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Innovative Initiatives: Targeting the Declining Science Enrolments in Ireland

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Abstract:

At a time of economic growth in Ireland, the declining numbers of students enrolling in the sciences is emerging as an educational concern. Using a 2002 Government of Ireland commissioned report on science: The Task Force on the Physical Sciences (TFPS) *as a guide, this article examines initiatives aimed at promoting science education in relation to recent social, philosophical, economic and cultural changes in the Republic of Ireland. Shifts in thinking about science teaching and innovative pedagogical strategies at both the secondary and tertiary levels of education are discussed.*

Until recently, Ireland suffered from a long history of ongoing population loss as Irish emigrants travelled widely in search of prosperity or economic stability. In recent times, however, with the economic success of the " Celtic Tiger" economy, for the first time in its history Ireland has become a wealthy country. With the third highest GDP per person in the world (US$52,940; NZ$85,271) (Economist Intelligence Unit, 2006), it is now attracting immigrants and the Irish diaspora are starting to return home.

In this paper, we argue that shifts in global capitalism and competing philosophical perspectives about knowledge have had a considerable influence on the way science is now regarded, both in terms of public discourse, and as an academic subject. We argue that because of current trends, it is necessary to re-examine where we can place ourselves advantageously within this new settlement. A re-examination of science education and pedagogy may be a strategic step

towards making science work for both scholarly interest and national/economic prosperity. As Jacobs argues: "A vigorous culture capable of making corrective, stabilizing changes depends heavily on its educated people and especially on their critical capacities and depth of understanding" (2004, p. 63). In exploring this issue, we first present some of the social, economic and philosophical shifts and ruptures of the contemporary postmodern condition that may contribute to the decline in science enrolments in Ireland. Secondly, we provide an overview of the nature of this decline. Thirdly, following the recommendations of The Task Force on the Physical Sciences, we examine a number of key initiatives developed by Irish scientists and educators to address it.

Changing Discourses of Science

Starting with the "Enlightenment" and followed by what has been called "The Age of Reason", scientific inquiry has attempted to ground and order our knowledge of the world in specific, carefully defined, methodological approaches. Science was once seen as a civilizing force to counter "the poison of enthusiasm and superstition" (Adam Smith, cited in Porter, 2003, p. 342). It was believed that, "Science would come to the rescue of truth, setting it at last upon rock-solid foundations after all the centuries of scholastic castles in the air" (p. 80). With the advancement of the industrial revolution, at the end of the eighteenth century it became clear that there was "no technology without wealth, but no wealth without technology" (Lyotard, 1989, p. 45). Contemporaneously, science is funded by public, private and mixed-sector research foundations, and it has a degree of accountability, not to truth or to a quest for knowledge alone, but rather to its ability to efficiently produce innovations that drive national economies. Due to these shifts, science and technology have become commodified.

State-sponsored educational institutions were originally designed to address the needs of the citizens of rapidly industrializing economies. Today however, educational institutions are being encouraged to follow a business model that serves the needs of "clients" (parents and children/students), and produces tangible "outcomes" in the form of differently skilled workers that are properly "trained" to meet the demands of the knowledge economy (Fullan, 2003). "Just as prescriptive technologies have … overwhelmed holistic ones, so have production models now become almost the only pattern of guidance for public and private thought and action" (Franklin, 1990, p. 31). Thus, social and

economic shifts toward the marketisation of education have somewhat shaken science from its position as a dominant "grand narrative" of knowledge. While some might argue that the decline of science enrolments may represent a "crisis", we would argue that it has more to do with a crisis of legitimation in the face of competing discourses of knowledge.

Furthermore, over the last forty years or so, philosophers of science have debated various ontological positions, often referred to as the "science wars" between constructivist and realist perspectives. Recently, however, in the growth of a field known as "science studies", Bruno Latour has argued for a "third way" for science, one that does not aim to pass judgment on the legitimacy of particular scientific methods, but instead, examines how the natural material world is made into "facts", knowledge, and popular discourses of science (Latour, 1999). This interrogation of the culture of science has attempted to illustrate how science intersects the natural, cultural and social world. Presenting science in a broader, complex, interlocking context may help to illustrate how the discipline of science not only offers us objective knowledge of the natural world, but is also part of the subjective way we construct reality all around us. This may mark out the documented decline as an important area of academic study, because it suggests that science is not simply an external discipline of facts; rather, it is one of the central models of thought in our world.

If contemporary discourses of science and education have been put to the service of productivity, then educators at both second and third level institutions may be strategically positioned to interrupt a discourse of production and create a pedagogical counter-discourse of scientific knowledge that is connected to individual students and not the distanced abstract demands of "capital" and industry.

This is not easy work. The excitement of discovery in the golden age of science is often taken for granted by students, and science now has to compete with many other curiosities and distractions. Traditionally, science has promised answers and solutions, and postmodernity resists being seduced by "truth effects" (Foucault, 1980). Many still assume science is our best bet for progress. But what is different is that the complexity of our world, from photosynthesis to social interaction, can no longer be contained or completely accounted for through scientific means and methods. Yet with the breakdown of the authority of positivist inquiry, and the corresponding creation of greater space for other approaches to knowledge, we may do better to embrace the

multiplicity of inquiry, as it may offer us more ways to broaden and increase the pool of those who may take up science as a subject and a career.

Declining Numbers in Science in Ireland

For the past twenty years, there has been a steady decline in enrolments in the physical sciences at secondary, and consequently, tertiary institutions in Ireland (Department of Education and Science [DES], 2002). Concern about the need to remain competitive in the new global marketplace caused the Government to initiate an in-depth examination of this issue. As a result, the Task Force on the Physical Sciences (TFPS) was set up in 2000, with a mandate to examine the nature of the problem and in response, to devise a plan of action. In 2002, the TFPS published its report, which concluded that the Government was right to be concerned, that the problem was major, and that its extent had been largely understated.

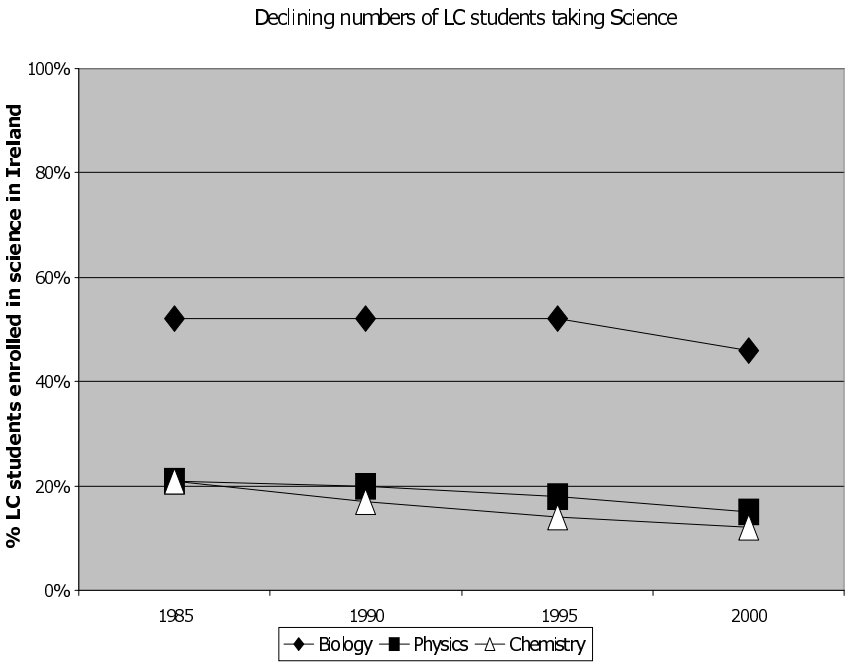

Figure 1 Percentage of LC students enrolled in the pure sciences in Ireland (DES, 2002, p. 43, Table 17)

Figure 1 illustrates the extent of the decline of second level Leaving Certificate (LC)[1] science students taking science over the past few decades in Ireland. Although participation in science at the lower secondary level (ages 12-15 years) has been relatively stable, this is not a useful indicator, as almost all students at this level have no choice but to take science as a subject. However, this is not the case at upper secondary level (ages 16-18 years), where science subjects are offered as an optional choice amongst a vast range of other subjects. It is here where enrolment numbers of LC students have been falling in recent decades. Chemistry is the subject most affected. Participation rates fell from 21% in 1985 to 12% in 2000). In physics, participation fell from 21% in 1985 to 15% in 2000. Although biology remains the most popular choice amongst the science options for LC students, statistics show that it is also becoming less popular (student participation fell from 52% in 1985, to 46% in 2000). This reduction in student participation in the sciences may not seem excessive, but the worry is that if this downward trend continues at the current rate, the knock-on effect in terms of tertiary enrolments and research and development may hinder scientific innovation and progress in Ireland.

In 2002, Ireland positioned itself to "take advantage of contemporary technological change by encouraging the investment of high-tech industries and by providing a highly-educated workforce to sustain and enlarge them" (DES, 2002, p. i). To sustain this intention, urgent action is needed to reverse the current decline and to increase the quantity of scientists being educated, and also to address the equally important issue of quality. In response to the nature and extent of the crisis, the Task Force identified six areas for action (DES, 2002):

1) Planning & resources for school science
2) Equity of access
3) Teaching & learning of science
4) School curriculum & assessment
5) Promotion of science and careers
6) Careers, science education at third level.

The next section will use these six areas for action as a framework for illustrating some of the challenges we face, and will also identify and describe the initiatives that have been (and are in the process of being) established to promote science and to increase enrolments at the secondary and tertiary levels.

Addressing the Concern: Science Initiatives in Ireland

1. Planning and Resources for School Science

Planning development and experimentation in science

In response to these concerns, the government has created a structured support service for science education in both primary and secondary education. At the primary level, there is the primary science support team (See <www.primaryscience.ie>). At secondary level, there is a support team for the Junior Certificate (JC)[2] science course (See <www.juniorscience.ie>), and a separate set of support teams to assist the senior cycle, both the LC physical and biological sciences (See <www.slss.ie>). These national teams aim to support each school in prioritising and developing science education. They are linked to regional education centres that run courses and provide support locally. The encouragement of a collaborative approach aims to address barriers and problem areas in a practical way, while at the same time, motivating teachers and promoting best practice.

This support structure follows through to all aspects of the science teaching courses, particularly in terms of practical investigation. The effective integration of experimental science is fundamental for effective teaching and learning in science. According to the Task Force report, only about half of the student cohort carried out practical work once a week and 10 percent had not ever had the opportunity to work with apparatus or scientific materials. In response, there has been an increase in funding for laboratory equipment, and the science curricula have been revised to provide a stronger focus on investigative and experimental science.

Developing technology-based resources in science

A large amount of funding has also been directed towards the integration and use of technology in the classroom to assist in the creation and development of appropriate and relevant resources for science teaching. In an effort to target the role technology integration can play in supporting and improving the uptake of science in schools, the Schools IT2000 Initiative was launched in November 1997. This initiative inextricably links the two fields of science and technology. It is the first large-scale attempt to integrate technology with teaching and learning in both first and second level education in Ireland.

Policy implementation began in 1998 through the establishment of the National Centre for Technology in Education (NCTE – See

<www.ncte.ie>), and as a result, many science education-related projects emerged. The Schools Integration Project (SIP) was one of the key initiatives of the NCTE. It focuses on whole school development and the establishment of projects which examine and explore a range of teaching/learning techniques from the perspective of ICT integration. Eighty pilot projects have been established, many of which are in the discipline of science, uniting partnerships with education centres, businesses, industry, tertiary institutions and the community. Another vibrant resource which stemmed from this initiative is Scoilnet (See <www.scoilnet.ie>), an online resource providing curricular support and information to teachers, students and parents, focusing on all subject areas, including science. In addition to the core initiatives, the NCTE is also actively involved in a number of other innovative projects, including Sci-Spy (See <www.sci-spy.ie>), directed towards 10-12 year old primary school children, and Science Unleashed (See <www.scienceunleashed.ie>), directed towards 12-15 year old junior science students. For the latter, extensive video footage was recorded on a wide range of science topics, and following school-based evaluations, interactive DVDs and websites were developed

2. *Equity of Access*

Measures have been initiated to address possible disadvantages for students who attend small schools, or rural schools, for students with special needs, and for female students. The TFPS reported that: approximately 10% of students were not enrolled in any science subject at lower secondary level; 14% and 11% of LC students were in schools where pure chemistry and pure physics, respectively, were not offered; and 3% of the LC student cohort were in schools that did not offer the physical science subjects to LC level. The TFPS stressed the need to ensure that every student in Ireland has the opportunity to study the physical sciences.

Lower secondary science is not compulsory nationwide, and as a result, there is a loss of 10% of the cohort at this level. In addition, between 3% and 14% of this cohort are in schools that only offer select science subjects at senior level. Clearly there is a need for more schools, of all sizes, in all areas of the country to offer science courses as one way to increase interest in the sciences.

With regards to gender inequity, at the lower secondary level in single-sex schools, 20% of girls were found not to be taking any science subject – as compared to only 4% of boys (DES, 2002). The absence of

one-fifth of this particular cohort of girls could have a serious impact on the numbers of students taking science at the higher levels. A study, which examined gender issues and senior secondary physics students in England and Wales found gender different in terms of perception and learning preference:

> The female students also seemed to prefer physics teaching and learning to be "contextualized", often with a people-oriented focus. Males tended to think there should be more mathematical input into their physics teaching, and females thought there should be more input of sociological examples. (Stewart, cited in Hipkins & Bolstad, 2005, p. 30)

Applying a gender analysis in relation to the decline of science enrolments in Ireland may not only serve as a useful pedagogical tool, but addressing this issue might help turn the tide of declining enrolments. Further to this, in an attempt to promote the role of women in the sciences at tertiary educational institutions in Ireland, the Women in Technology and Science (WITS) (<www.witsireland.com>) project was set up in 1990. This has had the effect of creating a useful and active network of members from a broad range of scientific, engineering and technological backgrounds to act as mentors for girls and women who are considering careers in the fields of science and technology. Gender initiatives, similar to WITS, are warranted in order to address the issue of under-representation of woman in science, and raise enrolments more generally.

3. *Teaching and Learning of Science*

A 2005 study carried out by the Irish Council for Science, Technology and Innovation (ICSTI) was critical of the teaching methods that currently prevail in Irish schools. The Chair of the Physical Sciences Task Force, Dr. D. O'Hare, supports this stance and argues that the marked fall-off in interest in the sciences is largely related to science pedagogy in Irish schools (O'Hare, 2002). Further to this, King-Rice (2003) identifies teacher quality as the most important school-related factor influencing student achievement. According to the National Science Teachers Association (NSTA) position statement: "Effective science programs are likely to emerge when teachers become engaged in the process of developing or critically appropriating curricula to fit specific pedagogical concerns" (NSTA, 1990, p. 2).

Irish science teacher educators in tertiary level education departments are well placed to respond to this concern. For example, the teacher education program at The National University of Ireland, Galway (NUIG) aims to target the declining numbers of science students through teacher-education research, experiential practice, and by endorsing and promoting new (evidence-based) methods of teaching and learning.

Some of the innovative techniques that we use within our teacher education course are addressed below, under three headings:

a) Innovative models of teaching and learning;
b) Integration of technology;
c) Socio-cultural changes to science education.

a) Innovative models of teaching and learning

Changing methods of instruction have been warranted for many years in science education in an attempt to challenge the predominant didactic model of teaching prevalent in our schools. The underlying theme in many of these science-teaching methods is the constructivist model of learning. Jenkins (2000) explores and challenges the validity of constructivism and its domination in science education discourse. Although Wadsworth (1997) promotes the idea that students who learn science using the constructivist approach are "noticeably different" from those who are learning under more passive methods, many questions remain. Jenkins identifies a number of practical concerns that are lacking in the research literature regarding constructivism in science education. For example:

- If the students' understanding of natural phenomena [previous learning experiences] are wrong, the science teacher would argue that they are to be corrected. Constructivism, however, offers little in the way of guidance about how this may best be done;
- Science evolved very late in human history and it seems more than optimistic to assume that young students can construct scientific explanations simply by observing phenomena and generating and testing hypotheses;
- Can we assume that engaging students in the necessary practical activities is the most efficient way of promoting their learning?
- What it is that "constructivist teachers" wish their students to "construct" during the course of their science lessons? (2000, p. 601)

In highlighting the problematic nature of the model of constructivism, Jenkins alerts educators to the importance of clarifying implementation strategies, and challenges our acceptance of popular trends in teacher education. This recommendation has been built into the science teacher-training programme at NUIG. Rather than focusing on just one or two teaching models, we encourage our students to try out and assess a variety of teaching models in their practice in an effort to address the multiple learning styles evident in the classroom, investigating and comparing models of both a formal and didactic nature, as well as those that are more informal and exploratory. Students are also challenged to try out a range of innovative models that have shown to be successful in the science classroom: for example, Just in Time Teaching (See <www.jitt.org>), Peer Instruction (Mazur, 1991), Modes of Demonstration (Crouch et al., 2004), and the Staged Self-Directed Learning Model (Grow, 1991). The degree of information in the literature regarding the pedagogical implementation of these models is varied, although we invite our students to adapt each model within their classroom situation, which is as varied as the models which they explore.

b) Integration of technology

Technology is an integral part of all aspects of our science education course, from preparation through to implementation, assessment and finally professional development. Digital technology can enhance both the practical and theoretical aspects of science teaching and learning. Osborne and Hennessy outline the potential contribution of technology integration in science as:

- Expediting and enhancing work production; offering release from laborious manual processes and more time for thinking, discussion and interpretation;
- Increasing currency and scope of relevant phenomena by linking school science to contemporary science and providing access to experiences not otherwise feasible;
- Supporting exploration and experimentation by providing immediate, visual feedback;
- Focusing attention on over-arching issues, increasing salience of underlying abstract concepts;
- Fostering self-regulated and collaborative learning, and
- Improving motivation and engagement. (2003, p. 4)

It is not sufficient to assume that the simple integration of science-related technologies will automatically transform the learning environment. "Technology ... becomes valuable in education if learners and teachers can do something useful with it" (OECD, 2001). Although the introduction of technology into the classroom is largely welcomed, there are many practical teacher constraints that restrict its progress: "lack of time to gain confidence and experience with technology, limited access to reliable resources, a science curriculum overloaded with content, assessment that requires no use of the technology, and a lack of subject-specific guidance for using ICT to support learning" (Osborne & Hennessy, 2003, p. 5). Many of these pragmatic issues can be addressed through adequate teacher education and in-service training. Hence, our science teacher education course, in particular, focuses on technology competence, technology-based science pedagogy, and the creation, sourcing and evaluation of relevant resources, in order to target the technology expertise of our new teachers.

c) Socio-cultural approaches to science education

In terms of scientific literacy, there is considerable concern as to whether we adequately prepare our students with a clear understanding of the application of in-class learned concepts beyond the classroom walls. According to Hipkins and Bolstad (2005), science teaching needs to engage students in the contemporary world of science. They advocate the incorporation of discussion about "real" science by real people, suggesting the possibility of inviting scientists to discuss their current occupations in the light of scientific endeavours, and viewing effective science education as a means of connecting and engaging students with social and ethical scientific issues that are relevant in society. Tytler and Symington (cited in Hipkins & Bolstad, 2005, p. 36) suggest the use of "narrative curriculum (representing contemporary science), ... closer links between community science, industry, and schools, and a restructuring of the curriculum around meaningful problems."

Roth and Désautels (2004, p. 19) take the idea of the modeling of publicly controversial scientific debates a step further, whereby the concept of situated cognition supports the notion of authenticity: "The level of expertise in dealing with school case studies does not predict the level of expertise in real situations of which the cases are said to be models." They propose that if a school activity is to be authentic, "the activity has to be legitimate at the societal as at the individual level." As a result, "participating in 'authentic' activity leads to the development

of knowledgeability – rather than the (short-term) storage of isolated facts" (Roth & Désautels, 2004, p. 19). Thus, it is argued that science education must encourage students to engage directly in current scientific public discourse and become actively involved in local and societal scientific conflict and discussion. The question arises as to whether the knowledgeability developed in our classrooms around current scientific issues and debates is sufficient, or whether we should invest and extend this notion beyond the classroom.

Further, there are also a variety of active and critical debates that challenge universalist Eurocentric science models. Such critiques suggest that there is a need to broaden Western science traditions to include cross-cultural and "traditional ecological perspectives on science." Coming to terms with the fact that "all systems are ... culture-laden, and that science (Western science) is the system of knowledge about nature that is predominant in Western culture" (Lewis & Aikenhead, 2000, p. 4) may make the discipline more inclusive and appealing to a student body that is less and less mono-cultural.

4. School Curriculum and Assessment

The last six years have seen significant changes in Ireland's science curricula and assessment at both the primary and secondary levels. In 2000, revised curricula were introduced for both the LC physics and chemistry syllabi. Three years later, the LC biology and JC science were also revised, in line with the introduction of a new science curriculum at primary level. The National Council for Curriculum and Assessment (NCCA) is also in the final stages of preparing a revised and updated draft curriculum for a combined LC physics and chemistry course, which will be incorporated into the senior cycle in the very near future.

There have been big changes in the structure and emphasis of our new and revised syllabi, where now almost one-third of each syllabus is allotted to the integration of Science, Technology and Society (STS). The three senior cycle core sciences (Physics, Chemistry and Biology) have allocated 70% of their content towards pure science, with 22.5% for its applications and interface with technology, and the final 7.5% for science which is concerned with issues that are of political, social and economic concern to citizens. Similarly, the revised JC science curriculum and the new primary science syllabus also have a stronger social and applied emphasis, providing an integrated, more practical application of the theoretical concepts of science.

Although the revision of the science curricula is a largely welcomed innovation, the powerful influence of assessment in terms of its ability to inform the curricula plays an integral role. Regarding practical experimentation, the revised JC science curriculum has incorporated an assessment component whereby 35% of the final grade is now allocated to continuous assessment through investigation and experimentation. Similar assessment procedures are currently under consideration at senior level, further emphasising the importance of the scientific process.

In order to support the implementation of these new curricula and to provide for some consistency between the tiers of the Irish education system, regular in-service workshops and courses have been organized by the government Department of Education and Science (DES). These in-service training sessions are designed to prepare teachers by exploring new approaches to teaching, learning and assessment. They provide teachers with many training opportunities, including: to test out new experiments and equipment; to explore technology integration in the classroom (through general classroom activities and experiments); and to promote schemes that encourage classroom-based research. It is envisaged that these new and revised curricula will revitalize the sciences, and influence how they are taught, with a stronger emphasis on experimentation and science for citizens. With these new foci for science, the aim is to attract a stronger student base, and to educate our secondary students with a more relevant and practical scientific understanding beyond the classroom walls.

5. *Promotion of Science and Careers*

The promotion of science nationwide

Over the past few years there has been a noticeable increase in science initiatives nationwide that focus on the promotion of science and science education within our schools and community. The Discover Science and Engineering (DSE) Initiative, launched in 2003, has brought together, and built on, existing science awareness activities and promotion strategies throughout the country. The key objectives of this programme are to raise awareness levels in relation to the physical sciences by: 1) increasing student numbers studying the physical sciences; 2) promoting a positive attitude towards careers in science, engineering and technology; and 3) fostering a greater understanding of science and its value to Irish society (Forfás, 2005). The target audience for DSE includes students at all levels (with a particular focus

on the primary and secondary sectors), their parents and teachers, and the wider public.

The DSE initiative hosts a variety of events that promote Science (IUPS, 2003) including: All-Island Innovation Awards; the Science, Technology & Engineering Programme for Schools (STEPS) (See <www.iei.ie/Steps>); Primary Science Day; Science Week Ireland (See <www.scienceweek.ie>); a new science television series called SCOPE (now in its third series) that combines science, engineering and technology, and explains everyday experiences of these areas in accessible language to a varied audience. The DSE has also developed an excellent website (<www.science.ie>) that focuses on science careers, news in science and SCOPE science events. Although we do not assume that the solution to increasing the participation rates in science would merely lie in promotional activities and media ventures, we believe that an active strategy to increase the awareness of science and science-based activities across the community could provide a further avenue of supporting and improving scientific literacy to a broader audience.

Career guidance: Student choice and participation

The issue of decision-making and subject choice at various stages of the secondary and tertiary system clearly plays a major role in determining the degree to which students take up science education. Hipkins and Bolstad (2005, p. vi) highlight some of the key transition stages that need to be targeted in terms of student retention and participation in the sciences: the transition from lower secondary to upper secondary; the transition from secondary to tertiary education; and finally within that sphere, the transition between each of the subsequent years of tertiary education. This highlights the crucial role of career guidance at each stage in our education system.

Hipkins and Bolstad (2005, p. vii) suggest that in addition to their experiences of school science, students' knowledge of the range of study and career options that involve science is an important factor in their choice whether to continue or not to continue with science. Similarly, the TFPS (2002) indicated that guidance counselors were cited as the most useful source of information on courses and careers in science. Hence, the lack of adequate career guidance in the Irish context, discussed in their report, draws much concern: "Effective career guidance at second level requires adequate numbers of guidance counselors, and the present student guidance counselor ratio of 500:1 is

an impediment" (2002, p. iv). This, in turn warrants greater investment by policy makers and education partners. Hipkins and Bolstad support this claim by stating: "Careers advice and information *do* make a difference to students" in terms of their subject choice (2005, p. vii). It is here where teacher education can also play an active role. In the majority of cases, teachers are the closest advice link and role model that our second level students have in terms of subject and career choice, and as such, our teachers are challenged to take an active role in encouraging students in their specific discipline.

6. Science Education at the Tertiary Level

The effect of declining numbers at secondary level is further heightened when reviewed in terms of its impact at tertiary level. The TFPS identified that student recruitment to science, engineering and technology courses in higher education is, in many instances, far below capacity, with fewer first preference applicants than places on offer. A serious repercussion of this trend is the potential impact of lowering the standard of entrance grades into science courses, where many certificate and diploma courses are now offering places to "all qualified applicants". Clearly, this has major implications in terms of academic standards. In addition to this, and in relation to postgraduate studies and research, the number of students enrolled in postgraduate science courses is far below the strategic target set by various review bodies as necessary simply to maintain the quality of scientific research. In Ireland, the number of PhD students in science and engineering is considerably below the OECD mean (DES, 2002), which does not augur well for the future.

One of the key recommendations of the TFPS is to "increase recruitment to science, engineering and technology courses in higher education institutions and to improve the teaching and learning experience ... the underpinning rationale is that quality is a driver of participation, integration and retention" (2002, p. xxi). As a result, our tertiary science departments are in the process of reviewing their courses, what they contain, how they are taught and what the learning objectives should be. Teaching support centres have been set up within many of the universities to help support innovative teaching initiatives. At NUIG, the Centre for Excellence in Learning and Teaching (CELT) was established in 2002 to target and support academic staff development at the local level, promoting methods that encourage active learner engagement and critical thinking.

In addition to this, the science departments have become involved in many novel and exciting initiatives that are hosted and organized throughout tertiary level institutions. The science faculties of the Irish universities have their own website (<www.universityscience.ie>) through which their events and activities are made available. The deans and faculties of science at Irish universities are working to promote science and science education to current students, prospective students, and the public at large, nationally and internationally. The science division of the university sector has also taken a keen interest in science teacher training in an effort to support their teaching and invite their participation in research experiences at third level. Two such initiatives that have been recently established are the Science Teacher Assistant Researchers (STARs) programme and the Lucent Science Teacher Initiative (LSTI), outlined below:

- In 2004, the STARs initiative was set up to encourage a collaborative programme between participating tertiary scientists and engineers, and science teachers in the community. This university-based research study invites local science teachers' participation for 6-8 weeks over a 12-month period. It provides teachers with challenging opportunities to work at the cutting edge of research and also to become an integral part of the wider scientific community. Thus, the knowledge and skills acquired can then be passed on from the teachers to their own students, extending the dissemination of their research, and in the process giving future potential tertiary students (and possible members of the next generation of scientists) a taste of contemporary and relevant "science in action" experiences.
- LSTI aims to support the education and the professional development of experienced science teachers by involving schools as partners with the university in the professional training of student teachers. (Childs et al., 2003). In 2000, the University of Limerick initiated the LSTI in the form of a three-year pilot project. The main purpose of this scheme is to strengthen the overall teacher education experience for science education teaching practice students, by providing the opportunity to work closely with a teacher expert, who is also their mentor. Experienced teachers are trained in the theory and best practice of mentoring and on completion of their training they qualify as Lucent Mentor Teachers (LMT). Although this pilot project has recently concluded, the host

team is in the process of searching for new funding to establish this venture on a permanent basis.

Such initiatives invite practising science teachers to continue their professional development by partaking in innovative scientific research and also play an integral role in teacher education. These are only a small sample of some of the creative ventures that have been developed to promote collaboration between various partners in our education system.

Childs (2002) argues that in order for ventures of this nature and other initiatives in science education to succeed in properly addressing the areas of concern highlighted by the TFPS Report, there needs to be a well-considered and cooperative partnership developed between government, industry, professional bodies, schools and third level institutions. In an attempt to further develop this suggestion, the Department of Education at NUIG, has sought collaboration with a number of education partners to partake in the process of promoting science through education and through contributing to our teacher education program. As such, the Department is in the process of creating stronger networks between ourselves, the Faculty of Science, the community of local science educators, and partners in local industry; thereby creating a viable and visible interconnectedness of science educators and practitioners. For the most part, although a variety of initiatives are being undertaken in science education, there is a lack of connection between partners across the education sector. It is our hope that the relationships currently being developed will present possibilities for research collaboration and may influence educational policy and practice.

Conclusion

At a time when science seems to have lost its appeal, and yearns for an injection of enthusiasm coupled with clarity of scientific understanding, numerous creative initiatives are being instigated and implemented throughout the country. These initiatives have gone a long way to make science more visible to students and in resurrecting science as a public discourse – one that is more connected and accessible to students. At the time this article went to press, the Irish Government released a new pro-active plan: Strategy for Science, Technology and Innovation 2006-2013, with targeted funding of 3.8 billion euro. The Government acknowledges that there are very real challenges ahead and that

"Science, Technology and Innovation (STI) in Ireland is still relatively underdeveloped" (DETD, 2006, p. 8). In order to address these concerns, it has identified a number of key areas for improvement in the sciences, specifically: efficiency, quality, productivity, and innovation The report echoes some of the key issues discussed in this paper (curriculum and assessment, teaching methodologies, teacher education, teacher professional development, career guidance and the current initiatives that are being developed to target the declining enrolments in the sciences), isolating a separate strand specifically for science education and society.

To strengthen the economy and knowledge base, the promotion of science may hinge on the many imaginative ways that educators are able to exploit their influence over how science is taught to teachers, and how teachers convey science education to students. According to Hipkins and Bolstad (2005, p. 40), "to compete effectively with other options, science courses need to be interesting, and relevant to real life, and the actual working worlds of scientists with their diverse careers." The literature is full of innovative ideas about desirable changes in science education, although the achievement and implementation of these is not always as transparent. We suggest addressing the decline in enrolments is a much more complex issue than simply attempting to make science more interesting to students. Rather, as we hope this article has illustrated, it is necessary to take into account the multi-faceted nature of the problem. As we have indicated, a number of public and private sector groups in Ireland have attempted to address the decline in science enrolments by employing a variety of different initiatives. Yet we believe that the ability to turn the tide may lie in the particular way that teacher education departments at tertiary institutions take up this challenge. Because teacher education departments are uniquely positioned to influence future teaching and learning in the discipline of science, they have the potential to effect greater change than any individual department or organization interested in promoting the sciences. Thus, in combination with other interested partners, in order to influence change, teacher education departments might do well to incorporate a wide range of innovative strategies that take into account the many complex factors related to the decline in science enrolments.

Notes

1. The Leaving Certificate Examination is the final examination in the Irish secondary school system accredited by the State Examinations Commission. Two years' study is required, and it is usually taken three years after the Junior Certificate Examination. Most students taking the examination are aged 17-19 (Wikipedia, 2006a).
2. The Junior Certificate Examination is a mandatory Irish second level test accredited by the State Examinations Commission. The test is taken in a secondary school student's third year and not before age 14. A student usually takes 9 to 10 subjects, including English, Irish, Mathematics and a foreign language. The examination does not reach the standards for college or university entrance; a school leaver in Ireland will typically take the Leaving Certificate Examination two or three years after completion of the Junior Certificate (Wikipedia, 2006b).

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