gamers indicates the hold and strong engagement with the gamers. In one of the research studies, gamers were asked why they play the game. The top answers were that it provides challenge, creativity and winning. Other outcomes were social environment, friends, Problem-solving, random surprises, exploration, imagination, sharing, teamwork, role-playing, recognition, (Anderson, 2003; Setzer&Duckett, 2000). Some studies have shown argumentation of a sense of efficacy and self–control over one's environment (e.g. Jones, 2002), enhancements in learning (Gee, 2003; Johnson, 2005), increase in the life span and ore happiness (Setzer, V. W., & Duckett, G. E. (2000).

In this research, work author has used gamification in classroom formative assessment for a lab session. The intervention was administered to a lab group of 22 students. The intervention in form of 'reverse grading' has shown significant improvement in student engagement. It has also markedly improved the results of the slow learner during the classroom deliberations and participants. This research work will expound upon the need and methodology to gamify the classrooms especially assessment.

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Scholarship of LT (Wednesday 29th, 13.50)

Workshop: Growing an inclusive (field) teaching environment

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Geography and Environmental sciences (teaching and research) have fieldwork at their core (QAA, 2019) and academics, researchers and students have, until recently (e.g., Stokes et al., 2019), perpetuated the notion that to be a good scientist means being physically present in the 'field'. However, fieldtrips pose significant challenges for equality, diversity and inclusion (EDI) and may, in part, explain the lack of diversity across the subject areas (e.g., Dowey et al., 2020). Disciplines across the spectrum of environmental fields are stereotypically seen as white, male and middle class (McIlwaine and Bunge, 2019; Milner, 2020), which is reflected in data showing an under representation of students identifying as BAME or with a declared disability (HESA, 2021). Although multiple factors will be behind these trends, it is clear we need to show that environmental fieldwork is inclusive and open for all.

Whilst there are numerous challenges associated with addressing EDI in fieldwork, there are many examples of good practice in delivering field teaching (Lawrence and Dowey, 2021; Prior-Jones et al., 2020). In addition, the adoption of digital technology to support students in accessing field sites is creating a more inclusive environment (e.g., Whitmeyer et al., 2020). However, whilst resources and approaches do exist, these are not always shared or easily accessible to the wider community of field scientists. As a result, the NERC-funded CULTIVATE project was developed to capture and share inclusive and accessible approaches to field teaching with a particular focus on the use of digital technology to open up the field. In this workshop we will explore the issues surrounding inclusion and accessibility in geosciences teaching, shared experiences that support and encourage change in our teaching practice, and the resources and digital technology to make field teaching more inclusive. The workshop will comprise:

- Hands-on training in digital technology and resources to support inclusive field teaching.
- A 'design critique' to evaluate the effectiveness of these approaches to address EDI within field teaching.
- Small-group discussions to explore the benefits and challenges of a community driven approach.

Outcomes for the participants in this workshop are: (i) an understanding of how digital technology can be used to open-up fieldwork, (ii) a greater awareness of solutions to EDI fieldwork challenges, and (iii) networking opportunities to 'breakdown the silos'.

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Milner, C. (2020) Classroom strategies for tackling the whiteness of geography. *Teaching Geography*, 45(3), pp.105-107.

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Quality Assurance Agency, (2019) Subject Benchmark Statement: Earth Sciences, Environmental Sciences, and Environmental Studies, 4th edition. QAA, Coventry

Prior-Jones, M., Pinnion, J., Millet, M.A., Bagshaw, E., Fagereng, A. and Ballinger, R. (2020) An inclusive risk assessment tool for travel and fieldwork. *EGU2020, Sharing Geoscience Online* https://www.researchgate.net/profile/Michael-Prior-Jones/publication/341179943_An_inclusive_risk_assessment_tool_for_travel_and_fieldwork/links/5eb28e6f45851523bd464204/An-inclusive-risk-assessment-tool-for-travel-and-fieldwork.pdf Accessed 24/02/22

Stokes, A., Feig, A.D., Atchison, C.L. and Gilley, B. (2019) Making geoscience fieldwork inclusive and accessible for students with disabilities. *Geosphere*, 15(6), pp.1809-1825. https://doi.org/10.1130/GES02006.1

Whitmeyer, S.J., Atchison, C. and Collins, T.D. (2020) Using mobile technologies to enhance accessibility and inclusion in field-based learning. *GSA Today*, 30 https://doi.org/10.1130/GSATG462A.1.

Online Learning (Wednesday 29th, 13.50)

Celebrating innovation of digital learning tools in STEM education

LearnSci's Teaching Innovation Awards celebrate and share best practices using digital tools that positively impact teaching quality and enhance student learning. The 2021 winners showcase their outstanding work from virtual reality to labcasting, from Smart Worksheets to e-portfolios.

- Labcasting: Bringing the lab to the student. Presented by Dr. Phil Craven and Mr. Edd Kyi.
- Diversifying the science curriculum and increasing student engagement by the use of Smart Worksheets to decrease the attainment gap. Presented by Dr. Bhaven Patel.
- Using Pebblepad for E-portfolio Generation in Medical Science at ATU Galway. Presented by Dr. Joan O'Keeffe and Mz. Helen Cregg.
- Virtual Reality in Science Education: The Impact of VR Supported Lessons on the Learning Experience of Postgraduate Diploma in Education (PGDE) Student Teachers. Presented by Dr. Gabriella Rodolico.
- Using Augmented Reality to deliver Practical Chemistry. Presented by Dr. Lesley Howell

Decolonisation (Wednesday 29th, 16.00)

Decolonising and diversifying the biomedical sciences curriculum at the University of Bristol

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Decolonisation is broadly about confronting how colonialism, Eurocentrism, and racism have shaped our world. Decolonisation and diversification of the STEM curriculum recognises these issues in the science we teach and aims to include a range of perspectives of people who have been overlooked. We undertook a project to decolonise and diversify a selection of teaching content in units within our Biomedical Sciences curricula at the University of Bristol.

Eleven undergraduate students were recruited to work as paid partners, contributing their lived experiences and perspectives on our curricula. After undertaking training with external partners, our students reviewed content from specific courses, producing a summary spreadsheet and report to disseminate their findings to teaching staff. Interviews with students were also filmed, for inclusion in a new *'Equality and Inequality in Science'* learning resource used in our undergraduate courses.

Students identified several areas of existing good practice as well as areas for improvement, including: choice of images (lack of diversity or images re-enforcing negative stereotypes); bias towards men and the Global North in references and reading lists; the lack of representation among teaching staff; exclusive use of binary genders; examples of 'hero worship' and overlooking scientists of colour / women; occasional non-inclusive language and a lack of discussion of problematic scientists. We have a further 8 undergraduate students continuing this work this academic year.

Following this, questionnaires have been sent to all staff and students within our Schools to obtain baseline data of understanding and views on decolonising and diversifying the curriculum. We have also recruited a paid postgraduate partner to conduct and analyse focus groups with our undergraduate students, to gain a broader view of their opinions of colonial effects within our curriculum. This survey of attitudes will be repeated next year to ascertain the effectiveness of this work.

Our findings thus far have been captured in an "Emerging Themes" document, which has helped to shape changes within teaching content of the units analysed, and lead to an article in Immunology News (Burton and McKinnon, 2022). It has also fed into our newly-formed Faculty of Life Sciences Decolonising and Diversifying the Curriculum Working Group and forged collaborative relationships with other Schools and Faculties within the University and beyond. This has helped us produce a booklet, which includes tangible steps staff can take to start decolonising and diversifying their teaching material.

This work has laid the foundation towards decolonising and diversifying our curriculum, opening conversations between staff and students, and helping to make our curriculum and the university more diverse and inclusive.

Burton, BR and McKinnon, CM (2022). Decolonising the immunology curriculum: starting to interrogate structural inequalities in science. Immunology news, **22** (*in press).*

Suggestions for decolonising the science curriculum

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Previously we have reported Kingston University students understanding and views of decolonising the science curriculum, based on a survey completed in November 2019 (n=142) (Williams and Benjamin, 2022). This indicated that many students had limited understanding of decolonising the curriculum. However, the was a reasonable level of support for suggested actions to decolonise the curriculum. These actions were based on Swartz's theses for decolonising the curriculum (Swartz, 2018). Support for actions was strongest from Black African/Caribbean students.

Awareness and calls for action on decolonisation grew after the murder of George Floyd. In December 2020 students were surveyed (n= 46) again. The aims were to explore changes in science students' understanding of decolonising the curriculum and after providing a simple definition, to investigate their views of actions to decolonise the curriculum. In this presentation a comparison of survey results before and after the murder of George Floyd will be given. The results highlight an increase in support for decolonising the science curriculum. To finish an animation which suggests ways to decolonise the curriculum, based on the student survey results, will be shown. The production of the animation was supported by an AdvanceHE Good Practice Grant (2020/21).

Swartz, S. (2018) Decolonising the curriculum: what we can learn from global South theories and experiences. (Paper presented at the Institute of Education, University College, London

Williams, N., and Benjamin, A. (2022). An investigation of students' views on decolonising the science curriculum. *Compass: Journal of Learning and Teaching, 15*(1).

A novel approach to decolonising the curriculum via staff and student partnerships using an active learning framework

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Decolonising the curriculum is moving fast at the top of the higher education agenda. Individuals, however, often struggle to identify where to start and what approach to take in their teaching practice to implement positive change. Using an evidence-based approach, we developed a model around decolonising the psychology curriculum, involving undergraduate and postgraduate students as co-creators of the curriculum, taking an equality, diversity and inclusion (EDI) perspective. As part of this project, a working group of students reviewed and rated a Psychology Module based on specific EDI criteria and made some evidence based recommendations to improve the module. Subsequently, relevant module changes were implemented using an active learning approach and further feedback was obtained by the student working group. Additional qualitative and quantitative feedback on the updated module was obtained by students enrolled in the course via a novel measure developed as part of this project. Here we present key features of this approach, as well as insights on the impact of module changes made, based on the novel EDI impact evaluation measure we developed. We will share key findings from the initial stages of the project and some practical suggestions for teaching practice, from the student perspective, within the context of an active approach to learning.

Employability 1 (Wednesday 29th, 16.00)

Experiences of women on computing student placements

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In the UK less than 20% of students on computing courses are women (UCAS), indeed women are under-represented on computing (and engineering) courses across the Western world. While 31% of the tech sector workforce are women, this falls to 10% for leadership roles (Trueman, 2021). There have been many initiatives to encourage women to study computing, with limited success. While there has been considerable research into why more girls do not select computing as a subject to study, there has been markedly less research into women's experiences of tech workplaces and their ability to act as a pull mechanism, i.e. pulling women and girls through tech courses towards a good career.

At Edinburgh Napier University computing students are encouraged and supported to gain relevant work experience, in particular a paid one-year placement in industry. This is seen as valuable preparation for a graduate career. In this preliminary study, we were interested in how women on a student placement experienced the workplace in terms of their interactions with other staff and with their sense of belonging, i.e. whether the placement acted to encourage their future careers in tech or re-think their next steps after graduation.

As part of a wider international study, in November 2019 a focus group was run for five women who had had experience of placement. The aim was to reveal themes which could then be explored more widely in a student survey. Participants were asked to share their experiences of their placements, with a particular focus on getting feedback on their work and whether they had encountered any situations they had felt were unfair, relating to gender.

Participants all sought feedback, both for reassurance that their work was satisfactory but also as a means of gaining confidence to take on new project work. Feedback given was often vague and non-specific (for example, "you're doing fine") which acted to make them feel as though they were wasting their manager's time by asking. There were many examples where participants felt they had been treated unfairly at work, including being asked to take on 'impossible' tasks and missing out on training events.

Overall, the focus group discussion revealed unexpected levels of misogyny, especially from younger men, in placement workplaces. The women's placement experiences undermined their sense of belonging, and left them in general less confident about their abilities, however all could still envisage a future as a Woman in Tech.

The presentation will share initial findings, the next steps for this work and make some recommendations for pre-placement workshops – for students and employers in male dominated workplaces.

Trueman C., 2021, What's the Landscape Look Like? *Computer World*. https://www.computerworld.com/article/3610588/women-in-tech-whats-the-landscape-look-like-in-the-uk.html. Accessed 17/02/2022.

Design of an inclusive programme to encourage more black students to engage and embrace careers in the pharmaceutical industry

Nigel Page, Jacqui Piner, Amanda Baker, Martha Mador, Gilbert Ampem, Victoria Ademisoye, Olivia Sealy and Zion Sengulay-Thomas

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We outline a sustained collaboration and co-creation between Kingston University and GSK, Black students, careers and employability, and enterprise support services at Kingston University. In preparing bioscience and chemistry students with the necessary graduate attributes, we have initiated strategies to embed and contextualise creativity and innovation using real-world challenges. Key to this strategy has been the design of a 'Discover Industry' programme that runs over three months, where students explore and identify future challenges in healthcare and emerging disease. This has afforded students with an immersive employer experience through 'hands-on' learning and guidance from an interactive workbook. In this manner, students acquire knowledge about the multifaceted roles available whilst considering how the various aspects of industry work. A primary consideration in designing the programme has been to address head-on diversity and inclusion including 'Black Lives Matter'. Specifically, many Black students express they feel excluded or not belonging and are unclear where to start in seeking their graduate ambitions; this is set against a backdrop of differential degree awarding outcomes and employment prospects. The programme, therefore, sets out to provide targeted advice to help navigate the world of industry, from how to find out what's out there, to working out how to enter the job market, networking tips, and to how to achieve career goals. A capstone hackathon enables student teams through facilitation with industrial experts to consider the various aspects of industry from research to project management, design, and implementation through to the resources required, potential market and any ethical and policy implications. Finally, students pitch their ideas to a judging panel of experts to win prizes with a concluding Q&A reinforcing the next steps available.

This presentation will outline our steps in developing this programme and its evaluation highlighting the opportunities for students to work with, network and learn through activities, including storytelling from Black industrial role models. We hope this initiative will provide sector insights into new ways of enhancing wider meaningful industrial engagement that are informed by the lived experiences of Black students and employers.

This programme is supported by a Biochemical Society's Diversity in Science Grant.

Does a life sciences student's demographic background correlate with their access to careers and developmental opportunities and, therefore their academic achievement as well as graduate destinations?

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Achieving a good degree alone is no longer sufficient to ensure employability post graduation. Undertaking additional opportunities alongside academic studies is now essential in a competitive employment landscape. For example, High Fliers identified that 34% of graduates they would recruit in 2021 would have previously completed work experience with their business whilst at university (High Fliers Research Ltd, 2021). It is clear that work-integrated learning provides essential benefits, potentially increasing graduates' future employability (Andres and Higson, 2010 and Jackson, 2013). Alongside these formal placement opportunities, universities also offer a diverse range of activities that students can become involved with, some where formal credit can also be gained. These include involvement with, for example, supernumerary modules such as languages, volunteering, part-time work, student voice representation and involvement with research and enterprise events, which allow various skills to be developed.

This study aims to analyse and build a better understanding of key student characteristics within two Schools at Newcastle University within the life science subject area. By gaining this insight, investigation of student engagement with the numerous personal development and career-supporting opportunities can then be studied. Updated registration data from 2015-2021 was collected via Business Warehouse software to gain insight into the student population - including details on age, gender, nationality, home postcode, POLAR4 status, disabilities or challenge group status, caring responsibilities and for those who have graduated; degree outcome and graduate outcome. Activities and opportunities investigated included; placement years, laboratory assistant roles, ncl+ award completion (in house badge), volunteering via the Student Union, vacation studentships, international exchanges abroad and University internships. These were then collated from across the University and Student Union with data sets linked via student number to the Business Warehouse data, whilst retaining student privacy.

A student survey during semester 1, 2021, investigated further details on student demographics and characteristics, opportunity uptake and motivations and inhibiting factors related to activity involvement. A total of 178 students responded to this survey and survey results will be presented, supporting the first set of data.

It is vital that we determine which student groups are represented, and whether these opportunities are available to all or if are there potential barriers that certain groups face, preventing engagement and potentially impacting degree classification and graduate outcomes. Data are currently being analysed by two excellent student interns Ross and Sarah. Many challenges with accessing the data have also been encountered and some ‘tips’ and lessons learnt will be given in this talk.

Following full data analysis of this challenging study will allow appropriate additional support and initiatives to be introduced, helping ensure that all of the opportunities are accessible to all students.

Andrews J, Higson H. Graduate Employability, ’Soft Skills’ Versus ‘Hard’ Business Knowledge: A European Study.(2010) Higher Education in Europe.33(4):411-422.

Jackson D. The contribution of work-integrated learning to undergraduate employability skills outcomes.(2013) Asia-Pacific Journal of Cooperative Education.;14(2):99-115.

High Fliers Research Limited. The Graduate Market in 2021: Annual review of graduate vacancies & starting salaries at the UK’s leading employers.(2021) London: High Fliers Research Limited.

Pedagogic research 1 (Wednesday 29th, 16.00)

Embedding a Theory of Change approach to plan and disseminate STEM scholarship projects

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Practitioner-led scholarship projects seek to gather evidence and critically review practice to improve teaching and learning but frequently struggle to evidence impact beyond the scope of their project. Outcomes oriented evaluation approaches, such as the Theory of Change (ToC) approach adopted by the Office for Students, are intended to explicate the assumptions and methods used to bring about changes in practice and evaluate the impact of those changes. However, despite funders' requirements, applying the ToC approach to plan and evaluate scholarship projects does not come naturally to practitioners, whose scholarship projects are primarily motivated by their interest in teaching their subject and alleviating the difficulties experienced by students studying it.

In this presentation, we will describe the approach we've taken to embed ToC approaches within the guidance and resources we provide to support colleagues proposing and managing scholarship projects in The Open University's STEM Faculty. We will describe how a ToC template can help guide the systematic development of a scholarship project proposal by prompting the project team to frame the problem or proposed intervention within a wider context. Further, through a question-driven template, which we developed by drawing on the evaluation literature, we will show how ToC concepts can be used as prompts to improve project planning. For example, to identify stakeholders (including beneficiaries); risks to the project; any assumptions, or conditions on which the project's success will rely on; and the resources and skills available to the project, and any specialist skills that may be missing.

Once a project has been formulated, we will demonstrate through examples how textual and visual representations can serve as project management tools for a scholarship project. For example, for monitoring and evaluating the project; engaging project team members and other stakeholders to develop a shared understanding about the initiative; planning and implementing evaluation; and to report project progress through monitoring of the causal pathways between the project's resources, activities, outputs, and outcomes. Through this short presentation, we are particularly interested in sharing our experiences and opportunities to discuss with delegates' their experiences of scholarship project planning and impact evaluation.

A review of group-based methods for teaching statistics in Higher Education

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The teaching of statistics in higher education in the UK is still largely lecture-based. This is despite recommendations such as those given by the American Statistical Association's Guidelines for Assessment and Instruction in Statistics Education report (Carver et al, 2016) that more emphasis should be placed on active learning strategies where students take more responsibility for their own learning. One possible model is that of collaborative learning, where students learn in groups through carefully crafted 'problems', which has long been suggested as a strategy for teaching statistics.

We review two specific approaches that fall under the collaborative learning model: problem- and team-based learning. We consider the evidence for changing to this model of teaching in statistics, as well as give practical suggestions on how this could be implemented in typical statistics classes in higher education.

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Evaluate the benefits of early embedding reflective practice into student experience and personal skill development

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Reflection is a key fundamental trait that we do throughout our lives both willingly and sometimes subconsciously. Developing a better understanding of the students' perspective of reflective personal development will enable the embedding of more focused and student led reflective experience for underscoring the importance of confidence building and a 'personalised higher education journey' and transition into graduate careers. This student led SADRAS project aimed to establish what students understand by 'reflective learning', what opportunities and gained benefits are perceived by students from reflective practice. In 2018, the Science Foundation year was brought in-house to Kingston University from Kingston College, with the aim of fully integrating students into the University. This allowed the opportunity for a course review and restructure, allowing for the early embedding of a variety of academic and employability skills that served to prepare students for subsequence levels in Higher Education. One novel implementation from these changes to the foundation course was the introduction of the module FX3002 Foundation Project-based Learning which focused on varied skill-based assessment such as critical thinking, problem solving and group work, and importantly the development of reflective appraisal and writing skills. Although key and transferable skills are embedded within assessment throughout Undergraduate study, often focusing on facts and figures, there is little evidence that students are fully aware of the importance of reflective practice on their personal development (Veine et al, 2020). The ability to question, relate, reason and imagine solutions are the key premise of reflection (Ryan 2013). The changes implemented through FX3002 were aimed at promoting habitual reflective practice not only during academic study but beyond (Rogers 2001).

Preliminary data from our findings comparing students who undertook FX3002 with those who did not, shows that those who felt they understood the term 'reflective practice' was 75% and 54% respectively. The second finding was aimed at foundation students to a certain if their experience of reflection on FX3002 helped them feedforward with reflective practice on other (level 4-6) modules. 62% of students answered no. Other points to note from the data was whether reflection helped students in their career choice after graduation in which students had to choose a mark on a scale between 0-10 resulted in an equal spread of marks so thus inconclusive. Further thermatical analysis of data and pending interview findings will be used to better understand and provide possible ways to implement reflection in our degree courses in order to encourage better student engagement in their own reflective practice approaches for personal academic success and their career beyond university.

Mary Ryan (2013) the pedagogical balancing act: teaching reflection in higher education, Teaching in Higher Education, 18:2, 144-155, DOI: 10.1080/13562517.2012.694104.

Rogers, R.R. Reflection in Higher Education: A Concept Analysis. *Innovative Higher Education* **26,** 37–57 (2001). https://doi.org/10.1023/A:1010986404527.

Sven Veine, Martha Kalvig Anderson, Nina Haugland Andersen, Thomas Christian Espenes, Tove Bredesen Søyland, Patric Wallin & Jonathan Reams (2020) Reflection as a core student learning activity in higher education - Insights from nearly two decades of academic development, International Journal for Academic Development, 25:2, 147-161, DOI: 10.1080/1360144X.2019.1659797

Student Support 1 / Mathematics (Wednesday 29th, 16.00)

Refreshing students' mathematical knowledge via a massive open online course (MOOC)

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In September 2019, the University of Nottingham embarked on the delivery of Level 6 Degree Apprenticeships. A Degree Apprenticeship combines a job with a programme of academic study that awards a bachelor's or master's-level qualification. The university currently offers three programmes; Laboratory Scientist, Data Scientist and Electro-mechanical Engineer, and the cohort of students recruited onto these courses have a mixed exposure to mathematics. Some students begin their course having just completed Further Education (predominantly via A-levels) whilst other students may not have studied Mathematics in over 20 years. In fact, Butcher et al (Office for Fair Access, 2017) acknowledge that the science curriculum can act as a barrier to learning for many students with more diverse backgrounds (such as adult learners) due to the general decline in maths skills. They suggest that there is a need for integrated entry curricula teaching skills, rather than abstract/theoretical knowledge. With this is mind, and to aid the transition from pre-university mathematics education to the degree apprenticeship course(s), in 2021 a team at the university created a MOOC (massive open online course) entitled "Introduction to Mathematical Methods for University-Level Science". Research indicates that learning through a MOOC is very efficient and effective and that some students thrive on online access (Alhazzani, 2020). Moreover, since the MOOC was to be rolled out before the commencement of the Degree apprenticeship course(s), the MOOC would act as a way of preparing students to the online learning nature of degree apprenticeship content.

The course was created to mimic A-level Mathematics topics (carefully selected and chosen to best prepare students with the pre-requisite maths skills required) and was designed to ensure flexibility for future use so that other Schools and courses could use the MOOC as an online learning tool for mathematics. An additional purpose of the MOOC was to support new undergraduate students, especially those from Widening Participating backgrounds whose prior maths education experience was disproportionately affected by COVID. Preliminary findings from usage statistics and student feedback indicates that the initial roll out of the MOOC has been very successful.

A further statistical analysis of the Mathematics results of the first cohort of the Level 6 Degree Apprenticeship in Data Science was performed at the end of the first semester. Perhaps unexpectedly the mature students achieved a higher median score than the non-mature students, possibly due to their increased exposure of problem solving in a workplace setting. Although there was no statistical significance between the difference in scores, the small sample size should be taken into consideration when evaluating the overall effect the MOOC has had on student performance in mathematics.

Noura Alhazzani, (2020). MOOC's impact on higher education, Social Sciences & Humanities Open,Volume 2, Issue 1, 100030, ISSN 2590-2911,

Office for Fair Access (2017). Understanding the impact of outreach on access to higher education for disadvantaged adult learners. Office for Fair Access, accessed 21st February 2022 < http://oro.open.ac.uk/50339/1/Final-Report-Understanding-the-impact-of-outreach-on-access-to-higher-education-for-disadvantaged-adult-learners-docx.pdf.

Recognising and coping with maths anxiety in adult learners, oral presentation for pedagogic research - (online presentation)

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An investigation into helping mature students engage with the learning of mathematics. Many mature students returning to education feel anxious and find maths difficult, particularly true of Access to HE students who typically leave school with minimal qualifications and in later life return to College for a new start.

Maths anxiety is a phenomenon studied for over 60 years (Dowker, Sarkar, & Looi, 2016). It can be defined as “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in ordinary life and academic situations" (Richardson & Suinn, 1972, P.551). Historically, the focus for such research has been on younger learners. The research reported here is instead concerned with adult student returners, specifically focussing on cohorts of Access to HE students.

Dweck (2007) asserts that if students realise that maths anxiety is ‘normal’ and widely accepted as a debilitating state; then they will be that much more able to challenge and defeat their negative feelings in pursuit of maths proficiency. A broad research programme has been undertaken into potential interventions building on this assertion, with the aim to help mature students more easily engage with the learning of mathematics.

Their college experience was investigated exploring their views, which are “personal, subjective and unique”, (Cohen, Manion and Morrison, 2018, p.5). This research focuses on real lives and considers a variety of views, captured using surveys, observation and interviews. Over a three year period, students have been surveyed and participated in various interventions. Two research aspects will be presented.

Firstly, the extent to which mathematical anxiety exists in the Access students was investigated using the Maths Anxiety Survey (MAS, Betz, 1978). A high percentage of the students were found to experience consistently high levels of maths anxiety of around 81% over the three-year period.

Secondly, using a method of action research, an intervention was conducted in the form of a short presentation to help students understand why they feel anxious and to introduce strategies to overcome such feelings. The differences in student feelings of maths anxiety prior to and following the presentation were encouraging: in the worst-case a measure of ‘Anxious feeling negative’ reduced from 38% down to 7%; those reporting ‘Confident’ were 22% before the presentation, compared to 52% after; and ‘Concerned But Positive’, were 40% before, compared to 52% after.

The research has found significant numbers of students (>80%), do have maths anxiety at course entry. The research has revealed that with appropriate intervention and motivation, it is possible to reduce anxiety levels in mathematics. This practical intervention supports the work of Lee and Johnston-Wilder, (2017), who found that if potentially anxious students were presented with the known facts about mathematics anxiety and strategies that were known to reduce this anxiety, then this could yield an overall improvement in the way in which they responded to future mathematical problems and scenarios. This research is likely to be of importance as students take their place as confident, competent, problem-solving health professionals.

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? Frontiers in Psychology, 7, Article 508

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. Journal of Counselling Psychology, 19(6), 551–554.

Dweck, C. 2007, Child Development, the Society for Research in Child Development, Inc, Volume 78, Number 1, Pages 246 – 263

Cohen, L. Manion, L. Morrison K. (2011) Research Methods in Education (6th edition, London: Routledge Falmer.

Betz, N. (1978). Prevalence, distribution, and correlates of maths anxiety in college students. J. Couns. Psychol. 25, 441–548. doi: 10.1037/0022-0167.25.5.441

Lee, C. and Johnston-Wilder, S. (2017). The Construct of Mathematical Resilience. In: Xolocotzin Eligio, Ulises ed. Understanding Emotions in Mathematical Thinking and Learning. Elsevier, pp. 269–291.

Statistics anxiety: does this differ by qualification?

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Students taking a qualification in data science and economics are now the largest cohort of students on a second-year undergraduate statistics module. The student numbers on this module have been steadily growing, with a current cohort of 738 students compared to 561 in 2020 and 457 in 2019. The module was last rewritten in 2017 when most of its students were on a mathematics and/or statistics qualification. As such, the module content is very much focused on serving the needs of those students. However, in recent years the students are studying from a more varied set of qualifications and in the current cohort, over a quarter of students are Data Scientists and nearly a fifth are Economics students.

At the OU modules must work at scale and we cannot provide different modules for students studying different qualifications. Therefore, to support the differing study intentions of the students, the way in which we have supported students on this module has been gradually changing since 2019. For example, students studying Economics have a limited exposure to some of the mathematics techniques that are used in this module. A large amount of support material now exists for these students which they can work through during the summer months prior to the module start.

A more radical change has been the way in which we have allocated students to individual tutors based on the qualification that the student is studying. Small group tutorial support in now focussed on individual qualification, together with a set of tutorials covering the main areas of the module.

The talk will outline some discussion of the evaluation of this approach, which has included increased participation in synchronous qualification-based tutorials. One explanation is the value which students place on the social aspect of these tutorials. In addition, this module has a smaller ‘good pass rate’ gap for students who declared a disability, compared to other modules in the STEM faculty. Both these finding could suggest that this approach is reducing statistical anxiety in students. To explore this idea further we are adapting existing statistical anxiety rating scales to see if these can be used to identify different forms of statistical anxiety and in the first instance explore if these different forms are related to the different qualifications which students may be studying. The talk will outline our intended approach to this evaluation and invite feedback.

Poster session (Wednesday 29th, 17.00)

Enhancing Social Dimensions for Online Learning

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The pandemic created challenges for learners to socialise and benefit from informal learning opportunities and supporting well-being. The ability to socialise in an Open University (OU) context, e.g., residential schools, post face-to-face tutorial chats, OU meet-ups, etc., was particularly hit and limited during the pandemic. This is at a time, where students are increasingly trending towards using apps like WhatsApp, etc. and the use of online discussion forums (such as module & tutor group forums) appear in decline. The postpandemic experience is likely to retain elements of working practices developed in recent months as well as the increasing number of 'full-time students' (especially in the range 18 -25) wanting to engage in higher education in a more blended / distance model and for the OU entirely distance learning. Nevertheless, it is important for well-being, inclusivity and developing the feeling of belonging and cohort identity that opportunities exist to share experiences and to socialise generally in a safe, welcoming, inclusive, and friendly online environment. This paper will provide: (i) a brief introduction and summarise learning from key texts / literature presenting a proposed conceptual framework & principles for creating social dimensions online; (ii) an empirical approach used in a capstone module from the OU MEng qualification (Module T885: Team Engineering) where students use Adobe Connect to engage and where communication and motivation are fundamental to the learner's success allowing readers to empathise with the student experience; and (iii) an overview of the conceptual framework tested by reflective workshops analysing this case study which also led to the generation of a toolbox for tutors to use. The work shows the added value that can be created by facilitating informal online gatherings outside 'timetabled' online sessions, and presents a conceptual framework linked to the 10 principles of student engagement generated by Bryson (2014) which is used to measure performance against the framework. It is envisaged this work will help inform others and module teams delivering a predominantly online teaching and so enhancing student engagement and fostering co-creation of the student experience.

Bryson, C (ed.) (2014). Understanding and Developing Student Engagement, Taylor & Francis Group, London.

Implementing STEAM education through teacher training

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Schools should encourage trends of diversity versus conformity, creativity over obedience, etc. Investing in the concept of Integrated STEAM and SEL (SIS) – that is, integrating teaching STEAM subjects (sciences, technology, engineering, art and mathematics) with SEL (social–emotional learning), to encourage tolerance, developing self-efficacy and social values – may foster collaboration to leverage and link all relevant resources towards a STEAM learning model.

In 2022, a 30-hour professional development course for teachers to deepen their SIS approach in education took place.

The course included a constructionist approach in teaching, principles and characteristics of SIS through practice teaching, and presentation of a group project, discussions about future professions, and analysis of selected local and global projects.

During the course, the teachers experienced in Design Engineering in a collaborative learning strategy. Design Engineering has been imported from engineering into the fields of education in a STEAM approach and is used to promote students as active citizens in the future. The leaders of this field see it as an interdisciplinary area, a leverage for the development and realization of new economic, environmental, and social opportunities.

Our goal in this research was to create a common discourse and to promote research to gain insights into the professional development of STEAM education.

This research used mixed methods. A qualitative research method with the addition of quantitative aspects was used. The qualitative findings were classified according to categories, both as they related to the spirit and the essence of the categories. Quantitative reference to every category was made using theorical statistics, to identify tendencies or trends among the study participants.

The research was conducted among 15 primary school Arab teachers from different disciplines. They were given pre- and post-course questionnaires to see if there was any change in their approach to the subject. They were also given an assignment to reflect the stages of their own design engineering process.

The pre-course questionnaire and the post-course questionnaire showed that while almost all the teachers arrived without knowledge about Design Engineering process, through the course they gained confidence and managed to realize much of the process to the point of their being able to implement in the field.

Teachers' responses at the conclusion of the course conveyed their feelings about the importance of studying the Design Engineering subject.

A unique element that was examined in this study is SEL expression for implementation in stages of the Design Engineering process, and we found that emphasizing this topic in the course opens the door to its application in the field.

Every STEAM teacher must be given an opportunity to gain experience in the Design Engineering process and learn how to teach this subject. If teachers acquire more understanding and knowledge on the subject, their teaching methodology is likely to be more correct and meaningful.

Archetypal modes of engagement in blended learning

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From the ashes of online-only courses at the start of the pandemic, rose the phoenix of Hybrid Learning. It is important that Hybrid Learning is not confused with Blended Learning: where all students participate in a mixture of online and in-person activities (with each mode of delivery being optimised for its respective format). Rather, Hybrid Learning refers to the educational practice whereby a subset of students attends an educational session in-person, whilst *at the same time* the remainder of the cohort participate in synchronous online activities. While this undeniably offers flexibility for students and cost benefits for universities, it increases staff workloads and potentially provides an inferior experience for some students – particularly those attending online.

Further unwelcome side-effects of this mode of delivery are the observed reduced levels of in-person attendance, with many students (even though residing locally) opting for online only involvement. The patterns of engagement have also shifted, with less questions being posted on discussion forums, fewer students attending practical lab sessions and completing formative assignments. This has in turn resulted in lower average marks across cohorts for many programmes of study.

In order to aid the design and development of Hybrid education in the face of these unfamiliar student behaviours and modes of participation, we have identified a set of distinct ”archetypes” or personas (Cooper, 2004). These act as drivers and ”vantage points” from which to consider the benefits and disadvantages of various educational innovations and initiatives. The personas we have identified include learning types such as ”the fully engaged in-person learner"; ”the anonymous avatar”; ”the self-guided blender”; ”the proxy spokesperson” and the ”night-shift asynchronous learner”.

In this poster presentation, we will detail each of the different archetypes and apply them as personas to the design of a specific educational activity, in order illustrate their potential utility. Our aim with this work is use these personas as a catalyst to initiate mutually beneficial discussion with colleagues from different institutions, with a view to understanding what might constitute best-practice in this area.

Alan Cooper. 2004. ”The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity“ (2nd Edition). Pearson Higher Education.

Case of “Invisible” Women Contribution in STEM Classrooms and Workplaces

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In India, parental pressure plays an important role in deciding the career of a child. STEM is the most sought after education pathway. The foundation for a STEM career is laid early in life, but scientists and engineers are made in colleges and universities. They are nurtured in workplaces, laboratories and universities. Though everyone starts with equal footing it is observed that not many women are visible for their work and contribution in STEM classrooms and the workplace. A simple query by the author, “name five women scientists” from sixty respondents of STEM background and only one answer has laid the foundation of the need of this research work. This research work is quantitative and qualitative. It will ponder upon the reasons and assumptions behind the “invisibility” of women's recognition in STEM classrooms and workplaces, especially in India. The work will also try to propose solutions.

Effect of sleep and mood on academic performance—at interface of physiology, psychology, and education

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Academic achievement and cognitive functions are influenced by sleep and mood/emotion. In addition, several other factors affect learning. A coherent overview of the resultant interrelationships is essential but has not been presented till date.

A literature review was conducted that compiled these interrelationships. Data showed that although sleep and mood are known to affect learning, there have been conflicting observations. In part, this could be due to the multitude of other regulatory factors that influence learning; namely, age, gender, diet, hydration level, obesity, sex hormones, daytime nap, circadian rhythm, and genetics. There are underlying physiological mechanisms that mediate the effects of these factors on learning. Furthermore, sleep and mood show a bidirectional relationship. Based on the available data, contextual pictorial models were drawn that hypothesised learning on an emotion scale and

emotion on a learning scale.

This concept is unique and interdisciplinary. It sits at the interface of physiology, psychology, and education. Essentially, convoluted associations between physiological and psychological factors including sleep and mood that determine academic performance are recognised and affirmed. The emerged picture reveals far more complexity than perceived. It questions the currently adopted 'one-size fits all' approach in education and urges to envisage formulating bespoke strategies to optimise teaching-learning approaches while retaining uniformity in education. This information can help improvise education strategies and provide better academic and pastoral support to students during their academic journey.

An Exploration of The Lived Experience of Informal Student Carers During Covid-19

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This research explored the lived experiences of Informal Student Carers (ISC) and the challenges they have faced throughout Covid-19 pandemic. Currently there is limited research on ISCs as a specific group, and no research on this specific group during the pandemic. This research is important because ISCs are an under-recognised group who benefit from social support when it is available. Being an ISC brings its own unique set of challenges, especially during Covid-19. Universities have a duty of care to their students to recognise diversity across the student body and the distinctive challenges that student carers are facing and respond to them by making reasonable adjustments. Study objectives:

1. Understand the specific challenges that ISCs face balancing student life with caring, and the impact the pandemic had on their responsibilities and studies.
2. Suggest recommendations for universities to make reasonable adjustments to support student carers.

A scoping review was conducted followed by a questionnaire-based survey informed by the review. The questionnaires were distributed through carer charities and through university student networks and followed up with telephonic interviews. The responses were coded and organized into themes. The results have been the basis for recommendations to the higher learning institutions to make reasonable adjustment and provide support for informal student carers.

This research has explored the lived experience of ISC's and the challenges they have faced throughout Covid-19. The combination of financial worries (NUS,2013; Carers Trust, 2015), time constraints (Sempick and Becker, 2014, Kettell, 2018, Onwumere et al. 2021) along with the lack of visibility of student carers (Kettell, 2018) has a large part to play in the poor mental health of this student group. These issues have helped inform recommendations which universities would do well to consider supporting the unique and varied needs. Universities need to reach out to student carers. They have a duty of care to the students, and they are accountable for dropouts. They should therefore design effective retention strategies, based on the recommendations that made throughout this discussion which are informed by the lived experience of ISCs. The pandemic and the stages after its peak continue to be difficult for student carers. The pandemic has been more difficult for student carers that it has been for their non-caring peers. Universities must not let Covid-19 be yet another reason for student carers to go unseen and unheard.

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Carers Trust, (2015). Supporting Students with Caring Responsibilities: Ideas and Practice for Universities to Help Student Carers Access and Succeed in Higher Education England version.

Sempik, J. and Becker, S., (2014). Young adult carers at college and university. London: Carers Trust

Kettell, L., (2018). Young adult carers in higher education: the motivations, barriers and challenges involved–a UK study. Journal of Further and Higher Education, 44(1), pp.100-112.

Onwumere, J.et al (2021). COVID-19 and UK family carers: policy implications. The Lancet Psychiatry, 8(10), pp.929-936.

Introducing Human-Machine Interfaces through Active Learning in the Laboratory

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Implantable human-machine interfaces is a rapidly advancing field bringing together engineering, neuroscience, and medicine. In a new module, we aimed to introduce postgraduate students to the field, and equip them with an understanding of the engineering paradigms behind implantable devices aimed at treating conditions including restoration of motor function, brain-computer interfaces, epilepsy, chronic depression, and chronic heart failure.

Two laboratory assignments were developed as part of the new module to provide scope for active, student-led learning (Freeman et al, 2014). In a first assignment, students are introduced to electrode interfaces with the nervous system and the instrumentation used to characterise these interfaces. In a second assignment, students are introduced to real-time neural signal processing, wireless signal transmission and microcontroller programming.

Students join the module with a variety of backgrounds, from engineering to neuroscience, and therefore prior knowledge is diverse. A key challenge of the module design is to address the required prerequisite knowledge for the laboratory sessions, to equip students with the tools to direct their own learning.

We created an active and problem-based learning environment, where students gain knowledge during problem-based laboratory tasks. The new laboratory assignments follow our previously successful approach: students are guided through practical aspects of the assignment with detailed practical methods, and prompted with appropriate discussion questions to investigate and learn new key concepts (Lancashire and Vanhoestenberghe, 2021). With this approach students succeeded in learning the key laboratory concepts rapidly, requiring only introductory level electronics and programming knowledge as prerequisites.

Student feedback and student and peer evaluations are being collected for detailed analysis and improvements to our approach. We will present a reflection on the use of active learning in the laboratory where learners have diverse backgrounds and students' prior knowledge is not known.

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Lancashire, H., and Vanhoestenberghe, A. (2021). Rapid Conversion of a Biomedical Engineering Laboratory from in Person to Online. Biomedical Engineering Education. 1(1):181–186. DOI:10.1007/s43683-020-00031-y.

Action Research to Address Ethnicity Awarding Gaps in Design

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Brunel University London has identified differences in degree awarding (1st and 2:1) between white and Black students, and white and Asian students, and set goals to halve the percentage differences by 2024/25. In order to achieve the goals, ten research projects were funded in 2021/22. The project reported here is one of these; it had a focus on reducing the ethnicity awarding gap within Brunel Design School which had 36-39% of non-white graduate students in 2020/21.

Action research (Mertler, 2017) was adopted as the methodology. Learning analytics and focus groups were used to understand the issues and identify potential solutions. Students were involved as participants, designers and co-researchers (Minocha, 2021). The questions for focus groups were co-designed with students' input. The research received ethics approval from the College of Engineering, Design and Physical Sciences' research ethics committee.

The initial analysis based on design undergraduate data between 2016/17 and 2019/20 suggests: ethnicity awarding gaps were between 9%-16% for BA Industrial Design& Technology (ID&T) Programme; between 8%-29% for BSc Product Design Engineering Programme (PDE). For BSc Product Design (PD) Programme, in 2016/17 and 2019/10, the gaps were 50% and 9% respectively. In 2017/18 and 2018/19, more percentages of non-white students obtained 1st and 2:1 degrees than white students (in 2017/18 there was only one BAME student in that programme). The 2020/21 data (studying under the pandemic, with no-detriment policy/'safety net' and changes to exams) show ethnicity awarding gaps of 35% (BA ID&T), 12% (BSc PDE) and 37% (BSc PD).

Focus groups are being conducted to explore questions such as:

- What type of difficulties do you encounter in your course?
- Do you use the University's English study support? How effective is it for your study at Brunel?
- For teamwork, what challenges do you have in co-working with Caucasian / English speaking students? And with students from your own country/similar culture?
- How do you think about the existing assessment methods? Do they allow all students to be assessed fairly? What could be improved?
- What do you think about the learning and teaching environment at Brunel Design School? Do you feel included? What could be improved?

Possible solutions to address awarding gaps in design may include adopting fairer assessment methods; providing tailored support to students in need; and creating culture-sensitive teaching and learning environment. More strategies and solutions may be identified through the studies and will be shared in the conference.

Mertler, C. A. (2017) Action Research: Improving Schools and Empowering Educators. 5th edn. CA: SAGE Publications, Inc.

Minocha, S. (2021) Scholarship of Teaching and Learning in STEM. Open University free course, accessible from. https://www.open.edu/openlearn/science-maths-technology/scholarship-teaching-and-learning-stem/content-section-overview?active-tab=description-tab [accessed on 31st Dec 2021].

The future of 3D models in education: insights from usage data of virtual outcrop models from varied teaching and assessment exercises in Earth Sciences

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Fieldwork is a vital part of the Earth Science curriculum, but photorealistic 3D virtual models of rock outcrops are becoming increasingly easy to generate and provided a critical alternative method of teaching during the COVID-19 pandemic, through virtual fieldtrips, self-guided learning, and assessment. Here, we present three case studies of virtual or hybrid fieldtrips involving 3D models and evaluate student engagement and feedback in each scenario.

Teaching – Virtual fieldtrip to Bude, Cornwall, UK. Sixty-five 1st year undergraduates had to describe the morphology of folded rocks using three 3D virtual models which were viewed, on average, 1.04 times per student.

Self-guided – Blended-learning field trip to Bradgate Park, Leicestershire, UK. Fifty-nine 2nd year undergraduates constructed a geological map based on virtual material and their own field observations. Students had a selection of resources to choose from, but the use of 3D models was not mandatory. We created fourteen 3D models for all the main rock outcrops the students visited in the field, and these were viewed, on average, 0.7 times per student.

Assessment - Virtual fieldtrip to Monmouth Beach, Lyme Regis, Dorset, UK. Sixty-two 1st year undergraduates completed an assessment that involved logging and describing a rock outcrop entirely from two 3D models, each of which were viewed, on average, 3.15 times per student.

As we transition beyond the pandemic, 3D models continue to provide a valuable and accessible resource to compliment fieldwork or provide an alternative assessment method. We will develop a range of metrics to quantify student engagement from both web-based data and student surveys. Our current usage data suggests that students engage with these models most effectively when used as a core part of their teaching or summative assessment and that active inclusion in the teaching program is necessary to maximize student engagement with the virtual material.

Co-designing resources to support the transition to a research-focussed degree: stopping postgraduate Psychology students feeling “lost at sea”

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The transition to postgraduate education is characterised by anxiety, self-doubt, and lack of clarity on expectations (McPherson, Punch, & Graham, 2017). However, there is a lack of research into this topic, and it is important that institutions take steps to minimise potential anxieties and stressors associated with this process. One area of potential focus is providing resources designed to ease the transition into postgraduate learning. For example, Psychology programmes in the UK offer Conversion courses that allow postgraduate students to study Psychology as part of a Master’s degree. However, in terms of pre-requisites students are only required to hold a 2.1 in any undergraduate subject, as well as some experience of maths at GCSE level or equivalent. Thus that postgraduate students will enter the course with a wide variety of qualifications. Whilst some may feel they have the mathematical background to cope with the research and practical aspects of the programme, others may feel less capable. By not effectively managing and supporting the wide range of expectations resulting from this, this can lead to increased feelings of anxiety in research topics such as statistics (Primi & Chiesi, 2018). This could in turn exacerbate negative feelings associated with transitioning from undergraduate to postgraduate study. The aim of this research was to co-design resources with students which would help support their transition from an undergraduate degree with less experience in research, to a postgraduate degree with a significant focus on research methods and statistical analysis.

Students enrolled onto a Master's Conversion Psychology course in the UK were invited to take part in a series of co-design workshops. Including students as co-design partners has been described in previous research as important for providing more authentic voices on the University transition experience (Maunder et al., 2013). Three postgraduate students took part in three workshops structured according to the 'WE DID IT' approach to co-design research (Dollinger & D'Angelo, 2020). Workshop one explored the experiences of students during the first few weeks of Research Methods and Practical Methods modules, workshop two was used to discuss the advantages and disadvantages of different types of resources used to support learning. Knowledge from workshops one and two was used to create resources that were tested and evaluated in workshop. Preliminary findings based on qualitative data from workshop one suggest that even those with a mathematics background still felt "lost at sea" compared to undergraduates on the same module when first studying research methods and statistics modules. Suggestions to increase support included considering the timing of resources, managing the expectations of teachers and students, and providing clarity of language through teaching. The theoretical implications of these findings will be discussed, and suggestions of resources and strategies that could support the transition into postgraduate research methods modules, based on this research, will be highlighted.

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Are virtual visits an effective way of engaging learners?

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Mature students often choose distance learning due to its potential to fit around life priorities (Butcher 2015. Rasheed 2020). However, personal circumstances such as geographical location, disability and time poverty can prevent distance learners from participating in extra-curricular activities such as field trips (Roosmaa and Saar 2016). Inability to participate may negatively impact student experience (Butcher 2015. Baxter 2019).

Advances in technology mean it is now possible to deliver live virtual visits which produce many of the same benefits as face-to-face visits. Despite this, the use of live virtual visits has rarely been fully exploited.

The aim of this project was to investigate if a live virtual visit to Bletchley Park Museum is an effective way of engaging Open University distance learners studying Computing and IT.

Level 2 students were invited to participate and a mixed methods approach was used. This involved quantitative analysis of participant demographics, a participant survey which included use of a 1-5 Likert scale and free text responses and a reflective account composed by the project authors.

101 students participated in the virtual visit. Results found that 42% of students were identified as being in the lowest 50% of the index of multiple deprivation. Participant survey results found that 54% would find it difficult to visit in person, yet 100% now wish to visit the museum.

Results indicate that virtual visits may be an effective way of engaging learners, widening participation, promoting museums and diversifying workplaces.

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STEM in America

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I've been involved with STEM education since 2018 in Latin America and have been through many experiences around different cities of México and the U.S. In my journeys I have worked with many different schools on a wide variety of levels that go from 1st grade elementary school to final high school semesters. Working with kids from 6 years old till 18-year-old young adults. I work at an organization called "El Garage Project Hub" where I have been an instructor for workshops STEAM-related like video game coding, electronics, internet of things, 3D Design, Drones, Roblox and Minecraft Education. After working with private and public schools I've noticed a difference in necessities between every sector.

I had the opportunity to work in many community's service projects such as "Science vs Violence" and "FORTASEG". Giving support to children to inspire them to aspire to something big. Change their way of seeing the world that surround them and open them to new opportunities. México is where the main offices of Garage are, also thanks to this I've given workshop around the country in cities like Tijuana, Jalisco, CDMX and many different areas of Mexicali.

In August 2019 I got selected to participate in a program called "Professional workshop for STEAM Instructors" at the Institute of the Americas located in La Joya, California U.S. where with other instructors from LATAM we spent a week at UCSD (University of California San Diego) learning about STEAM Education with the help of professional instructors from that school.

I wish to share all this experiences at the chaired session along with the challenges that we have been going through with the pandemic situation and how this has helped us with some topics but damaged others and discuss how STEAM has changed education and the future of it.

Plenary 2 (Thursday 30th, 9.20)

Made in Brunel: how student-driven initiatives contribute to design learning experience

Chloe McCout, Connor Ray and the Made in Brunel Team.

Talent is everywhere, opportunity is not. Made in Brunel is an opportunity.

As a student-led initiative of the Brunel University London, Made in Brunel showcases design students' talents, skills and entrepreneurship to the world through a range of events and publications carried throughout the year.

Made in Brunel started in 2006. Over the last 17 years, it has become one of the shining examples of how these types of initiatives can contribute greatly to the learning of university students. Each year the baton of Made in Brunel is passed by the graduate cohort and sustained by the next one. Blueprints was created by the 2022 cohort; the brand represents the hard work behind our polished designs and individual journeys of discovery and growth.

The students presenting this plenary are all 2022 graduates of the Brunel Design School and will discuss the student learning experience from the fresh perspective of the students themselves.

Active learning 4 (Thursday 30th, 10.00)

A walk in the virtual woods – embedding active learning into immersive worlds

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Cost and time have historically been a barrier to the use of immersive technologies for learning, (Cliffe, 2017), but recent innovations in hardware and hosting, specifically of 360 degree imagery, have lowered the barrier to entry. Using tools such as 360 cameras, and hosts such as ThingLink, it is now relatively easy to produce a virtual replica of a real-life environment, and to add learning content into that virtual world. Virtual worlds are attractive from an inclusivity point of view as they can allow students to visit places they may not be able to physically visit, and they can also be powerful tools for learning. Lee, Wong and Fung, as far back as 2010, highlighted a set of factors that can enhance learning outcomes, four of which are particularly relevant to virtual worlds: presence, motivation, control, and active learning. Immersive learning environments can incorporate several of these factors into one resource, but only if they are well designed and include activities to elevate it from being a prescriptive virtual tour. Diane Laurillard's (2002) framework for learning activity types can also be applied to immersive environments to help shape the activities that students can engage in within the immersive world, which with the right tools can range from acquisition and inquiry through to production. In addition, it is useful to consider the power of a deliberate narrative to draw the students through the environment in an engaging manner.

With reference to the Virtual BIFoR resource, based around a climate change experiment in a forest in Staffordshire, we discuss how we applied Lee, Wong and Fung's enhancement factors to a successful immersive experience.

Presence was provided through the use of HD 3D images, motivation through the narrative that invites them in to explore, control through going step by step, and being able to explore at one's own pace, and active learning with activities such as downloading data from dendrometers, or counting tar fungus spots on leaves. Student feedback was gathered from the Virtual BIFoR and a range of similar resources, which showed that students found these experiences to be both engaging and interactive. Future enhancement to the portfolio of tools and techniques include embedding 3D models within a virtual landscape, and the use of conditional navigation to enhance the sense of agency in the leaner.

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Using STEAM to power HPV vaccine awareness and advocacy among Irish post-primary students

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Human Papilloma Virus (HPV) vaccines can save lives and eradicate associated cancers, but the uptake of the vaccine among first-year second level schoolgirls in Ireland, to whom it is offered for free, has dropped in recent years. Building on the experience of a previous pilot study with Biological Science and Design students (presented at Horizon 2021) this project aimed to validate the findings of Macdonald, Malone & Firth (2022) with these questions: In what ways can STEAM engage and motivate TY students to learn about immunology and vaccination? And in what ways can STEAM help them develop the competence and confidence to communicate their understandings about immunology and vaccination? It brought together Irish and Scottish academics from Education, Design, Biology, the Irish Cancer Society, and Irish post-primary students in an interdisciplinary, intersectoral and international collaboration.

Twenty 16-17 year old students, from three Irish post-primary schools in County Kildare, participated in a weeklong series of on-campus STEAM workshops, facilitated by the team. Taking an active learning approach we combined science education with drama in education activities, storytelling through artwork, and video creation. COVID restrictions necessitated a blended delivery approach with a mix of in-person and parallel online collaborative participation from colleagues in Scotland, and contributors from the ICS. The workshops facilitated a dialogical peer-to-peer teaching and learning (Topping 2009) amongst the participants to co-create localised, culturally inclusive, and scientifically informed stories around HPV vaccination and immunisation. Using the principles of active learning (Bransford et al 1999) the students constructed their own knowledge and understanding through drama improvisation, storytelling through scripts and storyboards in an iterative process of presentations and idea selection in a visual thinking methodology (Averinou and Pettersson 2020).

A qualitative arts-based research methodology was adopted and embedded into the workshops. The success and impact of the workshop series was evaluated on 3 key criteria: students' knowledge of immunology, their confidence in expressing their knowledge about immunology, and their confidence in advocating for vaccination and countering misinformation. A thematic analysis of the data was employed (Clarke et al, 2015).

The project highlights four key insights: a lack of personal research and open discussion results in a poor awareness of HPV vaccination and immunisation among post-primary students; a STEAM approach is successful in engaging students in active learning and changing their attitudes towards the HPV vaccine from passive to positive; the use of a STEAM approach enabled and encouraged students to become more confident in their understanding of HPV vaccine and immunisation and to more confident to advocate for HPV vaccine to peers; combining creative learning and teaching approaches with scientific content can lead to meaningful changes in human behaviour.

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Building primary and secondary computer science and cybersecurity teaching self-efficacy

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The push for teaching computer science (CS) and cybersecurity (CY) in United States (US) schools has become fervent as persistent deficits in technological, computational, and computer literacy continue to be documented along with negative unemployment in Cybersecurity careers. Indeed, this is not an issue that confines itself to US education (see Webb et al, 2017). Practitioners, researchers, and education stakeholders are calling for early student engagement with CS/CY skills in order to provide fertile ground for improving student interest and success in CS/CY as they progress toward adulthood (Barr & Stephenson, 2011; Grover, 2017; Jocius et al, 2021; Yadav et al., 2016b). Current efforts are focused on training non-computing primary and secondary teachers how to utilize CS/CY as an essential part of their regular classroom instruction. However, this kind of educational shift requires both content and pedagogical expertise on the part of the educator, thus adding to the heavy load they already carry. It is widely acknowledged that deeper understandings of the professional development needs of these educators are essential in order to make positive strides toward successful implementation (Yadav et al., 2013, 2014, 2016a, 2016b). In order to address this need, a cross-disciplinary group of education and computer science professors worked together to build and implement an extended course of professional development for primary and secondary teachers, grounded in Bandura's theory of Self-Efficacy and its hypothesized sources (Bandura, 1997). Through this 8-month grant-funded mixed-method study, we were able to identify the biggest factors for improving CS/CY teaching self-efficacy in non-computing primary and secondary teachers. Additionally, we identified specific, essential, unique structural elements that can be used to provide impactful CS/CY professional development for these teachers. Results are important for anyone who designs professional development for both pre-service and in-service teaching professionals, but specifically for those who are involved in science, technology, engineering, mathematics (STEM), Computer Science, and/or Cybersecurity education efforts.

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Enhancing anatomy and physiology education through design of simulation suits

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Simulation suits have been used in healthcare education to improve ageing knowledge, empathy, and attitudes towards geriatric patients through active learning (reviewed in Bowden et al., 2021; Eost-Telling et al., 2020). Rather than using existing simulation suits in this manner, students were asked to apply anatomy and physiology (A&P) knowledge to design and test a home-made simulation suit in order to deepen their A&P understanding of a typical geriatric person. This novel practical and assessment applies Bloom's taxonomy (Bloom, 1956) to deepen A&P understanding through creativity and evaluation.

Building on previous lecture, seminar and practical material, second year students (level 5, mix of healthcare and STEM) worked in groups of 5 over a 6-week period to design and test a home-made geriatric simulation suit. The multi-stage group assignment incorporated designing and making a simulation suit (creativity), testing the simulation suit in a practical class (experimental design and evaluation), and writing a lab report (written communication).

A student survey was carried out to determine student views on this novel assignment, including learning gain (of general / geriatric anatomy and physiology, experimental design and statistical analysis), enjoyment, transferable skills, as well as any changes in attitude or behaviour towards elderly people. Students also had the opportunity to highlight problems or areas for improvement in the assignment such as workload, team dynamics etc.

This work highlights opportunities for use of creativity to deepen A&P understanding in both healthcare and STEM students.

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Assessment 4 (Thursday 30th, 10.00)

On Unpacking the Coursework Assignment

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Unpacking assessments is gaining acceptability as one way to support students with diverse background and skills and promote inclusivity and equality of opportunities (Baglione, 2008; Cureton et al., 2017). Following the 'Fourteen rules for better assessment in higher education' (Ramsden, 2004), assignment unpacking is a key enabler to measure student learning by minimising misunderstandings; namely for open-ended assignments that can take over four weeks to complete. Furthermore, misunderstanding such expectations is a key issue for students that contributes to the BAME degree awarding gap reported in (Advance HE, 2021).

We have considered two computer science modules respectively with 30 and 200 students. Both modules were delivered online during the pandemic (Year 2020-2021) and designed to promote active learning (Goodell et al., 2020). A weekly formal teaching time consisted of

- Three-hour long sessions delivered using cycles of 15-20 minute pre-recorded lectures on specific topics followed by hands-on short exercises and TopHat quizzes with 10 minute break for each hour.
- Two-hour long Laboratory work with questions sequenced by their difficulty level.

Both modules are coursework-assessed including assignments. Specific sessions were devoted to unpacking the assignment wherein students work in groups and share their understanding of the assignment expectations and the marking criteria. They then share their understanding with the class and interact with the lecturer to iron out possible misunderstandings. This enables all students to demonstrate what they have learned and earn an appropriate mark, rather than spending time trying to interpret the assignment brief. Time was set aside to go through a previous student work on a different assignment and explain to the students what made that submission excellent.

We have evaluated the effectiveness of this approach through the students' feedback formal system within the University and their performance on the module. Looking at the collected data, we have found the followings:

- Average mark went up to 8.45% compared to that of 2019 where there was no 'assessment unpacking'
- Time used to support students reduced by half from an average of 30 hours of one-to-one meetings for a five weeks long assignment.
- Failure rate was reduced by up to 16.7%.
- The feedback score from the students on the question 'The marking criteria for this module were made clear' went up by 11.63%.

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Collaborative exams to enhance student experience in physics and chemistry

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Collaborative exams not only can measure the learning previously gained, but also can be an optimal opportunity to produce new learning, while reducing exam anxiety. In order to enhance the student experience during assessments in remote teaching and learning, we introduced a form of collaborative exam, adding to the usual two-stage design a third stage with student self-marking. In addition, we encouraged students to become active participants in the design of the exam by incorporating student-generated content. This presentation discusses the study outcomes and the student perceptions on these exams, within the framework of an active learning intermediate-level physics course.

Creating a collaborative feedback environment to enhance the student academic experience at Kingston University

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During the summer of 2021, a second-year undergraduate module at Kingston University, *Crime Scene, Evidence and Law*, was identified as a module that offers feed-forward formative feedback opportunities that enables students to improve their subject-specific knowledge applied to an assessment. The selected module forms part of the Forensic degree that is traditionally made up of non-traditional students that may have entered higher education through non-traditional routes, therefore may not be so prepared for the demands of academic writing that is of the upmost importance in a field such as Forensic Science that involves extensive written communication of reports (Wingate, Andon and Cogo, 2011). Part of this module's assessment method involved a group project: constructing a mock forensic crime case file, which often involves being able to explain complex terminology and concepts in lay terms, as if they are being presented to a jury.

In the first semester of the 2021-22 academic year, in collaboration with the SEC Academic Success Centre (SASC), the module leader, Dr Baljit Thatti, organised a dual feedback process on the formative group submissions. Critically, students received feedback on both the subject-specific aspect of their work, as well as the written academic style element, especially around their adherence to academic conventions. For the latter, the idea was that students would learn key skills that they could apply to the future assignments. This paper explores how formative feedback opportunities could involve not only subject specific feedback but detailed academic style feedback how the process of providing feedback was organised and delivered, and what the impact was on the student experience.

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Promoting a feedback dialogue with students: implementation and impact.

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Self-assessment, in which students are involved in making judgements about the quality of their work, is an important tool which can be used to support student learning (Boud & Falchikov, 2006; Taras, 2010; Wride, 2017; Andrade, 2019). Furthermore, self-reflection on feedback can be used to promote feed-forward (the spill over of feedback to the next assignment) and ultimately a more effective use of feedback (Quinton and Smallbone, 2010; HEA, 2012). Active involvement of students in their own learning enhances their engagement (Sadler, 2010) and has been shown to improve student performance (McDonald & Boud, 2003; Sharma et al, 2016). Perhaps more importantly, it contributes towards the development of self-regulation (Pintrich, 1995), and thereby the potential of students to develop as lifelong learners (Boud, 1995; Carless and Boud, 2018). This project explored three components of feedback: 1) Self-assessment, 2) Feedback Dialogue, and 3) Reflection on past feedback and feed-forward. The aim was to promote reflection on, and more effective use of, feedback.

Undergraduate students on all levels of two professionally accredited Nutrition degrees were supplied with a self-assessment template, which they were required to complete and submit with each assignment over 4 * 30 credit modules during the academic year 2021-22. The task was compulsory and contributed to final assignment mark. The study built upon a previous study of self-assessment in the same university (Mulrooney, 2019). The template required students to:

1. Identify the grade they would award the work and provide justification for that grade (*Self-Assessment Component*),
2. Comment on the strengths and weaknesses of their work and identify specific aspects they were seeking feedback on (*Feedback Dialogue Component*); and
3. Identify which aspects of previous feedback they were using to improve the current submission (*Reflection on past feedback and feed-forward Component*).

Overall, these components promoted a feedback dialogue between students and marker and explicitly linked feedback to subsequent assignments, creating an iterative cycle in which students articulated how they were using feedback given to improve their work.

The project is ongoing. Student self-assessment grades and their actual grades will be collated and tested for impact of demographic characteristics (e.g. age, gender, year of study), on likelihood of correct self-assessment. Multiple assignments submitted by the same students will be tested to establish whether self-assessments improved in accuracy over time. Qualitative data will be collated and basic thematic analysis will be carried out.

In this presentation, we will discuss the project findings and their implications, making recommendations for future practice.

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Equality, Diversity and Inclusion 2 (Thursday 30th, 10.00)

Measuring student awareness of equality, diversity and inclusion in the chemical sciences

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In order to better support the diverse needs of all new students, the School of Chemistry at the University of Leicester designed an inclusive induction programme which aims to develop a strong sense of community at the early stages of student programmes of study. Developing strong learning communities can potentially result in numerous benefits including improved student retention, enhanced student outcomes and a greater sense of student satisfaction for all students[1]. An important part of developing a strong sense of community involves helping students and staff alike recognise and celebrate the diversity within our subject area and to recognise the significance of developing an inclusive environment for study[2].

This study measured year one chemistry student awareness of Equality, Diversity and Inclusion (EDI) in the chemical sciences based on their pre-University educational experience. This was achieved by inviting all first year undergraduate students to voluntarily participate in a questionnaire-based study[3]. The study also investigated the impact of our induction programme on student awareness of EDI in chemistry. Analysis of the collected data showed that only 51.4% of Leicester chemistry freshmen participants in this study (n = 72) had pre-University educational experiences that raised their awareness of EDI in the subject and 60.6% of respondents agreed that their pre-University education completely failed to address EDI matters in the subject.

The chemistry induction programme at Leicester includes a student-led poster conference which celebrates the rich diversity that exists in chemistry research. Students work in small teams to design posters based on major research conducted by individuals (or groups of individuals) from under-represented minority groups. Students presented their posters to peers, academic staff and undergraduate and postgraduate students from other year groups. 86.1% of study participants agreed that the team poster activity improved their personal awareness of EDI in the subject and 87.5% of respondents agreed that was an effective way of discussing EDI in chemistry with their peers and 71.8% of respondents agreed that this approach was an effective way of discussing EDI in chemistry with faculty members.

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Designing inclusive learning environments: building learning communities, identifying benefits, and overcoming barriers in blended and active learning environments

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Active learning approaches to teaching have been associated with higher learning gains amongst learners and reduced achievement gaps. Universities have recently seen a move towards more blended approaches to teaching and learning, given the context of the pandemic. It is important to consider how adopting such approaches to teaching may impact students' learning experience, outcomes, but also community building and sense of belonging more specifically, and how these may be influenced by factors such as neurodiversity, confidence, and individual differences. This project sought to investigate what the practical benefits are of adopting such approaches in teaching and learning practice and what potential barriers may exist, considering how factors such as diversity, disability, past experience, may influence student engagement, outcomes, and sense of belonging within such learning environments. A survey was distributed to students in the School of Psychology, capturing (i) student experiences, including the nature of engagement with their learning, (ii) confidence, performance, and sense of belonging, and (iii) key factors that may affect those experiences (e.g., background, neurodiversity). A survey was also circulated to teaching staff to capture their experiences with adopting active learning approaches in their teaching practice. Findings from this project provide key insights into ways in which we can strengthen our approach to designing effective curricula around factors associated with EDI, building effective and supportive learning communities, and overcoming barriers to success.

Science capital and engineering education: exploring the nature of engineering and its lack of diversity in the United Kingdom

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The United Kingdom faces longstanding issues of inequity within the study and practice of STEM (Science, Technology, Engineering and Mathematics) subjects. For engineering these inequities are particularly severe. The UK faces an annual deficit of over 200,000 engineering educated individuals contributing to a national engineering skills shortage. The diversity of participation is particularly poor: 88% of engineers are male, over 90% are White, and recruitment skews towards middle-class backgrounds (EngineeringUK, 2018a; EngineeringUK, 2018b). Efforts to address these engineering inequities are motivated by drives for economic competitiveness and social justice, yet these efforts have to date been met with mixed results. This paper argues that the endurance of these issues is related to a fundamental knowledge gap as to the nature of engineering inequities in the UK. There is, therefore, a need to understand UK engineering participation and inequity in more granular detail.

Whilst not explicitly related to engineering, the 'Science Capital' model developed by Louise Archer and colleagues is a prominent model for understanding science participation and inequity in the UK (Archer et al., 2015). This popular perspective explores different assets – or 'capital' – for science that support young people to aspire to science educational or career pathways. These science capitals are positioned as a useful lens to examine group differences and understand inequitable patterns of science participation in UK society. This valuable work has facilitated a deeper comprehension of science inequity in the UK and the development of a 'Science Capital Teaching Approach' to support pedagogical reform (King et al., 2015).

However, the appropriateness of using science capital to understand engineering inequity is unclear. This paper positions science and engineering as related in general terms but also characterised by deep distinctions when examined in finer detail. It is argued that such a rich, detailed conceptualisation is required to robustly understand and address complex issues of engineering inequity. As a result, there is uncertainty as to the scope of science capital and its capacity to consider the deeper nature of engineering and its issues of inequity.

In this paper the scope of the science capital model is theoretically and empirically examined with a conclusion that it is unsuitable for use in addressing engineering educational and career inequity. First, a theoretical examination explores similarities and differences between science and engineering in the UK. Next, the implications of this relationship for the use of science capital to understand and address distinct issues of engineering inequity are outlined. Finally, the relationship between science capital and engineering is empirically investigated. Data from over 900 young people in the UK explores the relationship between science capital and aspirations for science and engineering pathways. Statistical analyses reveal that science capital applies more strongly to science than engineering, highlighting disparity in its utility and questioning its suitability for addressing engineering educational inequity. An alternative, but related, model of 'Engineering Capital' is introduced and supported with empirical evidence as a more appropriate tool for engineering inequity. Implications for STEM pedagogical reform and potential future research are explored.

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Are there value conflicts between Engineering & EDI?

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Vocational education involves a process of professional socialisation into the accepted processes and procedures of a given discipline. Becoming a professional requires being able to use both the accepted codified knowledge, such as using codes of practice and common terms, and non-codified means, including the values and norms that underpin what are legitimate forms of knowledge, who is listened to and how well they are respected.

It is now a threshold requirement that UK engineering education schemes address Equality, Diversity and Inclusivity (EDI) in their schemes. As a result, it is worth reflecting on whether the norms, values and tools adopted through engineering education equip students to engage authentically with the difficult and personal issues that discussions about inclusivity raise.

It is a cause for concern that several scholars have documented the knowledge deficits of engineering students with respect to social concerns. Nicolau & Conlon (2012) highlighted substantial knowledge gaps in students' understanding of the social dimension of sustainability. Of more concern, Cech (2014) showed that engineering students' public welfare beliefs can decrease over time.

One contributing factor could be inherent conflicts between the domain of engineering and the socially orientated domain of inclusivity. The rational culture of engineering, which is historically

driven by the rigour and objectivity of scientific method and strives for consistency, can be interpreted to be in methodological opposition to the grounded, interpretative approach that is better suited to acknowledging how others experience the world. The basis of this ontological approach lies at the core of inclusivity, but is not covered in most engineering curricula, nor understood by the majority of engineering educators and practitioners – it isn't part of the shared language and knowledge base of the profession.

Unlike codified knowledge which can be tested, non-codified factors such as values are implicit and hidden. Though values drive decision making behaviour, they can do so sub-consciously without the individual or social group being aware.

In this paper, we use the Schwartz Value System (Schwartz, 2012) to surface and explore the possible interactions between the values reinforced through engineering education, and the values aligned to inclusivity and openness to change. We show that engineering values are rooted in values of conservation and self-enhancement, and consider the challenge this poses to the sector as we seek to introduce opposing values of openness to change and self-transcendence.

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Employability 2 (Thursday 30th, 10.00)

Year in research: enhancing graduate employability with another tool in the work-integrated learning toolbox

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Research is one of the most rewarding activities students undertake during their undergraduate degree, and the wide-reaching, higher-order cognitive skills developed during independent research establishes students' as professional, critical thinkers. Most UG programmes offer the capstone research project as the sole enquiry-based, hypothesis-driven research graduates undertake. While this has considerable benefits for developing the foundations of independent thinking and research skills, students are rarely exposed to the complete research experience, such as working collaboratively in a research group, dealing with multiple projects, experiencing a wide range of research-based skills and techniques relevant to the discipline. Many graduates progress to become research academics, and with ever shifting baselines of work-based norms, graduates with the agile, flexible and resilient research skills are highly sought after and employable and will make valued contribution to enhancing the workforce..

Year-long Industrial Placements are a well-established Work-Integrated Learning (WIL) strategy embedded in UK Higher Education employability frameworks. There is recognition that industrial placements improve the employment outcomes as students are immersed within the work-place and develop enhanced transferable and interpersonal. However, a Year in Industry (YiIn) can pose significant financial costs to students (depending on funding), institutions (administration) and employers (time and resource investment). The requirement in the UK for UGs to only undertake paid placements is problematic for disciplines where most placements are in non-profit, volunteer-based organisations unable to support this. Industrial placements can exclude minority groups, mature and disabled students. Furthermore, in some cases, disparity has been reported between industrial partners in skills training, mentoring, assessment and overall learning experience and students can become detached from the academic curriculum, meaning some students struggle to adapt upon their return to study.

As a solution to the challenges presented by the YiIn and to offer students a greater range of learning opportunities that enhance student research and professional skills, we created a Year in Research, as an alternative pathway to our YiIn in our Biosciences programme. The Year in Research differed fundamentally from the YiIn as students were anchored in a research group within their home

department and affiliated with an industrial partner over a 40-week placement. While on their placement, students undertook a research project and were embedded within the day-to-day activities of the research group, while also experiencing work-based learning with their partner employer. In this presentation we discuss the advantages and challenges of this new learning opportunity using student, academic supervisor and employer surveys to evaluate the experience. We promote the Year in Research as a novel, inclusive and essential learning opportunity that can be adapted nationally in HEIs to complement the employability agenda and Work-Integrated Learning framework.

The changing shape of computing in the UK: perspectives from Higher Education and industry

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Computing in Higher Education (HE) has recently seen changes in the shape and scale of admissions, and the computing industry has seen employment trends that reflect systematic changes in the role of computing graduates. In this talk we analyse the changing landscape of computing in HE alongside the trends and recruitment challenges facing the commercial sector.

Computing admissions in the UK grew 46% between 2014-15 to 2019-20 and have seen increases in year-on-year growth up to 18.8% growth in 2019-20. These statistics position Computing as one of the fastest growing areas in UK HE. Moreover, the growth seen at a national level is not homogenous and in this talk we breakdown the institutional growth profiles based on specialisation, diversity, and level.

The last five years have seen a high level of digital innovation and adoption across all sectors, placing the digital economy among the largest contributors to GDP growth in the UK at £149 billion in 2018, which accounted for 7.7% of the UK economy. Alongside this growth, computing employers have also experienced challenges and changing trends in recruitment, though this has not been homogenous by region, sector, or level. In this talk we will analyse the rising demand for Data and Software talent based on government report data, job market meta-analyses, and surveys of business leaders.

The role of computing has rapidly changed in HE and industry. This talk will then summarise the implications of the disjoin between the growth in computing in HE and the growth of the digital economy that are quantified in the Shadbolt review in 2015 which highlighted employability issues with Computing graduates, and reports on digital skills and data skills in 2016 and 2021 respectively which quantified the employer demand. We conclude this talk with a discussion about the role of HE in addressing the tech talent crisis, and suggest potential avenues for positive change.

Employability skills gained through engagement with practical investigations

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Within the HE sector, there is increasing awareness of the importance of ensuring that the curriculum equips students with appropriate employability skills. HE institutions have therefore striven to develop and strengthen activities which relate to employability.

Student participation in experiential learning activities (Kolb, 2015) - which include practical work - helps students to make connections between theoretical academic knowledge and practice, and hence develop skills such as reflection, evaluation, and self-confidence, and increases their level of understanding (Pitan and Muller, 2019). Engaging with practical activities helps to develop skills which are important for the workplace. Including more such activities in the curriculum should therefore improve student employability (Olo, Correira and Rego, 2021).

Life Sciences degree students at the OU undertake one particular practical investigation which is introduced in one module, and subsequently revisited in another where they design their own follow-up investigation. This presentation focuses on the results of a survey of students who had successfully completed both modules. Qualitative analysis of the survey responses was done using NVivo, and explored whether students had (i) developed and progressed practical and problem-

solving skills by undertaking these practical investigations and (ii) could articulate these as employability skills.

Students undertaking both the initial and the follow-up investigation not only reported having progressed their practical and problem-solving skills, but also having developed personal attributes such as patience and perseverance. The main themes to emerge from the analysis of the respondents' comments were that many students found the practical investigations satisfying, rewarding and thought provoking, although some reported frustration with - and dislike of - repetitive work and a few viewed the investigations at face value and did not recognise the more far-reaching skills they were developing.

Approximately half the respondents had equated the skills developed with employability skills, but very few had articulated these in a job situation, e.g. on an application form or in an interview.

The main outcomes of this work are:

- An additional learning outcome 'Developing creativity and innovation' has been added for the modules involved.
- It has now been made clearer to students on the Life Sciences pathway that they are developing crucial employability skills through engaging in the practical investigations within their modules.
- Online workshops have been delivered to Life Science tutors - more are planned for students - to help them appreciate the full set of skills which can be developed through engaging with practical investigations.

Delegates will be invited to consider practical investigations which students undertake at their Institutions, and whether more could be done to make the employability skills students develop more obvious.

Outreach in the curriculum: Impact on transferable skills and science identity in undergraduate and postgraduate students

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The ability to stand out as a graduate no longer relies on high academic achievement alone, but also the ability to demonstrate confidence in a wide range of transferable skills desirable to employers. Equipping students with the experiences and skills industry needs has been identified as a challenge for universities (Wakeman, 2016). Many creative and innovative ways to enhance skills development have evolved including authentic assessment (Sokhanvar *et al* 2021) and capstone projects (Lewis 2020).

In the Department of Biosciences and Chemistry, Sheffield Hallam University, we have been integrating a model for embedding outreach opportunities into both the undergraduate and postgraduate programmes. Evidence shows that involving students in outreach early on in their academic studies can both improve their skills set (Clark, *et al* 2016) and encourage a culture of continued science public communication (Brownell, 2013). As scientists we have a responsibility to engage lay audiences and communicate science beyond our peers in our field, however the opportunities for training in science communication to a non-scientific audience is not routinely offered and having the confidence to participate is often perceived as a barrier (Stofer 2018).

Our study evaluates the impact of students participating in outreach on multiple factors including ownership of science and confidence in skills set. Previously we have shared the findings of our

questionnaire analysis (n=92, Horizons 2021) reporting that whilst our general population of students could describe some of the broad advantages of science outreach (mainly around knowledge transfer) they were narrow in their views as the broader considerations and notion of two-way dialogue with mutual benefit to the scientist and audience. Undergraduate students also did not recognise themselves as important in regards to getting involved in outreach, suggesting low levels of science identity.

In continuation, we are analysing post outreach participation individual student interview transcripts (n=25) through open line-by-line coding and thematic analysis to a framework including themes of science identity, aspirations and confidence.

The findings of our analysis will be presented and discussed in the context of the complete study, fully unloading the impact of integrating outreach into undergraduate and postgraduate programmes on both student participants and others involved. We will share 'lessons learnt' and best practice during development of this successful model with the aim of enabling transferability to other institutions.

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Clark, G. et al (2016). Science Education Outreach Programs That Benefit Students and Scientists. PLOS Biology 14(2): 1-8

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Stofer, K. A., & Wolfe, T. M. (2018). Investigating exemplary public engagement with science: Case study of extension faculty reveals preliminary professional development recommendations. International Journal of Science Education, Part B, 8(2): 150-163

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Workshops (Thursday 30th, 11.50)

Exploring different styles of online tuition to enhance student experience

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Evidence from educational research projects and internal quality control processes indicated that students who attend online tutorials are reluctant to fully participate (Butler et al, 2018). Online tuition can often result in a didactic, transmissive style of teaching, which can leave students passive and disengaged. This was a concern at our institution because active engagement has been shown to support deeper learning (Rüschoff and Ritter, 2001; Herrmann, 2014) and meaningful interaction is associated with student satisfaction (Kuo et al, 2014). Furthermore, the importance of online tuition and its additional role in helping students feel part of an academic community of learners became more crucial since the start of the Covid pandemic when all tuition moved online.

The focus of this work was to develop and explore different styles of online tutorials in an attempt to increase student engagement and participation, and to appeal to a more diverse cross-section of students. The alternative models of tuition included informal drop-in sessions, module wide workshops and enrichment Q & A tutorials; these were trialled across all levels of the undergraduate programme within the school of Life, Health and Chemical Sciences at the Open University. Following a preliminary review of attendance data and informal feedback from participating students and tutors, several of these alternative tuition events have subsequently been embedded into our regular online offering to students and we are intending to undertake a comprehensive survey of participating students and tutors over the next couple of years.

During the workshop we will describe several different tuition styles and share the experiences of lecturers who facilitated, and students who attended, these alternative tuition events. Delegates will be invited to discuss potential pedagogical benefits associated with these alternative tuition styles and to share their experiences of providing a variety of models of online tuition.

We hope that this discursive workshop will facilitate reflection and a refresh of online tuition strategies within the HEI context.

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Gamifying STEM classrooms for better and sustained student engagement

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Teaching in post covid 19 pandemic is challenging. Students are still trying to adjust to in person mode and many of them are suffering from pandemic related issues such as depression, locked down anxiety etc. Teachers around the world are adjusting to now this new normal. Engaging students in STEM classrooms will be challenging. A study has indicated a significant decrease in emotional engagement, with students reporting a drastic decline in positive attitudes toward science (Wester et al, 2021). The need is to devise and employ tools to make learning more engaging and classroom more vibrant. The author has used gamification in one of her classrooms to make the learning more engaging. Gamification means using the philosophy and science of game elements and game design techniques in non-game contexts. In the context of education, it means integrating game dynamics into teaching content, pedagogy, and assessment to spur participation. Thus it involves using principles, procedures and systems of game designs and using it to motivate, engage and inspire individuals, groups and communities, and alter their actions and result in desired results (Ray wang).

The motivation behind using the philosophy and science of gamification was its addiction and popularity among students. The insatiable appetite for the games and quantum of playtime by avid gamers indicates the hold and strong engagement with the gamers. In one of the research studies, gamers were asked why they play the game. The top answers were that it provides challenge, creativity and winning. Other outcomes were social environment, friends, Problem-solving, random surprises, exploration, imagination, sharing, teamwork, role-playing, recognition, (Anderson, 2003; Setzer&Duckett, 2000). Some studies have shown argumentation of a sense of efficacy and self–control over one's environment (e.g., Jones, 2002), enhancements in learning (Gee, 2003; Johnson, 2005), increase in the life span and ore happiness (Setzer, V. W., & Duckett, G. E. (2000).

In this research, work author has used gamification in classroom formative assessment for a lab session. The intervention was administered to a lab group of 22 students. The intervention in form of 'reverse grading' has shown significant improvement in student engagement. It has also markedly improved the results of the slow learner during the classroom deliberations and participants. This research work will expound upon the need and methodology to gamify the classrooms especially assessment.

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Applying for an advance HE fellowship/award (sponsored by the Society for Natural Sciences)

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The workshop will discuss:

- The range of requirements for Fellowship (Associate, Fellow, Senior, Principal) and AHE awards (National Teaching Fellowships, Collaborative Awards for Teaching Excellence)
- The benefits of a fellowship/ an award
- The difference between a fellowship , a national award and internal promotion or job application
- The application process – disentangling the jargon
- Finding a mentor – the revision process
- What makes a successful application

The workshop will be delivered by Principal Fellows, National Teaching Fellowship and Collaborative Awards for Teaching Excellence recipients and a recent Principal Fellow applicant, and would be useful to anyone thinking of applying for an award or fellowship at some point in the future

The **Society for Natural Sciences** is a professional body for scientists, educators and students working across the discipline boundaries of science (https://www.socnatsci.org/)

Inclusion into what? Unpacking effective inclusive STEM teaching using "out-of-STEM" perspectives

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In the context of underrepresentation, awarding gaps, and substantial issues of participation, there is a drive to make Higher Education (HE) more inclusive (Stentiford & George Koutsouris, 2021). Traditional approaches in the field, such as decolonising the curriculum, have emerged in the Humanities or Social Sciences. STEM academics have been slower to engage with these approaches, although there are now abundant of examples of good practice in inclusive education in STEM HE, e.g., teaching with historical perspectives and bringing a much-needed focus of attention on how diverse STEM disciplines are and have always been (Johnson, 2019).

However, there is a persistent view within STEM communities that there is a limit to what these actions can achieve, given the fact that STEM-content is perceived as EDI-neutral, since atoms/waves/biomolecules/energy/equations/etc are devoid of gender, ethnicity, sexuality, dis/ability, etc (Johnson, 2019). Of course, the assumption seems to ignore that while we teach *about* atoms, the educational environment is a social space with interaction between participants. More importantly, we are convinced that there is an opportunity to dig deeper to find other ways of being inclusive in STEM education.

Our approach starts by reflecting that education must embody in itself an inclusive trajectory or not be considered education at all. Indeed, particularly in HE, education involves a trajectory into subject expertise – an inherently exclusionary concept – from a starting point of newcomer (Lave & Wenger, 1991; Wenger, 1998). Our reflections have also taken us to challenge qualification and skills gaps, normally is not considered to be related to the inclusivity agenda. This gap between qualifications and skills is well documented for STEM HE in the UK (National Audit Office Report, 2018). This gap confronts us with the question: inclusion into what? Clearly, effective inclusive education must both

result in equality of access, opportunity and engagement, *and* effective learning, to be truly inclusive.

Therefore, our approach to inclusive education, in STEM in particular, is to focus on understanding how STEM expertise and identity are formed, shared, and established, identifying on what constitute barriers to learners to practice as effective members of their subject communities. In essence, identifying what the *hidden curriculum* is, and how to make it apparent for all learners (Hinchcliffe, 2020). In doing so, we bring in expertise from outside of STEM (sociolinguistics, communities of practice), focussed within STEM communities to unpack our practices and make them accessible to learners.

In our workshop we will discuss these issues in detail, presenting evidence-based examples of effective inclusive STEM teaching practice, analyse them from "out-of-STEM" perspectives, in the spirit of proposing STEM-teaching methodologies for inclusion. We will invite participants to reflect on how they can adapt these strategies in their own teaching, providing commentary from "in-STEM" and "out-of-STEM" perspectives.

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Equality, Diversity and Inclusion 3 (Thursday 30th, 13.50)

Remodelling learning, teaching and assessment to support transitioning students

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In the UK around 700,000 students apply for full-time UG courses and transition to one of 370 universities and colleges. This is a major step-change to young adults as they gain independence and become immersed in intensive academic studies. Secondary Education provides a standardised, benchmarked and reliable education foundation for students that underpins constructivism and proximal development throughout HE. This baseline education is highly significant in skills focussed STEM disciplines where learners require extensive time practicing technical techniques in the laboratory or field.

The Covid-19 pandemic however has severely disrupted the status quo of Secondary Education, inevitably impacting students' subject knowledge, foundational and technical skills, interpersonal qualities and well-being. Furthermore, mass shifts in assessment norms led to all exams being either completely removed or altered to remote delivery, creating a double-disruption scenario.

The result has been a cohort of students (particularly those from deprived areas) with marked skills-deficits and little experience of the formal, high-stakes exams (on-site and online) typical of many STEM disciplines. This presentation sets out two innovative ways in which academics at Swansea University Biosciences have attempted to support these students' skills development and adjustment to HE.

Even before the Covid crisis, the increasing diversity of the background education of learners means that high-stakes summative assessment impact retention and progression. This is because the learning support and skills development needs of higher-risk and protected characteristic students can be overlooked. Lower-stake, scaffolded, and smaller assessments accompanied by high quality feedback provide a more applicable, relevant, supportive and inclusive structure to enhance and secure learning and pragmatically transition students to HE ecosystems. This led to a project to remodel assessments, in first-year modules, into 'bite-sized' chunks, thus avoiding a heavy assessment period with many high-stakes and stressful exams in January. This involved taking a programme-level view of assessment and identifying areas where the assessment strategy could be successfully adapted without overloading both staff and students. The aim was to enable students to become familiar with a range of assessment styles, to develop and build on their critical skills, and to experience regular high-quality, meaningful, timely feedback.

Related to this were changes made to the structure of the semester that were intended to support student transition to university by allowing for more flexibility in assessment and skills development. The traditional structure of the academic year at Swansea has involved two semesters of eleven weeks of teaching followed by a three-week assessment period. In the academic year 2021-22 a more flexible structure was employed to break up the eleven weeks

of teaching and a wellbeing week was added into week six to allow student to spend quality, unfragmented time on their independent learning. The curriculum was also enriched in ways that support students to develop their study skills and focus on their assessments. Student questionnaires confirmed these changes have been extremely popular and have led to a more inclusive and creative approach to assessment practices, greater engagement and student wellbeing.

Influence of a diverse curriculum on students' knowledge and attitudes to diversity in health sciences

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Improving diversity and decolonising curricula are key objectives across the HE sector for varied disciplines of teaching, although the focus and approach to achieving these aims differs from subject to subject. In health sciences, content has historically tended to focus on a limited demographic viewpoint, often focusing on white (frequently male) models for reference. Therefore, one method to improving diversity the health sciences discipline is to improve student awareness of the varied diversity in physiology, anatomy, signs, symptoms and outcomes experienced by people of varying demographics (Marcelin *et al*, 2019), to better prepare them for the diverse society in which they will later work (Muntinga *et al*, 2016).

The University of Reading has recently (2020) launched three health sciences degrees (UG Physician Associate, Pharmacology and Medical Science), and as part of this initiative new modules have been designed to implement these programmes. One module Anatomy and Physiology 2 (level 5), includes the clinical application of anatomy and physiology and therefore provided opportunity to improve diversity in our curricula. In this module, each bodily system included signposted discussions of the diversity in physiology (and pathology) amongst different demographics to increase students' awareness of the heterogeneity in future patients. Different demographics discussed within clinical anatomy and physiology content included gender, ethnicity and age.

To determine if this signposted approach to highlight diversity in anatomy and physiology had been successful, students on the module took part in a survey to assess their attitudes and knowledge. Student attitudes were surveyed to determine what participants understood by the terms "diversity" and "decolonisation" in the context of healthcare education, as well as their feedback on how diverse they rated their current curriculum. Then students' knowledge was surveyed to determine if they could correctly identify misconceptions in healthcare relating to gender, ethnicity and age (e.g. that only light-skinned individuals are affected by skin cancers), and therefore apply awareness of diversity in healthcare.

The session will cover the analysis of the survey, giving insight into the attitudes of health sciences undergraduates to diversity and decolonisation, as well as their knowledge of diversity in healthcare.

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Muntinga, M.E., Krajenbrink, V.Q.E., Peerdeman, S.M., Croiset, G., and Verdonk, P. (2016). Towards diversity-responsive medical education: taking an intersectionality-based approach to a curriculum evaluation. Advances in Health Science Education. 21:541-559.

Caught ZZZing? Engineering Education and Gen Z

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The question of how to attract more young people into engineering underpins a perennial conundrum whereby the complexity and excitement of engineering as a potential or actual career appears to be lost on 'Generation Z' who, despite being born into a digital age, are often more

committed to 'virtual gaming' than 'real-life problem solving and making'. In taking a birds-eye view of engineering education this paper raises a number of uncomfortable questions. It queries why, at a time when society relies on engineers to maintain it's (current and future) socio-economic and public infrastructure, so much credence is given to 20th Century paradigmatic beliefs about so called Professional Standards and Standing.

Asking whether Engineering Education has lost its way, the paradoxical question of how to attract and keep young people in engineering is considered. Building on the paper authors' research findings and taking into account the extant literature, the paper critically examines contemporaneous engineering pedagogy, policy and practice in the UK and, where applicable, beyond. Contextualized by Brexit and the Pandemic, the influence that Professional Bodies continue to have in shaping engineering education is debated. Whilst the paper also questions how 'academic engineering science' has become so detached from 'engineering professional practice'? Looking closely at issues of equality, diversity and inclusion, industry-education industry collaborations are put under the spotlight whilst the question of whether the standard pre-requisition qualifications to study engineering can act as a barrier for students from widening participation backgrounds is discussed.

Sticking their heads well above the parapet, the paper authors challenge accepted cultural and educational norms that underpin engineering education. In doing so it is anticipated that a lively debate will ensue!

Experiences of under-represented and widening participation medical students during their time at medical school

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Medicine as a profession is increasingly looking to widen the characteristics of those that become doctors to be more reflective of the population as a whole. Nationally, there has been much focus in recent years on widening access (i.e. increasing the number of students from backgrounds of traditionally low participation in higher education) but there has been less focus on the support of these students after they enter the university. This study investigated the experiences of students from under-represented groups during their time at medical school and explored whether any additional activities should be in place to support these students during their studies.

All Year 2 medical students at Hull York Medical School were invited to complete a survey which gave participants the opportunity to reflect upon their experiences at medical school and to indicate potentially useful support measures. The survey was followed-up with a number of semi-structured interviews. Data analysis is ongoing but preliminary results and reflections will be presented. These include differences between students who undertook a Gateway (i.e. Foundation) Year and those that entered Year 1 of the five-year programme directly, the impact of open-book exams, and positive aspects that students from under-represented groups experience. We will emphasise the practical support measures suggested by students.

By having a deeper understanding of the experiences of students from under-represented/widening participation groups, we hope to better recognise the challenges they face in medical school and identify effective support to empower all students.

Student Support and Wellbeing 2 (Thursday 30th, 13.50)

Exploring student and staff expectations and experiences of university life.

Hilda M Mulrooney, Alison F Kelly, Magdalena Dolecka, Noor U Khan and Vanee Sivagurunathan

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The extent to which institutions meet student expectations is important. Disparities between expectations and the reality of student life may fuel dissatisfaction and potentially affect student engagement. However, what students actually expect is unclear, as is the possible impact of sociodemographic and other factors (Hassel & Ridout, 2018). For example, an alcohol-centric university life is common (Brown & Murphy, 2020; Fuller et al, 2017), but not considered acceptable by some students for cultural, religious or personal reasons (Piagentini & Banister, 2009). Student understanding of the academic requirements of university are unclear. Academic staff also have expectations of their new students, which need to be managed. In this ongoing project, we sought to explore what students (under- and postgraduates) expect from university, and what academic staff expect of their students. We also explored the extent to which expectations are met, with both groups.

The study, which had ethics approval, involved completion of a short questionnaire with optional interview; administered both online and on campus. The questionnaire had a demographics section which included age, gender, ethnicity, year and mode of study, commuting and disability status. The section on expectations included academic, social and personal expectations and student concerns. Qualitative data were collected using open questions and optional interviews, while quantitative data were collected using Likert rating scales to ascertain levels of agreement with a series of statements. Staff questionnaires comprised a demographics section, as well as the Approaches to Teaching Inventory (Trigwell & Prosser, 2004). Additional questions relating to staff perceptions and expectations of students comprised Likert rating scale questions, multiple choice questions and open text boxes to allow participants to elaborate on their responses.

Data collection have been slow due to the pandemic. To date, responses from 28 staff and 45 students have been collected but data collection is ongoing. Qualitative data will be analysed using basic thematic analysis. Quantitative data will be statistically analysed to explore differences by demographic characteristics, and the extent of differences and agreement between staff and students will be explored. We aim to develop a factsheet to clarify specific areas of confusion for students, potentially using the personal tutor scheme as a platform to discuss realistic expectations of university life.

In this presentation, we will cover the project findings and their implications; by then, data collection and analysis will be complete. Preliminary findings indicate substantial differences between staff and students relating to expectations about independent study and the nature and extent of academic support on offer.

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Fuller A, Fleming KM, Szatkowski L & Bains M (2017). Nature of events and alcohol-related content in marketing materials at a university freshers' fair: a summative content analysis. Journal of Public Health 40 (3): e320–e327. https://doi.org/10.1093/pubmed/fdx181

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Piagentini MG & Banister EN (2009). Managing anti-consumption in an excessive drinking culture. Journal of Business Research 62: 279–288

Trigwell K & Prosser M (2004). Development and Use of the Approaches to Teaching Inventory. Educational Psychology Review 16(4): 409-424.

Development of an enhanced personal and professional development programme supported through a tutee peer network to facilitate transition, inclusion and belonging

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We outline an enhanced personal and professional development programme integrated within our bioscience tutor scheme and curriculum at level 4. This initiative co-designed with students aims to provide seamless integration and dialogue between tutees, tutors, module teaching staff, the careers and employability service, student enrichment and our student success centre. The role of personal tutors is often cited as crucial in facilitating professional and personal development, supporting academic progress, and well-being and engagement. Yet, the effectiveness and consistency in value and support gained can be variable and dependent on the success of focalised relationships. Therefore, to provide broader support for our tutor scheme and professional development programme, we embedded a complimenting personal development programme into the curriculum collaboratively designed by our careers and employability service and student enrichment. The programme, which encourages its own active dialogue feeds directly into themed tutor meetings, which are extended to a network of tutee peer support teams, where students can connect to discuss their professional development portfolio, work together in supporting each other, and identify opportunities and share ambitions. Support is provided by linked workshops on preparing students on how to 'work together and support each other', 'understand each other', 'understand themselves' and 'understand their future'. A primary driver for embedding a peer support network has come from the recognised need to establish earlier and more inclusive connections between peers to encourage belonging and a positive transition. In addition, the outcomes from the professional development portfolio are quantified through a series of evidence-based activities and short assignments designed to encourage not only active engagement in career development but provide employability metrics to inform both students and tutors to where inventions or support may be required. This presentation will outline our steps in developing this initiative and its evaluation.

Exploring the extent of maths anxiety within the STEM faculty at a distance learning University

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Maths Anxiety can be described as "an emotion that blocks a person's reasoning ability when confronted with a mathematical situation" [Spicer 2004], in an extreme form, "when confronted with a math problem, the sufferer has sweaty palms, is nauseous, has heart palpitations, and experiences paralysis of thought" [Krantz 1999]. Unsurprisingly, students with maths anxiety who are required to study mathematics, often to support a related discipline, frequently react with avoidance techniques such as delaying study or not studying regularly and this puts them at high risk

of failure. Whilst maths anxiety has been recognised by academics for over half a century, little work has been done within the Open University (OU) to establish its extent within our population of mainly mature adult learners, how it may be affected by distance learning and what techniques can be used to mitigate its effects in this context.

To begin to investigate this issue we have undertaken a quantitative study, across core OU introductory modules in STEM: this includes modules with a primary focus on mathematics, engineering, science, computing, design, environment and health studies, requiring varying levels of engagement with mathematical content. Using the recognised Maths Anxiety [Betz 1978] and Maths Resilience [Kooken et al 2013] scales augmented with additional questions to investigate factors specific to distance learning we measured the extent of the problem. Qualitative data has been gained through in-depth semi-structured interviews which further investigate specific issues and explore how these might be addressed and supported. The interviews included questions about previous experiences with learning mathematics, attitudes towards mathematics, and any teaching methods or personal strategies that have been particularly helpful or unhelpful.

Initial findings suggest 44% of students who responded are visibly anxious, with 26% of these students believing that studying at a distance will increase their anxiety and a further 27% undecided on whether it will have an effect. The survey results reveal clear differences in levels of maths anxiety between students studying in different disciplines, along with some interesting, though less pronounced, variations in different aspects of maths resilience. The data is further analysed by student characteristics such as age, disability, ethnicity and gender to see what conclusions can be drawn.

Our presentation will cover the key results obtained from the surveys and some initial insights gained from the interviews.

Betz, Nancy E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. Journal of Counseling Psychology, Vol 25(5), 441-448. doi: 10.1037/0022-0167.25.5.441

Krantz, S.G. (1999). How To Teach Mathematics. *Providence: American Mathematical Society*

Kooken, J., Welsh, M., McCoach, D., Johnston-Wilder, S., Lee, C. (2013). Measuring Mathematical Resilience: An application of the construct of resilience to the study of mathematics . Paper presented at national conference of the American Educational Research Association, San Francisco.

CA. Spicer, J. (2004). Resources to combat math anxiety. *Eisenhower National Clearinghouse Focus 12(12).*

Peer group interactions with a blended learning space, how students are using social media to answer assessment questions.

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COVID-19 has moved us to a new way of working, delivery is blended and assessments are predominately on-line. Previously, students would have had many interactions in the physical space, establishing personal learning networks with direct contact with a tutor. These support groups bridge physical and digital spaces in the blended environment and are mediated by social media tools. The groups are often closed to the academic, and the subsequent inability to help direct students' learning can lead to the propagation of misconceptions within peer groups. The use of the blended digital learning space for incoming and current students is a grey area for many, with academics forced to make assumptions on how the students are interacting. Understanding this environment will lead to interventions that can be ubdertaken at an organisational level. The

research question here is “how do students form and use supporting peer-group networks in a blended learning space?“

We have had a long-term interest in learning spaces within biosciences and chemistry at Sheffield Hallam University, leading to publications on student interaction in the lecture theatre and laboratory and how personal learning networks form and operate. Networks were identified that gained statistically significant differences in grades, with both high and low achieving groups being observed (Lacey et al., 2020, Smith et al., 2018). Within this study, a mixed-methods approach has been employed whereby students across the whole provision were questioned on their use of social networks regarding assessment and personal learning. Preliminary finds show that students are seen to establish a variety of personal learning networks (PLN) depending on need. Large groups form early during a course around finding friends but then dissipate and are replaced with short-lived groups linked to assessment tasks or modules. These short-lived groupings are seen to replicate those we observed in the physical environment as students seek out those with similar levels of attainment or background for support, with some students reporting difficulties in accessing these groups. Students highlighted that time taken to allow group formation to occur would be a clear benefit at the start of a new module or task. Social networks are being accessed during on-line assessments, and ideas around assessment design will be considered. The long-term impacts from this study will be changes to interventions and working practices leading to: (1) Enabling interactions between peer groups and limiting the propagation of misconceptions. (2) Identify lone students and facilitate their inclusion into peer groups. (3) Development of teaching practice to enable inclusion and sharing of information within blended learning activities and environments. (4) Understanding the use of peer groups in a digital space and how this affects on-line time-limited assessments. Each of these will be explored during the presentation.

Pedagogic Research 2 (Thursday 30th, 13.50)

Improving delivery of primary science through teacher development

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Few primary teachers have a background in science beyond GCSE, with only 43% of science leaders holding a Level 3 qualification in one science subject (Leonardi et al, 2017). It is known that a lack of science background can lead to confidence issues for teaching the science curriculum (Leonardi et al, 2017; Murica and Pepper, 2018; Ofsted, 2021) and this may lead to a reduced experience of science for pupils at this educational stage. To inspire learners to engage with science and raise their aspiration and interest for science study post-16, early experiences, and the development of science capital (Archer et al, 2015) are key.

This contribution discusses the impact of a one-year focussed professional development programme for primary teachers which aimed to provide them with the skills to deliver inspiring science lessons and empower them to sustain their delivery post project. Working with a cluster of primary school teachers' regular professional development sessions were held to enhance subject knowledge and thematic schemes of science learning were co-developed using the UN sustainability goals as a focus (https://sdgs.un.org/goals).

A perceived self-efficacy (Bandura, 1993; 1997) survey, captured at key time points, aimed to measure changes to teachers' confidence and self-efficacy (Velthuis et al, 2015) over the course of the programme. This survey was adapted from previously validated questionnaires, to measure confidence and self-efficacy in terms of pedagogy, skills and knowledge and engagement in science lessons (Friedman & Kass, 2002; Tschannen-Moran & Hoy, 2001). The 11-point Likert scale survey considered confidence levels from 0 = no confidence to 10 = completely confident in the categories. 0-5 are interpreted as lower confidence and 6-10 as higher confidence levels. Initial baseline survey findings indicate the mean teacher confidence levels for pedagogy, skills and knowledge and engagement in science were 5.7 (SD = 1.2, 95% Cl = 0.3); 5.9 (SD = 1.4, 95% Cl = 0.3) and 6.0 (SD = 1.3, 95% Cl = 0.3) respectively. Pupil engagement initial findings indicate that some learners are now discussing science with their parents and how they aspire to become a scientist in the future.

Archer, L., Dawson, E., DeWitt, J., Seakins, A. & Wong, B. (2015). ''Science Capital'': A Conceptual, Methodological, and Empirical Argument for Extending Bourdieusian Notions of Capital Beyond the Arts. *Journal of Research in Science Teaching*, vol. 52, no. 7, pp. 922– 948.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, 28, 117–148.

Bandura, A. (1997). Self-efficacy: The exercise of control. New York, NY: Freeman

Friedman, I. A., Kass, E. (2002). Teacher self-efficacy: a classroom-organization conceptualization. *Teaching and Teacher Education,* 18, 675–686

Leonardi, S., Lamb, H., Howe, P. & Choudhoury, A. (2017). 'State of the nation' report of UK primary science education. Available at: https://wellcome.org/reports/state-nation-report-uk-primary-science-education [Accessed 24/02/22]

Murcia, K., & Pepper, C. (2018). Evaluating the social impact of a science centre's STEM professional learning strategies for teachers. *Issues in Educational Research*, 28 (2), 438–452

Ofsted (2021) Research review series: Science [Online] Available at: https://www.gov.uk/government/publications/research-review-series-science/research-review-series-science [Accessed 27/01/22].

Tschannen-Moran, M. and Hoy, A. W. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education*, 17, 783–805

Velthuis, C., Fisser, P. and Pieters. J. (2015). Collaborative curriculum design to increase science teaching self-efficacy: A case study. *The Journal of Educational Research,* 108, 217–225.

Born in the USA - Exploring the PLTL Model in U.K Higher Education

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Peer Led Team Learning (PLTL) is an educational tool that has been successfully implemented in the USA for many years now (Gosser et al, 1998). It is often referred to as the workshop model, where students meet in small groups on a regular basis to work through a series of challenging questions and problems. These workshops are facilitated by "peers" - students who have successfully completed the course previously. There are six critical components to PLTL (Gosser et al, 2001) which state 1) PLTL is integral to the course, 2) peer-leaders are suitably trained, 3) academics are actively involved in the preparation of teaching material which is 4) suitably challenging and promotes discussion, debate and collaboration. 5) The room is suitable for group work and finally 6) PLTL is integrated into the institutional structure. As part of ongoing work exploring approaches to student engagement and belonging, we have piloted the implementation of PLTL in two undergraduate chemistry courses and one economics and finance course at a UK Higher Education Institution - Queen Mary University of London. We will present our approach, the challenges we have faced and evaluate our findings.

Gosser, DK., Roth, V. (1998). Journal of Chemical Education, 75 (2): 185.

Gosser, DK., Cracolice,M., Kampmeier, J.A., Roth,V., Strozak, V.S., Varma-Nelson,P. Peer-led Team Learning: A Guidebook, 2001, Upper Saddle River, NJ. Prentice Hall.

Decolonising Computing education and practice – a sociotechnical perspective

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Initiatives to decolonise curricula are becoming increasingly widespread across HE. Initially in the humanities, these approaches addressed issues such as the inclusion or exclusion of particular perspectives from histories or literatures. A route to addressing these concerns, then, can readily start from broadening the reading lists.

Where, though, does these leave STEM subjects in general and more specfically, for us, computing and cognate disciplines? While it is true that the ‘canon’ is dominated by authors from the global North, does this always imply that viewed from a different standpoint the finding would be different? Well, sometimes yes – for example, technical standards and conventions generally carry the interests of corporate and state organisations and look very different from other perspectives. In other cases, though, this is likely to be less true: for example mathematical proofs of computability are true independently of the social context in which they were derived (though of course, which proofs are generated (and which not), where, and so on are social matters).

The Critical Information Studies group in The Open University's School of Computing and Communications are conducting a series of workshops with students, tutors, staff members and external advisors to identify ways we might approach decolonising computing practice. We see exploring colonial aspects of our existing curriculum as a starting point for a broader project of decolonising computing practice - our graduates will be building the software tools, data structures and other infrastructures which will enable and constrain the future; we hope to identify ways actively to avoid simply reproducing injustices sustained by existing computing practices and to build emancipatory alternatives.

This presentation will introduce our initial perspective on decolonising computing which, while specific to our discipline, may help to generate ideas for similar approaches in other STEM disciplines in ways that reflect their distinct social and material natures. We will present:

- Our initial conceptualisation of decolonising computing;
- The design and conduct of DC project workshops and student survey;
- Some initial cases from our curriculum, and wider discipline, and some possible implications for how we might approach decolonising our curriculum.

A Review of Pedagogic Best Practice for Technology-Driven Design Curriculum

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The UK's higher education sector remains a highly lucrative industry. Pre-COVID, the sector provided £13.4bn towards the UK economy (Hinds & Stuart, 2019). However, in favour of STEM education, funding for creative arts education, including design, is expected to fall by 49% in real terms (Scrivo 2021). Despite the importance of the creative economy as shown by findings from the Design Council, fewer students are taking up design as a vocation at university level and this is also partly due to reduced UK government investment in favour of other STEM subjects (Dawood, 2017). In addition, today's outdated curricula may not have responded well to the challenges that are driven by emerging technologies (Meyer & Norman, 2020). These new and disruptive technologies, such as Artificial Intelligence (AI), Machine Learning and Industry 4.0 are having a profound impact upon contemporary Product Design. More specifically within product design practice, the use of Computer-Aided simulation tools such as additive manufacturing, generative design and topology optimisation have changed learning curves for students and educators alike. The skills and knowledge required to drive innovative product design futures have changed. There is now a need for higher education providers to equip future designers to work at the intersection between disruptive technologies and people, thereby applying design to create opportunities for innovation. There is also a greater need towards high level digital skills such as programming that still traditionally reside within a Computer Science or Electronics subject domain and have not fully integrated into design practice. This review paper examines the skills and knowledge required for higher education providers to utilise emerging technologies. The paper investigates topics such as the Internet of Things and the emergence of AI driven products-service platforms. We propose higher education curricula within Product Design requires a greater emphasis towards teaching embedded hardware, open-source software, AI functionalities, big data analytics and machine learning. As an initial scoping study, this presentation discusses the findings of two case-studies using SWOT analysis Brunel Design School in the UK currently provides engineering content within the design curriculum, for example including the use of electronics programming with Arduino, embedded systems and human factors with a range of collaborative projects with the industry.

Ulsan National Institute of Science and Technology (UNIST) in South Korea is a specialized science and engineering research institution providing courses in technical and scientific disciplines. Finally, we suggest new teaching approaches to integrate technical skills and knowledge that will respond to disruptive changes within industry and society for Design 4.0. The findings of this presentation will contribute to a great awareness that today's Product Design curriculum may need to be refreshed to embrace the technological changes and will benefit educators, policymakers and design practitioners.

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Hinds, D. & Stuart, G. (2019) Education generates billions for UK economy. UK Department for Education, UK Department for International Trade, Article, accessed 19th Oct. 2021. https://www.gov.uk/government/news/education-generates-billions-for-ukeconomy

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Active Learning 5 / Engineering (Thursday 30th, 13.50)

Development of an interactive digital tool to encourage active learning in heat transfer

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The purpose of this study was to explore the difficulties that students encountered within a 3rd year Heat Transfer unit delivered to engineering students at the University of Bristol, and to propose a useful teaching intervention to improve student learning. Typically, heat transfer is a difficult topic, with extensive literature confirming common misconceptions at undergraduate level (Thomaz et al., 1995; Reiner et al., 2000; Jasien and Oberem, 2002; Miller et al., 2006; Prince et al., 2012; Yang et al., 2020). Students on the unit were surveyed to gauge their opinions on the difficulty of topics taught within the unit as well as the quality and usefulness of existing resources available for learning. Results from the survey aligned with the literature, confirming that there are difficulties with student learning on the unit.

The study aimed to identify and develop an effective teaching intervention to combat this lack of understanding and improve comprehension within the unit. Student opinion suggested that the addition of interactive simulations to existing teaching materials would be appreciated. The use of similar interactive digital tools, encouraging inquiry-based active learning to combat misconceptions, has already been shown to lead to significant improvement in student conceptual understanding (Laws et al., 1999; Ribando et al., 2004; Prince, Vigeant and Nottis, 2009; Yang et al., 2020). After evaluation of existing interactive digital tools, a new tool was designed, incorporating the best features from existing tools alongside new features relevant to the content of the specific unit being considered. The tool was named the Heat transfer Interactive Learning Tool (HILT).

The HILT was built and then pilot tested by a small group of students who were guided through a series of tasks using the HILT and then surveyed to investigate their experiences. Feedback showed that 80% of students would recommend the tool to someone studying heat transfer, but also identified a number of ideas for improvements and additional features. These ideas were implemented in a further development sprint, and the extended HILT was released to a cohort studying the Heat Transfer unit in 2021/22, with feedback and results from this release to be gathered and duly analysed.

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Implementation of novel approaches in the design of a first-year curriculum in Architectural Engineering

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Abstract

This presentation introduces a new curriculum in Architectural Engineering (AE), designed by University College London (UCL) for implementation at a new higher education institution, Newgiza University, located in Giza, on the outskirts of Cairo, Egypt. AE is one of a suite of degree programmes that UCL Consultants have designed for implementation at NGU. The inaugural cohort in AE entered in October 2021 and will graduate in four years' time. The presentation aligns with the STEM Horizons22 conference themes of Active Learning and Pedagogic Research.

The framework for the design of the AE curriculum is drawn from Fung (2017) and UCL's Integrated Engineering Programme (Mitchell et al, 2021) as extensively documented by Graham (2018). Using this integrated approach, fundamental topics are not taught separately but integrated in various ways into the design studio as well as project modules and activities, called Challenges and Scenarios, that students encounter. Distinctive qualities of the new AE curriculum include: vertical threads (aimed at integrating individual skills development, business acumen and entrepreneurial thinking and social science, arts and humanities to the disciplinary core); trans-disciplinarity; authentic learning through projects; teamwork and other student-centered learning pedagogies; and the use of digital portfolios to document the individual student's learning journey.

The course is designed to meet Part 1 accreditation standards of the Royal Institute of British Architects (RIBA). Frameworks underpinning the design of the first-year curriculum in AE include the Informed Design Matrix (Crismond & Adams, 2012), theories on student learning and development (e.g., Dweck, 2017; King & Kitchener, 1994; Kolb, 2014; Perry, 1999), and research on feedback and assessment in architecture (Anthony, 2012; Boyer & Mitgang, 1996; Flynn, n.d.).

The overall curriculum has been developed (with a programme specification written and mutually agreed) and a detailed design has been produced for the first year. The programme specs with overall yearly projections are already in place (planning for an eventual steady intake of 100-150 students annually). Detailed curriculum design (syllabi, assignment briefs, lecture slides, and the like) have been and will be produced each year. Also on a yearly basis, the curriculum will be cross-culturally transferred, meaning that some level of modification is needed to translate the

UK/Western approach for implementation in the Egyptian teaching and learning space, and utilized in a way that works for the Egyptian teaching team and their students.

To improve the curriculum design and implementation process, we are beginning to collect qualitative data. This data will help the overall team understand the experience of students engaged in the AE course. We intend to conduct several focus-group interviews with current AE students, to identify what works well for them and what doesn't. We aim to understand how the curriculum design and its innovative features have been received and adopted by the school, and to enhance future performance of our curriculum designers, curriculum "translators", and module instructors.

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Situational awareness in aerospace engineering education

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Situational Awareness (SA) (Endsley, 2015) is the reactive ability to perceive (think) about what is happening, comprehend (feeling & understanding) what needs to be done, and finally execute necessary actions within a complex environment. SA is critical to the operational safety and progression of engineering projects, as a sensemaking process for practical aerospace engineering. All engineering disciplines rely upon on well-trained, experienced practitioners to act as pivots for the ongoing success of practical projects and tasks. This paper explores the potential of SA as a pedagogic framework to aid learning the skill of working within complex socio-technical-environmental systems.

Expert practitioners who display enhanced Situational Awareness rely on a combination of both explicit (codified) knowledge from techniques and toolkits, and tacit knowledge gained through experience in the complexity of the workplace environment. Lecture theatres and online learning are simplified environments with less opportunity for engagement in complexity. In contrast, apprenticeships, industrial placements, virtual reality and authentic assessment are examples of educational modalities that could be more conducive to development of SA.

In a recent survey, 41% of employers reported skills gaps in their professional workforce and 33% said that 'complex problem-solving skills specific to the situation are a concern' (Institution of Engineering and Technology, 2021). In engineering education, SA could offer a framework and set of tools to explore the gap between engineering science and the practical skills required by industry. SA can characterise how different engineering education modalities deliver skills associated with practice.

This paper combines reflections of the lead author (a veteran UK Royal Air Force aircraft engineer, now teaching aerospace engineering in Wales), alongside a systematic review of literature on situational awareness and related terms contrasting with contemporary aerospace teaching paradigms. *" I served thirty years as a Royal Air Force aircraft engineer. Fast jets, big jets, helicopters, including operations controller for a worldwide helicopter fleet. This enables unique reflection into my current position as an aerospace student/academic in the UK. I constantly experience parallels in what real life experience can provide to the intrinsic ethos and pedagogies within engineering education. Situational awareness appears to be a missing element that needs to be fed back and integrated within aerospace education "*

Future work includes a longitudinal study tracking a student cohort over time, to chart how students and academics perceive their situational awareness over time through difference educational modalities. Rather than SA playing a 'bit part' in the diaspora of aerospace education, SA could unify disparate elements of teaching and learning, and encourage the development of valuable cognitive and practical competencies.

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Scholarly empiricism in engineering education: developing connected engineers in a disjointed world

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As the Pandemic seems to be drawing to its natural end, or is at least, teetering on the beginning of the end, Higher Education in the UK is at something of a crossroads. Indeed, the emergence of 'hybrid teaching' where learning is offered online, in the classroom and in the lab, as well as in a blended format students are inevitably asking whether they are receiving value for money with regards to fees and other costs. In Engineering Education, the introduction of hybrid learning is manifested in a series of previously unimagined challenges. Indeed, in seeking to promote 'authentic' engineering education, (Chang et al 2010), colleagues have found themselves questioning how 'real-life' engineering activities and problems previously aligned to a curriculum designed for a very different world, may be adapted and improved to fit with hybrid learning approaches.

With the underlying aim of providing a deeper and more meaningful learning experience and taking into account organizational theory around 'Deliberately Development' organisations (Kegan and

Lahey, 2016), this paper focuses attention on the professional growth and development of student engineers. It critiques the purposively instrumental pedagogic approach of the organisation where the paper is set and in doing so introduces the concept of 'Connected Engineer'. Drawing upon five distinctive foundational elements: *The Connected Curriculum: The Pedagogy of Holistic Student Development: Employability: The Impact of 'Deliberately Developmental Organization' Thinking: Research into student perceptions of ' Engineering Education';* the paper considers how we can better promote connectivity across three different operational spheres: Higher Education: Industry: Policy Making (including Professional Bodies). In introducing an innovative model of STEM Education, grounded in the emergent findings of engineering education research conducted by the paper authors, the paper argues that Higher Education needs to produce STEM graduates who are globally aware, professionally competent and emotionally-socially confident.

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Student Support 3 (Thursday 30th, 15.30)

Improving undergraduate self-efficacy in science learning by leveraging the design process

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For non-majors, the obligatory science credit continues to be a source of dread for many undergraduate students. Last year, a science faculty member enlisted the help of science education colleagues to help redesign the Environmental Science course for non-majors in hopes of improving student success. The decision to modify course presentation came after several successive semesters of observing students becoming increasingly disengaged with course material, the professor, and each other. In Fall, 2020, the newly formed team decided to redesign the lecture part of the course using current STEM educational literature (Saunders, 2009; Wells, 2016) and Bandura's theory of self-efficacy (Bandura, 1986), and specifically his hypothesized sources of self-efficacy (Bandura, 1997) to guide the process. The semester-long course was redesigned to include a connected series of design projects to complement the lecture material and provide differentiated opportunities for each student to achieve content mastery and develop deep understandings.

The new and improved pilot course took place over Spring 2021 in a virtual format, with students meeting synchronously three times a week for fifty minutes. Mixed-method preliminary results reveal the aspects of the design process that impacted each of the four sources of self-efficacy (Bandura, 1997) and overall science self-efficacy. Results revealed clear preferences among students in how they learn science and clear differences among male and female undergraduate students regarding how to learn science and why to learn science. These results can be used to inform other science course designs to maximize differentiated positive impacts on science self-efficacy and future applications will be presented and discussed.

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Food asset mapping to enhance belonging in university staff and students.

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Developing a sense of connection to an institution matters for both students (Thomas, 2012) and staff (O'Brennan et al, 2017). However, for those from atypical backgrounds, this may be more difficult (Reay, 2010; O'Shea, 2015, 2016; Southall et al, 2016; Barnes et al, 2021). Food is intrinsic to every culture and community, with multiple meanings including personal, cultural, religious and health-related (Lupton, 1994; Rozin, 2005; Williams et al, 2012). Food experience therefore represents a potential mechanism to understand cultural experiences and perspectives. During the 2021 lockdowns, sharing recipes and their stories was used to enhance sense of belonging among staff and students in a large London university with a widening participation agenda (Mulrooney,

2021). In the same institution, the current project sought to understand, through the medium of food-related images and their meaning, the role and importance of food in the lives of staff and students.

The project, which had ethics approval, used modified photovoice techniques (Castleden et al, 2008), administered using an online questionnaire and an optional interview. All participants were asked to submit an image representing their food values or experiences, and to explain the meaning of the image. Participants were asked about their sense of belonging at the university and whether and how participation in the project affected this. Questionnaires included a demographics section including relevant personal information (e.g. disability, age, gender and ethnicity), and study/work characteristics (e.g. mode of study/ work). They also included a series of statements in relation to belonging (adapted from Gehlbach, 2015; Gehlbach & Brinkworth, 2011 & Yorke, 2016) and statements about the meaning of food to which participants rated their level of agreement. Qualitative data were collected using open text boxes and optional online interviews.

The project is ongoing but to date 21 staff and 47 students have completed the questionnaires and submitted images. Qualitative data will be analysed using basic thematic analysis. Quantitative data will be analysed to explore whether responses differ by demographic characteristics. Preliminary data suggests that food is considered very important for both staff and students, with high levels of involvement in a range of food-related behaviours (e.g. food shopping & cooking). Although a range of food values were identified, social aspects of eating appeared to be particularly important. In addition, food as a medium of creativity, relaxation and enjoyment was highlighted. Links to family and home were frequently made using the food images chosen; food potentially bridging the physical gap for those separated from family and friends. This presentation will explore whether this project impacted upon belonging in participants, the multiple roles of food they identified and their significance. Food potentially represents an under-explored medium through which to enhance belonging.

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Projects (Thursday 30th, 15.30)

Practical or data-based projects? Types of undergraduate capstone projects chosen by distance-learning biology and environmental science students at the Open University

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The COVID-19 pandemic challenged universities to develop online undergraduate research project opportunities for students that could provide an authentic research experience. As a result, many universities have now broadened their capstone project offerings to include online, data projects and are deciding whether to return to their traditional model. Furthermore, heads of biosciences at several universities have been "reimagining" the capstone experience. Jones *et al.* (2020) suggested that by offering students a choice to allow them to select a project type that best fits their skills, experience, and aspirations their learning experience would be improved.

Until 2020, students studying biology and environmental science degrees by distance learning at the Open University completed primarily literature and field-based research projects respectively. Students commencing field-based projects in February 2020, supported by the module team, were required to make a quick switch to online data-based projects due to COVID-19 lockdown restrictions. This change met the accreditation requirements for the degree, meeting the same learning outcomes. Encouragingly, the achievement of this cohort was not negatively affected. Coincidentally, at the start of the pandemic, we were already working to move from literature-based to practical and data-based project options for biology students to better meet sector and accrediting body expectations. As a result, in February 2021 we decided to give students studying both biology and environmental science degrees the choice of completing data-based, field-based or home (e.g., potted plant) investigations. In addition, a small number of students completed work-based laboratory projects.

As part of a larger project, we are evaluating the impact of introducing these new project options on student achievement, and both student and tutor experience over two years (2021 and 2022 student cohorts) to help inform further development of our undergraduate science capstone project module.

Here we share initial findings from the 2021 cohort relating to the students' project choice - which project types do students choose and why?

Project type (field-based, data-based, combined field and data or lab-based) was recorded for 98 biology and 143 environmental sciences students who completed their projects in 2021. Survey data collected from biology (n=24) and environmental science (n=16) students following completion of their projects provides insight into reasons for their project choice. As part of a larger survey (of 320 undergraduate science students, 16% response rate) other factors affecting their choice of project were assessed including their career aspirations, the development of their project idea and whether they felt completing their project had helped them progress towards their goals. In addition, student characteristics data such as ethnicity, disability and employment status were obtained to investigate any association with choice of project type.

An understanding of undergraduate students' preferred project options will help to ensure we are providing options that are suitable and accessible for our students and will inform further development of undergraduate project modules at the Open University and at other institutions.

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Investigating how to enhance the idea generation process for academic projects by engineering students

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In the UK, as elsewhere, final year undergraduate projects (FYPs) are very common as a synoptic module (Healey *et al.*, 2013; Hussain *et al.*, 2019) and may be required for the degree's accreditation (QAA, 2019). Hauhart and Grahe (2015) highlight the importance of the initial topic selection and mention approaches which can be split into academic-led and student-led models (Hussain *et al.*, 2019; Knight & Botting, 2016). As the distance learning engineering project module investigated here adheres closely to the constructivist approach (Hush, 2015), it requires students to develop project ideas with minimal guidance. Unsurprisingly literature reports unsatisfactory results for such student-led project development as most students do not have research experience (Hussain *et al.*, 2019; Knight & Botting, 2016). To understand how to mitigate such deficiencies a toolkit to scaffold (Hmelo-Silver *et al.*, 2007) the ideation process was developed.

Literature research showed that various classifications of ideation tools have been proposed (Shah *et al.*, 2000; Wang, 2019), some of these tools having been used in engineering education (Sangelkar *et al.*, 2015; Sintoris *et al.*, 2018; Tseng, 2020). Based on this review and a survey of FYP modules at the Open University, a Google Forms based toolkit was produced to test the hypothesis that students need significant guidance to generated useful initial project ideas within their idea space and a project idea generation toolkit can increase the number and quality of such ideas.

An ideation toolkit prototype was designed serving five of the seven feeder modules and containing two sections: One for students who have no clear idea about their project covering three ideation tools (random stimuli, brainstorming and previous project titles). The other intends to focus an initial student idea by requiring students to choose from dropdown menus or provide short answers. This prototype was introduced to nine students from the five tutor groups of the participating lecturers in a two part workshop. The first section set the context before allowing the students to explore the toolkit, and second discussed the ideation tools contained in this toolkit further and explored them in breakout room sessions.

The eight returned student questionnaires which explored the contribution of the feeder module, workshop and actual toolkit to their ideation process were analysed. It was found that only one student noticed the informal guidance given by tutors on feeder modules and only one student had a clear project idea prior to attending. Students' main concern was the required project depth. Six students found the actual ideation tool discussion helpful and four students mentioned three specific ways that the toolkit assisted them in generating an idea.

The results so far indicated that students do need significant input in an easily accessible format to support their initial idea generation to more fully explore their project space and a purely constructivist approach may be sub-optimal. A toolkit similar to the one used here, together with a dedicated workshop, may be one way of providing this guidance, thus making subsequent tutor student interaction more efficient and meaningful.

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Public Engagement (Thursday 30th, 15.30)

Art and science case study: increasing public engagement in a non-science space and the impact on the audience demographic with students as presenters

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The science-related 'resources' to which an individual has access ('science capital' - economic, cultural, social and symbolic) are reported as key to influencing participation and engagement (Archer et al 2016). Disparities in science-related capital are reported to exist across society, particularly in ethnic minority and socioeconomically disadvantaged communities, and are suggested to contribute towards explaining inequalities in science participation (DeWitt & Archer 2017).

Much innovation has been seen in science public engagement, with the aim reaching traditionally hard to reach audiences, however events often report the same core demographic of visitors (Nielsen 2019). Previously we have reported that both community (Duckett et al 2021) and university-hosted (Rawlinson et al 2021) events can increase knowledge and components of science-capital amongst participants, however we are still failing to attract audiences representative of society.

This study aims to answer the following research questions: 1) can using a more diverse group of scientists attract an audience which better represents the ethnicity of local society? 2) what impact on science-capital does participation have amongst different groups of visitors?

Data will be collected via an exit questionnaire from our integrated arts and science public engagement event in March 2022, hosted in collaboration with Museums Sheffield. Students representative of the wider society have been recruited to participate in delivery of the event. Both qualitative and quantitative data, from open and closed questions, will be subjected to statistical and/or thematic analysis to determine the impact of the intervention on visitor demographics and science capital.

Our fully analysed data will be presented and discussed in the context of tacking barriers to participation and enabling equity and access to science. We will also discuss the benefits of utilising a diverse student body in public engagement events both in terms of student participation and audience engagement.

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Toolkit: making the most of public engagement

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Science public engagement is essential to maximise the impact of research on the public and to inspire the next generation of scientists. Inspiring diverse future scientists is essential as currently science is not representative of the communities it serves, an issue that is exacerbated by the STEM leaky pipeline. The leaky pipeline is the decrease in representation, including of women and ethnic minorities, moving through increasing levels of higher education and STEM careers (Almukhambetova *et al*., 2021, van den Hurk *et al* 2019). In turn, this increases the challenge of conducting representative science public engagement, as there is a lack of mid and high-level scientists to be representative role models for school and college students (Herrmann *et al.,* 2016).

Here we present a "coat hanger" approach to public engagement: a toolkit that different research projects and target audiences can be "draped" on. The three sides of the coat hanger are 1) co-design, where the target audience is involved in the project design, 2) research, where the public engagement is underpinned by publishable research and 3) student researchers, where undergraduate, Masters and doctoral student researchers lead the outreach project. This triangulated approach gives participants agency within the project both in the co-design and the research, and the student researchers showcase the diversity of early career scientists, providing more relatable role models.

We will present a recent co-designed, research and student-led project using the toolkit. This project encompassed 280 key stage one, 140 key stage two, 100 key stage three and 30 post-16 school students in an interdisciplinary soil chemistry and environmental science research project. The school students' science identity and career aspirations were ascertained by questionnaires with closed and open questions before and after the project. Data presented here will show the impact of the coat hanger approach to outreach across the spectrum of school aged children as well as impact of the project on the undergraduate student researchers.

Almukhambetova, A., Torrano, D.H. and Nam, A. (2021). Fixing the Leaky Pipeline for Talented Women in STEM. International Journal of Science and Maths Education. DOI:10.1007/s10763-021-10239-1

Herrmann, S. D., Adelman, R. M., Bodford, J. E., Graudejus, O., Okun, M. A., & Kwan, V. S. (2016). The effects of a female role model on academic performance and persistence of women in STEM courses. Basic and Applied Social Psychology, 38(5):258-268. DOI:10.1080/01973533.2016.1209757

van den Hurk, A., Meelissen, M. & van Langen, A. (2019). Interventions in education to prevent STEM pipeline leakage, International Journal of Science Education. 41(2):150-164. DOI:10.1080/09500693.2018.1540897.

Employability 3 (Thursday 30th, 15.30)

Opportunities to enhance graduate employability across the disciplines

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Following identifications of gendered inconsistencies in higher education delivery[1], this work exposes unseen gender-related issues in the graduate population. With graduates prevalent as managers, developing management attributes and employability is emphasised across higher education. Meanwhile, notable disciplinary gender imbalances exist across education and this research explores employability in this context by triangulating Higher Education Statistics Agency and Higher Education Academy data with graduates' degree experiences. Findings reveal notable levels of employability-related support existing, with significant disciplinary variations in its visibility. Some remains unseen, especially in female-orientated disciplines, creating a gap populated by almost 50% more females than males. Consequently, fewer female graduates may recognise certain capabilities as being management-related, potentially resulting in slower career progression compared to male peers, as observed by the Office for National Statistics[2]. Opportunities exist across disciplines, especially the arts, humanities and social sciences, to enhance the visibilities of employability-related support, building further upon the need to tailor such support according to degree subject[3].

[1] Ain, C., F. Sabir, and J. Willison. 2019. Research Skills That men and Women Developed at University and Then Used in Workplaces, Studies in Higher Education, Vol.44, No.12, pp.2346-2358, DOI: 10.1080/03075079.2018.1496412. https://doi.org/10.1080/03075079.2018.1496412

[2] ONS. 2019. Overeducation and Hourly Wages in the UK Labour Market; 2006 to 2017. London: Office for National Statistics. https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/april2019/overeducationandhourlywagesintheuklabourmarket2006to2017

[3] O'Leary, S. 2017. Graduates' experiences of, and attitudes towards, the inclusion of employability-related support in undergraduate degree programmes; trends and variations by subject discipline and gender, Journal of Education and Work, Vol.30, No.1, pp.84-105. DOI: 10.1080/13639080.2015.1122181. https://doi.org/10.1080/13639080.2015.1122181 .

Pathways to success in the physics workplace in the midst of a pandemic

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We developed a new employability module for second year undergraduate students based on active learning, interactive classes, favouring collaborative and self-directed learning. In order to bring the workplace to the classroom, the module includes sessions from industrial partners and academics from the Cardiff Business School. With COVID restrictions, we transformed the module to remote teaching, carefully maintaining the elements of the educational design that made the face-to-face version successful. In this session we will discuss the module design, the results obtained during face-to-face and remote implementations, and its effectiveness in developing student professional skills and supporting placements during pandemic times.

Plenary 3, Closing Keynote (Thursday 30th, 16.20)

Supporting Equity and Inclusion in HE STEM

Professor Louise Archer, Karl Mannheim Professor of Sociology of Education, Institute of Education, UCL

What causes inequalities in STEM participation and why are these so resistant to change? What can be done to make STEM participation more equitable and inclusive? In this talk I draw on findings and resources from several large, national research studies, including insights from the 13 year ASPIRES longitudinal study (which tracked a cohort of young people from age 10-23 to identify factors shaping STEM trajectories) and resources and teaching approaches developed by the Youth Equity+STEM project and the Primary Science Capital Teaching Approach project, both of which involved co-designed tools for practitioners to support equitable and inclusive practice