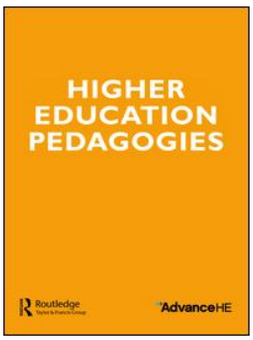

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UWE BoxED: empowering students in the 'real world' – providing responsible research and innovation opportunities through the BoxED project

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ABSTRACT

The Faculty of Health and Applied Sciences at the University of the West of England, Bristol has been piloting a schools outreach project entitled BoxED (*ED*ucation in a *Box*) since 2015. School activities are inspired from the research and teaching of our academics, and the BoxED team have developed a series of hour long activities, linked to the national curriculum, which are delivered in schools across the south-west region. Alongside the somewhat obvious benefits to school pupils, this project presents numerous opportunities and benefits for our students to develop 'real-world' skills, enabling them to successfully enter the employment market on graduating from their studies. The challenge now is to ensure the success can be built upon by securing future funding to enable a greater number of students the opportunity to engage with the project and they themselves to then develop those necessary enterprise and entrepreneurial skills appropriately, alongside their chosen subject of study – ready for the 'real-world'.

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Introduction

The University of the West of England (UWE) is a post-1992 university main campus based on the outskirts of Bristol, with other campuses based in the city centre, Gloucester and Hartpury – together they deliver undergraduate and postgraduate courses to 28,679 students (UWE, 2017a). The university is divided into four faculties, Arts and Creative Industries (ACE), Faculty of Engineering and Technology (FET), Faculty of Business and Law (FBL) and Health and Applied Sciences (HAS).

As a university that covers a large catchment area, the Faculty of Health and Applied Sciences at UWE was being increasingly asked to support Science, Technology, Engineering

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and Maths (STEM) events across the city's schools and colleges in events such as 'aspiration days', science weeks, employment fairs and similar. However, delivery by academic staff during university term time can be problematic. Even when carried out by the most willing of staff availability for STEM events can be sporadic, it may not be pitched appropriately for the target audience (deterring future engagements of both staff and/or schools), and finally is often focussed on those schools with informal connections to UWE staff. The development of BoxED (EDucation in a *Box*) was therefore designed to support UWE staff who were keen to engage in school outreach activities but were time restricted, whilst also helping staff to target their subject knowledge appropriately for the audience. The other key intention of BoxED was to widen and maximise engagements with schools by providing a 'free' resource. To enable us to do this effectively a proposed model was developed so that academic and research staff, supported by technical staff within Faculty of HAS and ACE, worked alongside each other to develop activities which could then be delivered by trained Faculty student ambassadors. The initial pilot was well received by both UWE staff and schools and sowed the seed to develop further, as a significant resource for the Faculty, to deliver outreach, widening participation and engagement. It benefited schools who are now able to more easily access inspirational STEM activities but also, serendipitously provided opportunities for university students to develop employment and enterprise skills, as well as their abilities to publically engage and communicating the ongoing research of our university staff to schools. The case study that follows is a reflection of what has so far evolved from the BoxED project for our students and the challenges we now see in making this a sustainable resource for development and delivery in future years.

Strategic rationale for implementation of BoxED

BoxED was primarily designed to reach children in their school environments; a popular site for communication or outreach activities which are aimed at young people but one which can also have its difficulties, including how to access schools, and design activities which are engaging to young people (Wilkinson & Weitkamp, 2016). However, schools based activities also offer considerable assets; teachers are often looking for content which might add value to their curricula, and from the perspective of embedding 'real' undergraduate students in those activities, school students are often keen to learn more about the individuals they are meeting, their careers and subject areas, in a personal and face-to-face way (Bowater & Yeoman, 2013).

Working with student ambassadors then offers young people an opportunity to meet students from a wide range of backgrounds and perspectives. In 2015/16, 56% of students studying at UWE identified as female, and almost 15% of students within the Faculty were from Black and Minority Ethnic groups. BoxED is therefore able, to some extent, to address concerns that school students may struggle to identify with role models in STEM, particularly amongst those students who are female, working class or from some minority ethnic groups (ASPIRES, 2017) by allowing pupils to interact with our diverse student communities.

In the case of BoxED, this opportunity offers additional opportunities to share 'real world' research. The student ambassadors are trained to deliver activities which are based on live, contemporary, science 'in the making', research which is currently ongoing at UWE Bristol and in some senses 'unfinished' but which can also offer links to the contexts provided in

school curricula. A common criticism of typical outreach, science communication and engagement activities is that they rarely present complex, incomplete or fallible science. An advantage of BoxED is that the dynamic and contemporary nature of the research, can allow for such questioning, as to how methods are being used, what might go wrong, what are the implications the science might create, both directly to researchers, or to the student ambassadors that are representing them.

This desire to frame engagement and communication opportunities earlier in the research process is currently embedded in approaches which are seeking to create Responsible Research and Innovation:

> Responsible Research and Innovation (RRI) implies that societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society. (European Commission, 2017)

Encompassed within RRI is an expectation that public engagement, opportunities to engage a range of citizens, including those that would not normally interact with each other, are important where science and technology is concerned (European Commission, 2017). Thus, BoxED provides not only an opportunity for school children to engage directly with contemporary, unfinished research albeit in a classroom setting, but also allows the next generation of science and technology researchers (current undergraduate students) to build the skills increasingly expected of them where public engagement is concerned.

Schools communication, engagement and outreach activities are not new, and nor are attempts to provide experience, placements and community relationships amongst undergraduate students and their localities (Dubetz & Wilson, 2013; Eilam, Bigger, Sadler, Barry, & Bielik, 2016; Vennix, den Brok, & Taconis, 2017; Watters & Diezmann, 2013). Where BoxED differs is in partnering up the need for undergraduates to gather experience via a 'service-learning' approach, educational approaches which combine learning outcomes with services for the community, and the opportunity to reach the next generation of pupils who may or may not have an interest in STEM.

Challenges in implementing BoxED

A significant challenge when the project was initially proposed was the need to gain the trust of academics and researchers whose work would be utilised. It was important that the BoxED team could design an activity that delivered the ethos of academics and researchers (often lifelong) work without them necessarily having to be present or involved in delivery at events. Initially, a few researchers took up the 'challenge' to work with the team to develop activities which were suitable for classroom delivery, typically within an hour, and that preferably complimented aspects of the national curriculum. It was a learning curve for both parties; researchers needed to have realistic expectations as to how their research could be presented and what was practical to delivery in a short time slots. Whilst the BoxED team needed to design activities to deliver, often in back-to-back sessions, and at an appropriate level for school pupils at each Key Stage. These initial opportunities allowed the BoxED team to build up school resources and appropriate activities to deliver to a number of primary and secondary schools in the region with great success in the first year of development. This success was measured by an increase uptake of UWE staff interacting

with the BoxED team, from 2 originally to 14 in the summer of 2017, for development of school and outreach activities.

An additional perceived challenge at the outset was the need to establish connections with schools, however, local word of mouth about the project saw a steady rise in schools requesting more activities as they began to see benefits (e.g. curriculum relevant activities to accompany their teaching, UWE students providing positive role models to their pupils). By the second year of delivery, the Faculty had up to 15 BoxED activities available to schools (see Table 1 for details) and was able to interact with over 5000 school pupils from the ages of 9 upwards in the south-west region.

An example of a BoxED activity developed with colleagues and with our external partners Health Education England, was one that was tasked with highlighting The 100,000 Genome Project and the future applications of this project (Genomics England, 2017a). This activity was aimed primarily at school pupils from 9 to 13 years of age with the intention that they grasp an understanding that a small change in your DNA code could have a significant impact on your health and well-being. The activity borne from discussions with researchers was titled 'Cracking the Genetic Code', (also known as 'Jessica's Box' as the box is built around the real-life story of a four year old girl, called Jessica who has undiagnosed epilepsy) (Genomics England, 2017b). In this activity the school pupils have to use genetic code to identify Lego® pieces that will allow them to build a 'pro-bot' (see Figure 1). If the code is correct they see that there Lego® pro-bot fits into its 'home', if it isn't it either fits poorly or doesn't fit at all. The school pupils return to their codes and compare their sequences, noticing that very few changes in the DNA code has occurred but yet their pro-bots, when comparing, can be very different. This enjoyable activity demonstrates a key aspect; that many genetic disorders can be caused by very few errors in the genetic code but can have considerable implications on someone's health. Additionally it opens up the discussion about what researchers are/ will be able to do with the data to support patients in the future and the benefits this may bring to human health. (UWE, 2017b).

Evaluation of BoxED

Thus far, BoxED has been evaluated over a number of iterations, focusing on individually funded activities or potential further development of activities beyond a specific funding phase. This has included research questions that have guided the evaluation, including a focus on how BoxED imparts information on research carried out at UWE, the role of student ambassadors, influences on university choices, and the added value offered by the activities. There are plans in future to add additional depth and detail to the evaluation activities of the project, with the creation of an evaluation toolkit (Evaluation in a Box) which will allow for a wider range of activities encompassed within the project to be evaluated systematically, whilst also drawing on contemporary research in informal learning and research communication to inform the projects practices and outputs moving forwards.

Despite the slightly patchy nature of previous evaluations, which have used mixed methods and included questionnaires with school students (n = 372), focus groups with student ambassadors (n = 8), observations of sessions (n = 8), and interviews/questionnaires with teachers (n = 14) some notable outcomes have been recorded (Last, 2016). These include activities being enjoyable, engaging and positively viewed by school staff, and 21% of (n = 78) students surveyed saying they 'hadn't considered university before BoxED but

Table 1. A list of current activities delivered and brief details included.

Activity name	Brief details of activity
Cracking the genetic code	Pupils learn how genes influence processes within human cells and the importance of this in identifying and treating diseases
Genes and inherited Diseases	Introduces the concept of genetic inheritance and the potential of gene editing as a therapeutic tool. Based on current research into Retinitis Pigmentosa (a genetic disease that causes visual impairment and blindness)
The science behind the GP surgery	An overview of the biomedical techniques used in patient diagnosis. Pupils will work with synthetic urine samples and mock case studies to diagnose patients
The problem with plastics and plankton	A look at the array of planktonic species that form the building blocks of all life on earth. Pupils will learn what microbeads are and gain an understanding of their devastating effect on our oceans and waterways
Crime stoppers – practical application	Pupils are introduced to a number of skills used by forensic investigators and opportunity for themselves to have a go
Crime Stoppers – Solving a Crime	A glimpse into the work of a forensic investigator. Pupils will help police solve an animal cruelty case
Plants vs. Microbes: an arms race	Plant disease-causing microorganisms (pathogens) and the plants they infect are engaged in an ongoing arms race. Pupils are introduced to how plants are immune and how bacteria evolve to overcome this immunity
Understanding the Human Brain	Pupils are introduce to the four lobes of the brain and what each of the functions of these lobes are responsible for
Flies do conservation too!	The aim of this activity is to improve pupils' understanding of the importance of biodiversity, the interconnectedness of nature and sustainable use of natural resources
Vader's Disease	Pupils are tasked with completing a family tree, undertaking biochemical and genetic tests to determine who in the family may be afflicted with (the imaginary) Vader's Disease
Microbial Fuel Cell Project	This activity is undertaken over 5 weeks within a school setting. Pupils set up their own microbial fuel cells (MFCs) inoculated from soil from their own playgrounds. They are charged with looking after them with the aim that the MFC, combined with their classmates, will produce enough electricity to power a small device e.g. an LED light
A Fair Test	Designed for KS2 pupils this activity introduces the skills of being a 'good scientist'. The effects of sugar and water added to yeast are measured, and terms such as 'variables' and 'control' are introduced and explained
Life under the Lens: An Astonishing Miniature World	This activity introduces the topic of microscopic life by examining the diverse array of organisms you may find in aquatic environments
Mining for Microbes	Bacteria are EVERYWHERE, including the human body. Pupils learn about the human microbiome, and understand the conditions needed to survive
Enzyme-linked immunosorbent assay (ELISA) – detecting disease.	Designed for KS5 this activity is designed to allow pupils to perform an ELISA to determine which patient has immunity to 'meningitis'
The Science of Smelling	This activity introduces the importance of smell in identifying the microbes in our mouths

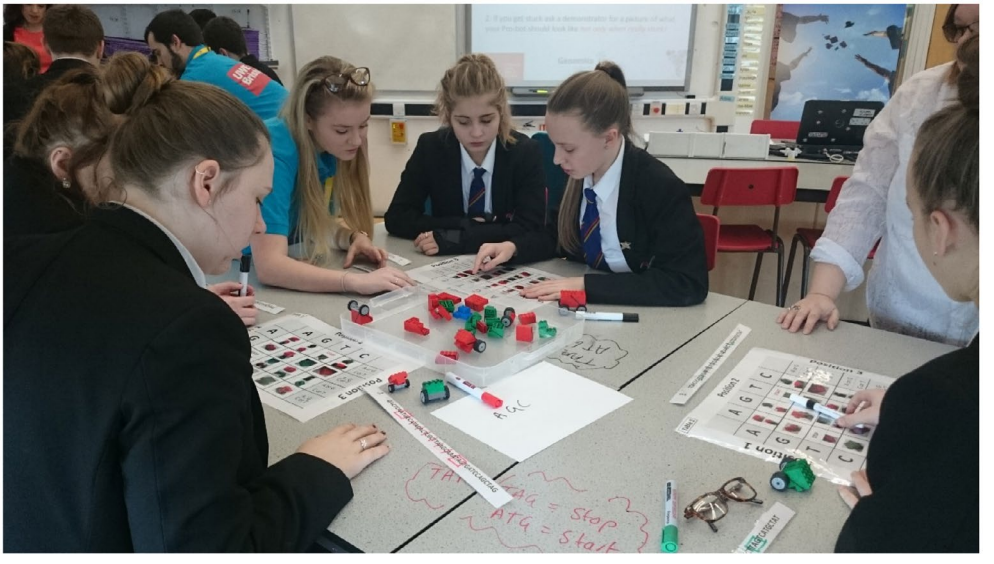

Figure 1. Student ambassadors and interns working with Year 10 pupils from the Bridge Learning Campus, Bristol on the activity 'Cracking the Genetic Code'. (*Parental permission has been gained for use of photographic material*).

would consider it now' (Last, 2016). The questionnaires covered topics including learning undertaken, views on ambassadors and researchers, as well as specific aspects of the activities themselves and the sample size of 372 exceeds number of responses required (n = 357) for a statistically representative sample. The interviews with teachers explored similar issues and varied considerably in length.

> For children of this age it has got to be fun but it's got to be real they've got to see the people and the places if it's going to have an impact in terms of them making the connection with universities. Teacher interview

All methods followed university best practice in regards to ethics. From the student ambassadors perspective (see Account 1) it is interesting to note that they are most often focussed on the broader outcomes of the activities, promoting the STEM content, making sure activities are carried out appropriately and having conversations about subject areas, rather than specifically promoting the institution or a particular programme of study (Last, 2016). Suggesting that for some student ambassadors at least, the potential of BoxED is to draw out a wider notion of science engagement, than simply for student recruitment purposes alone, an experience frequently replicated in wider surveys of researchers' vis-à-vis their motivations to engage (TNS BMRB & Policy Studies Institute, 2015).

Account 1: student ambassador perspective

> As a student ambassador BoxED has been a wonderful experience on so many different levels. It has been interesting getting to see all the different boxes being developed and given me an opportunity to learn and experience things that are not part of my degree. Also as a student, it has been fun trying to get children interested in everything from bacteria in their mouths, urine, DNA and so many other things that without BoxED they may have never experienced

> or ever shown an interest to. It's also a great feeling going back into a school that was visited months ago and having the children still remember you and get excited about what new activity you are going to show them. Over the years that I have been doing activities with BoxED I have watched as the 'boxes' have gone from filling whole cars and needing trolleys to get the activities into schools to now where a single person can carry all of the activity in one go and them only being a couple of small boxes. The only bad thing I can say about BoxED is that it wasn't around whilst I was in school. Catherine Noel, Biomedical Science student and BoxED student ambassador for three years.

Unsurprisingly, student ambassadors also feel most confident when delivering activities they have been specifically trained in, or those which relate to their own subject and discipline. From a practical perspective they rarely want to have more responsibility (for example, overall responsibility for maintaining a box and its delivery) and can experience practical and logistical difficulties, such as confidence in classroom management, and abilities to travel to a site.

Development of 'real-world' opportunities

As the success of BoxED emerged, a number of year-long BoxED Graduate Internships (see Case Study 2) were created to support the Faculty in the ever growing number of different boxes that were being requested to be devised and delivered. More importantly, it also offered an ideal opportunity to further develop employability skills, such as communication, team leadership, organisation, project management, resilience and work relationships, for some of our recently graduated students to enable them to gain necessary 'real world' experience when entering today's challenging employment market (Saunders & ZuZel, 2010).

Account 2: graduate outreach intern perspective

> I had studied at the University of the West of England (UWE) for four years prior to acquiring the role of Graduate Intern on the BoxED schools outreach program. I was a dedicated and committed student, with a broad knowledge of Biological Sciences and a passion for communication and engagement with others in order to promote the public's appreciation and understanding of science.
>
> I believe modern society places a tremendous pressure on young students to progress through the education system with little regard for 'real world' experience or applications. It is for this reason I had chosen UWE in the first instance; placing greater significance on practical work experience and volunteering than most universities, coupled with 95.6% of UWE students in full time work or further study 6 months after graduating, I knew this was the right establishment for me. I also firmly believe the trade-off between academic success and 'real life' skills will be a serious consideration for future students in the current climate of political unrest: it is becoming increasingly evident that employers require additional experience on top of a Bachelor's or even a Master's degree, and thus underlines the importance of universities supporting ongoing work experience schemes, such as BoxED.
>
> Using the internship as a platform from which to kick-start my career, I successfully established a number of working relationships with colleagues within and external to the university environment. I connected with hundreds of different organisations through attendance at Science Festivals and Fairs, careers days at schools, and local collaborative partnerships (i.e. Bristol Zoological Society, Bristol Aquarium). This networking is an extremely important

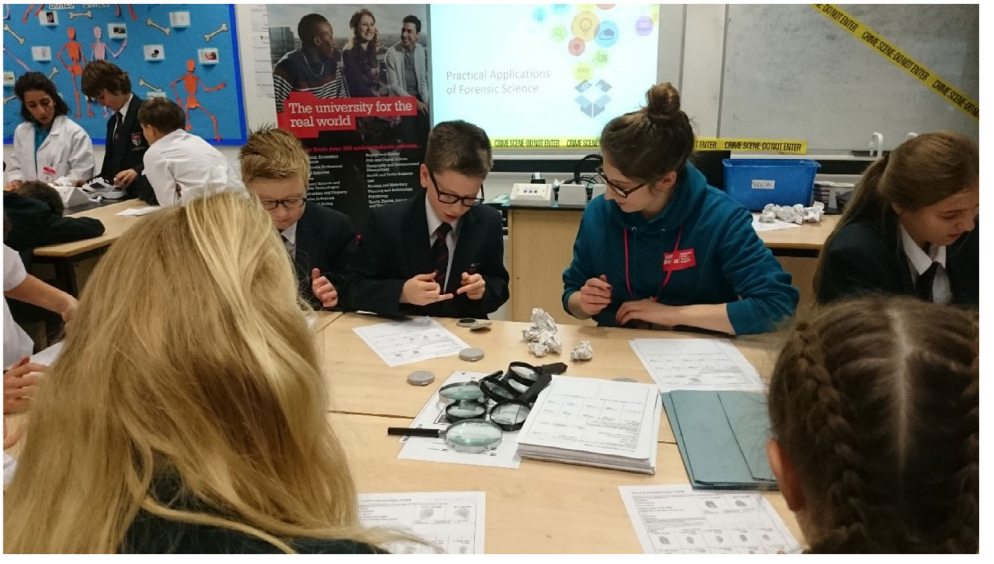

Figure 2. Katherine Bourne, BoxED Graduate Intern, attending a school event at promoting Forensic activities. (*Parental permission has been gained for use of photographic material*).

quality, often described as an 'essential' or 'desirable' skill for entry level jobs, in order to work collaboratively and promote productivity.

The scheme also offered me my first experience of management. As the Graduate Intern I had sole responsibility of a team of up to four student ambassadors pre- and during events. This involved providing extensive training that covered everything from Child Safeguarding policy to scientific expertise for specific techniques, as well as ensuring the ambassadors' needs were efficiently met during all events. This effectively introduced me to the pressures and demands associated with management, and greater understanding of building interpersonal relationships.

Due to the ethos of self-proficiency that BoxED promotes, I was given the freedom to independently design and develop school projects based on academic research taking place at the university. This enabled me to experience a feeling of 'ownership' of a project; and really empowered me as a role model for young people. In addition, I was offered a part-time place on a well esteemed post-graduate Science Communication PGCert in order to top up my communication theory alongside my practical work. I attended, and presented my own findings at multiple conferences in and outside of the UK, all on behalf of UWE BoxED. I had access to professional career performance development training, as I was now a member of UWE staff. I am very grateful for such a well-supported beginning to my professional career within the communication and engagement sector. Katherine Bourne, Graduate Outreach Intern December 2015–December 2016. (see Figure 2)

UWE BoxED acts as a conduit for students and interns to gain practical communication and engagement experience, whilst also rewarding the students for these efforts. In their final year of studies, students are offered the chance to achieve a localised award known as the 'Bristol Future's Award'; an accreditation for students that have exhibited a dedication to broadening and developing their practical experience, leadership skills, enterprise skills and global and cultural awareness via schemes such as BoxED. In order to qualify, candidates

must have experience of at least 30-h volunteering, working for the university or attending employability workshops. Alongside being paid for their contributions to university work, students can now provide evidence of these skills and confidently present them to prospective employers.

Developing BoxED as a sustainable resource

The university, and its researchers, have a responsibility to share their research with the public and are committed to, wherever possible, widening participation at the university from the local region. Funding for BoxED, has thus far come from University from funds to support these objectives. However, in periods of austerity, such budgets are often reduced and to enable BoxED to continue the project must 'think out of the box' and target other funding streams.

The nature of this case study highlights the impact the BoxED project has on our students in many ways but predominately as an employment opportunity to gain 'real-world' experience, particularly in regards to public engagement. Therefore, one avenue for future funding is to integrate BoxED into the Faculty's programmes to provide work placements, these could either be short-term summer undergraduate internships or a long-term, 12-month placement funded by internal or external sources. A number of existing undergraduate and postgraduate programmes already have placement modules which would allow such commitments to be recognised with credit. Many of our partner organisations, are also keen to engage with the public and BoxED could help facilitate these activities, supporting our partners to achieve their public engagement intentions through a funded placement which would allow them to partner up with UWE to access BoxED resources, such as equipment, expertise, school networks and large pool of student ambassadors to deliver their message more widely.

A second option, and one which we are already beginning to see some opportunities arise from, is embedding BoxED activities within larger grant applications. For instance, researchers when applying for Research Council grants may now incorporate a BoxED activity in plans for their 'Pathways to Impact', demonstrating due diligence in considering how they will communicate their work to relevant stakeholders, including the local community. As more academics and researchers (see Account 3) within the Faculty are aware of the benefits BoxED brings, we are seeing greater integration occurring within our more typical research funding applications. Increased evaluation of the BoxED activities will help to support evidence of its success for such applications, and it is also important that the direct link to researchers, also allowing them opportunities to engage alongside ambassadors, is maintained. Finally, the BoxED project, in its own right, is beginning to look at applying for grants which focus on the delivery of public engagement activities specifically.

Account 3: academic perspective

> Engagement with the public is a fundamental part of the academic role in a modern higher education institution; this encompasses outreach, widening participation and recruitment activities in addition to representing an essential part of research impact. For a research-active academic, who has engaged in outreach activities around research it was unsurprising that scientific research, when delivered well, would prove inspiring to school children. BoxED has

developed fascinating, accessible, practical resources to allow school children to engage in ongoing research projects. Aside from the benefits to the target audience, BoxED has been an overwhelmingly positive experience for the Student Ambassadors delivering the resources. In addition to the work experience benefits of being a BoxED Ambassador, students have engaged with live research projects and learned about and understood not just what that research involves, but why it is important. This is something which can be achieved through their programmes of study, but which is a key part of being a successful BoxED Ambassador. Students have also benefitted from experience of science communication in practice, which has had a positive impact on their ability to communicate science within their programme of study and for some, the experience has encouraged them to consider a greater breadth of career options. The skills students develop through delivering BoxED are important, not only in further engaging them with the research which is often integrated into their taught programmes, but in allowing them to develop into mature, confident graduates, ready and able to enter the employability market upon graduation. Dr. Gareth Robinson, Senior Lecturer and Biological Sciences Programme Leader.

The success of BoxED thus far has been phenomenal and it has exponentially grown from its humble beginnings of 'one activity, delivered at one school' to an extensive library of activities which schools can access. For others developing similar activities there are a number of key points which may be taken from the insights offered here:

(1) Plan how you will connect with schools, market to them and create ongoing links to revisit them again in the future.
(2) Design activities which are short, sharp and flexible to the school day, with easily transportable materials.
(3) Consider approaches which can embed undergraduate and postgraduate students within communication, engagement and outreach, as diverse role models for school students to connect with.
(4) Create infrastructure which can appropriately train students in public engagement, and efficiently organise practical aspects like travel and payment.
(5) Remember that students might be more attracted to participate if they can develop public engagement skills, as well as those which are more generally useful to their careers (people management, organisation, enterprise and entrepreneurial approaches) than to market the university or recruit students to programmes.
(6) Build trust and rapport with researchers, starting with a small number of good activities which can then encourage others to get involved.
(7) Encourage researchers to identify ways via which such activities can be built into public engagement plans on larger grant applications.

BoxED's success is down to the hard-work and dedication of the team, the academics and researchers who contribute to activities and the local schools adoption of the project. The BoxED team, in the main, is made up of our students, either as ambassadors and/ or internships, who have thrived in a supportive environment to develop 'real-world' skills that will, spring-board them into their future chosen careers and provide vital opportunities to develop public engagement experience. Future plans for the project include a more extensive evaluation of the activities, this will be directly focussed on how the project embeds opportunities for RRI, in addition to continuing to explore how the project influences, researchers, university students and the schools that it works with. We foresee BoxED developing further to provide increased opportunities to a greater number of students (both school pupils and those experiencing their higher education) in the years to come.

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