



Space Science: A Vehicle for Education and Engagement in STEM – A Review of Current Initiatives in Science Education in Ireland

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In September 2016 a new syllabus for Junior Certificate Science [1] was introduced to Irish secondary schools. There is one unifying strand on Nature of Science and four interlinked strands, including Earth and Space. The latter is seen as providing an ideal setting for developing generalising principles and crosscutting concepts. Students will be encouraged to develop a sense of the structure of the universe and some organising principles of astronomy. They will explore relationships between many kinds of astronomical objects and evidence for the history of the universe. They will use data to discern patterns in the motion of the Sun, Moon, and stars and develop models to explain and predict phenomena such as day and night, seasons, and lunar phases. They will also explore the role and implications of human space exploration. In other words, Space will become less abstract and more relevant for future generations of students. It will also improve literacy and competence in science, as well as engagement with STEM subjects and general awareness of the importance and relevance of space science research.

This review will also look beyond the formal curriculum to other initiatives to promote and educate about the importance of space science research. These include: engagement activities like Space Week; dialogue with other European Space Education Resource Offices (ESEROs); CanSat and other competitions for schools; formal and informal engagement within and by research groups.

Space is being promoted as a theme to inspire and engage young people in STEM subjects (science, technology, engineering and mathematics). Whether or not such inspiration and engagement has been or can be measured will be examined.

1. Introduction

“The inspirational value of the space program is probably of far greater importance to education than any input of dollars.... A whole generation is growing up which has been attracted to the hard disciplines of science and engineering by the romance of space.” [2] Arthur C. Clarke’s epilogue to the biography of Neil Armstrong encapsulates one rationale for inclusion of space science in the curriculum. The ‘Apollo Effect’ represents the earliest example of the relationship between space exploration and attitudes to science in higher education. The number of graduates in technical sciences in the USA grew significantly some 5–10 years after the start of the Apollo Program, and this increase was maintained throughout - the falling numbers then occurring only after the programme ended. [3]

However, learning about practical applications that have evolved from the sixty or so years of space travel to enhance our everyday lives in areas like health, environmental awareness, satellite technologies, communications and so on is perhaps a more practical way of enlightening students to the value of space science research.

2. Space Science in the Curriculum

2.1 Space and the Primary Curriculum

Primary students in Ireland study Science as part of the integrated Social Environmental and Science Education (SESE) curriculum. [4] The four strands of the science programme are Living things, Materials, Energy and forces, and Environmental awareness and care. Scientific education complements the growth of the child’s learning in geography and history and the geography strand Planet Earth and Space similarly complements learning in science - engagement and learning being reinforced using a spiral approach throughout the eight years of primary.

2.2 Discover Primary Science and Maths – Inquiry and Space

Discover Primary Science and Maths (DPSM) is a flagship project of Science Foundation Ireland’s Education and Public Engagement Programme. [5] [6] It facilitates teacher training in general primary science, and provides teachers with useful online resources, which can also be used by parents and students, and classroom activity packs. Some 3,100 primary schools participate in this project, which



has now become linked with the Irish European Space Education Resource Office (ESERO Ireland). [7] ESERO is an education project of the European Space Agency (ESA), co-funded by ESA and Science Foundation Ireland in active fields of education and space.

The ESERO objectives are to use Space as a theme to enhance literacy and competence in STEM subjects, to motivate and enable students to pursue a career in the STEM field, in the space domain in particular, to increase young people’s awareness of the importance of space research, exploration and applications in modern society and economy. To this end it has produced a wealth of curriculum-linked resource material. ESERO’s Continuous Professional Development facilitates sessions for teachers to develop confidence in Inquiry-based science education, using space as a trigger or a theme. This is in line with the recommendations of the Rocard Report for a reversal of school science-teaching pedagogy from mainly deductive to inductive, inquiry-based methods to increase interest in science. [8]

Curriculum reform has been driven by the need to ensure that young people gain the skills and aspirations to participate in an increasingly scientific and technological society, and, as citizens, to contribute to a society that is informed about the pivotal role of science and technology in the well-being of society in general. Placing STEM learning in the context of everyday topics like Space that engage young people should improve students’ perceptions about science. [9]

2.3. Space and Secondary Science

In Ireland students at lower secondary school level (age 12 – 15 years) are now studying for a Junior Cycle Student Award, and Science has been revamped to reflect the nature of this new award. [1] One of five strands of the new Science curriculum is *Earth and Space*, (Table 1) which is seen as an ideal setting for developing generalizing principles and crosscutting concepts, as well as building on the science learned at primary level.

<p>Strand: Earth and Space ELEMENT: Building blocks <i>Students should be able to:</i></p> <ol style="list-style-type: none"> 1. describe the relationships between various celestial objects including moons, asteroids, comets, planets, stars, solar systems, galaxies and space 2. explore a scientific model to illustrate the origin of the universe 3. interpret data to compare the Earth with other planets and moons in the solar system, with respect to properties including mass, gravity, size, and composition. <p>ELEMENT: Systems and interactions <i>Students should be able to:</i></p> <ol style="list-style-type: none"> 4. develop and use a model of Earth-Sun-Moon system to describe predictable phenomena observable on Earth, including seasons, lunar phases, and eclipses of the Sun and the Moon 5. describe the cycling of matter, including that of carbon and water, associating it with biological and atmospheric phenomena. <p>ELEMENT: Energy <i>Students should be able to:</i></p> <ol style="list-style-type: none"> 6. research different energy sources; formulate and communicate an informed view of ways that current and future energy needs on Earth can be met. <p>ELEMENT: Sustainability <i>Students should be able to:</i></p> <ol style="list-style-type: none"> 7. illustrate how earth processes and human factors influence Earth’s climate, evaluate effects of climate change and initiatives that attempt to address those effects 8. examine some of the current hazards and benefits of space exploration and discuss the future role and implications of space exploration in society
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Table 1: Expectations for Students in Junior Cycle Science

Senior secondary school students may engage further with space technologies outside the curriculum through participating in a CanSat project. [10]

2.4 Space at third level

At undergraduate level there are eighteen courses relevant to space science and technology. [11] Ten research groups, largely in the domain of Astrophysics, are active throughout Ireland. [12] University College Dublin has also a Masters degree in Space and Technology. [13]



In the past, Enterprise Ireland and the European Space Agency (ESA) jointly offered scholarships for Irish postgraduate third-level students to attend programmes at Alpbach Summer School and the International Space University (ISU). [14]

3. Extra-curricular opportunities

3.1 Societies

The Astronomical Science Group of Ireland has been participating in research, education and public outreach in Astronomy and Space Science since 1974. [15] The Irish astrophysics community is small but active, conducting research in areas such as stellar physics, solar system science, galactic physics, cosmology, high-energy astrophysics, extra-solar planets, and solar physics. Researchers use scientific instruments on ESA and NASA missions, and at a variety of ground-based observatories. Public outreach is a major activity of the Group.

Astronomy Ireland is the national astronomy society in Ireland with over 3,000 active members and an even bigger public following. [16] The society holds a number of events throughout each year, including monthly lectures, nationwide public watches and an annual fund-raising Star-B-Q. It also publishes a magazine and provides work experience for Transition Year students.

3.2 Observatories & Science Centres

The Irish Astronomy Trail, operated by Dublin Institute for Advanced Studies at Dunsink Observatory, is an online portal that links major locations around Ireland involved with astronomy, including heritage sites, centres of outreach and research, and upcoming astronomy events. [17] A selection is described in Table 2.

Astronomy Site	Location and provenance	Educational visits
Armagh Planetarium, Armagh [18]	Founded in 1790 and is the oldest scientific institution in Northern Ireland. Refurbished in 2006.	Digital Theatre with a full-colour 3D experience projected over the entire dome. Interactive displays. Astropark is a scale model of the Universe where visitors can walk through the Solar System and into the Milky Way and beyond.
Birr Castle Science Centre, Birr, Co. Offaly [19]	1840's became home to the largest telescope in the world (until 1917) with the construction of the Leviathan	Science centre. The Demesne home to TCD's Rosse Solar-Terrestrial Observatory, a suite of radio telescopes used by Irish astrophysicists to study the Sun and its effects on the Earth. Also proposed site for an Irish LOFAR radio telescope.
Blackrock Castle Observatory, Cork [20]	Origins in 1600s - one of the largest and most interactive astronomy exhibitions in Ireland.	Fully restored in 2000s as a science and astronomy centre. Excellent programme of educational and outreach activities. Co-ordinated inaugural Space Week 2016. Will host 2017 International Space University
Dunsink Observatory, Dublin [21]	One of oldest scientific institutes in Ireland - constructed from 1783-1785.	Used for meetings, workshops and regular open nights.

Table. 2: Selected Astronomy Sites and Science Education Centres in Ireland

3.3 Leading the engagement drive: Blackrock Castle Observatory

Blackrock Castle Observatory at Cork Institute of Technology (CIT-BCO) has one of the largest and most interactive astronomy exhibitions in Ireland. It has also been highly proactive: creating a suite of informal interactive public engagement initiatives to promote the importance of Space exploration, to ignite curiosity and discover new and engaging platforms for science in the Arts and in STEM Education, and to increase awareness of careers in Ireland's Space science industries. The initiatives included: A live multimedia theatre performance aimed at the general public & young adult, 'To Space' for secondary students 'My Place in Space', created for families. [22] This blending of humour, warmth



and humanity and positioning science within story is a highly effective public engagement tool in igniting curiosity across many audience types.

3.4 Space Week

CIT-BCO's programme is titled "Driving STEM Learning and Awareness using Space as the Theme". This includes public events, workshops for primary and post-primary schools, and continuous professional development training for teachers to enable them to use "space" in the classroom to support curricular objectives in an inspirational setting. [23] Science Foundation Ireland funding supported a new national STEM week, Space Week, which ran in parallel with World Space Week in October 2016, coordinated by CIT-BCO. [24] A number of events took place across the country and for all age groups and education levels. DPSM Toolkits for teachers were also produced. [25] [26]

4. Evaluation

Evaluation of Continuous Personal Development resulting from DPSM's ongoing collaboration with ESERO, and the inclusion of Space as a theme within the 2014/2015 programme was carried out to determine the impact this revised CPD programme had on the participating primary teachers' experiences of and confidence in teaching science.

A high majority of the teachers asserted that they felt Space was a good context for teaching science and mathematics and was suitable as a cross-curricular theme. There was general consensus amongst the teachers that Space was a topic in which their students generally showed great interest. However, the majority of the teachers surveyed indicated that they generally did not use Space as a context for scientific or mathematics inquiry, rather they would be more likely to use it as a context for developing pupils' literacy skills. [27]

5. Conclusion

The legacy of the past as evident in the Irish Astronomy Trail, and the public engagement with informal activities, including the 'Dark Skies' zoning in Ireland means that there is constant opportunity to engage with Space. Introducing it to the secondary curriculum is a positive initiative but CPD for teachers will be needed to ensure confidence in delivery of subjects that may never have been part of their own studies. Science Foundation Ireland has collaborated in CPD with the Junior Cycle Science Team, using ESERO resources to facilitate learning and teaching in 'Earth and Space'. [28] Evaluation of the impacts of all initiatives is on-going.

References

- [1] Junior Certificate Science Specification available at [http://curriculumonline.ie/getmedia/153bc83f-9848-49f0-ad87-0a0d6b9b596c/Specification-for-Jr-Cycle-Science-EV_20160126-\(1\).pdf](http://curriculumonline.ie/getmedia/153bc83f-9848-49f0-ad87-0a0d6b9b596c/Specification-for-Jr-Cycle-Science-EV_20160126-(1).pdf)
- [2] Arthur C. Clarke in Armstrong, N. "First on the moon. A voyage with Neil Armstrong, Michael Collins [and] Edwin E. Aldrin, Jr.", Little Brown, Boston, 1970, 434pp
- [3] Clements, A. Using Space as a context to enrich the teaching and learning of STEM <https://www.ase.org.uk/...science.../lrssr-december-2014-045-052-clements-et-al.pdf>
- [4] SESE curriculum <http://www.curriculumonline.ie/Primary/Curriculum-Areas/Social-Environmental-and-Scientific-Education>
- [5] Discovery Primary Science and Maths <http://www.primaryscience.ie/>
- [6] Science Foundation Ireland Discover Programme <http://www.sfi.ie/discover-science-engineering-dse/>
- [7] ESERO Ireland <http://esero.ie/>
- [8] Rocard, M., Csermely, P., Jorde, D., Lenzen, D., Walberg-Henriksson, H. & Hemmo, V. (2007) Science education now: a renewed pedagogy for the future of Europe. Retrieved from the Europa website: http://ec.europa.eu/research/scienc society/document_library/pdf_06/report-rocard-on-science-education_en.pdf
- [9] <https://www.education.ie/en/Publications/Education-Reports/STEM-Education-in-the-Irish-School-System.pdf>
- [10] <http://esero.ie/project/cansat-201516/>
- [11] http://www.careersportal.ie/courses/caocoursesectors.php?sector_id=35#.WKh0QjuLTIU
- [12] http://www.astrophysics.ie/?page_id=55
- [13] <http://www.ucd.ie/physics/spacescience/>
- [14] <http://www.science.ie/features/archived-feature-articles/a-space-education.html>



- [15] <http://www.astrophysics.ie/>
- [16] <http://www.astronomy.ie/indexa.php>
- [17] <http://www.astronomytrail.ie/>
- [18] Armagh Planetarium <http://www.armaghplanet.com/>
- [19] Birr Castle Science Centre <http://birrcastle.com/>
- [20] Blackrock Castle Observatory <http://www.bco.ie/>
- [21] Dunsink Observatory <https://www.dunsink.dias.ie/>
- [22] Shaw, N.; McSweeney, C.; Smyth, N.; O'Neill, S.; Foley, C.; Phelan, R.; Crawley, J.; Henderson, C.; Cullinan, M.; Baxter, S.; Colley, D.; Macaulay, C. J.; Conroy, L, Collaborating with Space-related Research Institutes, Government Agencies and an Artistic team to create a series of Space-themed public events in Ireland in 2014, European Planetary Science Congress 2015, held 27 September - 2 October, 2015 in Nantes, France, Online at <http://meetingorganizer.copernicus.org/EPSC2015, id.EPSC2015-778>
- [23] <http://www.bco.ie/education/>
- [24] <http://spaceweek.ie/>
- [25] http://www.primaryscience.ie/media/pdfs/sfi_space_week_workbook_solar_system.pdf
- [26] http://www.primaryscience.ie/media/pdfs/sfi_space_week_workbook_mars.pdf
- [27] Humby & Murphy, DCU, 2016, The Evaluation of the Long-term Impact of the DPSM / ESERO Programme on Primary Teachers' Approaches to and Confidence in Teaching Science Through Inquiry <https://www.dcu.ie/sites/default/files/smec/pdfs/>
- [28] http://www.jct.ie/science/cpd_supports_elective_workshops.php