



SwitchOnSTEM.ie Resources to Support Higher Education Engagement Activities

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Abstract

This paper outlines the roll-out of a project called SwitchOnSTEM.ie that aims to enhance Irish Higher Education (HE) STEM engagement with second level pupils. Through providing freely available all-in-one resources for hands-on activities that can be used by HE staff and students at STEM events, it aims to remove barriers to participation in STEM engagement. The project was funded by Science Foundation Ireland's SFI-Discover programme in 2015.

An interdisciplinary STEM team from five Higher Education Institutions in Ireland was formed and initially collaborated with a more experienced UK based HEA National STEM Project funded researcher. Together the team designed high quality activities with a hands-on focus, across the full range of STEM disciplines. They were directed and supported in these endeavours by an experienced Science Communicator who was employed onto the project as a developer and who also had a role in creating the supporting resources to accompany the activities. Each resource includes equipment and consumable lists, an instructional video as well as a manual/operating procedure, safety information, and technical information explaining the science whilst linking it to the Irish secondary school curriculum. All materials were packaged into a multimedia file and hosted through a dedicated, extensible, SwitchOnSTEM.ie website. The website also acts as a landing site with links to other useful STEM engagement resources. The presentation will showcase some of these activities and direct the audience to the others.

The project evaluation involved pilot events at two Dublin secondary schools, and included appointing 15 demonstrators unrelated to the project to run the activities. Evaluation involved online surveys to determine the pupils' sentiments towards the activities (N=200), before/after paper-based surveys to ascertain student learning from participation in the activities (N=40), and feedback from the activity demonstrators. The presentation will conclude with the outcome of this evaluation, and the changes made to the resources based on the results.

1. Introduction

The aim of the SwitchOnSTEM.ie project was to enhance Irish Higher Education (HE) STEM (Science, Technology, Engineering, Mathematics) engagement with second level pupils through providing a complete set of freely available resources for hands-on activities that can be used by HE staff and students at engagement events, thus removing barriers to participation in STEM engagement. The Irish National Strategy for Higher Education explains the role of engagement as the means by which the higher education system addresses all of its responsibilities towards society, including the wider education sector [1]. Meanwhile, Science Foundation Ireland (SFI) recognises that an engaged public is one that understands the role of science, can judge between competing priorities and arguments, and encourages young people to take science, technology, engineering and maths (STEM) subjects [2] in secondary school. SFI's Discover programme seeks to promote the awareness and engagement of the Irish public with science, technology, engineering and maths (STEM) with the objective of having the most engaged and scientifically informed public.

1.1 Context and rationale

SwitchOnSTEM.ie, funded through SFI Discover, aimed to enhance current STEM engagement events through the development of resources to support interactive engaging STEM learning activities that would bring STEM to life through providing every-day and global perspectives on concepts introduced in the classroom, encouraging pupils to think more widely about STEM applications, programmes of study, and future careers.

Initially, the project was proposed by members of the DIT Science Promotion and Recruitment Taskforce, who are charged with organising DIT STEM engagement events such as at the DIT Open Days, Science Week in DIT, school visits, and the SciFest science fairs - SciFest@College [3]. It was recognised that SciFest, particularly, provides an excellent opportunity during the two-hour break



between judging of entries and the award ceremony to further engage second level pupils who have already demonstrated an interest in STEM. However, barriers to using very interactive activities during the break include lack of staff time to develop or adapt ideas, and lack of appropriate equipment. It was agreed at the annual national SciFest@College coordinators event to create a network of experienced practitioners across Ireland and beyond who would together create an online resource supported through a dedicated website that could be used by all Higher Education Institutions (HEIs) for the purpose of enhancing engagement and furthering the STEM agenda.

2. Implementation

2.1 Objectives

The project was implemented through the following objectives

- Relationship building leading to cooperation with a highly experienced UK HE STEM Outreach project leader, Dr. Alison Hooper, who has led a national project across several UK Institutes into 'Constructing a Coherent STEM Strategy for Schools'.
- Formation of an inter-disciplinary team of lecturers and other staff working in the area of STEM Engagement across several IOTs in Ireland.
- Planning seminar and brainstorming workshop with all collaborators and an invited speaker from the Royal Society of Chemistry.
- Employment of an experienced Science Communicator with excellent IT skills to work with the team on the development of high quality activities that focussed on an engaging experience through hands-on student learning and linking to the Irish curriculum.
- Development of resources to support the activities, including equipment and consumable lists, an instructional video and a manual/operating procedure, safety information, technical information explaining the science, student worksheets, and high-quality videos created with the support of the DIT Telematics service.
- Employment of professional graphic designers to develop the project logo and merchandising, including banners, t-shirts and pens.
- Employment of a web designer to create an extensible SwitchOnSTEM.ie website to host the activity resources, as well as links to further resource sites, links to SwitchOnSTEM.ie social media, a dedicated area for pupils.
- Evaluation of the resources through involving more than twenty DIT postgraduate students at pilot events at local secondary schools.
- Reporting and dissemination the outcomes of the project.

2.2 Activities

The activities developed are outlined in Table 1. Further information is available at SwitchOnSTEM.ie

Table 1. SwitchOnSTEM.ie activities

Name	Main STEM area	Learning outcome
Platonic solids	Mathematics	Pupils learn about geometry by constructing models of 3D shapes
Bean machine	Mathematics	The bean machine activity demonstrates the normal approximation to the Binomial Distribution, which is important in probability and statistics
Robot code	Technology	Pupils are introduced to the basics of programming, including simple instructions and basic loops
Binary numbers	Technology	Pupils are introduced to binary numbers which are at the core of how every computer stores and sends information
Engines, power and motion	Engineering	Pupils explore how stored energy can be converted into kinetic energy using simple engines



Electronic inventors	Engineering	Pupils explore the possibilities of developing creative ideas with electronic components without requiring any specialist skills or knowledge of electronics
Electrostatic magnetism	Engineering	Pupils explore the forces of electrostatics and magnetism and learn about their practical application in the generation of electricity
Chemistry of Smells	Science	Pupils explore the relationship between volatile molecules, organic chemistry, and sense of smell
Chemistry of the Nanoworld	Science	Pupils explore the specific properties that arise with particles that are at nanoscale

The videos to accompany these resources were filmed in the DIT Telematics suite, and involved DIT students as actors.

2.3 Pilot events

The above activities were piloted at two events held during Science Week in November 2015 in two secondary schools in Dublin.

The first was Colaiste Phádraig, an all-boys school in Lucan, Co. Dublin. It was conveniently selected based on on-going engagement between the school and DIT through annual DIT staff visits for Science talks. The second was Larkin Community College, a co-educational (mixed gender) school based in Dublin's inner city. This school has links with DIT through its DEIS status (Delivering Equality of Opportunity in Schools) and involvement with DIT's Access to Education and Widening Participation strategies.

In advance of the pilot days, postgraduate students were recruited to run the activities through an open advertisement to all postgraduate students registered in DIT. While the activities were not in the field of research for most of these postgraduate students, they were matched to their discipline area. The postgraduate students were provided with the resources to review in advance of the event and prepare for the event. Since they had no prior knowledge of the project their feedback on the resources proved valuable as part of the evaluation process,

In advance of the event, the school was informed about our logistical requirements. We also requested that a range of secondary school pupils be invited to participate, from all ages and abilities. The schools facilitated our evaluation by bringing each cohort to a computer room to complete a post-event sentiment analysis evaluation form. Additionally, they selected a number of pupils to complete our before/after learning evaluation form.

On the day, each demonstrator was given the box of equipment for their activity, and based on the SwitchOnSTEM.ie resources, proceeded to set up their stands, which were organised at tables around the perimeter of a large hall.

The participants were organised into small groups using stickers for their sweater bearing the name of a famous scientist for each group. A schedule of activities for each group was posted on a large white-board. Once the activities commenced, they were allowed to run for about 10 minutes, after which a whistle was blown and the groups rotated to their next activity. Each pilot day consisted of three sessions and each group managed to rotate through about six of the activities. In all, more than 300 pupils participated over the two days.

2.4 Evaluation

The evaluation was broken into three categories:

Evaluation 1 - Sentiment: The opinions of the target audience, namely second level pupils, of the activities they have undertaken. A GoogleForms based validated survey from a UK HEA STEM project was adapted for use. The sentiments investigated in relation to each activity were -

1. I found out something I didn't know
2. I found it interesting
3. I could see connections with STEM subjects at school
4. Made me want to find out more
5. I had fun



The method was limited because we believe that in some cases pupils who did not complete the activity still answered the questions relating to the activity, choosing neither agree nor disagree.

Evaluation 2 - Learning: The learning arising from participation was captured using before/after anonymously coded paper based surveys. These were designed in the form of short questions relating the theory associated with the activity learning outcomes. A selection of pupils from a range of ages, abilities and gender were chosen to take part.

Evaluation 3 – Resources: The suitability of the draft resources to determine how clear, user-friendly, and appropriate they are was determined by a survey of those running the activities. A mixed survey containing quantitative and qualitative questions was used to gather feedback to allow the final version of the resources to be completed for the SwitchOnSTEM.ie website.

2. Results and Discussion

The sentiment results for each activity have been summarised in the radar graphs in Figure 1 below. As mentioned above, because pupils not participating in a given activity may have opted for the 'neither agree nor disagree' response in the survey, we decided to focus attention on comparing the positive (agree and strongly agree) against the negative (disagree and strongly disagree) data. These have allowed us to collectively and individually review the activities under the main themes of the sentiment study.

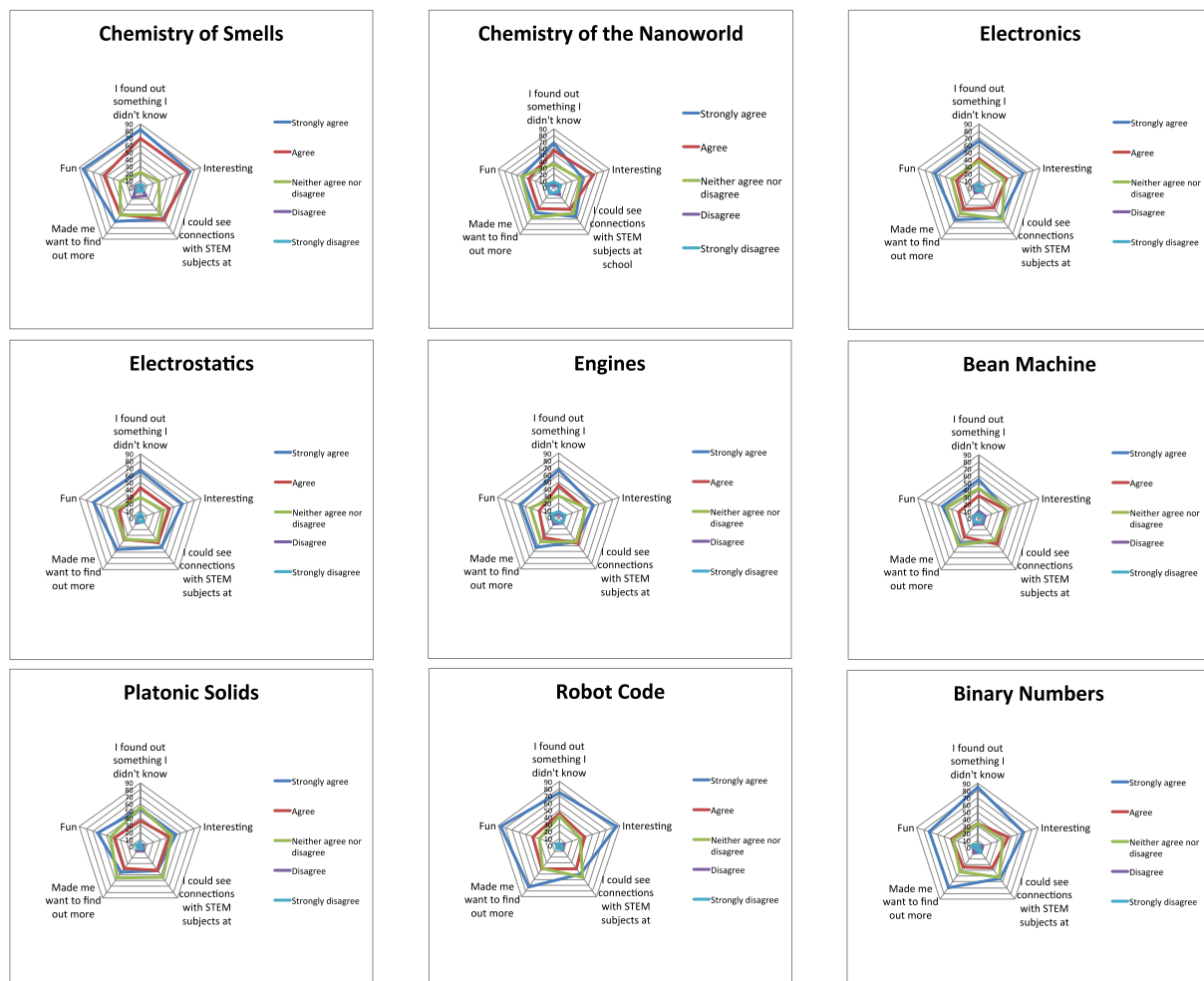


Figure 1: Results from sentiment evaluation (N=200)

When taken collectively, the findings show that the overall sentiment towards attending the event is significantly positive. None of the activities were deemed to be negative across any of the sentiment categories. The activity 'Binary numbers' ranked most highly for finding out something they didn't know. The 'Robot code' activity was considered the most fun, the one they wanted to find out more



about, and also the most interesting along with the 'Chemistry of Smells'. Most pupils could relate all activities back to the school curriculum.

The data from the evaluation to determine if any learning took place as pupils engaged in the activities was somewhat difficult to analyse. In many cases the questionnaire was not fully completed, or 'spoiled' by the teenage behaviour of some of the older pupils in the sample set. However some clear trends emerged. Learning outcomes relating to the Chemistry of Smells, the Robot coding, Binary numbers, and the Chemistry of the Nanoworld appeared to generate new knowledge for many pupils, drawing on new topics, and they showed a good interest in demonstrating this in their post-event answers, regularly mentioning volatility of aroma compounds, explaining loops in coding, correctly translating numbers to the binary system, and explaining ferrofluids and nanoparticles. Meanwhile, there appeared to be more initial knowledge in the areas relating to circuits, engines, forces and magnetism and probability. In these cases pupils were able to demonstrate some prior knowledge, even if not always completely correct, but also were able to build on this knowledge, for example expanding on the type of components used in circuits or illustrating the binomial distribution in the after-evaluation.

On the whole, there is an element of subjectivity limiting both student evaluations, depending on the dynamic within the group of pupils themselves, as well as with the demonstrator, along with the natural communication ability of the demonstrator. Nonetheless, all pupils reported through both evaluations that they would recommend the event to other pupils.

The responses from the evaluation of the activities and supporting resources themselves by the demonstrators showed that for the most part they were fit for purpose and allowed the demonstrator to operate the activity independently. Several constructive comments in relation to the logistics of running an activity, the usefulness of the student worksheets, and the requirement for more background information to address the most frequently asked questions from the pupils helped us to improve the resources before publishing them.

3. Conclusions and Future actions

The project was successful in generating resources to support interesting, fun, and educational hands-on activities for use in STEM engagement events. The prospective impact includes improving not just the quality but also the number of engagement events, through supplying readily available complete activities.

Clear instructions on how to contribute to the website are provided, and additional potential impact includes the provision of a vehicle for use by researchers to communicate their work. Postgraduate students showed great enthusiasm for participating in a Science Communication event and developing graduate attributes including communication skills. We expect SwitchOnSTEM.ie will be sustained and expanded through further development of resources, for example as part of their outreach duties, and by undergraduate students as part of research projects.

SwitchOnSTEM.ie will also be supported through an active social media community for participants. Pupils who participate in the activities will be invited to post their experience, or simply to *like* where appropriate. This is intended to bring young people together to exchange ideas about STEM in a fun way, and hopefully contribute to the aim of having a scientifically literate population.

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