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I'm a Nuclear Scientist! Online Stem Enrichment Inspiring the Next Generation of Nuclear Advocates – 22245

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ABSTRACT
There has been no in-person interaction between schools and nuclear professionals since February 2020, making it impossible for researchers and industrialists to meet moral and funding obligations for engagement with schools and the public. This schools engagement project aims to generate impact from academic research and industrial activities by improving pupils' career aspirations whilst promoting clean energy. This paper describes our experience taking STEM enrichment activities wholly online, by enabling direct contact between people working in the nuclear industry and academia with school pupils, hopefully inspiring younger generations to consider STEM and nuclear careers.

The objective is to address the national STEM skills shortage by encouraging young minds to contribute to the clean energy revolution, beginning with school STEM enrichment. The long-term success of the nuclear industry relies on a pipeline of new entrants, and this paper describes a national effort linking companies across industry with each other and with academia towards this common goal.

42 scientists, engineers and other professionals ("role models") working in nuclear energy have been asked questions about their work and career by 388 schoolchildren during an intensive 3-week period, in which the *I'm a Scientist* platform has hosted the "Nuclear Zone". This paper describes the activity and the industry's next steps to achieving the aims of improving the public perception of nuclear fission technology, sustaining key skills for the long term, and increasing diversity of the workforce.

INTRODUCTION
Low-carbon energy solutions such as nuclear energy play an important role in the UK's industrial strategy and its commitment to net zero emission targets, but this aspiration requires a workforce with excellent STEM skills. Industrial activities generate 21.6% of the UK's GDP [1] (mining, manufacturing, construction, electricity, water, and gas), but a chronic skills mismatch might prevent future economic growth in this sector, according to the National Audit Office [2]. Existing skills shortages are being made worse by a poor uptake of STEM at school, followed by, in some areas, low participation in higher education [3]. COVID-19 has exacerbated inequalities in pupils' education attainment and aspirations, and having missed out on part of their education during lockdowns, this generation are owed a helping hand. This project seeks to address both of these problems by encouraging school pupils to consider STEM careers as attainable and therefore improve social mobility.

The participation of local areas (POLAR) classification by the Office for Students shows regional variations in university participation, so this project targeted schools with low university participation, reaching out to regions geographically distant from universities. The UK Government has a 'levelling-up' agenda and this project supports this rebalancing of societal inequality by improving aspirations and encouraging social mobility, showcasing professional and relatable role models.

In previous years, in-person public engagement events have been conducted by the University of Bristol's Elen Williams <Elen.Williams@uknnl.com>South West Nuclear Hub [4], and other organisations working in nuclear, but due to the 2020-2022 COVID-19 pandemic, these exhibitions have not been possible, or at least severely limited. Described in this paper, an online, pandemic-proof solution to this issue has been proposed and funded by the University of Bristol (UoB). The "Nuclear Zone" on the UK's pre-eminent online website for schools STEM engagement, *I'm a Scientist* (IAS), showcases nuclear role models both from industry and academia, at various stages in their career, and with different career paths. A group of role models with a mixture of genders, ethnicities, backgrounds, roles and seniorities demonstrated the diverse workforce already employed in STEM roles, and showing that STEM and nuclear is for everyone.

Many of the role models found the interactions with school children fulfilling and challenging, and for many it will be the first time they have done any (potentially controversial) public engagement. The experience aims to encourage participants and their organizations to pursue further engagement opportunities, having built confidence that their expertise, knowledge and opinions are of wide interest to the public. Two-way discussions are excellent ways to generate impact, and opinions articulated by pupils may well shape the direction of our industry.

BENEFITS

Benefits to the industry, the pupils themselves and society more generally envisaged were:

- Career: promote the availability of skilled jobs in STEM subjects for school-leavers looking for an interesting and varied career.
- Social mobility: encourage underprivileged sections of society that science and engineering is for them, by targeting those schools with large proportions of deprived backgrounds.
- Skills: produce a pipeline of skilled workers to sustain the nuclear industry and enable the UK to be a world leader in nuclear technology and green energy.
- Sustainable growth: meet the demands of the UK's industrial strategy for "Clean growth" (important to the next generation of school-leavers).
- Workforce: nuclear organisations looking to sustain their activities long term with a skilled workforce should benefit from this kickstart to a new industry-wide public engagement programme. One aim of the project is to show how valuable this kind of activity could be for the industry, and encourage industry partners to fund follow-on sessions, targeting even more schools with a sustained annual effort.
- Communication skills: the role models taking part, and their colleagues in the future, will benefit hugely from this activity through involvement with schoolchildren, improving their communication skills and working as a team towards a common goal.
- Public acceptance: once established as a national schools engagement programme, this will increase the public acceptance of nuclear energy in the medium and long term as more environmentally-minded generations mature.

METHOD

The pre-eminent online website for schools STEM engagement, *I'm a Scientist* (IAS) is well-known by PhD students, many of whom have used it for STEM ambassador activities. IAS is an online STEM enrichment activity using energetic real-time text-based chats, known to give effective experiential training for scientists in engaging the public. The owner of IAS has agreed to partner with UoB on this project to facilitate a special dedicated "Nuclear Zone" on their platform. As a well-established brand trusted by schools, IAS was chosen for this project because:

1) The platform is a ready-made solution, avoiding the need for development of a bespoke website;
2) Schools engagement on IAS is very cost-effective compared to the time it would take to produce a similar system;
3) Impact can be generated with significant reach (nationwide);
4) It is pandemic-proof, not requiring school visits, and would even work during lockdown;
5) Significant time savings make it efficient (20% of the normal time for schools engagement): role models can participate from their desks and no exhibition preparation is required;
6) Staff contribute when it suits them and their workload
7) Text-based chat provides opportunity for parallel conversations and follow-up questions, which is particularly inclusive of introverted pupils.

PARTICIPATION

From the 12 schools which participated in the Nuclear Zone, there were 388 students logged in, of which 96 % were active. In at least one school, the chats were run in the classroom by the teacher. As such, the number of participating students is an underestimate. 259 questions were asked, although only 63 of these were approved – that is, passed on to scientists having been vetted for suitability [1]. These questions were asked over the course of 18 live chat sessions, with an average of 534 lines per live chat. Questions could be answered by more than one scientist, which was relevant for wide-ranging or general questions; 419 answers were given in total. Three of the schools admitted only girls, whilst the rest admitted students of all genders. This meant that schools of the former type were over-represented in the pool of schools who participated, representing 25 % of the pool compared to just over 2 % nationally [5].

Figure 1 shows the number of participating role models broken down by institutions and institution type (industry or academia). The modal number of participants was 1 per institution, both for the entire group and for each institution type. However, some institutions contributed significantly more than this, with the nucleargraduates industrial group in particular contributing 10 role models. Industrial support for the project was stronger than academic support (27%); there were both more institutions, and a greater mean number of participants per institution, in the industrial group.

Figure 2 shows basic demographic information for the scientists, namely age group and gender. The scientists were mainly between 25 and 34, with a substantial minority between 18 – 24, and one scientist in the 35 – 44 category. There were no participants from other age categories, meaning the group were young, which tallies with the age profile of the NI Young Generation Network (defined as under 37), this is evidenced by the data collected shown in Table 1. As for gender, the group were 60% male, to deliberately emphasize and showcase female role models, even though this is not representative of the current industry gender make-up. Women in Nuclear UK (WIN) sets a target of 40% women in nuclear by 2030, hence the basis for this representation.

[1] Under the circumstances of a quickly-moving live chat with teenagers, this was not always a perfect filter. Dealing with jocular comments and questions from students had the potential to generate awkward situations for participating scientists, as discussed later in the report.

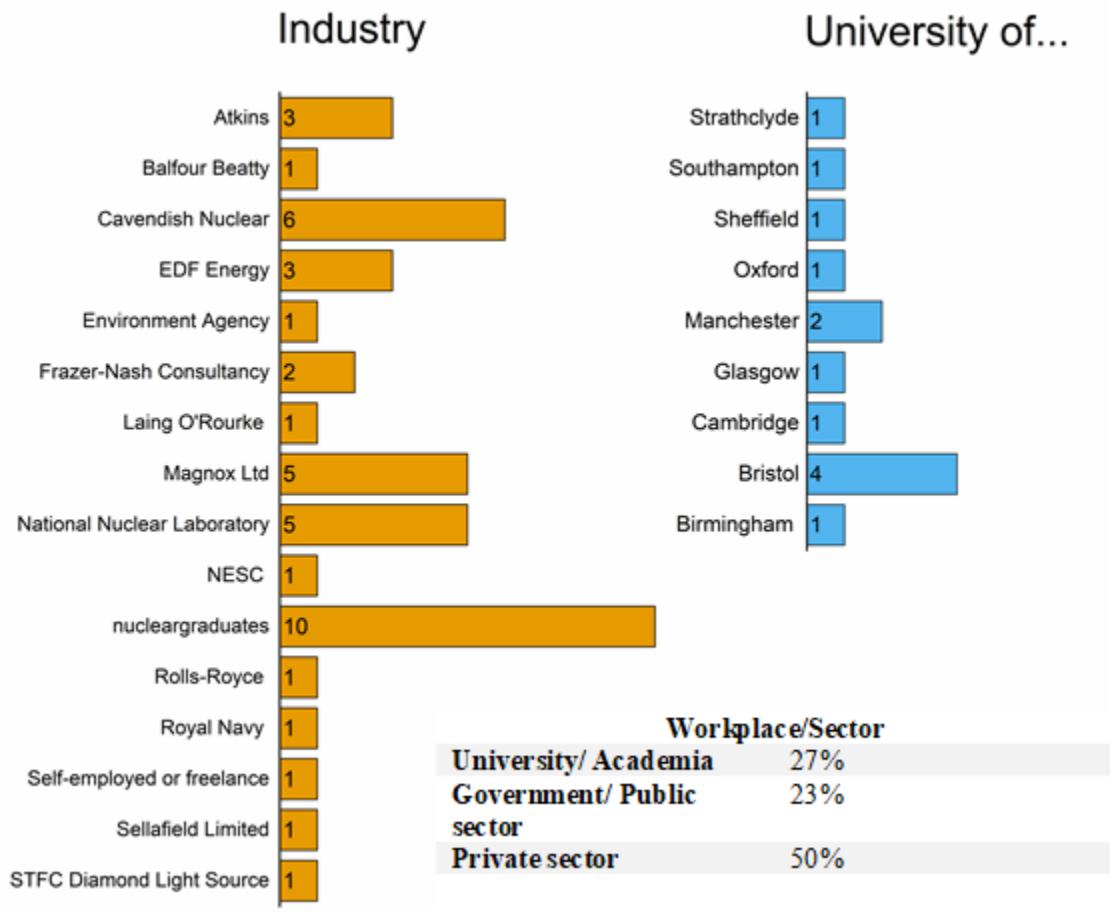

Figure 1. Participant numbers for industrial and academic institutions.

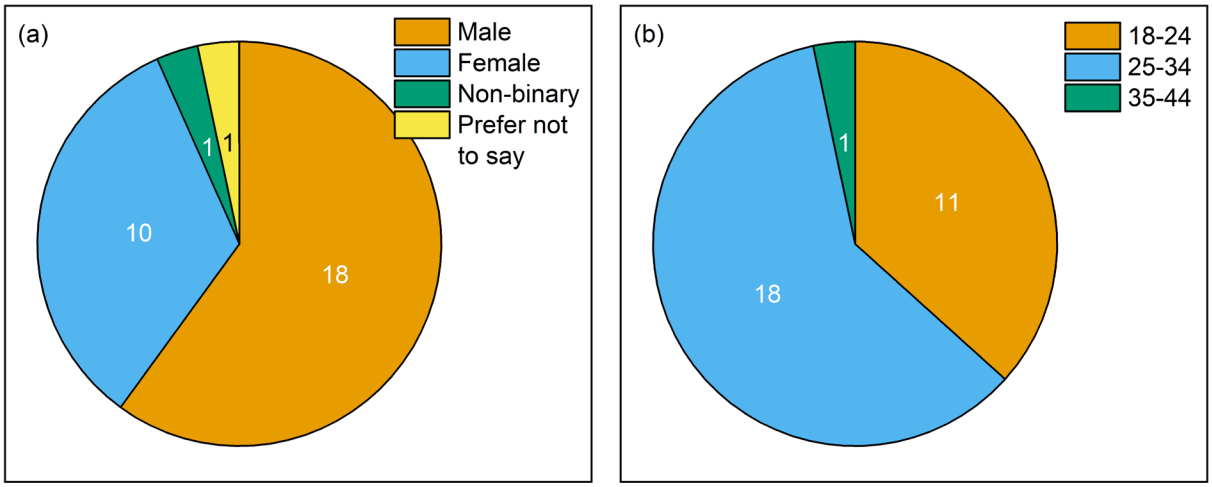

Figure 2. Nuclear role models' basic diversity information, namely (a) gender, and (b) age.

Seniority	
Apprentice	3%
Graduate	30%
PhD student	20%
Postdoctoral	7%
Senior/Management	10%
Undetermined	30%

Table 1: Seniority of nuclear role models

Figure 3. Nuclear role models' locations

Figure 4: School locations

Figure 3 and Figure 4 demonstrate the potential of remote engagement using an online system: there was no need for the role models and their organisations to be co-located with the schools –large organisations will mostly have good relationships with local schools anyway through family connections, in-person engagement and the local workforce and so this online technique increases the reach possible to schools distant from both universities and industry.

MEAUSURING IMPACT

Influencing children's aspirations will be the main impact of this project, but this is understandably difficult to quantify especially over such a short term. Decisions to work in STEM-related subjects will not manifest themselves for several years following inspiring encounters such as this, and it is known that a one-off encounter is not sufficient to develop a deep interest in a career [6]. Yet some measurement of impact could be possible in two ways:

1. Through identical surveys carried out both before the engagement and afterwards.
2. The I'm A Scientist platform collects analytics data on the question frequency and quantity, number of students engaging, types of questions and overall satisfaction.

Results

1. Just one teacher responded to the impact assessment questionnaire sent to all teachers participating in the nuclear zone. though this was a disappointing response rate it confirms that teachers pressed for time simply will not volunteer additional information so assessment of impact and engagement with teachers requires more careful consideration in future.

2. Questions were analysed using a typology which split questions into the following types: -

- **Science topics**. Questions on science topics were those which asked for specific, technical information, whether on nuclear science or otherwise.

- **Working scientifically**. These questions covered the relevance of scientific work to society and its nature as a discipline.

- **Careers and Education**. These questions asked about the daily work of a scientist, the steps by which one becomes a science, and other such matters.

- **Personal**. Personal questions were non-scientific questions asked by students out of interest or to humanize the scientists.

Figure 5 shows a breakdown of approved questions by question type, as well as some example questions. Questions could not all be rigidly characterized, and this should be borne in mind when viewing the results. For example, a questions such as "*Why is your research important?*" might well fall into any of the four types depending on the answer given.

Interestingly, a large proportion (40 %) of the questions were about personal topics, and perhaps this should not be surprising given that pupils want to understand if there are elements of scientists' characters that they can relate to. Just 7 % of questions were about science topics, and this shows us that STEM engagement is really about people's passion for their endeavours and their personalities, rather than trying to teach part of the curriculum.

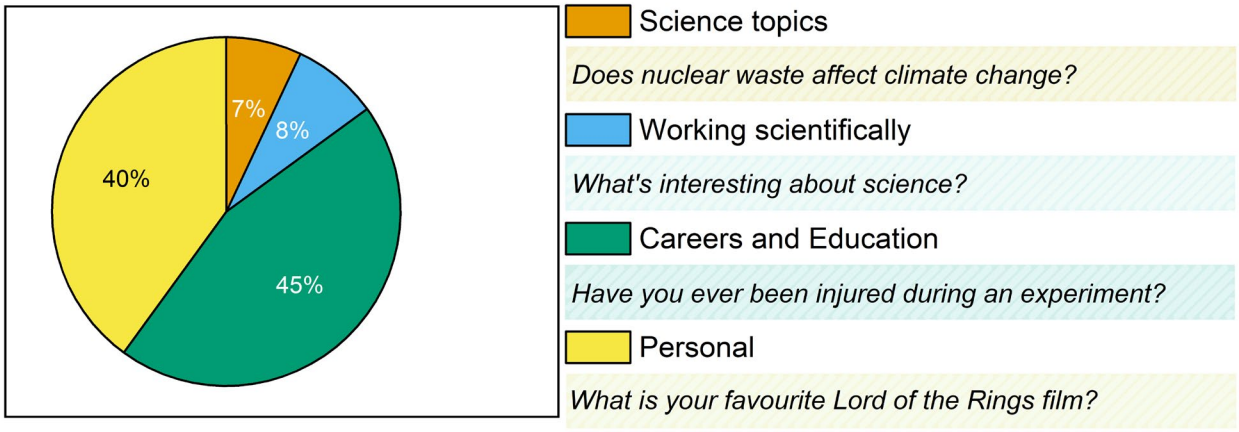

Figure 5. A breakdown of approved questions by type, with example questions shown at right.

LEARNING FROM EXPERIENCE

This project has brought together a large number of nuclear scientists, engineers and other role models with thousands of school children across the UK. The organising team are gradually building their experience of this activity and so understandably some teething problems were experienced, and these are areas of improvement for next time.

General Data Protection Regulation (GDPR)

The relatively new GDPR legislation heavily restricts the passing of contact details for new purposes, and so as a new programme, generating a database of interested individuals (both nuclear role models and teachers) has been challenging. For future continuation of this programme, this issue will be overcome by using a dedicated mailing list of teachers who are already known to be interested in nuclear STEM enrichment.

Safeguarding

The activity was moderated by a team of staff and communication between role models and pupils was at all times on the online chat room. Safeguarding training will be included as standard on future events so that all role models know the standards expected of them.

School engagement

Schools did not engage in large numbers, and there was potential for the reach of the programme to be more extensive. Coronavirus has made education in schools difficult following a series of national lockdowns, subsequently restrictions on life in classrooms have made school life difficult over the past two years. It is perhaps then understandable that the pressure school teachers have been under meant that their desire to engage in extracurricular activities was limited. There are several explanations for lower than expected engagement:

- Insufficient and untimely advertising of the available activity.
- Engagement with schools inadequate or through the incorrect channels.
- Schools were not in a position to change their planned activities.
- During December 2021 there were a very high proportion of school teachers either isolating and off work either with Covid or with a close contact. Therefore schools were having to be flexible about classroom activities, and even had to share teachers across classes during this time.

For future projects we plan to engage strongly with school teachers to establish exactly what aspects of STEM engagement activities are important to them and what can be done to improve engagement. The University of Bristol has a mailing list with a newsletter advertising outreach activities to disadvantaged schools which will be possible to use in the future given more time to arrange the activity.

FUTURE

The coronavirus pandemic has necessitated a shift away from physical in person STEM enrichment activities towards online STEM engagement, which has its benefits and drawbacks. For future continuation of this nuclear industry-wide STEM enrichment effort, it will be important to continue both online and in person engagement, because though in person visits will be more engaging, the reach of online activities is far greater, both in terms of geographical locations and numbers of interactions possible for the same personnel effort.

The online activity has provided an opportunity to collect contact details of a number of school teachers interested in having nuclear role models and STEM ambassadors visit their school in person to give a talk or show interesting exhibits to the students, and we hope to coordinate this activity across the country to enable joint participation from different organisations.

One of the main outcomes of this project has been the bringing together of different organisations in the UK nuclear industry under a single STEM enrichment programme, to realise that we are one team and that we all benefit long term from this activity which arguably is not optional both for the sustainability of skills for our industry and for the careers and zero-carbon future for school children.

Several organisations have stated that they would like to continue this STEM programme in the future, which is an excellent outcome given that sustained interaction is the best way to encourage more entrants to the industry.

CONCLUSIONS

Schools engagement carried out by the nuclear industry has been taken online due to the pandemic, which has prevented the in-person visits that used to inspire new entrants to the industry. Teachers and pupils have expressed significant interest in this form of educational enrichment, and by representing a diverse group of nuclear role models we aim to have inspired younger generations to join our industry in the future.

A particular benefit of this project has been the joining together of different organisations to carry out a single aim of promoting the nuclear industry. It is hoped that the industry-wide network built from this project will expand and sustain itself so that similar events can take place annually.

We owe it to future generations and the long term success of own nuclear industry to foster an ambition in STEM and a desire to support nuclear energy in schoolchildren. Schools engagement activities normally involve visits, which pose two problems: 1) a large time commitment for preparation and delivery; and 2) going into schools places COVID-pressure on scientists and teachers. Taking the discussion with 42 nuclear role models online mitigated these issues, whilst hugely increasing the reach of the social impact attained.

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