# DISTINGUISHED EDUCATION EXCELLENCE AWARDS

**Category: Collaborative Excellence Award**

## Digital Technology Enhancing Learning for Two Generations of Learners: Millennials and GenZs

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**Summary:**
The student and staff team collaboratively reviewed and recommended a new digital technology within the curriculum to meet the needs of two generations of learnings: mainly Millennial for postgraduate study (including some in Generation X (GenX) and Generation Y (GenY)) and mainly Generation Z (GenZ) for undergraduate study. The decision was influenced by the behaviours of both generations of learners enabling student directed independent holistic learning and practice of professional programming threshold concepts providing immediate formative feedback for enhanced problem-based learning (PBL), skills development and employability. The establishment and development of new innovative digital initiatives with immediate feedback and feedforward offered enhanced active and self-directed learning with excellent student feedback. These co-created initiatives came into a second strength when staff and students had to adapt quickly in response to the move to online learning due to COVID-19.

**Keywords:** *Co-creation, Feedback, PBL.*

**What was done:**

When co-creating to develop innovative and engaging learning strategies and environments with a student and staff Community of Practice (CoP) known as the SPICE model within SCEIS (Black et al., 2015, 2017), we quickly realised the benefits of this collaborative partnership.

The programming working group within SCEIS aimed to introduce programming to undergraduates in a fun and novel way, utilising years of expertise in computing education, cutting edge cloud computing digital technologies,

established pedagogical research and practices, and collaborative teamwork. As a CoP, we identified and researched several digital technologies to enhance our student engagement, developing their holistic learning to grow their practice of key professional computing skills to enhance their employability. We were also mindful that we teach programming at both undergraduate and postgraduate conversion level, covering a number of generations of student learnings, predominantly Millennial and GenZ, and wanted to use some of their behaviours and preferences to enhance their experience and learning.

Pearson (Pearson, 2018) research shows that two thirds of GenZ claim "My goal is to make it to the top of my profession/future profession one day" whereas less than half of Millennials make such a claim. YouTube is king, especially among GenZ, who use more modern versions of social media, compared to Millennials who predominantly still use Facebook. GenZ has been so immersed in technology in every aspect of their lives that they no longer see it as a transformative phenomenon, but rather as a normal integral part of life. Of key interest was that although GenZ are considered "Digital Natives" and bypass traditional learning methods, many still value printed materials and teacher interactions. Millennials need the flexibility of online methods of learning.

Our research into new innovative cloud-based digital technologies to suit both generations of learners needed to:

- Enhance student centred scaffolded learning of threshold concepts with immediate feedback;
- Offer student-centred independent learning opportunities with flexible and inclusive learning modes assisted with formative feedback, via an anytime-anywhere learning approach;
- Enhance student experience with online peer-community;
- Enhance student engagement;
- Enhance student PBL;
- Enhance the digital student experience, aligned with the sustainability theme with Ulster's Five & Fifty strategy, demonstrating academic excellence with respect to both teaching excellence and the student experience.

A range of technologies were researched and piloted by the team and feedback from current practitioners was reviewed with all stakeholders in mind. Key CoP agreement was to extend the rollout of Replit (Replit, 2021a), a cloud-based technology, in UG and PG programming modules with costs for licenses being covered by the SCEIS.

Replit is a cloud-based coding environment that enables educators to innovate on the delivery of programming. Staff can release coding exercises and challenges with automatic immediate release of feedback and feedforward, offering consistent guidance to students not only on how they have done but also how to improve and achieve better professional practice for future work. This can be used as a coding practice environment providing a comfortable private space for students to trial code, learn from making mistakes and use feedback and feedforward to improve. It can also be used as an assignment environment, allowing the creation of simple to advanced automated testing and grading.

Replit enables a student-centred holistic learning approach where students can reflect and decide how often they wish to practice with the anytime-anywhere concept.

**Motivation and aims:**

Computing attracts a range of generations of learners, particularly Millennial and GenZ at present, from a wide range of academic backgrounds. Currently there is no entry requirement for previous Computing experience. Students can join our courses with a range of IT, mathematical and computing backgrounds or alternatively with no previous computing knowledge and only GCSE mathematics at grade C. With this range of learners coming together, the School needed to deliver courses where students felt challenged but also become very comfortable to design and complete coding exercises, gain immediate feedback and learn and improve from making mistakes. We aimed

to provide engaging (Nygarrd et al., 2013) and challenging learning environments with consistent teaching approaches across a series of threshold concepts embedded in core programming modules across each year to:

- Design a consistent scaffolded learning with feedforward approach across our courses, introducing and enabling student practise of threshold programming concepts;
- Immediate feedback on threshold concepts;
- Enable student-driven independent practice and learning;
- Enhance student problem solving and PBL;
- Make the programming learning environment more accessible;
- Enhance employability of students.

By using a cloud-based learning environment such as Replit, we were able to tap into characteristics of the generation of learners we have on the course, which can also help the range of students with various computing and mathematics experience adapt to their course from a very early stage in their educational journey.

The team engaged with the Replit support team, their blogs and online user group meetings (Replit Blog, 2021b) to ensure we were able to use the tool to its full potential across the required modules. We also accessed and adhered to findings of the HEA What Works Final Report (Thomas et al., 2017), to which Ulster was a contributor, to ensure we used our CoP to help address the aforementioned points.

**Implementation:**

The team members have extensive experience in successfully adopting innovative technologies and practices and disseminating as shown in Callaghan et al., (2012,2017), Kerr et al., (2018, 2021a, 2021b), Harkin et al., (2007) and McCusker et al., (2014), some of which resulted in staff and student groups winning international competitions.

The School adopted a co-creation CoP approach: SPICE (Black et al., 2017) with both students and staff, presented by students at many conferences, shortlisted for a CATE award (2018) and were part of a HEA What Works project for the Faculty of Computing, Engineering and the Built Environment (Thomas et al 2017).

The implementation involved the following:

- Integration of the SPICE model with students as co-creators;
- Monthly Programming Team meetings;
- Digital technology workshops held, sharing initiatives, current applications and findings enabled sharing of this practice and wider dissemination within School and across the Faculty;
- Replit was initially introduced in one SCEIS module: COM136 in 2017;
- Used SPICE mentors (final year students returning from placement) employed by the school to work with year 1 students in programming labs;
- Student mentors provided key links between students and staff for feedback and feedforward of initiative;
- Replit was extended to a further four modules in AY20/21.

**Successes and lessons learnt:**

On team reflection the following highlights the advantages and achievements of the initiative:

- Enhanced multi-generation student engagement online as evidenced in digital resource monitoring;

- Evidence of this was captured as part of a *Student Experience Survey (2021)* that was distributed to students as part of the School's Remote Learning and Teaching Working Group. Some student comments include:
  - *"Using ReplIt to pre-start the weekly assignments felt like I was always ahead"*
  - *"Use of online resources to teach coding worked well"*
- Enhanced student skills in PBL;
- Enhanced student experience with excellent student feedback;
- Excellent feedback from Employers Advisory Board (EAB);
- Wider uptake across the School with more adaptation planned for 2021-22;
- Professional integrated testing environment for authentic real work lab work and assessment;
- Ability to have group coding projects with enhanced online digital student experience;
- Embracing new methods of co-creation using online tools aligns with the theme of 'Employment and Widening Access', as it ensures workplace readiness of students in the new, post-COVID-19 remote working environment;
- Enabled COVID-19 adaptation with enhanced online digital student experience;
- Flexible online adaptation of courses enhanced online digital student experience, particularity fast-paced courses such as the School's postgraduate conversion course, i.e. MSc (Professional Software Development);
- Innovative successes enabled applications for funding for fully online shorter courses via DfE and development of the PGCert Software Development course in AY20/21 to enable re-skilling to address employability shortcomings. It is worth noting that 25 students progressed from this PGCert course (140 students) to the MSc Professional Software Development programme.

Table 1: MSc Module 2019-20 face to face comparison to 2020-21 COVID online delivery with Replit

| | **2019-20 (Face-to-Face)** | **2020-21 (Online COVID-19)** |
|---|---|---|
| **Student Numbers** | 43 | 50 |
| **AVG** | 68.36% | 69.3% |
| **Distinction/Commendation** | 83% | 84% |
| **Fails** | 12% | 12% |

Table 1 shows that using technologies such as Replit to assist the teaching of challenging programming topics helped adapt and maintain student learning when having to quickly switch from face-to-face to online delivery. The adoption of such technologies while traversing to online delivery has not negatively impacted student performance during 2020-21. The tool enabled students to actively engage in independent PBL and coding practice with a student-centred approach where they could trial coding and learn and improve from feedback and mistakes. The quotes below also provide example evidence that students felt the technology impacted their learning positively within the range of modules.

Student Feedback from Module Survey

- "ability to upload programs and receive quick feedback on replit"
- "the practical coding aspect of the module via Replit was extremely engaging"
- "The practical classes were tough but very beneficial as when I was doing the code I found I could easily find out what I did know and what I needed to work on from doing the practical's myself"
- "This module helped me develop further with my Java programming and it helped me become independent with programming. Also it helped look good in my CV."
- "the amount of engagement and feedback in this module "
- "Built upon the previous knowledge from last module, allowing me to encounter and understand more difficult problems."

In Table 2a and Figure 1a we provide summary statistics for student performance in UG module COM139 over the last 5 years.You can find the total students enrolled, % of students that failed, mean mark across the class along with standard
deviation.

Table 2a: COM139 summary statistics comparing baseline with introduction of Repl.it and Code sprint

| | BBL + test (baseline) | Coding Sprint | Repl.it | Repl.it | Repl.it |
|---|---|---|---|---|---|
| | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 |
| **Total Students** | 186 | 136 | 117 | 95 | 106 |
| **Mean** | 56.29 | 67.73 | 67.77 | 70.23 | 70.76 |
| **StdDev** | 14.87 | 17.50 | 16.67 | 19.38 | 24.11 |
| **Failed %** | 12.37 | 9.56 | 6.84 | 8.42 | 11.32 |

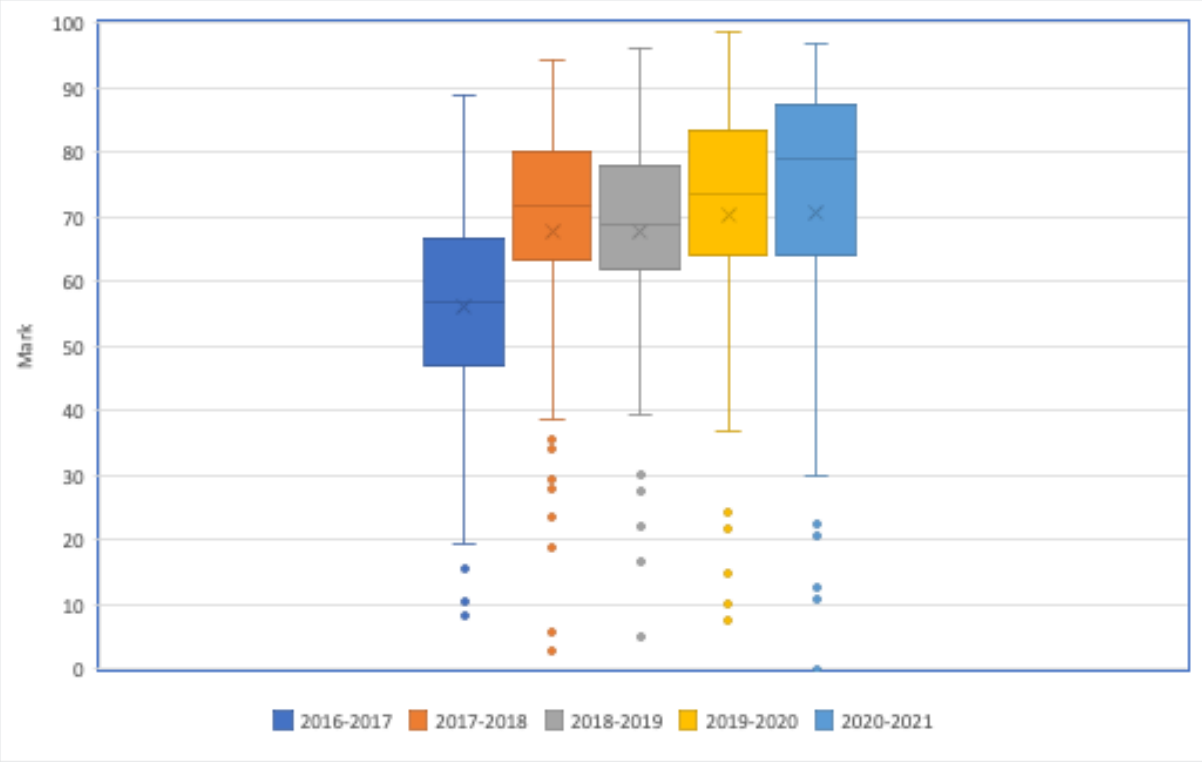


Figure 1a: Boxplot of COM139 summary statistics comparing baseline with introduction of Repl.it and Code sprint

2016-2017 is the module baseline when only Blackboard learn multiple choice assessments were used along with a written class test. In 2017-2018, we introduced the code sprint assessment and observed a rise in the module average mark and reduction in the percentage of students failing. However, the distribution of marks was skewed towards the upper bands indicating that the assessments were not clearly differentiating between some students. From 2018 - onwards we introduced Replit practical coding assessments along with the coding sprint and observed a return to a normal distribution. The module failure rate remained lower than the baseline. Even with remote learning during COVID-19, the module has maintained this improvement over the baseline.

In Table 2b and Figure 1b we provide similar summary statistics for student performance in UG module COM139 over the last 5years.

Table 2b: COM139 summary performance statistics comparing baseline with introduction of Repl.it

| | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 |
|---|---|---|---|---|---|
| 0<x<40 | 0.12365591 | 0.09558824 | 0.06837607 | 0.08421053 | 0.11320755 |
| 40<x<50 | 0.17741935 | 0.03676471 | 0.05128205 | 0.01052632 | 0.0754717 |
| 50<x<60 | 0.30107527 | 0.08823529 | 0.06837607 | 0.06315789 | 0.02830189 |
| 60<x<70 | 0.24193548 | 0.20588235 | 0.31623932 | 0.28421053 | 0.0754717 |
| 70<x<80 | 0.11290323 | 0.31617647 | 0.25641026 | 0.24210526 | 0.27358491 |
| 80<x<90 | 0.04301075 | 0.24264706 | 0.1965812 | 0.21052632 | 0.23584906 |
| 90<x<100 | 0 | 0.01470588 | 0.04273504 | 0.10526316 | 0.19811321 |
| total | 1 | 1 | 1 | 1 | 1 |

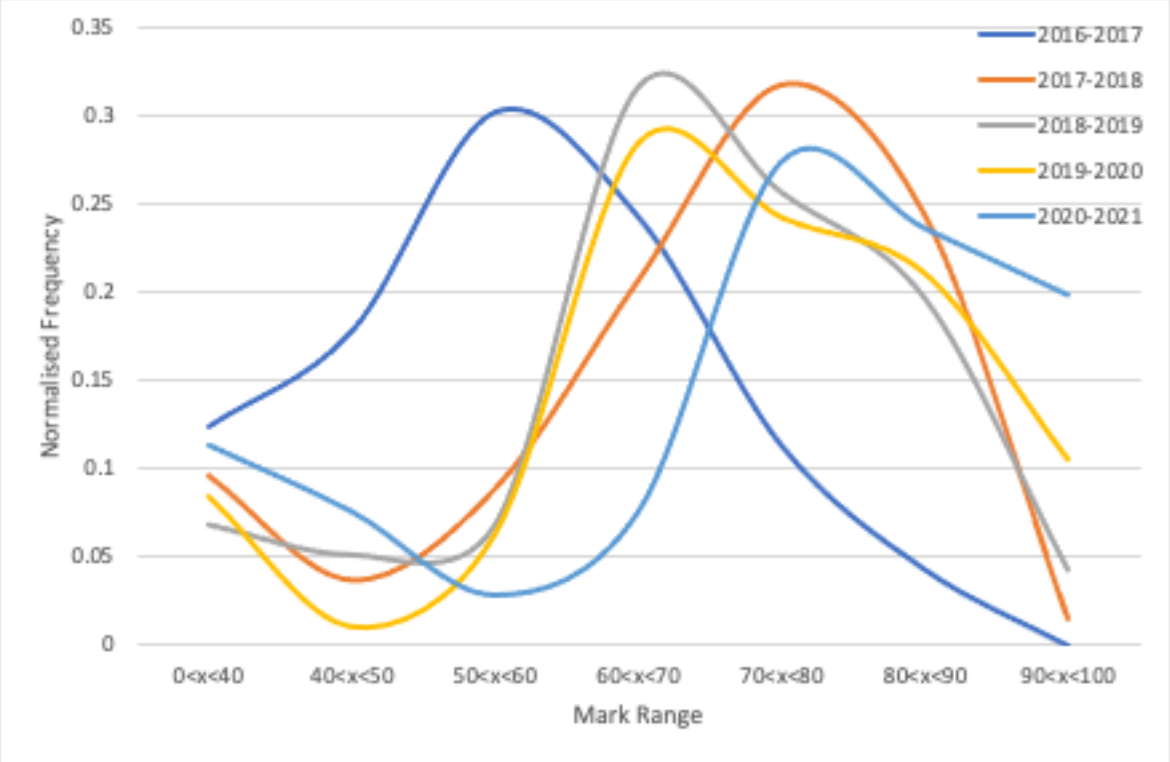


Figure 1b: Normalised Frequency of COM139 summary performance statistics comparing baseline

**Some feedback from the introduction of the coding sprint:**

- Coding sprint is a great way to use the knowledge you've learned and apply it practically in your own time
- The coding sprint allowed me to take time on my own to develop my skills and become more familiar with certain methods
- The coding sprint allowed me to work on my own programming skills and independently work out any issuesI had which gave me a better learning experience.
- I really enjoyed the coding sprint, as it had me solving problems on my own. I think more of these should be introduced to the module, as I find it easier to learn the topics by actually putting them into practice rather than reading about them.
- The coding sprint helped a lot in terms of understanding basic ideas of the course thus far. It forced me to sit down and work out different issues and understand the problem and solution. I think the coding sprint is a great idea.
- Was a very good assessment that suited my learning style (practical).

**Some feedback from the introduction of Replit:**

- Replit made me feel more capable as a programmer as I was able to complete tasks that I didn't know I was able to do for example, working out the average, I felt at a loss for a little bit but once i completed it, it made me feel more confident in my ability.
- Replit is a good idea to help us focus on the practical aspects of the module and put them into practice.
- Learning to program with Repl.it and developing a solution to solve problems, it keeps things interesting as there are many solutions and there are many different problems that it doesn't feel repetitive.
- This module helped improve my programming skills and really helped my understanding of code with Replit.

Again, you can see some improvements after the introduction in 2017-18 but more notably, with 2020-21 being remote, the performance of the students was well in line with previous on campus years and this was helped using the replit environment.

Similar technologies are currently being reviewed and shared across the team including WebPA: an automated, web-based peer assessment tool (Willmot and Pond, 2012) and AWS Educate (including AWS Cloud services). These technologies are in an earlier stage of adoption with on-going research, data collection and analysis.

**Transferability:**

This practice is very transferable which is already highlighted in that we are using existing pedagogic work with the Faculty: SPICE CoP model and the update in Replit in 5 years has already increased from 1 module to 5 within this one School alone.

- Practice is transferable across computing schools in UK HEIs;
- School SPICE model and similar CoP models are already widely adopted as evident in Nygaard et al, 2013;
- School Digital technology workshops – sharing initiatives and current applications and findings (Dec 2020);
- Shared at EAB – taken up by employer for interview activity of new recruitment (Civica);
- Digital working groups preparation for COVID-19 shared across Faculty;
- Potential conferences in education practice for dissemination to a wider audience;
- Findings will be disseminated within the School (via workshops), Faculty, the University through initiatives such as PSR, and outreach to the wider HE environment.
- Project work and findings have been discussed at regular Faculty meetings of Associate Heads of School. Sharing of best practice events are planned for 2021-22 semester 2 to showcase these findings.

*Further information:*
*e.g. links to website or publications*


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