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School-based Simulated Internships to support dialogic collaboration and authentic links with the world of work: a design-based research study

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ABSTRACT

Employers often complain that students leave school unequipped with the real-world skills needed, including problem-solving, teamwork and effective communication. Conversely, school-based education often suffers from limited perceived authenticity leading to low student engagement. Work experience is one solution, but it is labour-intensive and inequitably available. To address these challenges we undertook design-based research to explore a new relationship between enterprise and education: potentially scalable, curricular-integrated, simulated role-play experiences of the world of work. We developed a programme aligned to the English Key Stage 3 Computing and Design and Technology curricula (students aged 11–14). Student groups designed, modelled or built local solutions to global challenges, presented via videos from engineers in two international telecommunications companies. 326 students participated, led by eight teachers in four schools in areas of England traditionally associated with low social mobility. Findings identify structures, resources and approaches that authentically link to the world of work, whilst supporting students’ effective communication and shared group outcomes. We demonstrate proof of concept for an innovative education model made possible by the digital age. Using simulated real-world role-play scenarios, education across subjects could be made more authentic and many more students could experience working with leading-edge companies.

1. Introduction

1.1 Shifting sands of education

Amongst other things, education must address the skills students need for success in a rapidly-changing world of work (Strimel et al. 2020; Wagner 2010). This has influenced calls for new learning approaches that support the development of ‘future’ skills – including communication and collaborative problem-solving (Greiff, Niepel, and Wüstenberg 2015). To enable students’ genuine engagement, learning experiences should be
authentic – based on real-world challenges – to problematise meaningful solutions (Nicholls 2018). Facilitating collaboration between education and enterprise offers one means toward supporting young people to develop these skills. As Chalkiadaki (2018) contended however:

Countries invest in education on the expectation that it will contribute to their long-term economic well-being and sustainability. The problem, nowadays, is that although imperatives in the world of work have changed, education has not. (2)

Indeed the world changed substantially over the period of our project, with the COVID-19 pandemic challenging much of what we know about school-based learning and workplace practices. Teaching and learning practices changed dramatically over this time (Winter et al. 2021), but a danger is that as we ease back into physical gatherings and loosening restrictions, education will revert to previous models and become further isolated from the wider world. Initiated before COVID-19 but with increased relevance now, supporting the capacity for meaningful and manageable change in educational practice is a gap our Simulated Internships programme addresses.

Strimel et al. (2020; drawing on Lee 2017) argued that alongside a ‘skills gap’ between those entering the workforce, there exists a ‘perception gap’ – with students unaware of the array of job roles in many sectors. Broadly, the argument is that students may not pursue engineering because they do not know what engineers do, or have a narrow perception of what some engineers do. Widening these perceptions through enterprise-education links could engage interest and encourage purposeful skill development. To facilitate work-based skills and perceptions, students also need support in developing a capacity for teamwork (Mercer 1995), thus focusing on how we use talk to work together effectively is important.

There is substantial research evidence highlighting the importance of paying attention to how we use talk to communicate effectively, how teachers and students build opportunities for dialogue, and the impact of this on students’ learning (e.g. Howe et al. 2019; Mercer, Wegerif, and Dawes 1999). We also know from research however, that without explicit and repeated focus on developing such dialogic skills, classroom talk rarely develops into co-constructed dialogue: as speakers engage with different perspectives, invite and critically consider others’ views (Mercer 1995; Warwick et al. 2020). Closing this gap is embedded in our Simulated Internships programme.

1.2 Linking education and the world of work – Simulated Internships

Many charities and businesses are keen to establish links with education but their capacity to engage learners in schools is limited. Influenced by the work of Shaffer and colleagues (see Shaffer 2017), Simulated Internships offer a ‘proof of concept’ for a new approach that has potential to change how secondary school students relate to the world of work. Working collaboratively with teachers, and using digital technology to link two ‘real world’ global enterprises with schools [BT and Huawei], we developed and tested an innovative model of ‘Simulated Internships’ (SI).

SIs have roots in several theoretical perspectives, for instance, drawing on a sociocultural view of learning as a social process, mediated by a range of cultural tools (Mercer, Hennessy, and Warwick 2019). Following this tradition, we recognise all learning
experiences are situated – and so not reducible to isolated cognitive functions (Vygotsky 1962). Similarly, the beneficial influence of play and game-based learning is well recognised (Mayer and Mastik 2007). We argue these role-play-based contexts and situated, simulated scenarios can afford valuable insights and skill development – aligned to curricular targets and workplace practices.

We therefore define SIs as role-playing workplace practices, taking on the ‘mantle of the expert’ (Heathcote and Herbert 1985), responding to authentic workplace challenges. Partnership with industry colleagues informed resource development throughout the programme (including video induction and challenge setting, authentic evaluation criteria and worksheets to support various processes). During the present version of the programme such experts are not ‘on hand’ as groups engage with their challenges. Instead, co-present teachers are subject experts, and broker SI experiences for their students. Students are encouraged to use their initiative, group members and teacher as resources in overcoming challenges.

Substantial work by Shaffer and colleagues on virtual internships has identified positive outcomes. For instance, Chesler et al. (2013) reported female undergraduates who participated in a virtual internship within their course became more motivated to pursue an engineering degree than those on traditional engineering courses. Arastoopour et al. (2016) found students on such a course more successfully developed the identity and habits of mind of professional engineers. So what if we could do something earlier, for students who may not see the value of studying beyond compulsory education, or the link between school studies and workplace contexts? What if such a programme embedded development of key workplace skills, such as effective communication and groupworking, alongside consideration of workplace contexts and challenges? And what if an approach was less resource-intensive, offering digitally-mediated rather than on-site experiences of workplaces and employer encounters?

This is what Simulated Internships enable: developing lower-secondary aged (11–14 years) learners’ ‘future’ skills of dialogue and groupwork, during a Challenge-Based Learning programme (drawing on Apple 2010) linked authentically to the world of work through embedded digital resources offered by real-world engineers. Working with Design and Technology (D&T) and Computing teachers in ‘Education Opportunity Areas’ in England (where social mobility is traditionally known to be low), the programme was designed to take around 10 in-class hours over a half-term period (6–7 weeks), through five ‘stages’ with tasks structured to support teaching and student engagement (see Appendix 1 for programme outline). The programme involved small groups of students working collaboratively to define and research local responses to global challenges (climate change or digital divides), engage in dialogue to design, model or build a solution and present their findings.

1.3 Research questions

Informed by the above review, we address the following questions:

(1) How can Simulated Internships embed authentic links to the world of work?
(2) How can Simulated Internships be structured and facilitated to support students’ effective communication and groupworking, and shared group outcomes?
2. Method

2.1 Design-based research

Educational Design-Based Research (DBR) is a practice-centred approach involving collaboration between teachers and researchers (Bakker 2019). DBR puts theories of learning into designs for learning, that are iteratively implemented and evaluated to enable theories to be tested and developed. Involving participating teachers as teacher-researchers, students, industry partners, and the project advisory board was critical to this, reinforcing the project’s collaborative and dialogic ethos. Through building successful Simulated Internships we developed an understanding of not only what works, but more importantly, how and why it works (Anderson and Shattuck 2012). This enables us to make robust recommendations for future practice including the potential development of a scalable approach.

2.2 Participants and DBR process

We worked closely with various stakeholders to design SI experiences aligned to the English Computing and D&T KS3 curriculum, and to evaluate their impact with a view to developing further versions for different curricular areas. Students from four secondary schools participated during the 2019/20 and 2020/21 academic years. Class sizes ranged from 14 to 30, depending on subject and students’ needs. Schools were located in different urban and rural contexts, covering mainstream state schools and schools supporting students with additional learning needs. The intention of working with schools in different contexts was not to offer ‘generalisable’ findings – though we hoped to identify aspects with wider relevance – but to generate and rigorously investigate examples of successful implementation and points for improvement.

Overall, 326 students and eight teachers participated. Four schools were involved in Phase 1 Iteration 1, with teachers and students physically in school (October 2019 to January 2020). Three schools started Iteration 2 in school, though this was disrupted by COVID-19 lockdown in March 2020. One school participated in Phase 2 in 2020/21 with two cohorts: one before (September to December 2020) and one during (January to March 2021) the third UK lockdown. As no external visitors were allowed in school during Phase 2, and students accessed learning in school and at home at different points, minimal data collection was possible. Data collected in these ‘lead research schools’ includes video-recorded classroom-based lesson observations, audio-recorded post-programme interviews with teachers, student focus groups, and teacher workshops, and student retrospective pre–post surveys (see Table 1 and Figure 1).

| Table 1. Participants and data collection across Phases and Iterations. |
|-----------------------------|-----------------------------|-----------------------------|
|                             | Phase 1, Iteration 1 | Phase 1, Iteration 2 | Phase 2 |
| **School**                  | 1  2  3  4           | 1  2  3  4           | 1  2  3  4 |
| Teachers                    | 1  3  2  1           | 1  3  2  0           | 0  0  0  0 |
| Lesson observations         | 3  3  2  2           | 2  2  2  0           | 0  0  0  0 |
| Teacher interview           | 0  1  1  0           | 0  0  0  0           | 1  1  1  0 |
| Student focus groups        | 3  0  1  0           | 0  0  0  0           | 0  0  0  0 |
| Students                    | 26  66  12  14       | 22  54  12  0        | 0  0  120  0 |
| Surveys                     | 21  37  13  13       | 0  0  0  0           | 0  0  0  0 |

Note: N.B. some teachers were involved in multiple Iterations, with eight different teachers involved overall.
2.3 Ethics

Approaches to consent, privacy and data storage were underpinned by University ethical approval and safeguarding procedures, including BERA’s (2018) ethical guidelines for educational research. This was critical given increased pressures on teachers and students to continue meaningful education, whilst navigating a global pandemic.

2.4 Discourse analysis of lesson observation data

Video-recorded lesson data were explored systematically through discourse analysis, initially coding short sections for features of interest. Features were identified through discussion between the three authors, and instances coded by the lead author. Features included:

- group, whole class or individual work;
- using digital technology;
- student and/or teacher talk;
- using or referencing ground rules for talk;
- links to the world of work.

This coding strategy offered an overview of lesson interactions and actors, content and mediation, for detailed qualitative exploration. Extracts were selected by the lead author for transcription, in discussion with co-authors, aligned to specific research questions. Extracts presented in section 3 are followed by analytic commentary (drawing on Mercer 2004), to make salient features of dialogic interaction alongside other resources that promote or hinder dialogic and challenge-based learning, and authentic insights into the world of work, as well as identifying points for programme revision.

2.5 Thematic analysis of interview and focus group data

We used thematic analysis to explore interview and focus group data, drawing on Braun and Clarke (2006). Whilst not using a pre-set coding system, our analysis was aligned to
our theoretical concerns and research questions. Following iterative reading and coding by the lead author, 28 codes were identified, and grouped into themes. At this point, two codes were considered more appropriately as sub-codes, and one reclassified as a theme. This resulted in seven themes (see Figure 2, blue boxes), 25 codes (green boxes) and two sub-codes (orange boxes), as indicated in the thematic map.

Whilst this processing of reflective data was relatively inductive, based on what teachers and students said, we acknowledge participants’ comments were in response to questions we asked. We appreciate the interpretive nature of our reflexive thematic analysis: in outlining the process others could follow a similar approach, but would most likely reach different conclusions regarding salient meanings within the data. We argue however that through immersion by the lead author in the contexts, observations, interviews, focus groups and surveys with the different classes and schools, we bring an enhanced and more holistic sense of participants’ voices and perspectives to our analysis. Through transparent presentation of exemplifying data extracts, we seek to re-present these perspectives, and highlight their collective significance for ongoing research, development and practice.

2.6 Statistical analysis of survey data

After their SI programme, students were asked to complete a retrospective pre–post survey, responding to eight statements and three open questions. They were asked to think back to how they felt about each issue before their internship (on a scale of 1–5), and after – representing a perception of change. The eight statements were

1. What I learn and do in Computing/Design & Technology will be important for me in the future.
2. I enjoy working in a group.
3. I think group work is important.
4. I can reflect on what I’ve done well, and think about how I can improve my work.
5. I feel confident to present my ideas to others.
6. I can think about problems in different ways.

Figure 2. Thematic map of interview and focus group data.
(7) I know some of the skills people need in the workplace.
(8) I think I have some of the skills I will need in the workplace.

Likert scale data were ordinal, whereby any test of significance is non-parametric. Respondents answered pre and post questions, whereby samples are related, making the appropriate test of significance the related samples Wilcoxon signed rank test.

3. Analysis

The analysis section is structured according to the research questions, with evidence from the above data sources and analyses.

3.1 How can Simulated Internships embed authentic links to the world of work?

From the lesson data, evidence was identified via coding for ‘links to the world of work’. The extract below was selected to exemplify how this focus could be embedded in classroom interaction, discussing the importance of design. The extract also exemplifies the need for effective collaboration and what that can look like (linking also to coding for ‘group work’, ‘student talk’ and ‘discussion of ground rules’), toward mediated consideration of products that are ‘commercially successful’ and ‘profitable’.

3.1.1 Lesson extract 1

There were 14 Year 7 students aged 11–12 in the class, using the D&T version of the programme, where students defined and designed local solutions to the global challenge of climate change. The lesson occurred about half-way into their internship. The focal group were one boy and two girls, seated on two sides of a table around printed resources. The group had discussed ideas for a product logo to represent their solution, before the teacher joined them.

[T=teacher; where names are used these are pseudonyms]

(1) T: Right, have we managed to solve our … ?
(2) Beth: No
(3) T: Ok.
(4) Adam: Can you help us?
(5) T: Can I help? Right, what is the issue?
(6) Beth: He just thinks he is amazing and he (rocks) it.
(7) T: Ok. So what’s important, and it’s very important in the design, is – remember what we spoke about before – how you have to consider other people’s opinions because this product – is it just you who’s going to buy the product?
(8) Adam: I don’t know.
(9) T: Probably not, otherwise it’s not going to be commercially successful is it? Because you’re going to sell it to hundreds of thousands or millions of people for it to be a profitable product.
(10) Beth: But you’ve got to think ours are both great ideas, so putting them together creates one amazing great idea.
T: So, if we just take one person’s opinion, it’s potentially only going to appeal to one person, whereas if you take many people’s opinions, it’s then going to have more chance of appealing to a wider range of people. So that’s why it’s really important we don’t just sort of close ourselves down and think “well I’m going to choose my idea because it’s my idea.”

(School 4, Phase 1, Iteration 1, lesson observation 2)

In the above extract we notice a number of things in relation to our research question. Firstly, Adam asks the teacher for help. In school conversations this is not unusual. As discussion unfolds the teacher spontaneously links the task to parallel design processes in the world of work. He draws explicit attention to previous discussions to ‘consider other people’s opinions’ and not ‘close ourselves down’. Within this brief extract the teacher is a mediator – between education and the world of work, and between students trying to collaborate effectively. What the teacher does not do, is make decisions for the students: potentially seeking instead to support students’ ownership of the collaborative process and design, and making explicit the need in industry to consider different opinions. The students respond to this, evident as Beth identifies the potential value of combining ideas: ‘ours are both great ideas, so putting them together creates one amazing idea’. This highlights focus on collaboration rather than competition, but does not engage with how two distinct ideas can be combined into a coherent proposal.

From the interview and focus group data, evidence to respond to RQ1 largely came from the themes ‘value of authentic simulation of the world of work’, and ‘need for embedded and explicit pedagogic intentions’. Referring to processes simulated in the programme, and practices valued in industry developed through the SI, the teacher of the above class commented:

Working together is essential in the workplace … and any company that is involved in engineering or design, it’s very rare that one person is just responsible for everything. … you share ideas, you bounce off each other, and from what I saw from the idea generation with the students, what they came out with was very different to what I’m used to seeing when they only ever work as individuals. It was far more creative, far more varied. Normally you would expect a lot of the same thing, across the group, whereas the class all had different ideas which was nice to see. (Teacher, School 4, post-Iteration 1 interview)

Two particular points are of note here related to RQ1: the teacher’s reflection on the link between students’ engagement with the programme and collaborative working in industry, and the variety of groups’ outcomes in response to the same challenge. The teacher reflected that the relative freedom within SI lessons – illustrated briefly in the exchange above – was turned into an authentic, workplace-paralleled opportunity to engage, create and own group designs and ideas.

In two student focus groups at a different school, comments reflected the balance of structure and freedom within the programme, division of work amongst group members, continuing project work across lessons, and how such elements offered authentic insights into workplace practices:

I think like we learnt to – because obviously you didn’t give us a structure, we had to structure our ideas out and like plan when we were going to do things. Because we knew when the deadline was. (School 1, focus group 1)
Luke: in normal lessons we mainly just do like focus on one thing for maybe one lesson, then move on. But with doing like a whole project on it …

Heather: You don’t really realise how many different jobs there are to make something like we did (School 1, focus group 2)

The contrast Luke makes between ‘normal’ lessons and the ‘whole project’ encompassing the SI group challenge is intriguing. The students linked this, and dealing with the apparent lack of structure, to what they learned from their SI experience, alongside insights gained – things they ‘don’t really realise’ – of authentic workplace practices.

The importance of collaboration within the programme was reiterated by a teacher after Phase Two with the first cohort in School 2. This cohort experienced their SI amidst COVID restrictions with some students in school and some accessing remotely via Teams at home, unlike the teacher and students above who participated in pre-COVID classrooms. The teacher recollected conversations with her students:

we came to this discussion like, “why did we have to do group work?” I was like, “… tell me a job where there is no group work. You’re going to have to collaborate with someone at some point.” And that was something that I think stuck with them, because none of them could find a job. (Teacher, School 2, post-Phase 2 interview)

Thus we see how teachers saw, and embedded for students, the workplace relevance of programme collaboration on a sustained challenge. This highlights the critical role of the teacher engaging with underlying programme principles, and promoting these through lessons and activities, regardless of physical and digital context. Whilst the instantiation of the programme therefore had to adapt to local circumstances, this demonstrates the core programme’s flexibility to be delivered in different physical and digital contexts. In fact this was a telling difference within the above teacher’s Post-Phase 2 interview: reflecting on how the programme was run differently between two cohorts who experienced SIs in class (socially distanced), and those who experienced it fully online from home during COVID lockdown.

Teacher: [in cohort 2, during lockdown] We’re doing it on MS Teams as well. So basically following through the slides with them…. obviously a lot different from how it’s meant to be … No group work obviously.

…

Interviewer: Do you think there’s a way … it could be supported, in terms of group work online?

Teacher: [pause] Erm. I didn’t think about that … Because obviously, … it’s like a completely different unit. Because you’ve moved from everything that would have been done as a group, and picked up those skills, as a group in terms of learning and creating something together, which is what you would do in the real world, in work. But then … you’ve taken all of that out, and it’s just become an academic subject. (Teacher, School 2, post-Phase 2 interview)

We do not add this comparison to criticise the teacher and school – the challenges forced upon education would have been unimaginable a year earlier, and we applaud the teacher and school for offering innovative opportunities to students during uncertain
times. This reflection however underlines the different experience and real-world value of the programme, when students work independently compared to when supported to work collaboratively. This identifies a need to offer guidance on how SIs could be supported in different online and offline contexts, to capitalise on the potential benefits of digital tools in mediating pedagogically-grounded digital education futures. It also makes visible a benefit of the DBR approach, highlighting what could be improved. Due to COVID-19 restricting our access to the school, we were unaware the collaborative element had been considered untenable until the post-programme interview. Thus our learning of the need to offer pedagogic support around online collaboration will inform ongoing work, but came too late for this cohort.

3.1.2 Survey data
81 students completed surveys rating their level of agreement with eight statements – considering how they felt about the issue before, and after their SI experience. Responses were combined across the four institutions and two programme foci (Computing and D&T) from Phase 1, Iteration 1, and tested for statistically-significant change between pre and post. Responses plotted an average increase pre-to-post for all eight statements, but not all were statistically significant. Considering our efforts to embed authentic links to the world of work, addressed in RQ1, aggregated responses to two particular statements are encouraging:

- I know some of the skills people need in the workplace \( (z = -5.475, p = 0.000) \)
- I think I have some of the skills I will need in the workplace \( (z = -4.795, p = 0.000) \)

These strong findings correspond with comments raised above through qualitative analysis, about seeing the wider value of engaging in the programme, and the awareness and skills students developed through this experience.

3.2 How can Simulated Internships be structured and facilitated to support students’ effective communication and groupworking, and shared group outcomes?

In this section we use the data to evidence how explicit attention to communication and groupwork was embedded within the programme, student and teacher response to this, and project outcomes.

From the interview and focus group data, responses to RQ2 can be evidenced through the theme ‘need for embedded and explicit pedagogic intentions’. We know from existing research that effective communication and groupworking rarely happen unless explicitly encouraged – thus we focused on how to nurture such practices. For instance, one student reflected in the post-programme focus group:

- I think it’s better with a group because you’ve got multiple ideas to contribute to like one thing. (School 1, focus group)

Contrastingly, in unfolding lesson interaction at the same school, another student offered a different view of collaboration:

- I guess we should have four questions and each person focuses on one (Student, School 1, Phase 1, Iteration 2, lesson observation 2)
In the latter, we could interpret that students are working as a group, but not really collaborating. Thus an understanding of how to encourage effective communication and groupworking was not always shared, and cannot be assumed simply by putting students in groups. A critical pedagogic intention of the programme was setting and monitoring 'ground rules for talk'. The rationale was outlined in the 'teacher resource pack', with explicit tasks throughout the programme. A teacher from School 3 commented in his post-programme interview on how placing the creation of these ground rules in students’ hands helped their acceptance:

it [setting ground rules for talk] is probably new to them … So I think that was good that they took ownership of that, and the response from them was brilliant. (Teacher, School 3, post-Iteration 1 interview)

The teacher’s comments underline that encouraging student ownership of ground rules, structuring effective communication and groupworking, was a valuable element of SIs. Some instantiation of this collaborative engagement with each other’s ideas was evident in lessons, exemplified in the extract below, from the same school (supporting students with additional learning needs).

3.2.1 Lesson extract 2
This Year 8 class at School 3 were exploring the D&T version of SIs. The lesson was over half-way through the programme. Students in this group (three females) were working on a local solution of start-stop technologies for cars to reduce energy wastage. Interaction in the extract was solely between two students, with no nearby teacher presence or input:

(1) Kate: I’ve changed it to more of a sticker, so it sticks onto the actual engine and the exhaust pipe
(2) Lian: Yeah, would it be able to come off though?
(3) Kate: Yeah
(4) Lian: cos if you went to sell your car or something
(5) Kate: Yeah, so, you know how you have like, stickers where they stick onto stuff, and they have like a little tab that you can pull off?
(6) Lian: Yeah
(7) Kate: Yeah, it will have one of them
(8) Lian: OK
(9) Kate: OK, so I’m messing around with different designs

(two students, School 3, Phase 1, Iteration 1, lesson observation 2)

We draw analytic attention to how the communicative space between the two students is maintained by asking questions, grounding thoughts in recognisable scenarios, to develop shared understanding around an idea. The three students were working on separate project aspects, whereby such conversations were vital to ensure a shared approach, whilst still enabling Kate to be ‘messing around with different designs’. This reinforces the importance of time and space for students to work as a group, unmediated by teachers, and to explore where they can take ideas. Working through this challenging dynamic was reinforced as valuable for students and relevant to the world of work, by the teacher at School 4:
I think it comes down to compromise ... And everybody has their idea which they treasure, ... because it’s their idea and therefore they think it’s the best. Getting them to take on board other people’s ideas is probably quite a big jump for them in terms of maturity. ... whilst they may not be there yet, something like this project works towards that and helps them have those difficult discussions and come to those difficult compromises without arguing or falling out - hopefully. So yeah, I think there’s a lot of almost kind of social skills involved in that, which you wouldn’t normally get in an everyday lesson because that scenario doesn’t often present itself in anything other than sharing ideas in group work. (Teacher, School 4, post-Iteration 1 interview)

‘Difficult discussions’, ‘compromises’ and avoiding ‘arguing or falling out’ were not illustrated in the previous lesson extract, but there were certainly moments of this during programme lessons – potentially in the moments before the teacher’s intervention in lesson extract 1 above. Interestingly, paralleling the student’s comment earlier in the paper, the teacher contrasts what happens ‘normally in an everyday lesson’ with the SI programme. The importance in our programme therefore is raised of structuring activities that equip students with dialogic tools to work through difficult conversations – preparing for such scenarios in the workplace – toward negotiating group decisions and solutions.

Lesson extract 3 has been selected to exemplify how effective discussion can be achieved, building ideas amongst peers, whilst also illustrating how group ownership of ideas can be problematic resulting in sometimes superficial ownership of ground rules.

3.2.2 Lesson extract 3
The extract is from the same group and lesson as extract 1. It re-presents a student-only group discussion – discussing what their product, as well as their logo, should look like. One student invites the teacher to join them, but for very different reasons than in extract 1:

(1) Beth: If you have green and red, it could like indicate with different lights.
(2) Jade: No it could go red when it’s charging and then go green when it’s full.
(3) Adam: No. For this big sign we want it green because green would be our, green for fully charged and turned on.
(4) Beth: Yeah, you would be like an (apple green) plus …
(5) Adam: And then that’s eco, it goes with everything. It helps to save energy.
(6) Jade: It’s such a good idea.
(7) Adam: I know.
(8) Jade: Green because it’s like …
(9) Adam: Green because eco, and then green because it’s fully charged and turned on.
(10) Beth: It’s saving energy so it’s good. [to Teacher] Sir, we’ve got a really good idea.
(11) T: [joins group] Go on then.
(12) Beth: [to Adam] You say it because it’s your idea.
(13) Adam: Green because, green would be our main colour, because a green equals fully charged on our indicator light, and so green saving energy, and green would be for the eco-friendly and green for the earth.

(School 4, Phase 1, Iteration 1, lesson observation 2)

At the start of the extract there is perceived disagreement amongst group members, with turns 2 and 3 starting ‘no’. Within the following two turns however, rationale are
given for colour choices and the perceived disagreement fades, with contributors affirming their approval, and by Beth sharing their excitement with the teacher in row 10 ‘Sir we’ve got a really good idea’. Interestingly to the teacher Beth references the idea ‘we’ve got’, but as the teacher joins the group she steps back in the dialogic space and indicates to Adam, ‘you say it because it’s your idea’. Adam, however, identifies that ‘green would be our main colour’, potentially, or perhaps inadvertently, allocating ownership back in the collaborative space. The complex dynamics of effective communication and groupwork around idea generation and ownership are exposed, with acknowledgement of efforts but consolidation of group identity important.

Student groups devised various solutions through their SIs, aligned to different local challenges. Solutions addressing the Computing challenge of digital divides, included keyboard configurations to support access for visually-impaired people, and interfaces for mobile phones to learn user preferences. Solutions for the D&T climate change challenge include domestic ‘master switches’ to reduce energy consumption, solar-powered, wirelessly-charged buses, and consumer-awareness-oriented solutions that shut off devices once a daily threshold has been reached.

3.2.3 Survey data
Considering students’ reflections on the programme features addressed in RQ2, statistically significant positive change in two statements from the pre–post survey statements are promising:

I feel confident to present my ideas to others (z = -4.787, p = 0.000)

I think group work is important (z = -3.404, p = 0.001)

These findings are measurements of difference, pre to post: not a measurement of actual confidence for instance. Therefore someone with a pre-rating of 3 and post-rating of 5, would have the same difference value as someone with a pre-rating of 1 and post-rating of 3. What we can conclude is that whatever their starting and ending evaluations, over the course of their SI the students – on average – reported greater confidence to present ideas to others, and saw greater importance in groupwork.

4. Discussion and conclusions
COVID restrictions hampered efforts for iterative development and evaluation, and scaling of the approach. Flexibility to accommodate what was possible with schools during lockdown and self-isolation had to take priority – our approach had to be responsive.

Even before COVID, flexibility with school timetabling can be difficult to align with resource revision between Iterations and Phases. What we offered needed to be both an ambitious innovation, and a sufficiently-coherent programme to support learning objectives with students who rightly expect well-thought-out educational experiences. Aligned to this is a wider consideration of the ethical dimension of revising resources – who experiences the ‘improved’ programme, and who gets the version in development? This was perhaps underpinned by comments that teachers piloted the programme with ‘good’ groups (or students they knew would give it a go). The version developed and
implemented in Phase 1, Iteration 1 was based on research evidence and experience, but it was nevertheless a programme in development.

Potential methodological issues and limitations must also be considered. These relate, for instance, to the discourse analysis of lesson observation data and thematic analysis of interview and focus group data. Methodologically, there are many ways we could have analysed the data. We acknowledge our analysis is largely interpretive, grounded in sociocultural and dialogic theory. Others would likely approach the data in different ways, with different focal lenses. We therefore sought transparency of reporting, selecting data extracts to exemplify analytic claims. We outlined our different data sources and analytic process, and rationale for including both qualitative and quantitative elements to offer different angles on research questions. We included data from student and teachers, from the mid-flow nature of lesson interaction as well as the more reflective spaces of interviews and focus groups.

We acknowledge that in its present form factors such as affect, embodiment and gaze do not play a central part of the analysis (although they may still be accounted for during inductive elements). Such factors were not a focus of our work but might be for others with relevant expertise or different foci. It is also important to problematise the verbatim (orthographic) approach to transcription adopted. While less demanding to undertake (Hepburn and Bolden 2017), purely verbatim transcription can result in the omission of potentially important information such as intonation and stress, or body movement and use of different tools and technologies – the breadth versus depth choices of transcription detail and coverage are always decisions that require thoughtful consideration (Twiner et al. 2021). The use of standard orthography, rather than phonetic representation of sounds, might also influence a researcher’s understanding of verbal behaviour; it can also force a literal interpretation on utterances that otherwise may be simply objects of phonological manipulation (Ochs 1979). Such issues mean it is important for researchers to critically reflect on their transcription decisions prior to undertaking the research, given the implications these might have for participants and findings (Oliver, Serovich, and Mason 2005).

A range of mitigating actions are incorporated into the methodological approach reported to ensure methodological rigour. For instance, issues in coding classroom talk must be acknowledged (e.g. the use of pre-determined categories or target items limiting analytical sensitivity; Mercer 2010). Other limitations relate to the interpretation of research findings, particularly for the more inductive aspects of the analysis. Such issues were mitigated through discussion amongst the authors, and seeking contrasting examples. Other issues that commonly occur in video-based research – such as a ‘camera effect’ causing some participants to modify their behaviour for a short time at least – must be considered (Blikstad-Balas 2017) and were similarly addressed by liaising with teachers about the optimal (least intrusive) location for cameras and clearly explaining to learners how recorded data would be used prior to collecting data.

A number of limitations to the research are evident, arising particularly from the relatively small scale of the study and involvement of a small number of schools. The latter data in particular, where observation and obtaining data from students was not possible, could also be criticised in terms of a reliance on one source of data that came in the form of retrospective self-report.
Our analysis indicates the programme had some positive impacts. Students created unique responses to challenges that reflected their interests. They took charge of their learning, beginning to work well together to co-ordinate activities and outcomes – a pattern of interaction we know has benefits for learning (Howe et al. 2019). Over the course of their SIs, students saw greater value in groupwork and increased confidence to share ideas with others, gained meaningful insights into workplace practices, challenges and contexts, and increased understanding of skills needed in the workplace, and their sense of having some of these skills. A key response to the skills and perception gap identified earlier (Strimel et al. 2020): students who participated were proud of their achievement and believed they could make a difference. Through engagement with the approach, resources and pedagogical foundations, participating teachers were empowered to be mediators and brokers of experience, whilst maintaining their role as subject experts. They were also validated, through authentic industry-voiced digital resources without need for site visits and risk assessment forms, in highlighting the relevance of curricular tasks to students’ futures, and in offering these opportunities to all students regardless of location, finances or access.

Revisiting our research questions, SIs can embed authentic links to the world of work, and be structured to support students’ effective communication, groupwork and shared outcomes, through the following research-evidenced design principles:

- explicit attention to ground rules for talk, and engaging with each other’s ideas (Mercer, Wegerif, and Dawes 1999);
- positioning teachers as mediator and broker of experiences;
- positioning students as owners of group challenges and outcomes, experiencing the importance of groupwork to workplace practices (e.g. Chesler et al. 2013);
- considering user needs and impacts, and stretching their skillset to appreciate and accommodate these requirements;
- immersion through a mantle of the expert, role-play approach, in concepts, considerations and processes relevant to the world of work (drawing on Heathcote and Herbert 1985);
- providing space and time for students to explore their task (drawing on Wegerif 2007), and work through challenges toward shared ownership of ideas and outcomes;
- identifying the need to support collaborative working in various digital and physical contexts.

For teachers, we suggest that Simulated Internships offer an innovative programme integrating evidence-based resources with authentic work-based challenges and evaluation criteria from real-world enterprises. The programme was intentionally designed to meet curriculum criteria – allowing teachers time to explore it with students. In a time-poor curriculum, this was critical to programme feasibility.

For learners, preliminary analysis indicates that SIs offer structured opportunities to take ownership of their learning, working on real-world challenges in ways that are relevant now and for the future. The programme offers strategies and contexts to develop ‘future’ skills relating to dialogue and groupwork. Crucially SIs offer work experience opportunities and insights to students at scale, and earlier in education trajectories than more traditional models.
For education, Simulated Internships provide a rigorous, evidence-based programme structured with tasks that raise students’ aspirations and awareness of options beyond school. The digital model enables this provision without need for site visits, risk assessment, consent forms or funding for school trips, and at scale. Moving forward, we know online collaboration can be resourced if students are accessing remotely – a highly likely scenario as we envisage digital education futures. Various tools exist, and guidance could be included on effective pedagogic use of digital tools.

For employers wishing to shape future education practices, generating SIs and insightful digital resources aligned to their workplace priorities could offer scope to equip tomorrow’s workforce with necessary skills and understanding. We acknowledge considerations, in terms of employer investment to create resources, and concerns over what they may ‘expect’ in return from participating students and schools – of which school gatekeepers may be cautious. We argue however that such SI partnership-at-a-distance can offer a safeguarded means for students to explore workplace scenarios, requiring minimal ongoing time or financial investment from industry. Through this model students gain insights through structured activities couched in workplace challenges, employers raise the profile of their organisation, but without direct contact between students and employers.

For researchers, we offer a transparent account of how we adapted our DBR framework due to unforeseen and long-lasting challenges brought about by COVID-19. We underscored the importance of teacher support, empowering practitioners to facilitate students’ effective communication and collaboration, evidencing why this is relevant to students’ current and future options. We consolidated our intentions to work in partnership with teachers and industry colleagues, supporting rich Simulated Internship experiences in a range of digital and social contexts. We therefore conclude that SIs offer an innovative model of education, projecting scenarios in which anyone can experience solving real-world challenges with cutting-edge companies.

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### Appendix 1. Programme outline.

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<thead>
<tr>
<th>Stage</th>
<th>Stage Aim</th>
<th>Intended Outcomes</th>
<th>Core Stage Tasks</th>
<th>Links</th>
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<tbody>
<tr>
<td>1</td>
<td>To use challenges from the world of work to frame a challenge-based learning project – the aim of Stage 1 is for groups to take ownership of the ground rules for talk, have</td>
<td><strong>All groups</strong> establish whole class ground rules; agree and record group challenges.</td>
<td><strong>S1.T1.</strong> Watch BT/Huawei ‘welcome’ video. <strong>S1.T2.</strong> Discuss and establish ground rules for talk.</td>
<td><strong>Link to the world of work and curriculum:</strong> Explore a genuine workplace challenge. <strong>Link to C2C:</strong> Establish what ground rules for talk are useful and</td>
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<th>Stage</th>
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<tbody>
<tr>
<td></td>
<td>narrowed down from the big idea, and agreed on a challenge to pursue.</td>
<td>of local challenge to global issue.</td>
<td>presented by BT/ Huawei; Choose the ‘big idea’; Agree the group challenge.</td>
<td>productive, for group interaction and for meeting Task requirements.</td>
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<tr>
<td></td>
<td></td>
<td>Some groups consider research strategy.</td>
<td>S1.T4. Introduce student logbook.</td>
<td></td>
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<td>2</td>
<td>To ground a response to the challenge in research evidence and user perspectives, with consideration of appropriate methods, timescale, available tools and access.</td>
<td>All groups brainstorm ideas, plan and gather evidence in response to the challenge.</td>
<td>S2.T1. Brainstorm ideas and encourage a creative approach to the challenge.</td>
<td>Link to C2C: Brainstorm ideas; Stay mindful of ground rules; Divide research tasks amongst group members.</td>
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<tr>
<td></td>
<td></td>
<td>Most groups conduct research outside the classroom.</td>
<td>S2.T2. Research the challenge.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Some groups conduct interviews or surveys.</td>
<td>Link to C2C: Discuss themes from data, share suggestions and explore alternatives.</td>
<td></td>
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<tr>
<td>3</td>
<td>To understand user and/or expert perspectives on the challenge; Decide on a potential solution on the basis of this understanding.</td>
<td>All groups discuss different possibilities, and agree on ideas for a group solution.</td>
<td>S3.T1. Watch and discuss BT/Huawei ‘creativity’ or ‘collaboration’ video.</td>
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<td></td>
<td></td>
<td>Most groups ground their ideas in research evidence.</td>
<td>S3.T2. Discuss themes in the data – what does this mean for building a solution?</td>
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<td></td>
<td></td>
<td>Some groups explore multiple ideas before agreeing on one.</td>
<td>S3.T3. Brainstorm and consider alternative solutions; Select one solution to pursue, using authentic industry criteria.</td>
<td></td>
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<tr>
<td>4</td>
<td>To use the understanding from previous Stages to design, model or build a solution that is innovative, sustainable and user-focused, and to evaluate this against authentic workplace criteria.</td>
<td>All groups implement, discuss reasons and evaluate a solution (design, model or build).</td>
<td>S4.T1. Implement a solution.</td>
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<td></td>
<td></td>
<td>Most groups indicate how they could improve their solution.</td>
<td>S4.T2. Evaluate the solution.</td>
<td></td>
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<td>5</td>
<td>To present the group’s process and implemented solution, and give a rationale for its evaluation against workplace criteria.</td>
<td>All groups prepare how to present the group solution, and present it.</td>
<td>S5.T1. Prepare the presentation.</td>
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