An Evaluation of Discover Science Engineering

A Review by an International Panel

May 2009

Table of Contents

Acknowledgements

The completion of this evaluation would not have been possible without the input provided by numerous organisations and individuals. We would like to acknowledge the support of the Evaluation Steering Group for their assistance through out this process. We would like to thank The Circa Group and The Sia Group for their work on phase 1 and 2 of this evaluation respectively. We would like to thank the Department of Enterprise, Trade and Employment, the Department of Education and Science, Forfás, FAS, SFI, Engineers Ireland, Expert Group on Future Skills Needs, Institute of Physics, DSE Suppliers, ICT Ireland, Education Centres, IBEC, NCCA, Dr. Danny O'Hare (Chair of the Task Force on Physical Sciences), Paddy Purcell, DSE Agtel, Edelman, AMAS, State Examination Office, Central Application Office, Dr. Mikkel Bohm (Director of the Danish Science Communication), Dr. Ben Dipper (Science Engagement Office at the Scottish Executive) and the DSE Steering Group.

Finally we would like to acknowledge the input, and cooperation of the DSE team through the course of this evaluation.

Abbreviations

CAO: Central Applications Office

CSET: Centres for Science, Engineering and Technology

DES: Department of Education and Science

DETE: Department of Enterprise, Trade and Employment

DPS: Discover Primary Science

DSE: Discover Science and Engineering

EGFSN: Expert Group on Future Skill Needs

EU15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

GDP: Gross Domestic Product

HEA: Higher Education Authority

HEI: Higher Education Institutes

HERD: Higher Education Sector Performed Research and Development

ICT: Information and Communication Technology

IP: Intellectual Property

NCCA: National Council for Curriculum and Assessment

NDP: National Developmental Plan

OECD: Organisation for Economic Cooperation and Development

PISA: Programme for International Student Assessment

ROSE: Relevance of Science Education

S&T: Science and Technology

SET: Science, Engineering and Technology

SFI: Science Foundation Ireland

SME: Small and Medium Enterprise

SSTI: Strategy for Science, Technology and Innovation

STI: Science, Technology and Innovation

List of Figures

List of Tables

Preface

Discover Science and Engineering (DSE) is Ireland's national science awareness programme, set up in 2003 to promote an awareness and understanding of the importance of science and engineering in a modern knowledge-based economy. The raison d'être of DSE is to develop more effective ways of engaging students, teachers and the public in science, technology and innovation (STI).

DSE's overall objectives are:

1. To raise the general level of awareness of the physical sciences;
2. To raise the level of student uptake of the physical sciences at second and third level;
3. To promote a positive attitude towards careers in Science, Engineering and Technology; and
4. To promote a greater understanding of science amongst the public / society.

DSE owes its origin to two concerns. The first is the ability of Ireland's education system to supply the number of qualified scientists and engineers needed to maintain the growth of Ireland's high-technology sectors; the second, is the widespread lack of appreciation of the fundamental role played by science and engineering in Ireland's modern economy.

DSE emerged from a specific recommendation of the Task Force on Physical Sciences, which reported in 2002[1], on the numbers of students choosing to study the physical sciences in second and third level education. One of the Task Force's recommendations was the establishment of an integrated national science awareness programme. As a result, at the request of the Department of Enterprise, Trade and Employment, DSE was set up within Forfás in October 2003.

DSE aims to contribute to Ireland's growth and development as a knowledge-based economy helping to keep Ireland among the world's most competitive economies. Achieving this goal requires the people of Ireland to have an active and informed interest in STI, an appreciation of its importance to the economy, and a sufficient number of young people choosing careers in the sectors that comprise Ireland's knowledge economy.

[1] Task Force on the Physical Sciences.

The Purpose of this Evaluation

Forfás was asked by the DETE to undertake this evaluation of DSE. The evaluation was sought by DETE to ensure that the DSE programme remains strategically relevant and operationally efficient. The evaluation is timely given that DSE has been in operation for almost five years and that the scale of its budget and operations has increased substantially over that period.

The evaluation process comprised of two elements. First, independent consultants were engaged to conduct assessments of DSE's operations, management and governance. Second, an International Panel, comprising of experts in science awareness and science education, was engaged to review these assessments, consult with stakeholders and make recommendations on improving DSE's effectiveness.

The members of the International Panel are: Dr Graham Farmelo (Chair), Senior Research Fellow, Science Museum, London and Associate Professor of Physics, Northeastern University, Boston; Professor Heinz Wolff, Emeritus Professor of Bioengineering at Brunel University; Annette Smith, Director of Regions, British Association for the Advancement of Science; and Professor Svein Sjøberg, Professor in Science Education, University of Oslo. The Panel has overseen the drafting of this report by the Forfás secretariat and is responsible for its findings and recommendations.

This evaluation provides an independent assessment of DSE and addresses the following key questions:

- Is DSE achieving its stated objectives?
- Are DSE's current objectives the right objectives?
- Could DSE make a more significant impact and, if so, in which specific areas of activity?
- What level of resources is appropriate to ensure that DSE makes a significant impact?
- Where should DSE be located, administratively and physically, in order to maximise its impact?

The outcomes of the evaluation will be used by Forfás and DETE for policy development and implementation within the framework of the Government's Strategy for Science, Technology and Innovation 2006-2013; and to inform the development of a new strategy for DSE.

Foreword by International Panel

It has been an honour and a privilege to have participated in this evaluation of DSE. As researchers and practitioners in science engagement and science education, it has been immensely rewarding to see how Ireland has been responding imaginatively and effectively to the challenges it faces in S&T. We hope that by bringing an international comparative perspective this report will enable DSE to address those challenges even more effectively.

This report is not an evaluation of DSE's Programmes but rather a strategic evaluation of DSE, aimed at making recommendations that may be used to re-orient DSE into a unit that will be even better able to reach its stated objectives, in line with government policy. The context for this evaluation is Ireland's economy and international best practice in science education and science engagement.

It should be noted that DSE has been in existence for a comparatively short period of time and is working to effect change in areas where direct causal linkage is difficult, if not impossible, to prove. Nevertheless some reasonable judgements on how DSE is performing in relation to its objectives can be made.

Let us state at the outset that we believe that DSE represents very good value for money and is playing an important role in encouraging young people to study S&T. DSE is, in our experience, a unique organization – one of which Ireland can be proud.

The recommendations in this report can be grouped under three headings: first, recommendations on strategy that we believe would lead to a re-focusing in DSE's capacity to address the challenges it faces; second, recommendations on DSE's operations aimed at increasing DSE's effectiveness; third recommendations on strengthening DSE's governance which we believe are necessary to ensure DSE continues to operate with maximum impact. Finally, we make some recommendations on priorities for future additional funding, if available.

Strategy

DSE should focus on its unique role as an evidence-driven organisation that specialises in the development of new initiatives that deliver the best-possible quality of science teaching and public-science engagement. To do this, it needs to be more grounded in international research in science education and engagement.

DSE is playing an important role in piloting activities that makes S&T more readily accessible to teachers and students. These activities should continue and focus mainly on science education and promoting careers in SET. In order to allow DSE focus on this, proven activities should be mainstreamed into the education system.

Increasing Effectiveness

We make the following recommendations. In summary, DSE should:

- Include mathematics in its remit;

- Increase its involvement at second level; In doing so, DSE should concentrate on piloting new initiatives;
- Increase its involvement in promoting careers in science, technology, engineering and expand its remit to include maths (STEM);
- Take into account the fact that substantial gender differences exist in young people's attitudes to STEM;
- Make use of the areas of health, medicine and environment as hooks to capture young people's interest in STEM;
- Become involved in discussion of high-profile, topical issues in S&T;
- Encourage increased participation among those groups that are currently underrepresented in studying S&T; and
- Develop more reliable measures of effectiveness and a clearer statement of anticipated outcomes for its activities.

Governance

We have concluded that DSE, given its mission, should remain within the Forfás administrative structure, under the aegis of DETE. DSE's physical location within Forfás however means that DSE has limited direct access to its target audiences, particularly teachers and school children. We therefore recommend that, if possible, DSE relocate to Exploration Station in the future, while remaining under Forfás' aegis.

In order to strengthen DSE's strategic capacity, the membership of the DSE Steering Group should be reviewed and the roles and relationships of the DSE Steering Group and Forfás should be clarified. Finally, a process for improved coordination between DSE and other awareness activities is needed to optimise investment in the national programme in public-science engagement.

Priorities for Additional Funding

DSE could optimise its use of resources by implementing our recommendations above in relation to strategy, effectiveness and governance at little additional cost. However, some of our recommendations will require additional funding, if available, or that funding be reallocated within existing budgets. We believe that that the following areas should be accorded the highest priority:

- Initiatives to ensure that DSE's activities are informed by findings from the best international research and practice;
- Increasing DSE's activities in mathematics; and
- Targeting children underrepresented in SET.

With regard to mathematics, we recommend that DSE develop activities to support the learning of arithmetic as part of science at primary level and to increase mathematical literacy of students

studying science at secondary level. This recommendation would help increase the mathematical literacy of students studying science in schools. On its own, however, it would not resolve all the challenges associated with mathematics teaching in schools. To address these broader issues, we recommend the development of a new set of initiatives aimed at supporting the introduction of the revised curricula in mathematics that are about to be introduced at both Junior and Senior Certificate levels. Such an initiative is of an entirely different order and would involve funding, if available, of about €5 million annually.

Recommendations

The panel recommends that DSE should continue to be strongly supported by Government. Recommendations were made around DSE's role in science education; career promotion, role in public engagement; sponsorship activities and governance. These recommendations were then re-categorized depending of the action need be implemented, i.e. refocusing, increasing effectiveness, priorities for funding and governance. Each recommendation should be implemented on foot of the guidance and review of the Inter-Departmental Committee on Science, Technology and Innovation (IDC), and under the oversight of the Cabinet Committee on Science, Technology and Innovation.

	Refocusing of Core Activities
1	In order to allow DSE concentrate on its core strength as a change agent within science education, proven activities should be integrated into the education system. Only those activities that are still being developed should be retained by DSE. Action to be taken by : Department of Education and Science This will free DSE to focus on piloting creative new initiatives. **Action to be taken by : DSE**
2	More reliable measures of input, output and impact should be developed for the evaluation of DSE's activities. A separate, appropriate set of measures is needed for DSE's science education activities, career promotion activities and public awareness activities. In developing these measures, DSE should draw upon international best practice and involvement in international research cooperation. **Action to be taken by: DSE, consistent with the policy objectives agreed with Forfás**

	Increasing Effectiveness
3	DSE should do much more to highlight the importance of mathematics, notably elementary arithmetic, for the teaching of science. In particular, the DPS programme should be revised so that it repeatedly demonstrates the importance of arithmetic and measurement. DSE's remit at second level should include activities that pilot more effective ways of teaching mathematics in science classes at both Junior and Senior Certificate levels and support other ongoing initiatives of the NCCA and Department of Education and Science. **Action to be taken by: DSE, following engagement with appropriate stakeholders such as DES, NCCA**
4	Following the successful pilot of the "Discover Sensors" programme aimed at Junior Cert level, DSE's involvement in developing activities at second level should be increased as planned. **Action to be taken by : DSE**
5	Encouraging increased participation in science education among underrepresented groups should be an important part of DSE's remit. **Action to be taken by : DETE (to amend DSE remit) and DSE (to identify and prioritise relevant target groups)**
6	DSE's involvement in promoting careers in science, engineering and technology and highlighting specific opportunities in shortage areas should be increased. **Action to be taken by : DSE, with particular regard to the analysis of the Expert Group on Future Skills Needs**
7	DSE's involvement in promoting careers should be revised to include raising awareness of the wide range of careers available to graduates with a high level of mathematics. **Action to be taken by: DSE, with particular regard to the analysis of the Expert Group on Future Skills Needs**
8	More should be done in DSE's career promotion activities to address gender differences in students' interest in SET careers. **Action to be taken by : DSE in conjunction with other stakeholders**
9	DSE's public engagement activities should include medicine, health and the environment as hooks for key target audiences. **Action to be taken by : DSE in conjunction with other stakeholders**

10	DSE's remit with respect to science education and career promotion should continue to focus on the physical sciences, engineering and be expanded to include mathematics. **Action to be taken by : DETE**
11	DSE should work with the relevant government departments and others in its public engagement activities to pilot public discussion of topical issues relating to science and technology. **Action to be taken by : DSE in conjunction with other stakeholders**
12	In order to maximise DSE's strength as a piloting unit for new initiatives, DSE's sponsorship activities should be revised, both operationally and strategically. The current system of rolling application procedures for sponsorship should be phased out within six months and replaced by a small number of application deadlines. (This should be done in such a way that it allows the DSE Programme Director some flexibility in responding in a shorter timeframe to exceptional opportunities where sponsorship would add significant value). The administrative procedures for the selection and approval of sponsorship funding should be simplified. The minimum level of funding for sponsorship projects should be increased. A system for the evaluation of the impact of DSE's sponsorship activities, based on appropriate metrics, should be implemented. **Action to be taken by : Forfás and DSE**
13	A process for strengthening the coordination of the awareness activities of DSE, SFI, FÁS (and other awareness activities) is needed to ensure maximum value from their respective activities and to optimise investment in the national programme in public-science engagement. **Action to be taken by : DETE**

	Funding Priorities
14	We recommend that the Government consider increasing DSE's funding, if available, in order to allow the development of a new set of DSE-type initiatives aimed at supporting the introduction of the revised curricula in mathematics that are about to be introduced at both Junior and Senior Certificate levels, as follows: €1 million per annum as a priority to support the learning of arithmetic at primary level & to increase the arithmetic literacy of students studying science at secondary level €3 - €5 million per annum to develop a range of initiatives intended to strengthen maths and maths teaching in schools €250,000 per annum to target underrepresented groups €100,000 per annum for activities aimed at ensuring DSE's activities are based on international best practice and research on science education and promotion **Action to be taken by : Proposals to be formulated by the IDC for the approval of the Cabinet Sub-committee**

	Governance
15	DSE should remain within Forfás' administrative umbrella, but a number of disadvantages associated with its current physical location need to be addressed. In the longer term, consideration should be given to co-locating DSE with the Exploration Station, while remaining under the aegis of Forfás, if practicable. This should only be done of course provided security of tenure and economic viability are assured. We strongly urge that options be explored in the interim in order to improve the fit between DSE's mission and its working environment within Forfás, particularly concerning more open internet access and visitor visibility. **Action to be taken by : Forfás and DETE**
16	The composition of the DSE Steering Group should be reviewed. The effectiveness of the Steering Group would be enhanced by having a maximum of around twelve members. Meetings should also be held at least six times per year. Representation from both DETE and DES at the appropriate level is essential. The DSE Steering Group should include more researchers and practitioners in science education and public engagement in science and those who can best drive DSE's role as a change agent in primary and second level science education. **Action to be taken by : DETE**

17	The work currently done by the Sponsorship and Finance Sub-Committee should be a standing item on the agenda of the DSE Steering Group and the Sub-Committee should be disbanded. **Action to be taken by : DETE and DSE Steering Group**
18	The respective roles of the DSE Steering Group, the Forfás Board and the Forfás Executive Committee should be clarified and a clearer governance structure should be put in place. One option that was raised during this evaluation is that the DSE Steering Group could become a Sub-Committee of the Forfás Board. We recommend that this option be explored. **Action to be taken by : Forfás and DETE**

The establishment of DSE was one recommendation of the Task Force on Physical Sciences and as such was never expected to be the whole solution to the challenges of science and technology education and awareness, public-science engagement and the skills needs of a changing economy. It is important, when gauging the success of DSE in influencing Ireland's science education and engagement in Ireland, to bear in mind the relative size of DSE's budget compared with that of other stakeholders.

In our view, DSE has addressed its challenges with imagination and vigour and with very considerable success. Ireland should be proud of this unique organization and we believe that, by investing in it as we have recommended, it could play an even greater role in supporting the continued prosperity of the country.

Graham Farmelo

Chair of the International Panel

Chapter 1 – Introduction

1.0 Ireland's Growing Knowledge Economy

A Strategy for Science Technology and Innovation (SSTI) was launched by the Irish Government in 2006 with the vision that: "Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation-driven culture[2]."

The SSTI asserts that the continued success of Ireland's economy will depend, in large part, on its ability to evolve into a knowledge-based economy in which both indigenous and foreign-owned sectors perform strongly. It aims to position Ireland among the leaders in niche areas of Science Technology and Innovation (STI). The means through which this is to be achieved include:

- Increased participation in science and engineering by young people;
- A substantial increase in the numbers of people with advanced qualifications in science and engineering;
- The establishment of Ireland as a premier location for world class research and development;
- Transformational change in the quality and quantity of research undertaken by enterprise - both directly and in cooperation with third level institutions;
- An enhanced contribution from research to economic and social development across all relevant areas of public policy including agriculture, health, environment and the marine and natural resources;
- Higher output of economically relevant knowledge, know-how and patents from publicly funded institutions;
- Greater participation by enterprise and publicly-funded research institutions in international S&T cooperation and trans-national research activity; and
- Greater coherence and exploitation of mutually advantageous synergies in the development of STI policy between the Republic of Ireland and Northern Ireland.

1.1 Strengthening the Science System

In accord with the objective of increasing the number of students with advanced qualifications in science and engineering, there has been a substantial increase in funding for research in higher education institutions (HEIs) over the past decade. The Government has invested in building

[2] Strategy for Science, Technology and Innovation 2006-2013. DETE, 2006

research capacity principally through Science Foundation Ireland (SFI) and the Higher Education Authority (HEA).

Investment is also being made to strengthen research across a range of areas of government. Innovations in the areas of agriculture and food, health, environment, marine and energy are all recognised as having the potential to make real improvements to quality of life. Under the SSTI, higher funding is leading to an increased research capacity in these sectoral areas.

Given the greater level of research activity that is now being financed, corresponding support for commercialisation has increased to ensure that the returns on public investment in research are being optimised. The state development agency Enterprise Ireland is playing a leading role in this area. Recent activity has taken the form of strengthening the technology transfer offices in HEIs as well as measures to strengthen intellectual property (IP) infrastructure.

1.2 Science Centres and Science Communication

Internationally, science museums and centres often form the hub of public engagement with S&T and play a vital role in implementing national science engagement strategies. The recently opened Science Gallery in Dublin and the planned hands-on science centre, Exploration Station, will provide the Irish public for the first time with vital infrastructure for informal science learning.

In relation to research and training for public-science engagement, Ireland has a well-established MSc in Science Communication at Dublin City University which involves collaboration between natural scientists, social scientists and communication professionals in its delivery.

1.3 Supporting Business Innovation

The SSTI also emphasizes the importance of growing research and development (R&D) within businesses.

A primary objective of Ireland's industrial development policy, via the Industrial Development Agency, is to attract the R&D of major foreign firms. The promotion and marketing of Ireland as a location for enterprise R&D is therefore being stepped up and a stronger approach being adopted with the existing base of foreign firms in Ireland to attract additional R&D functions.

To maximise the returns to the local economy from foreign firm R&D activities, instruments aimed at developing effective links with indigenous companies are being developed. Science Foundation Ireland's Centres for Science, Engineering and Technology (CSET) Programme, the largest commitment to research within SFI, are helping to nurture a research environment conducive to the establishment and growth of linkages between HEIs and the R&D activities of foreign-owned multinational companies and indigenous enterprises (SMEs).

The movement of researchers from the higher education sector into industry and the growth of collaboration between companies and research institutions, through the development of industry led networks and competence centres, are also priorities.

1.4 Developing Human Resources for SET

Human resource development in Science, Engineering and Technology (SET) is central to the SSTI. The Strategy addresses key human capital investments across the education system and industry.

Ireland is making several strategic changes to science education at primary and secondary level. Science was re-introduced into the primary curriculum in 2003 and corresponding training for teachers has been taking place both in the Colleges of Education and via in-service training. At secondary level, a revised syllabus was introduced to the Junior Certificate Science in 2003 with a greater emphasis on investigative work. Revised curricula for physics, chemistry and biology at Leaving Certificate and for Mathematics at Junior Certificate and Leaving Certificate are currently being developed.

Ireland's has one of the greatest stocks of science graduates of any country in the EU. However, concerns remain regarding the numbers of school leavers opting to study SET. Addressing this issue has been one of DSE's key aims.

Before the launch of the SSTI, the number of doctorates graduating from Irish third level institutions was below the OECD average. To address this, a key human resource target within the Strategy is that the number of new doctorates in SET earned annually will almost double by 2013.

The growth in employment opportunities in Ireland in the past decade has seen a remarkable increase in inward migration. As an integral part of the SSTI, Ireland's immigration policy aims to attract some of the world's best researchers. The evidence shows that inward migration has indeed contributed substantially to Ireland's human capital. The most recent Census in 2006 shows that around 38% of PhDs in the country were born outside Ireland.

1.5 Progress to Date and Challenges Ahead

Progress is being made in improving the performance of Ireland's knowledge economy.

Total R&D spending across all performing sectors has increased substantially. Higher Education sector performed R&D (HERD), for example, climbed to just over €600 million in 2006, over 2.5 times the €238 million HERD recorded in 2000 and is now comparable with the European Union (EU) and OECD averages.

The number of employed researchers has risen dramatically since 2000. The ratio of full-time adjusted equivalent researchers per thousand in employment has risen from 5.0 in 2000 to 6.0 in 2006, and is now in line with the EU and OECD averages.

The SSTI details the primary challenges facing Ireland for the period 2006-2013, notably:

- Strengthening research in science, including establishing more stable research careers and more internationally attractive research environments;
- Attracting and embedding the R&D operations of foreign-owned firms;
- Building the research and innovation capacity of indigenous firms;
- Identifying the technology needs of future and potential enterprise in Ireland;

- Aligning the industrial and academic research communities more closely;
- Enhancing research commercialisation support and activity; and
- Developing a clear STI internationalisation strategy to improve and optimise links with actors overseas.

1.6 Conclusion DSE's Role in Ireland's Knowledge Economy

SET are now clearly seen by the Irish Government as major drivers of the Irish economy. However, the general public's interest in and awareness of S&T, and the country's ability to produce the numbers of qualified scientists and engineers needed, have remained causes for concern.

Ireland's has one of the greatest stocks of SET graduates of any country in the EU - yet skills shortages have persisted. This apparent paradox is partly explained by the unprecedented rate of job growth in recent decades.

The skills needs of the economy are also continually changing. The global economy continues to evolve, with the emergence of China and India as major economic powers. Ireland's economy also continues to evolve from a manufacturing based economy to becoming a more mixed economy, based on both manufacturing and services. The mix of graduates required for the future economy will continue to include graduates in the physical sciences, but will also require graduates in mathematics and engineering, many of whom choose careers in high value service industries such as financial services.

DSE was established to contribute to Ireland's continued growth and development as a knowledge-based society. This report seeks to address DSE's role in the changing national and global economic environment and to make recommendations that will maximise DSE's impact.

Chapter 2 – The Challenges for DSE

2.0 Introduction

This chapter describes the principal challenges facing DSE. The challenges associated with each of the following objectives will be considered in turn:

- Raising the level of student intake of the physical sciences;
- Promoting a positive attitude to careers in SET; and
- Promoting a greater understanding of science among the public.

2.1 Raising Level of Student Intake of the Physical Sciences

First and Second Level Schools

Science was introduced into primary schools in 2003 through the curriculum for Social, Environmental and Scientific Education. At second level, each student's performance is monitored via two state exams; the Junior Certificate and Leaving Certificate.

Data on the uptake of science and mathematics at Junior and Senior Certificate levels will now be reviewed.

Junior Cert Level Mathematics

At Junior Certificate level, mathematics is offered at three levels; higher, ordinary and foundation level, with student participation at one of these levels compulsory for all students. In 2007, 98.5% of students participated in mathematics, with 41.5% of this group sitting the higher mathematics examination. Participation rates in mathematics have been above 96% since 2002. The uptake of higher mathematics has increased by around 4% over this period, representing an absolute increase in student participation of 1,983.

Junior Cert Level Science

At Junior Certificate level, science is offered as a single subject composed of elements of physics, chemistry and biology. Student participation in science at Junior Certificate is not compulsory. Despite this, a large percentage of students participate in science. For example, in 2007, 87% of students sat the Junior Certificate science examination, with 61% of this group sitting the higher paper. Since 2002, the total participation rate of students in science has remained constant, while the uptake of the higher paper has increased by 6%. However, when percentage participation is reviewed in the context of changing demographics, it can be seen that since 2002 the absolute number of students participating in science has decreased by 1,991, while the uptake of the higher science paper has increased by 2,722.

PISA - International Comparisons of Student Performance at Junior Certificate

The Programme for International Student Assessment (PISA) is an OECD project designed to assess young adults' knowledge and skills as they approach the end of compulsory schooling[3]. It is conducted every three years, is targeted at fifteen year old students, and is conducted in three domains - science, reading and mathematics. The focus of PISA is not on students' knowledge of curriculum content, but rather on how well they can apply knowledge and skills they have acquired to real-world situations. Students complete a paper-and-pencil test and a student questionnaire.

The results of PISA from 2006, which involved over 4,500 Irish 15-year-olds in 165 schools, show that Irish 15 year-old students are:

- among the top performers when it comes to reading literacy;
- slightly above the OECD average in science; and
- at the OECD average in mathematics.

Irish students maintained their position in mathematics and science compared with their performance in 2000 and 2003.

Ireland is unusual in that there are fewer lower achievers and higher achievers than the OECD average, with the majority of Irish pupils scoring in the mid range of achievement.

The PISA project aims to provide results that can be used in the shaping of education policies in participating countries. Since its inception, PISA has indeed set the educational agenda internationally, as well as within many of the member countries.

However, limitations of PISA have been pointed to by researchers in the field of science education :

- PISA aims to test the knowledge and skills that are essential for full participation in society. However, the PISA test format – a paper and pencil test – can test only a subset of such essential knowledge and skills;
- PISA tests just a few areas of the school curriculum – reading, mathematics and science. Students' performances in the entire range of other subjects, from history, geography, languages, vocational skills, arts and humanities are excluded;
- PISA stresses that the skills and competencies assessed may be acquired not only in school, but also from experiences and influences from family life, friends, media etc. However, PISA results are more often than not interpreted by governments as a consequence of the school system only;
- PISA assumes that all students, wherever they live, are equally motivated to perform well in the PISA test. Markedly differing educational cultures across OECD countries make this assumption questionable however; and

[3] PISA – Ready for Tomorrow's World? The Competencies of Ireland's 15-year-olds in PISA 2006. Educational Research Centre, 2008.

- A move up or down the PISA league table is awarded great importance by some national governments, despite the fact that such differences may be neither statistically or educationally significant.

There is no doubting that PISA is influential. However, given its limitations, caution needs to be exercised by national governments in placing too much emphasis on PISA as a driver of national educational policy. In our view, Ireland's performance in PISA is not a cause for alarm.

Leaving Certificate Level Mathematics

At Leaving Certificate level, mathematics is taught at three levels: higher, ordinary and foundation. A minimum of a pass at ordinary level is required for entry into third level education. In 2007, 96.4% of students sat the mathematics examination. Since 2001, the overall percentage of students taking mathematics has remained constant. When the current mathematics syllabus was introduced in 1992, the expected target for uptake of higher mathematics was 20-25% of the Leaving Cert cohort. In 2007, 16.5% of the Leaving Cert cohort sat the higher mathematics paper. The percentage participation of students taking higher mathematics has remained constant since 2001. However, when percentage participation is reviewed in the context of changing demographics, which again has led to a decline in overall numbers of participation at Leaving Certificate level, it can be seen that since 2001 the absolute number of students participating in higher mathematics decreased by 1, 550.

Leaving Certificate Level Science

Science for the Leaving Certificate is taught as three single disciplines; biology, physics and chemistry. Students can choose which discipline(s), if any, to study. Examining percentage participation in each of the sciences the following trends emerge:

- The percentage uptake of physics has been constant since 2001. In 2007, 14.3% of students sat the physics examination with 10.3% of this group participating at higher level;
- Participation rates have increased marginally in chemistry, by 2%, since 2001. In 2007, 13.6% of students sat the chemistry examination with 11.3% of this group participating at higher level; and
- Participation rates in biology have increased by 8% since 2001. In 2007, 50.6% of students sat the biology examination with 34.4% of this group participating at higher level.

However, when percentage participation is reviewed in the context of the changing demographics the following trends emerge:

- Since 2001 the absolute number of students participating in physics decreased by 1, 160;
- Since 2001 the absolute number of students participating in chemistry increased by 571; and
- Since 2001 the absolute number of students participating in biology increased by 1,704;

Based on this data, it can be seen that while the education system is maintaining percentage participation levels in science and maths, participation targets are not being reached. This, combined with the decrease in the absolute number of Leaving Certificate students, is resulting in a decreasing supply of entrants into third level SET courses.

Third Level

This section reviews the data on uptake of SET courses at third level including (i) demand for courses in SET, as measured by students first preference choices; (ii) enrolment in SET courses; and (iii) graduation from courses in SET.

(i) Demand for SET Courses in Third Level Education

On completion of the Leaving Certificate, students apply to the Central Applications Office (CAO) for their college place in a chosen course. Students apply for enrolment in Honours degree level (level 8 education) or sub- Honours degree level (level 6/7 education) courses.

Level 8 Education

Table 1 shows the trends in student's first preferences for Level 8 science / applied science courses and engineering and technology courses since 2000. It can be seen that while demand for Level 8 science courses has remained essentially constant, student's first preferences for engineering and technology courses has fallen markedly over this period.

Table 1: Percentage of students applying for level 8 science / applied science courses, engineering and technology courses since 2000 based on first preferences choices

Students applying for level 8 science / applied science, engineering and technology courses (2000-2008) based on first preference choice		
Year	Science	Engineering
2000 (n = 51, 381)	9.56% (4,912)	17.48% (8,981)
2002 (n = 50, 996)	9.54% (4,865)	14.17% (7,226)
2004 (n = 54, 263)	8.33% (4,520)	13.69% (7,429)
2006 (n = 53, 488)	9.36% (5,006)	13.01% (6,959)
2008 (n = 56, 315))	8.85% (4,984)	9.92% (5,586)

Data normalised to absolute number of first preferences (data in brackets) for level 8. Data from the CAO.

Level 6/7 Education

Table 2 shows the trends in the percentage of students with first preferences in Level 6/7 science / applied science courses and engineering and technology courses since 2000. While the proportion of engineering and technology first preferences at Level 6/7 fell from 2000 to 2002, percentage demand has remained steady since then. Demand for science and applied science courses at Level 6/7 have not fallen in percentage terms since 2000. However, when reviewing the absolute number of students with first preferences in science and applied science courses it can be seen that a significant drop occurred in 2004 and 2006 but has since recovered and is now in line with the absolute number observed in 2000.

Table 2: Percentage of students applying for level 6/7 science/applied science courses and engineering and technology courses since 2000 based on first preference choices.

Students applying for level 6/7 science / applied science courses and engineering and technology courses (2000-2008) based on first preference choice		
Year	Science	Engineering
2000 (n = 52, 773)	7.64% (4,031)	28.53% (15,056)
2002 (n = 48, 676)	8.13% (3,957)	22.73% (11,064)
2004 (n = 43, 305)	9.64% (4,174)	21.39% (9,284)
2006 (n = 40, 403)	9.01% (3,640)	22.29% (9,005)
2008 (n= 37, 818)	12.64% (4,780)	22.79% (8,619)

Data normalised to absolute number of first preferences applying (data in brackets) for level 6/7. Data from the CAO.

(ii) Enrolment in SET Courses at Third Level

The percentage fall in demand for courses in engineering and technology evident in Table 1 and Table 2 is reflected in the percentage of students enrolling for courses in SET. The figures in Table 3 and 4 show that the percentage of students enrolling in science courses has been roughly constant over this period, while the percentage of students enrolling in engineering and computing courses has fallen. However, when the absolute number of students enrolling on third level education is reviewed it can be seen that the number of students enrolling on level 6/7 courses has decreased since 2000 for all subjects. At level 8 the absolute numbers of students enrolling for science courses has remained constant while absolute numbers for both engineering and computing have decreased.

It can also be seen that the major drop in student enrolments, in percentage terms, for courses in engineering and computing occurred between 2000 and 2004, and that percentage student enrolments in these areas have been roughly constant since then[4]. The drop between 2000 and 2004 may be attributed to the 'dotcom bust'. At that time, decreases in student enrolments in computing courses were also seen in other industrial countries.

Table 3: Student acceptances for Level 7/6 courses in science, computing and engineering (2000-2007) as a percentage of total third level enrolments.

Student acceptances for Level 6/7 courses in science, computing and engineering (2000-2006)				
Discipline	2000 (n = 63,451)	2004 (n = 63,696)	2005 (n = 63, 716)	2006 (n = 59, 485)
Engineering	14.5%	12.9%	12.1%	12.8%
Computing	13.7%	7.5%	6.3%	7.6%
Science	7.3%	5.4%	6.1%	6.9%

Absolute number of CAO applications (n) in brackets. Data obtained from HEA[4].

Table 4: Student acceptances for Level 8 courses in science, computing and engineering (2000 - 2007) as a percentage of total third level enrolments.

Student acceptances for Level 8 courses in science, computing and engineering (2000-2006)				
Discipline	2000 (n = 63,451)	2004 (n = 63,696)	2005 (n = 63, 716)	2006 (n = 59, 485)
Engineering	8.0%	4.7%	4.8%	4.5%
Computing	8.7%	3.6%	4.0%	3.5%
Science	12.0%	10.5%	10.7%	9.4%

Absolute number of CAO application (n) in brackets. Data obtained from HEA[4].

[4] An Overview of Applications and Acceptances to Higher Education. Higher Education Authority, 2006.

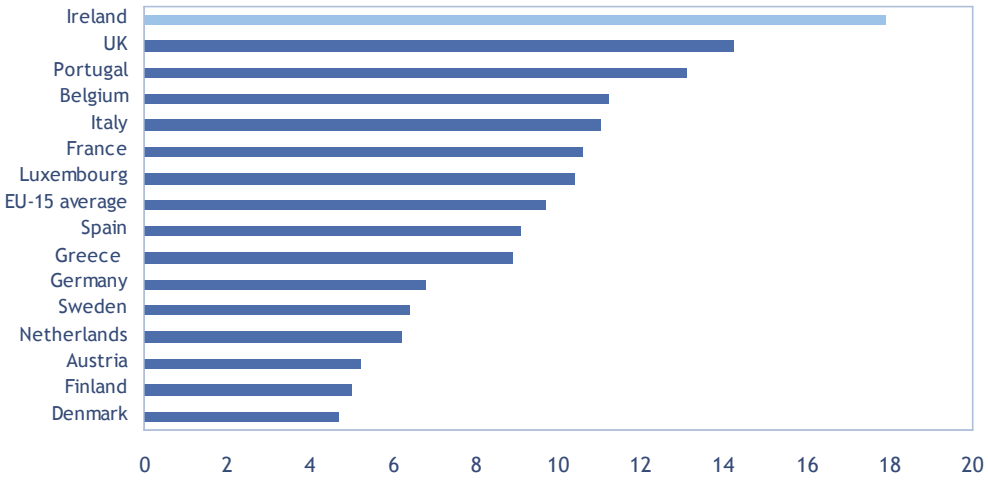
(iii) Graduation from Courses in SET

Eurostat figures show that, as a percentage of all tertiary graduates, Ireland is one of the leading countries in the EU in terms of science, mathematics and computing graduates (Figure 1)[5].

There are important differences among countries in terms of the mix of SET graduates, most notably, some countries have more engineering graduates and others have more science graduates.

While Ireland ranks highly in terms of graduates in science, mathematics and computing, Ireland is ranked well below the EU15 average in engineering, manufacturing and construction (Figure 2)[6].

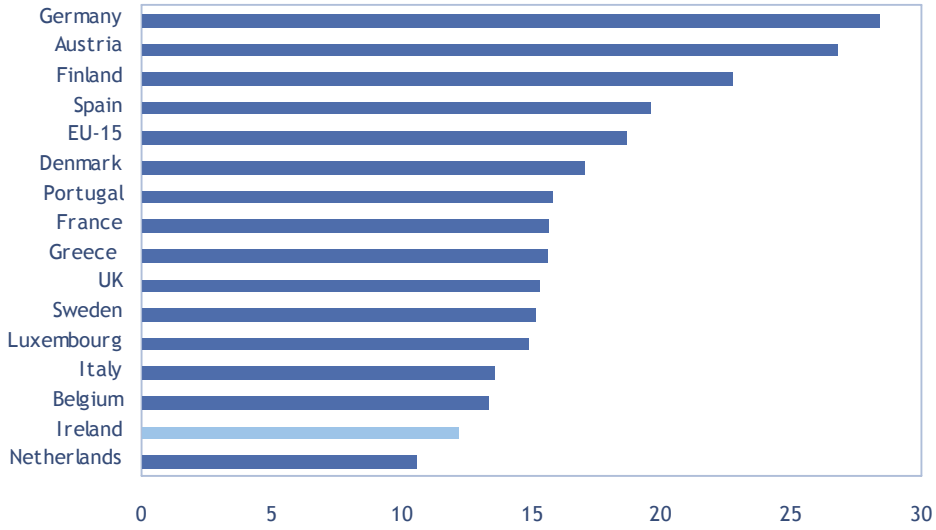
Figure 1: 2005 data on tertiary graduates in science, mathematics and computing aged 25- 64 as a percentage share of the total stock of tertiary graduates.



Data from Eurostat.

[5] Science Graduates are Better Employed. Statistics in focus, Eurostat Commission, 2006.

Figure 2: 2005 data on tertiary graduates in engineering, manufacturing and construction aged 25-64 as a percentage share of the total stock of tertiary graduates.



Data from Eurostat.

Around two thirds of Ireland's SET graduates are science graduates, while only one third of Ireland's SET graduates are engineering graduates[6].

The OECD data thus shows that Ireland's higher education system is in fact more geared towards science and away from engineering than is the case in most other advanced economies, where the majority of SET graduates are engineering graduates.

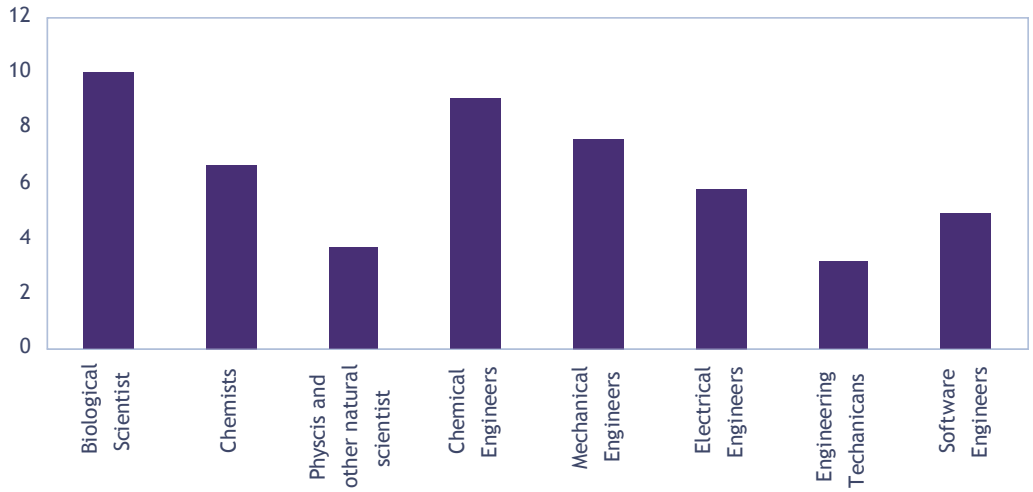
Skills Shortages

Although Ireland's higher education system is focused on SET, there have been skills shortages in these subjects in the past decade[7]. Demand for engineers and scientists has been unprecedented. Data from the Expert Group on Future Skills Needs shows that from 2001-2006 employment for engineers grew most strongly (Figure 3)[8]. Demand for science occupations also grew over the period, being greatest for biological scientists and chemists but lower for physicists[8].

[6] Main Trends in Science and Innovation. OECD, 2007.

[7] National Skills Bulletin 2007, Expert Group on Future Skills Needs, 2007.

Figure 3: Average employment growth in science and engineering occupations, 2001-2006.



Data from the National Skills Bulletin 2007.

The demand for SET graduates is increasing within the services sector[8]. Both worldwide and in Ireland, services are rapidly increasing in importance. In Ireland, two out of every three workers are employed in services, with this sector contributing sixty percent of "value added" in the economy. There is a high demand for SET graduates within this sector. In 2004, for example, 476,000 people with SET qualifications were employed in services in Ireland, compared to 88,000 in manufacturing. These figures show that that SET graduates are in demand in both the manufacturing and services sectors.

SET graduates are also in demand across Europe. The 2004 EU Commission publication "Europe Needs More Scientists" reported that in order to meet the Lisbon targets of 3% of GDP to be dedicated to research, an additional 1.2 million researchers are needed across the EU[9].

Summary

Several conclusions can be drawn for the data presented in this Chapter:

- The percentage proportion of students studying science and mathematics at Junior Certificate and Leaving Certificate levels has been stable since 2001; however, changing demographics has led to a decline in overall numbers of participation at both Junior Cert and Leaving Cert level

[8] Catching the Wave - A Strategy for Ireland, Report of the Services Strategy Group, 2008.

[9] Europe Needs More Scientists. European Commission, 2004.

- Percentage demand for third level courses in science and applied science, based on students' first preferences, has been roughly constant since 2000; percentage enrolment of students for third level courses in science and applied science reflect the trends in demand and have been reasonably constant since 2000;
- Percentage demand for engineering and technology courses, based on students' first preferences, has fallen overall between 2000 and 2008. Percentage demand fell sharply between 2000 and 2004 and has remained reasonably constant since then; percentage enrolment of students for engineering and computing courses likewise fell sharply between 2000 and 2004 and have remained reasonably constant since then;
- The area where a percentage decrease in enrolments is most marked is at Level 8 courses in engineering and computing;
- Ireland ranks as one of the leading countries in the EU in terms of science, mathematics and computing graduates. However, in terms of engineering graduates, Ireland is ranked well below the EU15 average. This is a direct consequence of the prominence within Ireland's higher education system of science compared to engineering.
- Skills shortages have persisted within both the Irish and EU economies, and are most pressing in engineering and computing;
- Graduate numbers in physics and chemistry are less of a concern.

Conclusion

There is a continued need for DSE to play a role in maintaining and increasing supply of SET graduates for enterprise in Ireland – particularly in engineering and computing.

2.2. Promoting a Positive Attitude to Careers in SET

Many countries have initiated programmes aimed at encouraging young people to consider careers in SET. It is widely accepted that this is a difficult aim to achieve and that multiple factors influence young people's career decisions.

However, data suggest ways in which career promotion activities can be designed to maximise the likelihood of such initiatives having their intended impact. The one finding that stands out most strongly is that activities aiming to encourage young people to choose careers in SET must take into account the fact that clear differences exist between boys' and girls' priorities when it comes to choosing careers.

The Relevance of Science Education (ROSE) project is an international project that aims to investigate students' opinions of their experience of school science and of science in general (www.ils.uio.no/english/rose). The ROSE results allow international comparisons of student attitudes to science to be made.

The survey questionnaire consists of 217 short questions, most of which can be answered by choosing options on a four-point scale. The target population is students in the age range fourteen

to sixteen who have completed a course of study in the first stage of their second-level education. The results of the most recent ROSE survey, completed by 37 countries, were published in 2007[10]. Ireland was one of the participating countries, with 688 students from 29 second-level schools taking part. All the students surveyed were in Transition Year or in the first year of their Leaving Certificate programme and had completed a course of study in Junior Certificate Science in the previous June.

The ROSE study found that internationally:

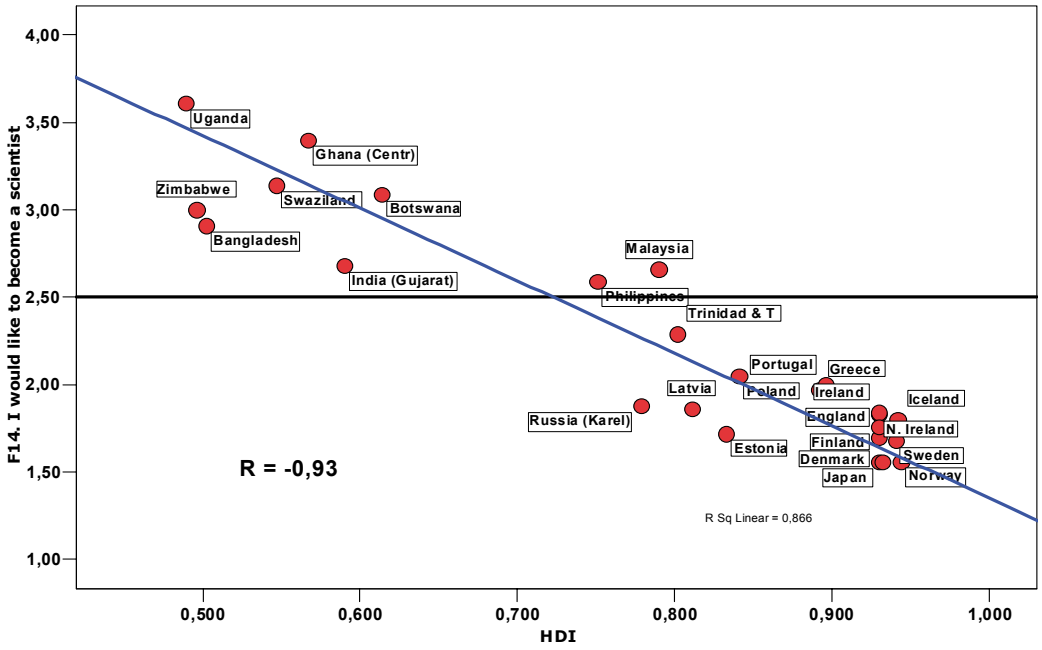
- Students are convinced of the importance of science and technology for society and are optimistic about the ability of SET to solve environmental and medical problems facing society;

But:

- When students were asked "Would you like to become a scientist?" the more developed the country, the less interested were its young population in a career in SET (Figure 4).
- The great majority of students in developed countries do not want 'to become a scientist' or 'to get a job in technology' (Figure 5). Of those girls and boys who did express preferences for careers related to science, the careers chosen were dominated by activities that had a biological/ medical/ health theme.
- As is shown in all studies of this type, there are clear differences between genders in career interests. In particular, girls are much less likely to express an interest in a career in technology than boys are.
- The more developed the country, the larger the differences between the attitudes of girls and boys in relation to interest in and attitudes to SET.

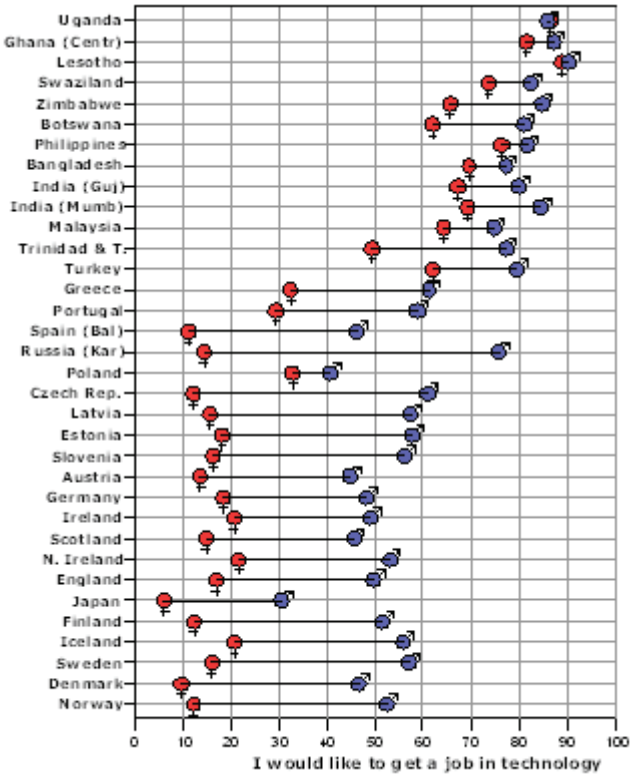
[10] How do Learners in Different Cultures Relate to Science and Technology? Results and perspectives from the project ROSE (the Relevance of Science Education. Sjøberg, Svein & Schreiner, Camilla. APFSLT: Asia-Pacific Forum on Science Learning and Technology, 7(1).

Figure 4: Comparison of the positive response rates of 15 year olds by country to the question 'Would you like to become a scientist?' plotted against the level of development of the country as measured by the Human Development Index.



Data from the 2006 ROSE Report.

Figure 5: Percent of 15 year olds who agree with the following statement; I would like to get a job in technology.



The red marking represents female views, while the blue represents male views. Scale is from 0: not at all interested to 100 very interested. Data from the 2006 ROSE Report.

The differences in attitudes to SET between the genders shown by ROSE are dramatic, particularly with regard to careers in technology. These gender differences are also seen in students' subject choices at Leaving Certificate level. For example, in 2007, 34% of female Leaving Certificate students participated in biology compared to less than 17% of males. In the same year, 11% of males participated in Leaving Certificate physics compared to less than 4% of females.

These results highlight the need for DSE to take carefully into account the gender differences in their career promotion activities, particularly when it comes to promoting careers in technology and engineering.

2.3. Promoting a Greater Understanding of Science among the Public.

DSE was established partly because of concerns about the widespread lack of awareness of, understanding of, and appreciation of the fundamental role played by SET in Ireland's modern economy.

SET is an integral part of modern living. Virtually every major issue facing society today has SET at its core, from health to global warming to sustainable development. Despite the centrality of SET, societies can display scepticism and wariness towards particular areas of science. This is sometimes the case for research on genetically modified organisms or stem cell research, for example. One aim of SET engagement programmes is to address such public concern.

The current consensus for successful public engagement in SET is that a convergence of the scientific community and the public is required, as opposed to initiatives targeted at educating the public on science issues. Innovative public engagement initiatives have taken the form of consensus conferences, focus groups and citizen's juries (in which members of the public question experts with opposing views). The extensive efforts at public engagement surrounding the launching of the Human Genome Project clearly showed how such dialogue can help assuage public fears about new areas of research. Successful public-science engagement aims to foster greater understanding between the science community and society, creating an environment where science can flourish.

The Eurobarometer surveys regularly examine awareness of SET among the general public across the EU. The 2005 Eurobarometer survey "Europeans, Science and Technology" aimed to measure public knowledge of science, interest in science, level of science activity measured by attendance at science museums and centres, and the level of esteem in which the public holds scientists and medical professionals in all EU countries[11].

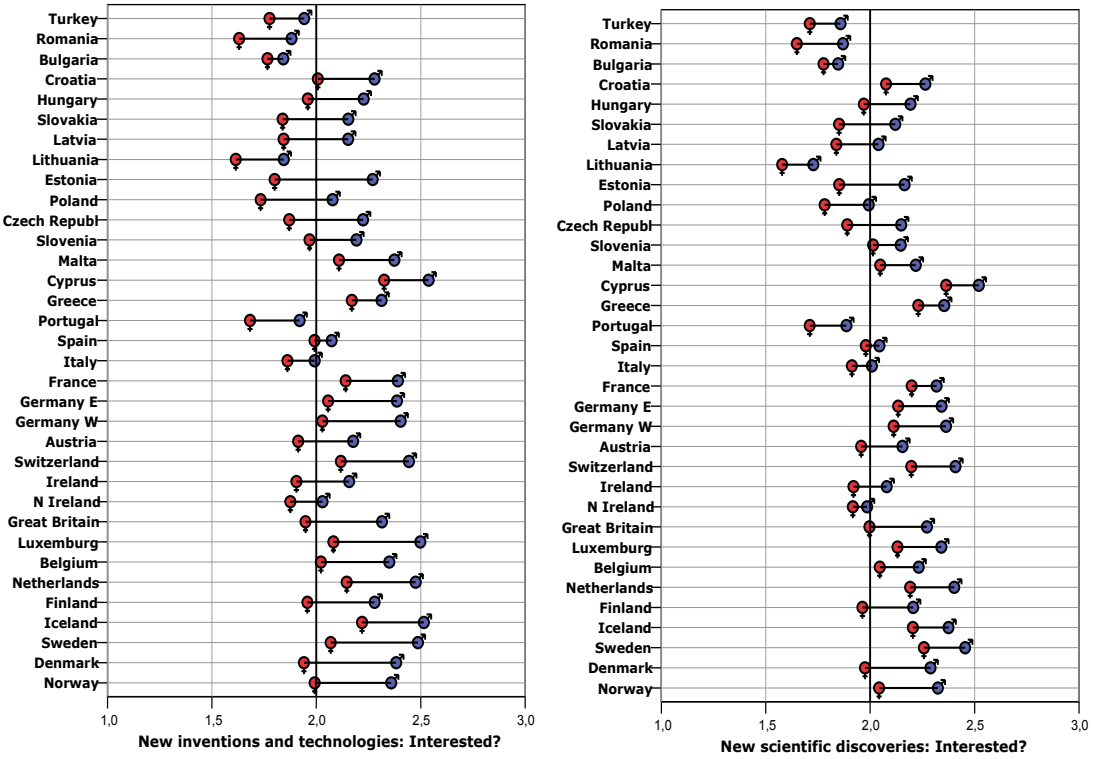
A comparison between ROSE and Eurobarometer allows comparisons to be made between the attitudes of 15 year olds and adults towards science and technology.

The Eurobarometer and ROSE surveys found that:

- Ireland ranks lower than most developed countries in relation to interest in new inventions, technologies and new scientific discoveries (Figure 6).
- Ireland ranks lower than other developed countries in relation to interest in reading science articles in the media (Figure 7).
- While Ireland ranks alongside other developed countries in relation to the belief that science will benefit the economy, it ranks lower than some other developed countries, most notably the Scandinavian countries, in the belief that science will create more opportunities for future generations (Figure 7).

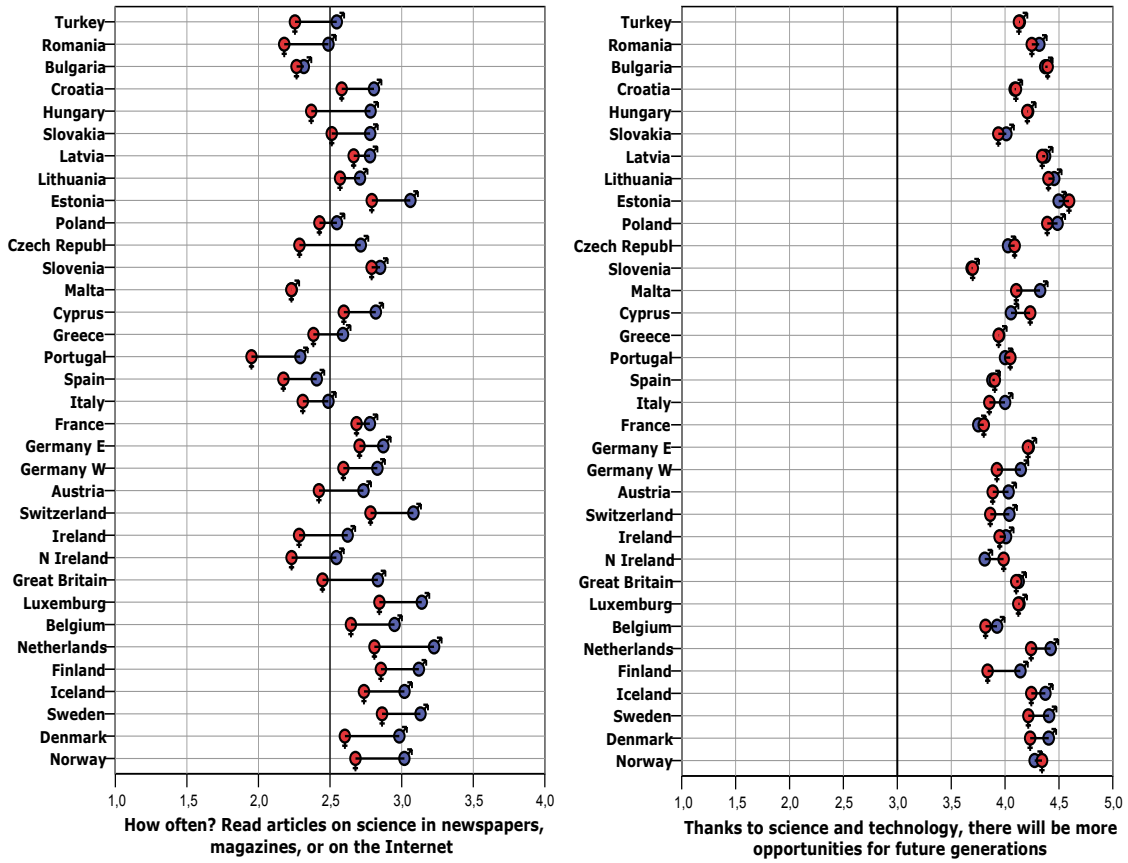
[11] Europeans, Science and Technology – Special Eurobarometer. European Commission, 2005.

Figure 6: Responses in relation to the following questions; (1) interest in new inventions and technologies and (2) interest in new scientific discoveries.



The red marking represents females' views, while the blue represents males' views. Scale is from 1: not at all interested to 3. Very interested. Data from Eurobarometer 2005 (analysis from a publication by Svein Sjøberg and Camilla Schreiner made for the Research Council of Norway).

Figure 7: Response of the general public in relation to the following questions: (1) how often have you read science articles; and (2) science will create opportunities for future generation.



The red marking represents female views, while the blue represents male views. On the first graph (to the left) the scale is from 1: never to 4: often. On the graph to the right the scale is from 1 = disagree completely to 5 fully agree. Data from Eurobarometer 2005 (analysis from a publication by Svein Sjøberg and Camilla Schreiner made for the Research Council of Norway).

Conclusion

There is a continued need for DSE to play a role in science awareness and public engagement.

Chapter 3 - Is DSE Achieving its Stated Objectives?

3.0 Introduction

This chapter begins with an overview of DSE's activities across primary and second level schools, in promoting careers in SET and in public-science engagement. The chapter then summarises the main findings from the Circa reports[12] and the focus groups and one on one interviews on DSE's operations, together with the additional findings that emerged from the meetings of the Panel.

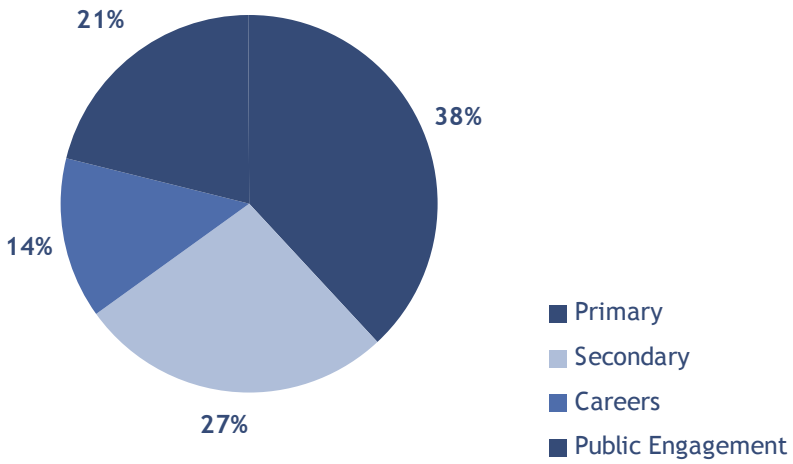
3.1 Overview of DSE Objectives

DSE's overall objectives are:

- To raise the general level of awareness of the physical sciences;
- To raise the level of student uptake of the physical sciences at second and third level;
- To promote a positive attitude towards careers in Science, Engineering and Technology; and
- To promote a greater understanding of science amongst the public / society.

[12] Literature Review of Monitoring and Evaluation of Discover Science and Engineering. The CIRCA Group, 2008.

Figure 8: Distribution of DSE's budget (2008) across their four target audiences.



Primary School Activities

DSE's main expenditure at primary level is the Discover Primary Science (DPS) programme. DPS's main objective is to support the teaching of the new primary school curriculum. DPS activities include support for the training of primary teachers, the development of classroom material linked to the primary science curriculum, and the coordination of a network of science-related centres around the country in support of primary science teaching.

Second Level Activities

DSE's activities at second level have been modest to date. DSE had no initiatives targeted exclusively at second level students until 2006, when DSE added second level initiatives to its work programme. A number of pilot programmes now exist. The main project in this area is Discover Sensors, which is piloted at students studying for Junior Certificate Science. Discover Sensors aims to support, as part of the Junior Certificate Science curriculum, the introduction of practical scientific investigations.

Career Promotion

The promotion of careers in SET has always been part of DSE's remit. However, until recently, DSE's activities in this area have been mainly indirect. The largest activity by far in this area is the programmes run by Engineers Ireland with sponsorship support from DSE. Since 2007 DSE has also become directly involved in career promotion activities itself through the development of a science careers portal for students on the internet.

Public Engagement

The main public engagement activities in which DSE is involved are: Science Week Ireland, an annual, week-long programme of events taking place across Ireland each November; the BT Young Scientist and Technologist Exhibition, a national competition where school students present results from their school research projects; a dedicated TV series, produced in conjunction with the national broadcasting organization, RTE, aimed mainly at the younger audience; and 'opportunistic TV' whereby science stories are continuously pitched to local and national media.

It is notable that few of DSE's public engagement activities are aimed solely, or even predominantly, at adult audiences.

Sponsorship and Partnerships

DSE differs from most national science awareness programmes in that it develops and delivers awareness activities and also sponsors other bodies in projects that pursue the same aims.

DSE's sponsorship expenditure is substantial. In 2008, for example, sponsorship accounts for approximately 25 percent of DSE's total budget. Sponsorship enables substantial leverage, both financially and in terms of the added impact that comes from supporting other organisations that seek to promote the public awareness of S&T. DSE does not provide full funding for sponsored activities, as matching funding is required.

Between July 2006 and December 2007, DSE dealt with almost 120 applications for sponsorship. Sponsorship funding for successful projects ranged from €200 up to €75,000. In around half of these projects, funding from DSE was less than €5,000.

DSE's major partnership is with the STEPS to Engineering programme operated by Engineers Ireland, which aims to encourage more students to choose engineering as a career.

DSE budget for sponsorship and partnerships was around €1.3m in 2007 and was divided roughly equally between the two types of activity.

3.2 Assessment of DSE's Performance

To date, evaluations of DSE's activities have been in the form of:

- Evaluations of DSE's management and operations, including reviews of governance and of compliance with financial regulations;
- Formative evaluations of individual activities, the findings of which are used to improve the content and delivery of each activity; and
- Output measures of each activity, such as numbers of students or teachers reached, attendance figures, etc;

This chapter will now review the data which is available on DSE's performance from previous monitoring and evaluation activities.

Management and Operations

Consultation with external stakeholders leads us to conclude that:

- the DSE programme is operating effectively, efficiently and with flair;
- the team is hard working, committed to innovation and passionate about the programme; and
- no other organisation in Ireland is better placed to undertake the task of promoting science and engineering.

However, the achievements of DSE are not well known internationally which limits the flow of knowledge and best practices between similar internationally SET awareness groups.

STEPS to Engineering is DSE's main strategic partner. This partnership is valuable – particularly for DSE's activities in promoting careers in engineering - and appears to be operating well. As part of DSE's internal monitoring and evaluation of STEPS to Engineering, quarterly reports are prepared for DSE, which monitor targets and outcomes for each activity and also provide details of all press, TV and radio coverage of the programme's activities.

Primary Level Initiatives

Since DSE's establishment, its expenditure has been greatest on primary level initiatives. Two external evaluations have been carried out to date[13,14]. The main findings from these were:

- The target of making DPS available to 3300 primary schools by the end of 2007 was achieved on time.
- 97% of teachers rated DPS's impact on pupil's interest or awareness of science as being a four or five on a five point scale.
- The recommendations from monitoring and evaluation of DPS have been used as part of the process of piloting, testing and improving programme activities. DSE's materials have become part of the core materials for many primary schools.

Second Level Initiatives

Before 2006 DSE had no initiatives targeted exclusively at second level schools. The first initiative targeted at this audience is Discover Sensors. Internal monitoring and review of the Discover Sensors programme has been carried out[15]. This found that:

An early target for Discover Sensors was to pilot in 50 schools by the end of 2006. This target was achieved ahead of time and Discover Sensors was piloted in 90 schools by this date.

---

[13] Evaluation of Discover Primary Science 2004-2005. Motherway Bebley Consultants, 2005.

[14] Evaluation of Discover Primary Science200-2007. 2007.

[15] Evaluation of Discover Sensors Pilot Project. Dr. D. Kennedy, University College Cork 2007.

The review of Discover Sensors reported that the project had been successful in achieving its main aims of supporting the use of sensor technology at the Junior Certificate Level. Teachers felt their participation in this programme had been beneficial to their teaching.

The findings emerging from this pilot have been used by DSE to refine the project and the pilot is to be expanded into 150 schools.

Career Initiatives

DSE's direct involvement in activities aimed at encouraging young people to choose SET careers has been limited to date. DSE's main involvement in this area has been via funding for STEPS to Engineering, which has a number of career promotion activities: the Engineer to School Initiative was established in 2005 and brought graduate engineers to visit schools to talk about the diversity of the engineering profession. In 2005, over 200 engineers and 7,000 students were involved.

In 2006, this activity was combined with Information and Communication Technology (ICT) Ireland's ICT Champion Programme to become the Engineering and Technology Champion Visits. It was designed to explain both engineering and ICT courses to the target audience. 400 schools, involving 8,200 students, took part in 2006 and a target of 10,000 students was set for 2007.

Career Choice operated by DSE, in conjunction with Engineers Ireland, was piloted in 2006. 400 schools were visited by young people working in the ICT industry to promote careers in engineering.

A new campaign, Areyouupforit, was introduced in 2006 to address the continuing drop-off in ICT students in third level. It took the form of an on-line competition to encourage students to consider studying ICT.

Evaluation reports are required at present of all sponsored activities. However, an increased focus is needed on determining the impacts derived from these activities. It is acknowledged that such evaluation is difficult. Clarity on intended outcomes and intended impacts at the time of application for sponsorship is needed to provide a benchmark against which impact evaluation can later be made.

Public Engagement Initiatives

Science Week is DSE's greatest monetary investment in public engagement. Two external reviews have been carried out[16,17]. The main findings from these reviews were:

- The awareness of Science Week, at 48%, scored well among the general population, compared with other national awareness programmes measured in a national survey. Among 15-24 year olds the awareness level was 63%. These figures are high in comparison to awareness of the UK Science Week, for example;

[16] Review of Science Week. 2005 OCS Consulting, 2006.

[17] Review of Science Week. 2006 OCS Consulting, 2007.

- Events targeted at primary schools are most popular, in terms of visitor numbers and recorded satisfaction;
- Positive responses were recorded from attendees; and
- The recommendations from these reviews have been used mainly to improve the effectiveness of the event.

DSE's primary initiative for television was a series of programmes called SCOPE, developed in co-operation with RTE and aimed at school students at second level. Audience ratings were monitored and two external reviews of SCOPE were conducted, one in 2004 and one in 2007[18] [19]. Ratings for SCOPE, while encouraging in the initial years of the series, had fallen by 2007. Based on the 2007 evaluation, SCOPE was discontinued.

DSE continues to use 'opportunistic TV', in which stories with a science content are continuously pitched to the news media, as a means of increasing public awareness of S&T. This involves pitching stories with science content to TV news personnel. The number of stories aired, as well as total airtime, are monitored.

DSE has a number of websites that have been developed both for specific projects and as vehicles for general science awareness. The visitor numbers and pageview data are regularly monitored for each of these. The most popular sites are science.ie (around 74,000 visitors and 180,000 pageviews in 2007) and primaryscience.ie (around 66,000 visitors and 282,000 pageviews in 2007).

Reviews are undertaken of all STEPS to Engineering public engagement activities on completion, such as Engineered! A Week of Wonder 2007[20]. The review of this programme reported that initial targets were reached and surpassed. Feedback obtained from forms distributed to parents at the events and from a follow-up survey of organisers reported that respondents reported high scores for educational value (4/5) and enjoyment (5/5).

3.3 Is DSE Achieving Its Stated Objectives?

Having reviewed the data from previous evaluations, each of DSE's objectives will now be considered in turn to address the question 'Is DSE achieving its stated objectives?"

DSE has been in existence for a comparatively short period of time and is working to effect change in areas where direct causal linkage is difficult if not impossible to prove. Nevertheless some reasonable judgements on how DSE is performing in relation to its objectives can be made.

[18] SCOPE Rating Analysis. Agtel, 2006.

[19] Review of SCOPE TV. OCS Consulting, 2007.

[20] Evaluation of Engineered! A Week of Wonder, 2007

To raise the level of student uptake of the physical sciences at second and third level

This is the principal objective of the area in which DSE has been most active, for example, Discover Primary Science. It is also the area in which DSE is showing its most measurable impact as reflected in teacher and student enthusiasm for and engagement with DPS.

The impact of DSE on student numbers studying S&T at second and third levels is harder to assess. It is of course impossible to know what the situation would be if DSE were not in place.

The evidence reported in Chapter 2 shows that the uptake of the physical sciences at second level in terms of the proportion of students choosing physics and chemistry has been more or less constant for almost a decade. While the term 'crisis' has often been used by some to describe the numbers of students choosing physical sciences, there appears little evidence of this in terms of student numbers at second and third level. In engineering and computing there has been more clearly an issue of skills shortages.

In terms of the quality of science education, Ireland faces a number of challenges. The introduction of science in the primary curriculum is a positive step and DSE has been playing an important role in facilitating the rollout of that curriculum. Most teachers at primary level, however, have not studied science and for many the new curriculum remains a challenge.

At second level, the practical aspect of science remains underdeveloped within science curricula. Changes in curricula for maths and science are being introduced and DSE can play an important role in facilitating the rollout of these.

We believe that one of DSE's strengths is the role it is playing in facilitating the improvement of science teaching in Ireland's schools. DSE should build on this strength.

Given the upcoming introduction of a new curriculum in mathematics at second level, there is a need for a DSE-type initiative to play a role in enabling teachers and students to engage with this revised curriculum. DSE has a proven ability, as demonstrated through the success of DPS, to fulfil this role in a non-threatening and facilitative way.

To promote a positive attitude towards careers in Science, Engineering and Technology

To date, DSE's activities in promoting careers in SET have been modest. This area requires more focus and greater assessment of the impact of DSE's career promotion activities is needed.

Following the unprecedented job growth of the last decade, DSE has invested considerable resources to encourage students to choose to study science and engineering in order to address skills shortages within the economy. Skills shortages have been reported in science and engineering, which have largely been met through a combination of an increase in the number of SET graduates from Ireland's higher education system alongside immigration of highly skilled SET graduates. As a result of the priority given to SET, Ireland's education system in recent years has been producing the highest proportion of science graduates in the EU. With Ireland's economy adjusting to a sustainable level of growth, the shortages seen in recent years are unlikely to persist. Skills shortages do, however, continue to be an issue in some high tech sectors, the evidence showing that this is more acute in engineering and computing careers than in physics and chemistry. In current economic circumstances, where job growth is expected to fall, it is important that DSE's remit adjusts accordingly.

We believe it is important that DSE continues to promote a positive attitude towards careers in SET. The evidence clearly shows that mathematics and engineering are the issues of greatest concern. However, DSE should focus more clearly on developing and testing new, more imaginative and better targeted programmes. Appropriate impact evaluations will also need to be developed and should be used to determine the impact and effectiveness of DSE's pilot initiatives in this area.

DSE's activities in promoting careers in science and engineering have been largely implemented via other organisations, mainly via sponsorship of STEPS to Engineering. In our view this is appropriate given that engineering represents the area where skills shortages are most acute and recommend a further strengthening of this relationship.

To raise the general level of awareness of the physical sciences and To promote a greater understanding of science amongst the public / society

The results from surveys of public awareness of science show that Ireland lies behind other EU countries in the public's understanding of, interest in, and engagement with science and technology. DSE thus clearly needs to continue its activities aimed at promoting public engagement with science and technology.

Impact evaluations of DSE's public engagement activities have been limited to date. Measuring the impact of public engagement activities is notoriously difficult. Greatest impact often results from engaging with issues that are already of public interest and concern. These areas often lie outside DSE's current core remit of the physical sciences and engineering. DSE needs to reassess its public awareness activities to ensure intended outcomes are more clearly defined.

3.4 Conclusion

Taking the findings discussed in this chapter into account, we believe that DSE is performing well; that it could have an even greater impact; and that a clearer connection needs to be drawn between DSE's objectives and its operational programmes.

In the following chapters we will outline how we believe greater impact from DSE's activities can be achieved.

Chapter 4 - Could DSE Be Making a More Significant Impact and, if so, in Which Specific Areas of Activity?

4.0 Introduction

This chapter will summarise our recommendations for changes to ensure that DSE has an even greater impact and the reasoning behind these recommendations.

DSE is a unique asset to Ireland. With modest resources, DSE has been able creatively to promote public awareness and engagement with science and technology. Some strategic adjustments – recommended below - would enable DSE to support national economic objectives more effectively.

4.1 Recommendations

Overall Recommendation

DSE should continue to be strongly supported by the Government.

DSE's Role in Science Education

By making science accessible to teachers, many of whom have not studied science, DSE is also serving as a change agent in school, enabling the cultural changes needed to improve the quality of science education. DSE should continue to develop its DPS activities, but proven and successful activities should be taken up elsewhere within the education system.

Recommendation

In order to allow DSE concentrate on its core strength as a change agent within science education, proven activities should be integrated into the education system. Only those activities that are still being developed should be retained by DSE. This will enable DSE to focus on piloting creative new initiatives.

Mathematics underpins SET, as well as many other disciplines. However, mathematics is also perceived as difficult by many students and this perception is one of the main obstacles to increased study of SET subjects. This has had a deleterious effect on the numbers of students taking up careers in SET, particularly in engineering. As outlined in Chapter 2, it is in engineering that the fall in numbers at third level has been most marked and where skills shortages are most acute.

There is clear evidence of a need for DSE-type initiatives aimed at supporting the rollout of the revised curricula in mathematics that are about to be introduced at both Junior and Senior Certificate levels. This option is discussed in more detail in Chapter 5. Meanwhile, DSE can play an important role by piloting ways of improving the effectiveness of teaching mathematics within science classes at both primary and second level.

At primary level, DPS, currently the largest project of DSE, is rightly acclaimed widely as a success. However, its activities do not explicitly emphasise basic arithmetic and measuring skills and their importance in science. This should be corrected at the earliest opportunity.

Recommendation

DSE should do much more to highlight the importance of mathematics, notably elementary arithmetic, for the teaching of science. In particular, the DPS programme should be revised so that it repeatedly demonstrates the importance of arithmetic and measurement. DSE's remit at second level should include activities that pilot more effective ways of teaching mathematics in science classes at both Junior and Senior Certificate levels and support other ongoing initiatives of the NCCA and DES.

There are now plans in place to expand DSE's involvement at second level and it is important these plans are implemented soon.

Recommendation

Following the successful pilot of the "Discover Sensors" programme aimed at Junior Cert levels, DSE's involvement in developing activities at second level should be increased as planned.

Many other industrialised countries are developing initiatives to encourage participation in science education, specifically targeted on underrepresented and marginalised groups. DSE is the only national programme in our experience in which such affirmative action is not taking place.

The logic behind such action is that in sectors of society where there is little history of engaging with S&T and of taking these subjects to a higher level, appropriate programmes can redress this situation and reveal young people with the aptitude to succeed in S&T. This increases the pool of young people available for science and engineering careers. It is, however, necessary to research appropriate methods for specific target groups and to use meaningful role models. An example of this is the connection of S&T programmes with Saturday Schools, which are common in the Afro-Caribbean community in the UK.

Recommendation

Encouraging increased participation in science education among underrepresented groups should be an important part of DSE's remit.

DSE'S Role in Career Promotion

DSE's activities to promote careers in SET have been marginal to date and have focused on careers in the physical sciences and engineering. A central aim of the Government is to increase the number of students who chose a career in a subject that will directly benefit Ireland's knowledge based economy. Such careers also include financial services and software, for example. All of these require a high level of mathematical knowledge. Many students, however, do not seem to be aware of the range of careers that are open to graduates who have acquired a high level of mathematical skills.

Ireland's education system now produces the highest proportion of science, mathematics and computing graduates in the EU. However, there are still some shortages of graduates in biological science, chemistry and computing. At the same time, Ireland's education system is producing one of the lowest proportions of engineering graduates in the EU. More acute skills shortages exist within the economy for engineers.

Recommendation

DSE's involvement in promoting careers in SET and highlighting specific opportunities in shortage areas should be increased.

Recommendation

DSE's involvement in promoting careers should be revised to include raising awareness of the wide range of careers available to graduates with a high level of mathematics.

Evidence from international studies clearly shows gender-based disparities in interest in SET careers for 15-year-old students in Ireland, as is the case in most other industrialised countries. Several careers continue to be, in general, less appealing to females, notably engineering. DSE, however, does not presently address gender issues in its strategy or activities.

Recommendation

Much more should be done in DSE's career promotion activities to address gender differences in students' interest in SET careers.

DSE's Public Engagement Activities

DSE's remit excludes several areas of SET that are most popular with the public, most notably medicine, health and the environment. These areas can serve as an introduction to the physical sciences and engineering for large numbers of people – all the evidence shows that medicine and health are especially appealing to females and that young people are particularly interested in environmental issues.

Recommendation

DSE's public engagement activities should include medicine, health and the environment as hooks for key target audiences.

The areas of medicine, health and environment are not areas where there are current skills shortages in enterprise. It is important therefore that the previous recommendation is implemented in a way that does not detract from DSE's focus on its science education and career promotion activities on the physical sciences, engineering and mathematics.

Recommendation

DSE's remit with respect to science education and career promotion should continue to focus on the physical sciences, engineering and be expanded to include mathematics.

In Ireland, the Government's motivation for public engagement in science is mainly economic. What is missing is the role of public engagement with scientists in discussion of topical areas of science – such as stem cell research, nuclear power or genetically modified organisms - in order to raise the general level of informed debate on such issues. Public engagement in other countries aims to promote trust in decisions taken on matters concerning science and to enable Government to promote public engagement in decision-taking and thereby take better-informed decisions. The Consensus Conference, pioneered in Denmark and used successfully in other countries, is one model of public-science engagement being used to achieve these aims.

Recommendation

DSE should work with the relevant government departments and others in its public engagement activities to pilot public discussion of topical issues relating to S&T.

Sponsorship

DSE is unusual among national science awareness programmes because it not only develops and delivers awareness activities but also sponsors others to do the same thing. DSE's role as sponsor of awareness activities brings distinct advantages. Sponsorship enables DSE to play a role in coordinating national awareness activities; being a major funder adds to DSE's influence nationally; DSE's sponsorship programme leverages considerable additional funding to awareness activities nationwide; sponsorship allows DSE to play a role as initiator and catalyst for new initiatives; and sponsorship has enabled DSE to establish key strategic partnerships.

However, the distribution of sponsorship funding places a considerable administrative burden on DSE. The Sponsorship and Finance Sub-Committee of the DSE Steering Group presently deals with this workload. Applications for sponsorship funding are presently accepted by DSE on a rolling basis and are considered by the DSE Sponsorship and Finance Sub-Committee approximately six times per year. Projects are scored against criteria set by the DSE Steering Group.

Recommendation

In order to maximise DSE's strength as a piloting unit for new initiatives, DSE's sponsorship activities should be revised, both operationally and strategically.

Recommendation

The current system of rolling application procedures for sponsorship should be phased out within six months and replaced by a small number of application deadlines. (This should be done in such a way that it allows the DSE Programme Director some flexibility in responding in a shorter timeframe to exceptional opportunities where sponsorship would add significant value).

Recommendation

The administrative procedures for the selection and approval of sponsorship funding should be simplified. The minimum level of funding for sponsorship projects should be increased.

Recommendation

The work currently done by the Sponsorship and Finance Sub-Committee should be a standing item on the agenda of the DSE Steering Group and the Sub-Committee should be disbanded.

Evaluation of DSE's Activities

Best practice in evaluation of public expenditure clearly differentiates between input measures (such as monies spent), output measures (such as numbers of events held), and impact measures (such as improved attainment in science subjects at Leaving Certificate).

As a piloting unit, DSE could benefit from the development of a more appropriate set of evaluation measures for all its activities, to help identify the most effective programmes. By implementing this recommendation, DSE should aim to become a leader in the evaluation of and learning from science awareness activities.

Recommendation

More reliable measures of input, output and impact should be developed for the evaluation of DSE's activities. A separate, appropriate set of measures is needed for DSE's science education activities, career promotion activities and public awareness activities. In developing these measures, DSE should draw upon international best practice and involvement in international research cooperation.

Recommendation

A system for the evaluation of the impact of DSE's sponsorship activities, based on appropriate metrics, should be implemented.

Coordination

DSE is not the sole player in the science awareness field. Funding for these activities by SFI is approximately the same as that of DSE. FÁS also has a sizable budget for science promotion activities. This is important because DSE was established to provide national coordination for public investment in science promotion and awareness and prevent duplication and waste of limited resources.

SFI and FÁS are not under the remit of DSE, so coordination takes place through sharing of information on the DSE Steering Group, rather than via direct coordination of policy instruments and budgets. We acknowledge that the activities of SFI and FÁS are targeted at different audiences and have different objectives. Therefore, coordination can only take place at a high strategic level. Nevertheless, Ireland still has the opportunity to maintain a national strategic focus in its science awareness activities which is practicable for a small country and rarely achieved for larger ones.

Recommendation

A process for strengthening the coordination of the awareness activities of DSE, SFI, FÁS (and other awareness activities) is needed to ensure maximum value from their respective activities and to optimise investment in the national programme in public-science engagement.

Chapter 5 - What Level of Resources is Appropriate to Ensure DSE Makes a Significant Impact?

5.0 Introduction

In this chapter, the level of resources needed to ensure that DSE makes a significant impact on Irish science education and engagement will be considered.

Since DSE's establishment in 2004, its budget has grown from €1.6 million to €5.2 million in 2008. In determining whether this level of funding is appropriate, we considered the levels of funding available for science awareness programmes in Denmark, Portugal and Scotland. However, caution must be applied when comparing funding between countries as no two countries have the same challenges in terms of SET education, of attitudes towards SET and of skill shortages in SET.

Each country adopts its own characteristic strategy, tailored to its own challenges. Portugal and Scotland, for example, make use of science centres as a core component of their national programmes, whereas Denmark supports science municipalities - towns which develop and adapt a strategy for science education - as a central part of their national programme. A breakdown of the budget by target audience for this programme is presented below (Table 5). A comparison of the overall levels of funding across the three countries shows that the Irish budget of €5.2 million is broadly comparable to these countries. The funding from the Scottish Executive for Scotland's science centre initiatives, for example, shows funding to be of the same order as DSE's budget in 2008 (Table 6). However, given Ireland's ambitious target contained in the SSTI and the implications of that for Ireland's future skills needs, an internationally ambitious programme of activity for DSE, with the necessary resources, is required.

Table 5: Breakdown of the Danish Science Communication budget by target audience for 2007.

Breakdown of the Danish Science Communication budget by target audience (2007)	
Audience	Budget
Public	60%
Secondary	30%
Careers	5%
Public Engagement	5%
Total Budget	€1.2 million
Staffing	10 FTE

Table 6: Funding provided by the Scottish Executive for science awareness activities, 2004 to 2008

Funding Provided by the Scottish Executive for Science Promotion				
Scottish Executive Budget Line	2004/05 (€)	2005/06 (€)	2006/07 (€)	2007/08 (€)
Total	2.8 million	3.7 million	4.7 million	4.7 million
Science Centres	2,701,000	3,561,000	4,543,000	4,543,000
Science and Society	166,000	172,000	172,000	172,000

In summary, we believe that:

- DSE gives value for money, relative to the overall budgets of DES and DETE for SET teaching and promotion; and
- DSE could optimise its use of resources by implementing our recommendations in relation to governance, coordination, sponsorship and mainstreaming of proven learning elements at little additional cost.

We will now consider options for additional activities should DSE's funding be increased.

5.1 Options for Additional Funding – Panel's Consensus

Reviewing the recommendations made in this report, the consensus of the Panel is that the following three areas should be accorded the highest priority, if funds are available:

- Initiatives to ensure that DSE's activities are all informed by findings from the best international research and practice;
- Initiatives in support of mathematics; and
- Targeting young people underrepresented in SET

Initiatives to ensure that DSE's activities are all informed by findings from the best international research and practice

DSE's activities need to be based more firmly on the findings of international research in science education and engagement. DSE should invest around €100,000 per annum to keep abreast of international literature, increase its international networking with science education and awareness professionals, increase attendance at international conferences and workshops, and participate in swap schemes with other international institutions. DSE should also consider mechanisms for becoming more involved in primary research in this area. A programme of long-term research should be instituted, aiming to investigate the long-term efficacy of DSE's programmes. This would enable the Irish government, within 5-10 years, to clearly evaluate the impact of DSE. We suggest that this research be pursued independently, in close collaboration with DSE.

Initiatives in support of mathematics

Our recommendations suggest that DSE should develop activities to support the learning of arithmetic at primary level and to increase mathematical literacy of students studying science at secondary level. We estimate that implementation of this recommendation would cost of the order of €1 million per annum and believe it should be implemented as priority. This recommendation would help increase the mathematical literacy of students studying science in schools. On its own, it would not resolve all the challenges associated with mathematics teaching in schools.

To address these broader issues, we recommend the development of a new set of DSE-type initiatives aimed at supporting the introduction of the revised curricula in mathematics that are about to be introduced at both Junior and Senior Certificate levels. Such an initiative would aim to strengthen mathematics teaching in schools and would involve support for teacher training, support for curricula change, research in mathematics education and awareness, and the coordination and promotion of best practice initiatives. We estimate such an initiative would require an annual budget of the order of €3 million to €5 million, and require additional staffing of around three to five people.

Recommendation

We recommend that the Government consider increasing DSE's funding, if available, in order to allow the development of a new set of DSE-type initiatives aimed at supporting the introduction of

the revised curricula in mathematics that are about to be introduced at both Junior and Senior Certificate levels.

Targeting young people underrepresented in SET

DSE is unusual in comparison with science awareness programmes elsewhere in that it does not have activities explicitly aimed at groups that are traditionally underrepresented in studying SET subjects and careers. Underrepresented groups are an untapped resource for the further development of human capital in SET. We would prioritise a number of pilot initiatives in this area targeted at a few key strategic groups.

Evidence presented in Chapter 2 shows that there are marked differences between male and female attitudes to SET. This needs urgently to be taken into account by DSE in developing future initiatives.

Certain social groups also represent an untapped reservoir of human potential for SET. In developing these initiatives, it is important to gather accurate demographic data about under achievers in SET subjects. A similar exercise in the UK, for example, identified Afro-Caribbean boys and Bangla Deshi girls as the groups which consistently underachieved in SET subjects. Following this, further research about other engagement activity in these communities would be necessary before the deriving of appropriate programmes. Careful attention to the use of language, imagery and role models, for example, is required in the construction of these programmes.

To initiate a pilot programme of research and positive action we estimate that a budget of around €250,000 would be required annually.

The above areas represent the Panel's consensus on the areas of highest priory, should additional funding be made available. Each Panel member will now give the priorities that they would personally recommend for DSE's funding priorities, should additional funding be made available.

5.2 Options for Additional Funding – Panel Members' Individual Comments

International Activities and Public Engagement - Dr. Graham Farmelo

I believe that DSE would be wise (a) to increase substantially its involvement in international activities, and (b) to pilot some innovative public engagement projects. The increased involvement in international activities would give the team greater awareness of pioneering research findings and hence would do much to ensure that DSE's work is based on the latest thinking. Another bonus would be that the excellence of DSE's activities would deservedly be given a much more prominent platform. The aim of the new public engagement activities would be to increase public involvement in the discussion of topical scientific and technological issues (e.g. genetic science, nanotechnology, global warming) and thus promote public trust in scientists. There is ample evidence that if such activities are well-organized and publicized, they do much to increase public engagement with science.

Education Research - Professor Heinz Wolff

Little is known objectively as to how an interest in engineering and science can be inculcated under classroom conditions. It becomes even more difficult if the teachers may themselves have little interest, or training in the field. What follows is one possible solution, because I argue that being skilful may be a more potent signpost into SET, then short term exposure to scientific demonstrations.

We live in a world where the functional beauty of the hand has been put at a discount. The keyboard and the buttons of a computer game have taken the place of activities where skilled manipulation is required. Construction sets, Meccano, sewing, puzzles, even peeling vegetables or shelling peas have largely disappeared. I believe that children who become "manipulate" (a companion word to articulate), that is who are skilful with their hands learn better - the organisation of the brain is still plastic at a young age and different connections are made when manual skills are learnt. Making and mending things is a direct route into engineering and science. I would make a big investment in Meccano (not Lego), old alarm clocks, clockwork toys, minor fiddly construction projects, which could have a engineering slant. Making a balance out of Meccano and using it, builds skill, comprehension of weight and balance and arithmetic. If I were a betting man, I would wager that this policy applied from age 5 to 11, would have a bigger impact than anything else you could do.

Learning from Others Internationally - Annette Smith

There are actions which would be useful for DSE to undertake which could put their activities into a wider context and help to ensure that they are using the best practice, both nationally and internationally. These need not be heavily cost dependent, but will require some human resource and a dissemination strategy throughout DSE with appropriate communication to Forfás. One of these is maintaining an international presence. In the past DSE has engaged with a European network of science event organisers and has benefited from this in terms of thinking about the international experience of science weeks. This relationship should be continued as well as bilateral communication with individual European countries which run nationwide initiatives. In addition to this, DSE should ensure that note is taken of the latest research findings in science education, so that the programmes are built on a solid foundation. This is not difficult or costly to achieve, for example by attending international conferences and keeping up to date with publications, but it may have personnel implications. In terms of public engagement, DSE could benefit by being more aware of international developments – for example the consultation practices which are highly developed in Denmark. The UK's Science Communication Conference provides a useful benchmark each year, and the international science communication forum, known as PCST and held biennially, also gives a world view.

On careers, it is important that DSE holds a view of the totality of science and engineering careers promotion across Ireland and of the quality of that promotion. It would be useful to carry out some research into the drivers of career choice in Ireland as these are likely to be highly specific to this country and the international perspective might be less relevant here.

Research - Professor Svein Sjøberg

Any initiative to stimulate young people's interests and motivation has to take into account the values, perceptions and priorities of the young learners. Otherwise, one cannot expect positive results. This view has the following consequences:

1. One needs evidence and research that sheds light on young people's values – in particular how these relate to science and technology. Currently, Irish involvement in such international research communities is rather weak. Hence, one needs to be updated on such research, and also needs to take part in internationally oriented research that focuses on such attitudinal aspects of young people and SET.

2. From such research, also in Ireland, one knows that young people, in particular girls, are very interested in issues related to human welfare, health, medicine as well as the emerging environmental challenges. In addition to the intrinsic importance of such questions for the future of our societies, they also provide pedagogical opportunities to show how such issues require SET knowledge and skills. Most young learners are unaware of the importance of the physical sciences for modern medicine, welfare and care for the environment.

3. Finally, research indicates that attitudes towards SET are formed at an early age. One should keep this in mind when priorities are determined.

Chapter 6 - Where Should DSE Be Located?

6.0 Overview

This chapter will review the findings on (i) DSE's physical and administrative location and (ii) DSE's governance.

We explored the following options for the optimal administrative and physical location for DSE:

- Within the Department of Education and Science (DES);
- Within other agencies under the aegis of DETE e.g. SFI or FÁS;
- As a separate body e.g. charity, quango, etc;
- Within Forfás and in the same building; or
- Within Forfás but in a different building.

The mission of the DES encompasses all subjects and not only SET. DSE's location under DETE helps maintain a focus on DSE's mission in SET in a way that would be more difficult to maintain were DSE under the DES.

We have concluded that: the administrative position under the aegis of DETE is correct given DSE's mission focus on economic development; that DSE has established a reputation based largely on that of Forfás and we see little advantage in moving DSE from Forfás to other DETE agencies. We have addressed the issue of coherence of science awareness activities in Chapter 4.

In addition, the Minister for Finance has recently called for the rationalisation of Government agencies. The establishment of DSE as a separate body is therefore unrealistic at present.

We therefore concentrate in some detail on the advantages and disadvantages of DSE's physical and administrative location under the aegis of Forfás and on how some of the disadvantages could be addressed.

6.1 DSE's Physical and Administrative Location in Forfás

There are several advantages to the present administrative location within Forfás, including: the maintenance of a strong relationship with DETE which encourages mission focus on SET; the Forfás corporate identity, which allows wide access including, crucially, ready access to teachers and students which in turn facilitates DSE's core strength as a change agent in science education; and financial and operational advantages in the areas of staffing, wages, pensions, overheads etc.

DSE's physical location within Forfás brings advantages with regard to accommodation and overheads.

DSE's physical location within Forfás brings several disadvantages, namely: limited direct access to target audiences, particularly school children; and restrictions on open electronic access.

On balance, we believe that DSE should remain in its current location, where it works quite effectively. However, it is important that the downsides of DSE's location are addressed.

The disadvantages of DSE's positioning within Forfás – namely limited direct access to target audiences and restrictions on open electronic access – could be overcome were DSE to remain under Forfás administrative jurisdiction but be located at another, more suitable location. One such location would be the Exploration Station which is due to open in 2012. Relocating DSE there, while maintaining DSE under Forfás' administrative jurisdiction, would maintain all the advantages currently accruing from DSE's current positioning, while overcoming two of the main disadvantages.

Recommendation

DSE should remain within the administrative umbrella Forfás, but the disadvantages associated with its current physical location need to be addressed.

In the longer term, consideration should be given to co-locating DSE with Exploration Station, while remaining under the aegis of Forfás, if practicable. This should only be done of course provided security of tenure and economic viability are assured.

We strongly urge that options be explored in the interim in order to improve the fit between DSE's mission and its working environment within Forfás, particularly concerning more open Internet access and visitor visibility.

Improving Governance

The DSE Steering Group is not functioning as effectively as it should. The Steering Group is too large; meetings of the Steering Group are not held as frequently as required for optimum governance; and the Steering Group would benefit from a more focused membership with enhanced expertise in research and practice of science engagement activities. International best practice would suggest a maximum size of around twelve Board members. This is roughly the size of the Board of Trustees recommended by the Charity Commission in the UK for an organisation of a similar size to DSE, for example.

Recommendation

The composition of the DSE Steering Group should be reviewed. The effectiveness of the Steering Group would be enhanced by having a maximum of around twelve members. Meetings should also be held at least six times per year. Representation from both the DETE and the DES at the appropriate level is essential.

The DSE Steering Group should include more researchers and practitioners in science education and public engagement in science and those who can best drive DSE's role as a change agent in primary and second level science education.

DSE's governance structure needs to be clarified. The Forfás Board and the DSE Steering Group are both appointed by the Minister for Enterprise, Trade and Employment. The DSE Steering Group has responsibility for setting DSE's strategy and for allocating spending across the various areas of DSE's activities. The Forfás Board and Executive have the responsibility for implementing and accounting for decisions made by the DSE Steering Group.

At present, the roles of the DSE Steering Group, the Forfás Board and the Forfás Executive are unclear.

Recommendation

The respective roles of the DSE Steering Group, the Forfás Board and the Forfás Executive should be clarified and a clearer governance structure should be put in place. One option that was raised during this evaluation is that the DSE Steering Group could become a Sub-Committee of the Forfás Board. We recommend that this option be explored.

Chapter 7 – Summary of Recommendations

The panel recommends that DSE should continue to be strongly supported by the Government and that the following recommendations under strategy, increasing effectiveness, priorities for funding and governance be implemented. Each recommendation should be implemented on foot of the guidance and review of the InterDepartmental Committee on Science, Technology and Innovation, and under the oversight of the Cabinet Committee on Science, Technology and Innovation.

	Refocusing of Core Activities
1	In order to allow DSE concentrate on its core strength as a change agent within science education, proven activities should be integrated into the education system. Only those activities that are still being developed should be retained by DSE. Action to be taken by : Department of Education and Science This will free DSE to focus on piloting creative new initiatives. **Action to be taken by : DSE**
2	More reliable measures of input, output and impact should be developed for the evaluation of DSE's activities. A separate, appropriate set of measures is needed for DSE's science education activities, career promotion activities and public awareness activities. In developing these measures, DSE should draw upon international best practice and involvement in international research cooperation. **Action to be taken by: DSE, consistent with the policy objectives agreed with Forfás**

	Increasing Effectiveness
3	DSE should do much more to highlight the importance of mathematics, notably elementary arithmetic, for the teaching of science. In particular, the DPS programme should be revised so that it repeatedly demonstrates the importance of arithmetic and measurement. DSE's remit at second level should include activities that pilot more effective ways of teaching mathematics in science classes at both Junior and Senior Certificate levels and support other ongoing initiatives of the NCCA and Department of Education and Science. **Action to be taken by: DSE, following engagement with appropriate stakeholders such as DES, NCCA**

4	Following the successful pilot of the "Discover Sensors" programme aimed at Junior Cert level, DSE's involvement in developing activities at second level should be increased as planned. **Action to be taken by : DSE**
5	Encouraging increased participation in science education among underrepresented groups should be an important part of DSE's remit. **Action to be taken by : DETE (to amend DSE remit) and DSE (to identify and prioritise relevant target groups)**
6	DSE's involvement in promoting careers in science, engineering and technology and highlighting specific opportunities in shortage areas should be increased. **Action to be taken by : DSE, with particular regard to the analysis of the Expert Group on Future Skills Needs**
7	DSE's involvement in promoting careers should be revised to include raising awareness of the wide range of careers available to graduates with a high level of mathematics. **Action to be taken by: DSE, with particular regard to the analysis of the Expert Group on Future Skills Needs**
8	More should be done in DSE's career promotion activities to address gender differences in students' interest in SET careers. **Action to be taken by : DSE in conjunction with other stakeholders**
9	DSE's public engagement activities should include medicine, health and the environment as hooks for key target audiences. **Action to be taken by : DSE in conjunction with other stakeholders**
10	DSE's remit with respect to science education and career promotion should continue to focus on the physical sciences, engineering and be expanded to include mathematics. **Action to be taken by : DETE**
11	DSE should work with the relevant government departments and others in its public engagement activities to pilot public discussion of topical issues relating to science and technology. **Action to be taken by : DSE in conjunction with other stakeholders**
12	In order to maximise DSE's strength as a piloting unit for new initiatives, DSE's sponsorship activities should be revised, both operationally and strategically. The current system of rolling application procedures for sponsorship should be phased out within six months and replaced by a small number of application deadlines. (This

	should be done in such a way that it allows the DSE Programme Director some flexibility in responding in a shorter timeframe to exceptional opportunities where sponsorship would add significant value). The administrative procedures for the selection and approval of sponsorship funding should be simplified. The minimum level of funding for sponsorship projects should be increased. A system for the evaluation of the impact of DSE's sponsorship activities, based on appropriate metrics, should be implemented. **Action to be taken by : Forfás and DSE**
13	A process for strengthening the coordination of the awareness activities of DSE, SFI, FÁS (and other awareness activities) is needed to ensure maximum value from their respective activities and to optimise investment in the national programme in public-science engagement. **Action to be taken by : DETE**

	Funding Priorities
14	We recommend that the Government consider increasing DSE's funding, if available, in order to allow the development of a new set of DSE-type initiatives aimed at supporting the introduction of the revised curricula in mathematics that are about to be introduced at both Junior and Senior Certificate levels, as follows: €1 million per annum as a priority to support the learning of arithmetic at primary level & to increase the arithmetic literacy of students studying science at secondary level €3 - €5 million per annum to develop a range of initiatives intended to strengthen maths and maths teaching in schools €250,000 per annum to target underrepresented groups €100,000 per annum for activities aimed at ensuring DSE's activities are based on international best practice and research on science education and promotion **Action to be taken by : Proposals to be formulated by the IDC for the approval of the Cabinet Sub-committee**

	Governance
15	DSE should remain within Forfás' administrative umbrella, but a number of disadvantages associated with its current physical location need to be addressed. In the longer term, consideration should be given to co-locating DSE with the Exploration Station, while remaining under the aegis of Forfás, if practicable. This should only be done of course provided security of tenure and economic viability are assured. We strongly urge that options be explored in the interim in order to improve the fit between DSE's mission and its working environment within Forfás, particularly concerning more open internet access and visitor visibility. **Action to be taken by : Forfás and DETE**
16	The composition of the DSE Steering Group should be reviewed. The effectiveness of the Steering Group would be enhanced by having a maximum of around twelve members. Meetings should also be held at least six times per year. Representation from both DETE and DES at the appropriate level is essential. The DSE Steering Group should include more researchers and practitioners in science education and public engagement in science and those who can best drive DSE's role as a change agent in primary and second level science education. **Action to be taken by : DETE**
17	The work currently done by the Sponsorship and Finance Sub-Committee should be a standing item on the agenda of the DSE Steering Group and the Sub-Committee should be disbanded. **Action to be taken by : DETE and DSE Steering Group**
18	The respective roles of the DSE Steering Group, the Forfás Board and the Forfás Executive Committee should be clarified and a clearer governance structure should be put in place. One option that was raised during this evaluation is that the DSE Steering Group could become a Sub-Committee of the Forfás Board. We recommend that this option be explored. **Action to be taken by : Forfás and DETE**

Notes

The national policy advisory body for enterprise and science

Wilton Park House, Wilton Place, Dublin 2
Tel: +353 1 607 3000 Fax: +353 1 607 3030
Email: info@forfas.ie
Web: www.forfas.ie