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Multiple Benefits of the Cell EXPLORERS Programme – a STEM Public Engagement Model in Ireland

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Abstract

In Ireland, education and public engagement goals have been integrated into higher education and research institutions' mandates and are also expected from research funders. However, in many institutions there is a lack of training or structures to facilitate these goals. The Cell EXPLORERS programme (www.cellexplorers.com) is an educational outreach programme based in NUI Galway that engages with civil society on Science Technology Engineering Maths (STEM) topics. The Cell EXPLORERS working model aims to build STEM capacity and works with a growing base of students and researchers involved as volunteers or as part of their curriculum. This working model has the dual benefit of engaging families in local schools and communities whilst facilitating the training of tomorrow's science communicators, educators or researchers in higher education institutions (HEI). The programme has followed action research approaches in its methodology to study the most sustainable way of delivering public engagement activities. It is currently studying its impact on children's perception of science and scientists, on volunteer team members' motivation for participation, as well as institutional values, support and commitment to outreach and public engagement. In parallel, it is also developing teaching and learning solutions by embedding some of its component in HEI student curriculum. The structure and organisation of the programme, its characteristics as well as preliminary findings are presented here.

Keywords: *Informal science education, Higher education institutions, Public engagement, outreach, volunteering, community-based learning*

1. Introduction

Public engagement in science is often part of HEI's mandates and expected by researcher funders [1-3]. However, despite its known benefits to both society and the researchers involved [4], Irish universities and institutes of technology have yet to develop a sustainable structure to deliver it. Many institutions mostly rely either on involvement of individuals passionate about communicating science or on marketing and recruitment strategies. In particular, initiatives that combine the education missions of HEI with public engagement in science have not been developed.

2. The Cell EXPLORERS working model

Founded in 2012 at NUI Galway, Cell EXPLORERS (CE) is a science educational outreach programme that has been designed to address this shortfall. The programme is based on the involvement of HEI undergraduate and postgraduate students, and employees (researchers, academics, technical or administrative staff) to deliver hands-on modern biology activities to the public. A unique characteristic of the programme is that students can engage in science communication and educational outreach activities either as volunteers or as part of their curriculum (Figure 1). CE has the dual benefit of engaging local communities in science, while developing desirable graduate attributes of Ireland future science workforce, and future science communication advocates, regardless as to whether or not they become educators or researchers.

By delivering interactive informal educational science activities, the programme aims to promote modern biology and biomedical sciences, combat the stereotypical image of scientist, and contribute to addressing the national shortfall of science graduates in Ireland.

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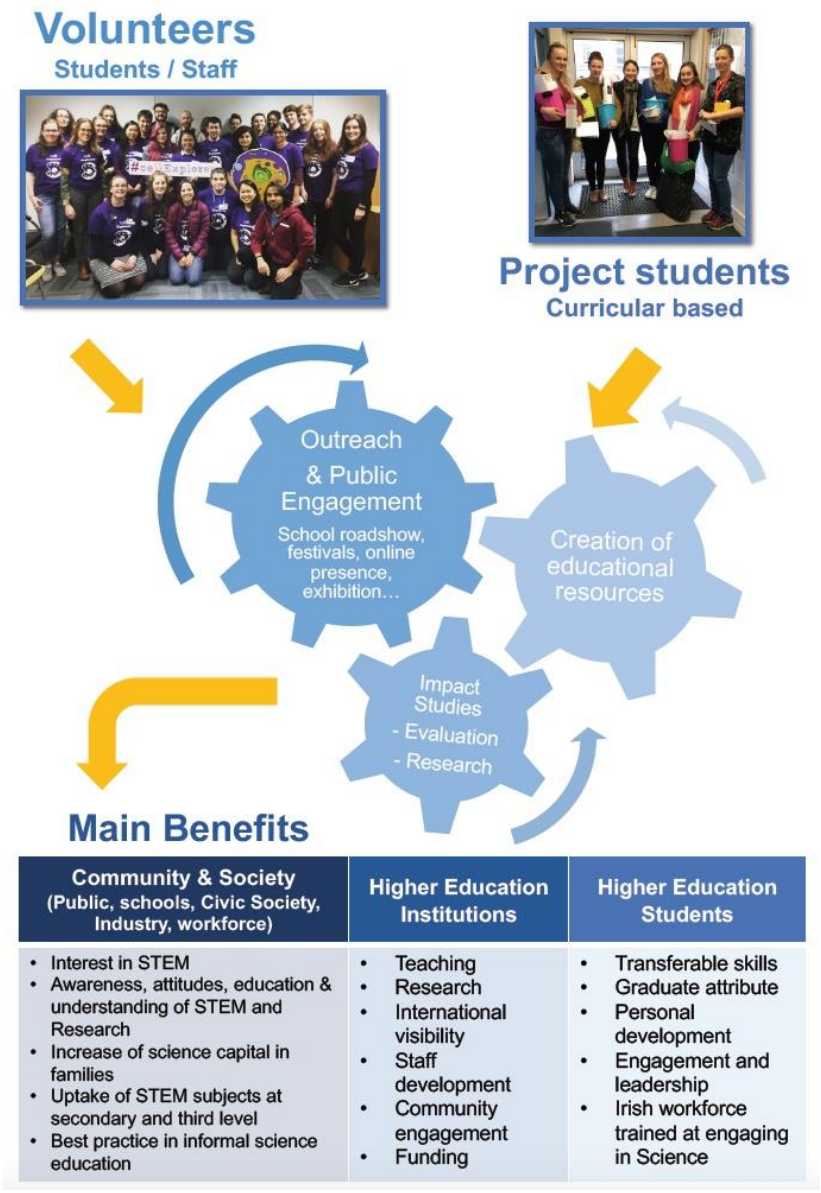

Figure 1: Schematic representation of the Cell EXPLORERS working model and its benefits

3. Methodology

CE has developed a teaching and research foundation for its development and uses an action research methodology. CE aims to identify the most sustainable way for volunteer teams to deliver public engagement in science to their local communities. It is also developing third level teaching and learning solutions by embedding some of its components in the student curriculum. Both the volunteering and curricular aspects have been revised and improved following the results of this research.

Data is collected from CE team members or community representative engaged by the programme. Team members (volunteers and curricular students) and partners complete pre- and post-involvement surveys, anonymous and independent offered online through Survey Monkey to investigate their motivations, expectations and experience. Printed questionnaires are distributed to teachers and children of the classrooms visited, or participants to public workshops, to anonymously collect opinions on session design and delivery as well as potential impacts of CE activities.

4. Public engagement in science by volunteer teams

4.1 Characteristics of Cell EXPLORERS interventions

The majority of CE informal science educational activities to young people and their families are facilitated by a large volunteer team disseminating a school 'roadshow' or workshops at public festivals (Figure 2). These volunteers bring engaging science activities and information on science careers to children at an age (10-14 years old) when they make decisions about their interest in STEM (primary school age) or make their choice of STEM as a career (secondary school age) [5].

Activities are hands-on and based on real-life science, with small groups facilitating one-to-one interactions following best practices to maximise learning [6]. Often these conditions cannot be replicated by teachers, due to lack of time, resources and/or confidence in the area [7].

In addition, using a diverse team of science role models addresses unconscious biases and debunks the 'brainy' image of scientists [5,8,9]. The participation of HEI students provides positive role-models of real individual studying science locally at 3rd/4th level.

Figure 2: 2017 CE activities in Ireland

4.2 The volunteering team

Since its creation in 2012, approximately 800 HEI volunteers have contributed to reach directly 21600 members. Since 2015, the programme has established volunteer teams in 10 HEI nationally, some of them in areas of low STEM interventions [10], each targeting their local communities. The volunteers are recruited at the beginning of the academic year. In 2017, 253 team members have run 50 events to reach more than 6800 people.

On average, the team is made of 70% of students (70% females), with slight variations between teams and years. Taking part in the programme is often described as a unique opportunity and the highlight of the university year.

"It's my favourite thing that I do as part of university" *Volunteer, 2016 CE team*

Evaluations of volunteer's involvement showed that the programme and its organisation suit team members. They reported both development of transferable skills and undergoing personal development. Details on motivation and benefits to team members will be described elsewhere.

4.3 Impact on school children

In 2017, the CE national school roadshow had a total reach of 63 schools, 108 classes, 2704 children (of whom 2430 in their classroom) and 108 teachers.

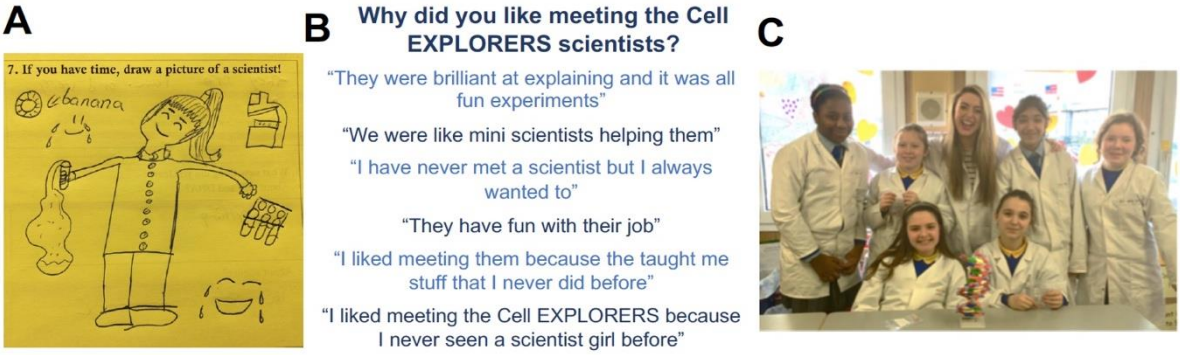

Figure 3: Meeting CE scientists in the classroom – Feedback from 2016 school roadshow. A/ 'Draw a scientist' child feedback. B/ Examples of statement given by school children as reason for liking meeting CE scientist. C/ Picture of a CE team member with her group.

Specifically, the teams reached 9 of the 13 Irish counties identified as having low levels of STEM intervention [10]. Interestingly a large number of the children visited, 60% in 2016 and 40% in 2017, have never met a scientist before the CE visit. This experience is reported as positive by more than 95% of the children. Children's justifications highlight how CE science role models contribute to change the image of scientists in young people's mind: they are seen as fun, kind and helpful, they can be girls, they are good explainers and they enjoy their jobs (Figure 3).

5. Curricular involvement of HEI students in science educational outreach

5.1 General description of research projects

CE aims to engage the public using informal science education activities that have been developed by its team members, are relevant to the research work performed in HEI and tailored to a given public. Early on, it was clear that volunteers would have limited time to develop new resources. Therefore, to support CE sustainability, a novel format of science outreach final year project was created to facilitate the design of new activities by undergraduate science students as part of their curricula.

A community-based learning final year module benefitting both final year students and community partners was created (Figure 4A). Students produce educational outreach resources for CE or other community partners and pilot them within schools. The students are guided through the project by a structured programme of workshops and seminars covering outreach and science education concepts and evaluation. These are then piloted within the community, evaluated and revised by the students.

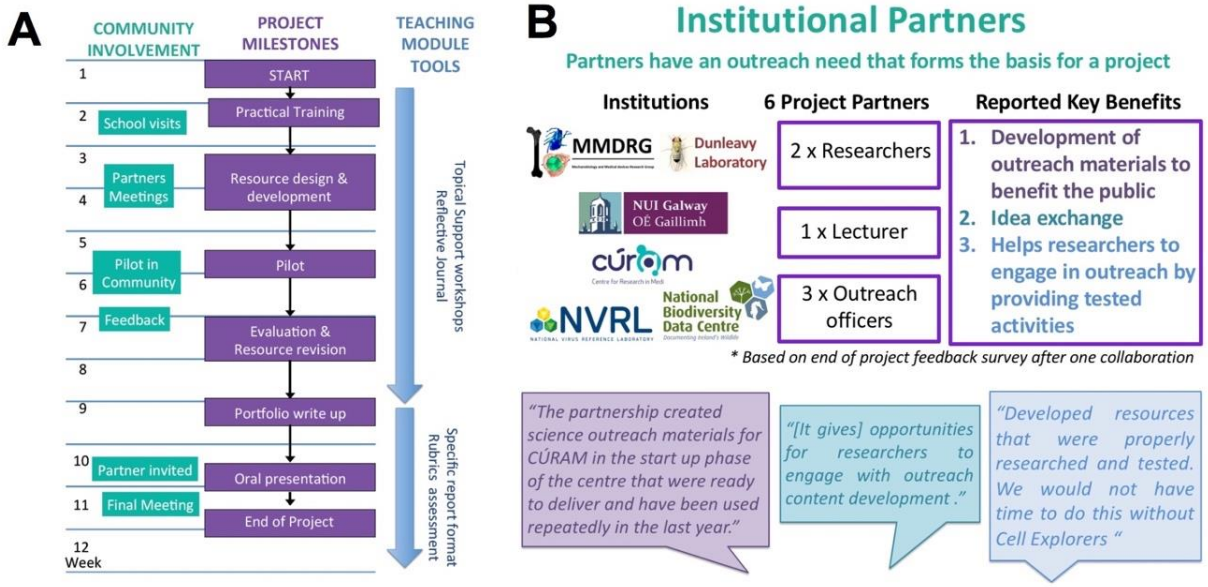

Figure 4: Education science outreach community-based learning module.
A/ Schematic of timeline and project content. B/ Benefits to 2015-16 and 2016-17 institutional partners.

5.2 Benefits to the final year undergraduate science students

Forty-nine students from final year Biochemistry, Microbiology or Zoology, age ranging 20 to 24, have undertaken these research projects in 5 years. 70% of these students chose to be involved in their project, illustrating the appeal such projects have on students who do not have laboratory-based career aspiration. Students and external examiners responded positively to the structure of the module and the teaching tools used. Student's most often reported liking the 'Working with children & outside organisations', 'Working in groups' and the 'Creativity' aspects of the course, which are also the key opportunities given by the projects, which differ to laboratory-based projects. Educational outreach students categorised their projects as being 'hard work', 'enjoyable' or 'worthwhile' but never 'boring' or 'easy'. This was similar to answers obtained in a cohort of laboratory-based project students. Finally, all students perceived gaining a range of desirable graduate attributes including communications skills, speaking in groups or working as a team. The detailed evaluation of the module will be reported elsewhere.

5.3 Benefits to the community

These projects have not only involved partnerships with CE but also with schools, educational entities, science festivals and research centres. To date, it has resulted in 46 resources produced and a reach of 1800 young people through project training/pilot visits or reuse of the resources. 70% of the resources produced this way are suitable for reuse with 24% of them effectively reused by CE, validating the module as a way of generating quality original educational material. Institutional and school partners report (Figure 4B) that involvement with the projects has had the key positive benefits of supporting researchers in disseminating information on their research work, providing role models of real people involved in science, strengthening connection between community and the university, and changing the public's perception of science.

6. Conclusion and future work

Volunteering and curricular involvement of students to deliver public engagement in science is being used by the CE programme with success. These approaches, underused in Ireland, have been explored in the UK [11] by several HEI. However, to date we are not aware of any programme that has scaled up to a national network or has combined both to deliver sustainable public engagement in science.

Further study of the CE working model at a national level could lead to the adoption of the model by HEI nationally and its use in STEM topics other than biology. The programme is also researching specific questions such as whether there is an impact on children's self-efficacy in science and their perception of science and scientists, whether it impacts on volunteer team members' motivation for participation, or on institutional values, support and commitment to outreach and public engagement. This research could directly impact the dissemination of science education and public engagement activities in Ireland.

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