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A Review of STEM Promotional Initiatives and Activities in Ireland

Marie Walsh
Limerick Institute of Technology (Ireland)
marie.walsh@lit.ie

Abstract

The Rocard Report [1] examined the then state of science education in Europe and made a number of recommendations to improve both the quality and uptake of science subjects in school. Recognising the pace of change of science and technology, and the need for promotion of scientific literacy among the general population, the report advocated a change in didactic styles from deductive to inductive. Curricula have undergone reviews and developments in response to this and other reports, both in Ireland and internationally, which have addressed the needs of society and of industry in regard to STEM education. This paper will review some of the responses of curriculum developers to the demands of the legislators and of industry. One point of focus will be Inquiry-based science education, with a brief survey of projects at a European level. It will also look at subject specific initiatives to engage students and promote science subjects for lifelong learning, such as competitions and science fairs.

1. Introduction

Attempts to analyse student motivations toward learning have distinguished between what students want and what motivates students in the classroom, concluding that an important factor is whether students care about or think the task is important in some way. [2]

Recent studies have considered the generation and maintenance of interest in STEM as a motivational factor. [3] Science education in Ireland has been hailed as a potential route to lifting the country out of economic gloom. Common sense tells us that the transition from the 'magic' of Science as an investigative, inquiry-based curriculum at primary and lower secondary level to the theory-laden subjects that have been characteristic of upper secondary level can only be de-motivating for some students. However, pedagogical constructs can elevate science education to provide a solid foundation for lifelong learning, within the limits of the students' motivation to learn science. [4]

A number of initiatives over recent years to promote STEM subjects in Ireland, appear to have had a positive impact on the uptake of Science subjects at both second and third level. Dr. Graham Love, then Director of Discover Science and Engineering said: *"Today's students are very savvy and are taking into consideration the areas where the best career opportunities lie. It is encouraging to see the higher uptake of students who have been offered and will undertake technology and science courses this year. There is a growing demand for graduates in these areas as they continue to thrive in Ireland and working in these industries offers graduates vast and exciting opportunities."* [5] [6] Perhaps this is a response to initiatives like the Chemical and Pharmaceutical industry's *Hearts and Minds,* a strategy to ensure wide appreciation of the benefits the sector brings to Ireland. [7]

Discover Science and Engineering has evolved into SFI Discover (Science Foundation Ireland) and this organisation is particularly pro-active in promotion of increased appreciation of and research informed initiatives in promotion of STEM subjects. Its current initiatives and proposed programmes are described in its SFI Agenda 2020 *Excellence and Impact* Strategic document. [8]

One key aspect of the Rocard Report was its promotion of the role of Inquiry-based science education as a means of revitalising the appreciation of STEM as a tool for lifelong learning. [1] It advocated that 'A reversal of school science-teaching pedagogy from mainly deductive to inductive, inquiry-based methods provides the means to increase interest in science'.

2 Science in Irish curricula

2.1 Science in Primary and early Secondary years

Science in primary school is part of a spiralled stream called Social Environmental and Scientific Education. Science at lower secondary level is presented as a single Junior Certificate subject with three distinct sections, Chemistry, Physics and Biology. While Ireland is unique among 21 European nations in that Science is not compulsory at lower second level, up to ninety per cent of students study this subject. [9]

In October 2012 the Minister for Education unveiled reform plans in which existing science and technology subjects will be retained but will be updated to reflect the new programme. Inquiry-based learning will underpin elements of the coursework. From 2016 standardised testing in Science will also be included for all students to provide a clear indication of the student's progress in the middle of the junior cycle programme. One study has looked at students' experiences of science in the first year of post-primary school and its findings revealed broadly positive attitudes towards post-primary school science, especially the experimental work that is at the heart of the curriculum. However, it would appear that students were not conducting open-ended investigations or using information and communications technology (ICT) to any great extent; moreover, there was some evidence of traditional didactic teaching methods being utilised. [10]

Transition Year is an optional year where students get a 'taster' of various subjects. Science delivered in this year is usually in the form of short modules with attractive titles, e.g. Cosmetic Science and Forensic Science. Few teachers have laboratory time for all of their science classes during Transition Year. [11]

2.2 Science in Upper Secondary School – in reform status

A new draft syllabus for each of the main science subjects - Chemistry, Physics and Biology - at senior cycle has passed through an extensive consultation phase and is now being prepared for roll-out. The proposed new syllabii will see the introduction of a practical component in the assessment procedures. A final component will be a written exam worth 80%. [12] The proposal to give value to practical work suggests that the new syllabus will be more 'active' for the students Research has shown a positive correlation between the use of ICT and academic performance. The reported benefits are gains in student achievement, increased student motivation, improvements in students higher order thinking and problem solving abilities and the development of students ability to work collaboratively. [13]

2.3 Inquiry-based Science Education (IBSE) as a motivational factor

One description of Inquiry is, '*the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments'*. [14] Inquiry Based Education is especially important when teaching STEM subjects. IBSE is a very flexible approach, in terms of implementation. IBSE education provides a window to engage in relationships with stakeholders of formal and informal education such as researchers and scientists, firms, parents associations, etc. A number of EC-FP7 projects promote an IBSE approach. Examples include: PROFILES, SAILS, Pathway, Fibonacci, ESTABLISH, TEMI, CHAIN REACTION, etc. [15]-[21]

3 Government Responses to the Issues with STEM

3.1 STEM Education Review Group

In November 2013 the Minister for Education and Skills commissioned a STEM Education Review Group. [22]

The Review Group recognised that a number of important STEM initiatives were already under way or were well-established and that other potentially important developments were evolving (such as Junior Cycle Reform). The STEM Review Group decided to focus on the following key areas:

- The preparation of teachers (at first and second Level) for STEM education

- The best methods of supporting the current cohort of STEM teachers within the system, with a particular focus on comprehensive and sustained continuing professional development (CPD) programmes.
- The introduction of new teaching and learning modalities that would enhance STEM education in our schools and for which there was a strong evidence base (such as inquiry-based and problem-based learning approaches, and new assessment modalities).
- The use of technology to enhance learning (especially digital and/or online approaches).
- The promotion of STEM careers and the identification of methods to enhance the engagement of students in STEM subjects.

In tandem with the work of the Review Group, the activities and mission of Science Foundation Ireland (SFI) were being reviewed and consolidated.

3.2 Science Foundation Ireland – SFI Discover

The purpose of the SFI Discover Programme is to support and develop the education and outreach science, technology, engineering and mathematics (STEM) sector in Ireland by investing in developing and extending capacity in this area and also exploring and encouraging novel means of public engagement and communications.[23] The work of SFI Discover is crystallised in its *Science Foundation Ireland Strategic Plan Agenda 2020* "Science and technology play an increasingly important role in addressing the economic, social and environmental problems faced by the world today. That role needs the support and active engagement of the public who fund the work and are the ultimate beneficiaries of it. An engaged public is one that understands the role of science, can judge between competing priorities and arguments, encourages young people to take science, technology, engineering and maths (STEM) subjects, and feels that is has the appropriate level of engagement with, and influence upon, the researchers. SFI, as the primary investor in scientific research in this country, must form a strong relationship with the Irish people, built on trust." [24]
Its activities include web resources, a careers portal, science ambassadors and active programmes like Among the programmes operated by SFI Discover are: Smart Futures, Science.ie web portal, Discover Sensors, Science Week Ireland, Maths Week Ireland, Discover Primary Science and Maths, CanSat and Greenwave.

3.3 Supporting Teachers through Continuous Professional Development

Initiatives like the establishment of the National Centre for Excellence in Maths and Science Teaching & Learning (NCE-MSTL) are attempting to bridge the gap between science and maths education and research and the classroom. The Centre also appointed Ireland's first Chair of STEM Education, Professor Sibel Eduran, in 2014. [25]
Science teachers have been supported for some time by the Second Level Support Service (SLSS), which is now under the umbrella of The Professional Development Service for Teachers (PDST). This offers induction and continuous development training at a local and national level. [26]
The Junior Cycle for Teachers (JCT) for Science are currently preparing to deliver CPD in collaboration with the PDST.[27] With regard to the implementation of IBSE a number of guidelines have evolved: take into account the teachers' existing beliefs and practical knowledge; enhance teachers' Content Knowledge, Pedagogical Skills, and knowledge about inquiry' be consistent with school's practices and general reforms of science education; provide opportunities for designing new activities or adapting existing ones provide opportunities for testing the activities with students and for peer collaboration; provide long-term support with the use of new technology.

4. More than STEM at school – opportunities to experience STEM extracurricular activities

4.1 Science Fairs

In most countries, science-related extracurricular activities at school are related to better student performance, a stronger belief by students in their abilities to handle science-related tasks, and greater enjoyment of learning science.
Throughout second level Irish students can become engaged in the inquiry-based approach to STEM by participating in events like the BT Young Scientist competition, SciFest, Salters Festivals

of Chemistry and other local initiatives. These are usually well-supported by industry, as are countless local initiatives like workshops, science magic shows, interactive lectures and industrial visits.

The BT Young Scientist & Technology Exhibition has run for fifty one years and the number of entries has increased, reaching an all-time high in 2015 when over 2000 projects were submitted. All entries were screened to select just 550 projects to go through to compete in the RDS. The event attracts over 40,000 visitors to view the exhibits, making it one of the largest events of its kind in Europe. [28]

SciFest is a series of one-day science fairs for second-level students hosted locally in schools and at regional level in the Institutes of Technology. The projects are evaluated by an expert panel of judges from academia, enterprise and government. The SciFest events have been run annually since 2008, and in 2015 1562 projects were exhibited by a total of 3586 students from 239 schools. [29]

4.2 Science Week

Science Week is promoted annually in November and attempts to engage all sectors in appreciation and understanding the importance of science. The theme changes every year but a key objective of Science Week is to inspire young people to take up studies and careers in the STEM disciplines. 2015 will see the twentieth such week, with at least 800 events taking place across all parts of Ireland, and activities to engage all ages and educational levels in the wonders of STEM. [30] There are also dedicated weeks for Mathematics and Engineering promotion.

4.4 Promotion of STEM careers: Smart Futures

The SFI Discover *Smart Futures* initiative is aimed at increasing by 10 per cent uptake in these subjects by 2016. [31] It aims to raise awareness of career opportunities in this area by encouraging industry to play an increased role. Specific measures include: building a database of volunteers to deliver Stem career advice to secondary schools throughout the country by training over 450 people from STEM industries and SFI research centres by 2016; offering industry opportunities to participate in more student outreach activities; highlighting exciting career opportunities in industry to help challenge stereotypes associated with people who work in Stem; supporting students and parents in decision making related to Stem careers and further study; monitoring targets for increased participation by industry, increased numbers of students and schools involved, and increased numbers of careers roadshows.

Conclusion

In January 2015, SFI announced that it will provide funding of €1.6 million for STEM educational and public engagement projects in Ireland in 2015. The funding, delivered through SFI Discover, will support 39 initiatives designed to encourage participants to develop an active and informed interest and involvement in STEM. By the end of 2015, it is estimated that over 4.5 million people will have engaged with the various projects.

This latest round of initiatives shows that considerable imagination is being put into new, and more inclusive ways of engaging students in STEM. This review has only considered a portion of the initiatives at a national level, but there are many projects and events at local level as well as national that would form part of a longer paper.

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