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Realising the Management Challenges for Science Communication Outreach: A Social Marketing Perspective

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ABSTRACT

Social marketing recognises that neither government nor education alone can solve the growing range of complex and multifaceted social policy issues facing societies around the world. Social marketing is about behavioural change for the good of the individual and society, combining individual factors with institutional, organisational and policy variables. Social marketing is, potentially, extremely compatible with and beneficial to science communication outreach. This paper discusses ways in which social marketing can enhance the management of science communication outreach as a means to engaging citizens and mobilising a science-orientated public, thereby advancing the smart economy in Ireland.

Key Words: social marketing; science communication outreach; science literacy

INTRODUCTION

Engaged and science-literate citizens increase the quality of life of all in society and strengthen democracy in society (Miller, 2001; Edwards, 2004). Science communication outreach programmes connect with diverse audiences to increase public awareness of, support for and participation in science. They allow children, teachers and parents to experience science in a fun, hands-on, exciting way, to stimulate their interest and to participate in science as a school subject, higher education degree choice, career option and research avenue. The assumption is a flawless, and uni-directional, link between science interest, science literacy levels, science careers, and economic and social prosperity (Layton et al., 1993; Beetlestone et al., 1998). Hence, communication, outreach and public engagement programmes lie at the centre of the European Union's policy to create a knowledge-based economy supported by science-literate people interested in research and innovation

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(Government and Scientific Advice Unit, 2006). As a consequence, governments are embracing science communication outreach as part of their science policy.

However, it is also widely recognised that the traditional science communication outreach approach of advertising and communication has not resulted in the needed behavioural changes in science, i.e. an increase in science literacy and science graduates, deemed desirable and beneficial for society (Evans and Durant, 1995; Department of Enterprise, Trade and Employment, 2006; McCauley et al., 2006). Ireland, in a recent Eurobarometer report (European Commission, 2010), demonstrates this very potently, reporting lower than EU average levels of stated interest in talking with friends about science and technology, new scientific discoveries and reading articles on science in newspapers and magazines or on the internet. The results of the Relevance of Science Education (ROSE) survey completed by 688 students from 29 second-level schools in Ireland signal that the great majority of students do not want 'to become a scientist' or 'to get a job in technology' (55 per cent of students chose the extreme 'disagree' option for the former statement and 44 per cent for the latter statement).

The Irish students respond in a similar way to students in the other industrialised countries They share the general trend – an aversion to 'becoming a scientist' (Matthews, 2007: 75).

Science communication outreach and public engagement with science are not commonly associated with social marketing (Domegan, 2007; Davison et al., 2008). Social marketing 'is about behavioural change for the good of the individual and society, combining individual factors with institutional, organizational, and policy variables' (Domegan and Bringle, 2010: 198). However, the successful application of social marketing to issues that concern societies, such as smoking, drink driving, exercise for young children, teenage drinking, safe sex and leprosy (Andreasen, 2006; Rothschild et al., 2006; Kotler and Lee, 2008; Hastings, 2007), suggests that social marketing could be employed to effectively manage and achieve the goals of science communication outreach. Social marketing captures the very essence of science communication outreach – behavioural change for the betterment of the individual and society; improving life for the consumer and the citizen. At the micro level, primary and secondary school children, their teachers and their parents, constitute different target audiences with different social, economic and educational needs. At the macro level, relationships between community groups and regional bodies facilitate the exchange process with agents at the top end of the value co-creation chain shaping the context for such exchanges to occur. In order to sustain a long-term public engagement with science, the complex and dynamic relationships between the various parties and competing interests on both the micro and macro levels necessitate an analysis and direction that can account for how humans behave socially.

How is science communication outreach policy to go beyond awareness, promotion and simple communication to engage and activate citizens and a science-orientated public? Is there a broader role for science communication outreach beyond informal and/

or supplementary education? How can science communication outreach be effectively designed and implemented to develop a more holistic science-engaged society? Can science communication outreach contribute more effectively to resolve the perceived 'science is good versus science is to be avoided' tension embedded in Irish society? The theory of social marketing suggests it is a particularly amenable framework for the effective management of science communication outreach: it focuses on achieving change outcomes for the betterment of the individual and society; it has the ability to tackle long-term, complex and multifaceted behaviours; it uses a planned systematic approach to analyse social issues and problems; it combines individual aspects with institutional, community, organisational and policy factors, thereby acknowledging and using the interconnected social and institutional dimensions to behaviour; and vertical and horizontal partnerships are central to its success (Andreasen, 2006; Hastings, 2003).

This paper reflects upon social marketing and its potential implications for the management of science communication outreach in Ireland. It first examines in greater detail the theoretical framework of social marketing to better understand how it is beneficial to the macro-micro management of science communication outreach in Ireland. It then discusses the methodological approach taken to map current outreach activities on the island of Ireland, identifying particular barrier points to a social marketing approach that would create a broader and more systematic engagement with science and society. In doing so, we explore how social marketing can offer new thinking and tools for those concerned with science literacy, science communication outreach and science policy to understand and manage the 'interaction between, and interdependence of factors within and across all levels of people's behaviour with their physical and socio-cultural environment' (National Cancer Institute, 2005: 10).

THE THEORY OF SOCIAL MARKETING

Social marketing, even within the discipline itself, has historically been defined in multiple ways (McDermott et al., 2005). Since Wiebe (1951–52) penned the phrase 'selling brotherhood the way we sell soap', and Kotler and Zaltman (1971) coined the term 'social marketing', as selling 'ideas', social marketing in the early 1980s and 1990s was about interventions and programmes to improve people's quality of life. Classically, this early social marketing made use of subsidised brands or targeted vouchers and extensive distribution was heavily donor-based (Satyal et al., 2008). This view of social marketing is the more traditional understanding of the concept (French and Blair-Stevens, 2006).

Twenty-first-century social marketing delineates its domain around behavioural change (Kotler and Lee, 2008; Andreasen, 2002; Hastings et al., 2000; Hastings, 2007; Smith, 2000; Smith, 2006). Four levels in society are affected by the behavioural change sought by social marketing strategies: micro level, group level, macro national level and macro global level (see Table 1).

The application of social marketing at *all* of these levels results in a conceptual maturing towards the 'market with' and 'relational' approach (Hastings, 2003; Hastings and Saren, 2003; Lusch and Vargo, 2006; Gronroos, 2007; Wilkie and Moore, 2003). This 'market with'

Table 1: Types of Social Change, by Time and Level

Change	Micro Level (Individual)	Group Level (Group/Community/ Organisation)	Macro Level (Society/Nation)	Macro Level (International or Global)
Short term	<i>Behaviour change</i>	<i>Changes in norms/ administrative change</i>	<i>Policy change</i>	<i>Policy change</i>
Example:	Attendance at stop-smoking clinic	Removal of tobacco advertising from outside a school	Banning of all forms of tobacco marketing in Ireland	Banning of all forms of tobacco marketing, e.g. in all EU countries
Long term	<i>Lifestyle change</i>	<i>Organisational change</i>	<i>'Socio-cultural evolution'</i>	<i>'Socio-cultural evolution across societies'</i>
Example:	Smoking cessation	Deter retailers from selling cigarettes to minors	Eradication of all tobacco-related disease in Ireland	Eradication of all tobacco-related disease in the EU

Source: Adapted from MacFadyen et al. (1999: 702).

approach of social marketing embraces upstream stakeholders, partnerships, multiple exchanges and the co-creation of value at all levels, including that of the whole system – a macro society level constituting those who control the social context influencing the other units (Brenkert, 2002). This is attributable to the fact that individuals influence, and are influenced by, those surrounding them, thereby requiring this tiered approach to the exchange process building upon both economic and social dimensions. Bentz et al. (2005) demonstrate how the wants of policymakers, consumers and marketers (i.e. macro and micro levels) come into congruence to meet similar goals:

Marketer: *I want to reduce childhood obesity;* therefore I will offer support for policymakers who champion improved nutritional and recreational choices for kids and families.

Policymaker: *I want to increase my public support;* therefore I will fight for improved policies for nutritional and recreational choices for kids and families.

Consumer: *I want healthier kids;* therefore I will give up short-term pleasures and conveniences and support those who champion improved public policies (Bentz et al., 2005: 21).

This multiple exchange process results in social marketing having an extensive constellation of co-creating value stakeholders and relationships to satisfy and manage. The relationships are simultaneously active and engaged at all levels with customers, communities and

policy makers. This, in turn, achieves synergy between the multiple change agents to bring about the desired behavioural change of benefit for the individual and society (French and Blair-Stevens, 2006). Typically, it incorporates a key characteristic of social marketing – the direct contracting by government of services from private providers and the voluntary sector. For complex social issues, such as science communication outreach, no one entity can provide a solution independent of other stakeholders (Australian Public Service Commission, 2007). It is necessary for the government, private and non-profit sectors to coordinate their activities and resources. Strategies need to incorporate many stakeholders working simultaneously in various sectors and settings. Social marketing, through its total market approach and interplay of complex upstream and downstream systems, lends itself to a synergistic, rather than an additive, framework where the sum of the change created is greater than the sum of the parties acting independently. This synergistic total market approach reinforces social marketing's appropriateness to science communication outreach. It introduces the concepts of co-creation, co-contextualisation and co-delivery of services, experiences and solutions, moving significantly beyond simple messaging and mass communication campaigns (MacKay, 2008; Satyal et al., 2008).

Social marketing is a value co-creation process that works up-, down- and in-stream throughout an entire holistic system of relationships (Vargo and Lusch, 2008; French and Blair-Stevens, 2006). The 'pre' and 'post' exchange circumstances, processes and participants are as important as (if not more than) the activities *in the exchange itself* – a characteristic not linked to discreet economic exchange marketing activities – often associated with communication or promotion. Behaviour and relationships are socially as well as economically determined (Maibach and Cotton, 1995; Hastings, 2007; Quelch and Jocz, 2007). What social marketing is particularly good at is managing the exchange and value co-creation processes when the individual self-interested behaviour is not consistent with social or collective behaviour. It turns social goals, through free choice and value co-creation in the marketplace, into voluntary behaviour changes or modifications that may be perceived by the individual to be of self-interest. When individuals have little or no connection to society, social marketing uses the marketplace and self-interest as the primary mechanisms to link the individual to the collective and vice versa. This differs from most communication outreach and educational practices that focus on giving information to people – it's good for your heart to exercise; too much exposure to the sun can cause skin cancer; drinking impairs your ability to drive a car safely; civic involvement improves the community's quality of life. Education in general, and the current science communication outreach models in particular, assumes behaviour follows information. However, there are numerous examples to show 'information campaigns that emphasize enhancing knowledge or altering attitudes frequently have little or no effect upon behaviour' (McKenzie-Mohr and Smith, 1999: 10). Unlike social marketing, neither education nor science communication outreach alone provides direct individual benefits for the desired behaviour (Rothschild, 2002). This often results in communication and educational inertia and apathy for many students and the general public. Lefebvre (2009: 143) explains:

The recognition that these marketplaces of ideas and behaviours also exist, and are subject to such forces as proximity and access, incentives and costs ... illuminates how programmes that focus on only economic levers or education or laws ... fail to achieve all the social good that is intended.

In social marketing, partnerships reflect the social context of complex multiple exchanges. Downstream partners turn their attention to creating and distributing the interventions (Wallack et al., 1993). Upstream partners are concerned with changing the environment and barriers that block the individual from altering their behaviour. They also have responsibilities for policies affecting the target audiences, the objectives of such policies are to encourage and support the required individual behaviour change. One such example is the Heart Truth, the National Heart, Lung and Blood Institute's initiative to create awareness about women and heart disease, where collaboration with the United States' fashion industry was essential to access the 'considerable promotional and communication capabilities and distribution channels of the fashion industry ... and opening doors to opportunities with the corporate and media sectors' (Temple et al., 2008: 68). While upstream partners aim to engage the public, the media and policy makers (Andreasen and Herzberg, 2005; Andreasen, 2006; Hastings, 2007), they tend to be time-consuming and expensive (Haytko, 2004). In fact, the best social marketing strategies advocate approximately ten years' duration. Concurring with this, Lusch and Vargo (2006) explain that lengthy time-frames for adaptive learning and flexibility are necessary for some marketing practices. The ability to adapt and learn from the community of partnerships and exchange parties is the result of extensive formative, impact and process evaluation in social marketing (Hastings, 2007). This requires science communication outreach officers, funders and policy makers to ask 'What behaviours need to change?' as well as 'Whose behaviours (and circumstances, and policies) need to change?' and broaden their analysis of, and responses to, science in Irish society. Given these gaps, a mapping study was conducted into science communication outreach activities in Ireland.

METHODOLOGY

The mapping of science communication outreach in Ireland was undertaken with the objectives of i) better understanding the scope of science communication outreach activities in Ireland and ii) identifying particular 'barrier' or leverage points where social marketing may be applied to strengthen communication outreach activities and policy. This approach was chosen so that the outcome moves beyond a simple description of current practice and signals effective approaches to science communication outreach in the future.

The mapping research was based on a census of science communication outreach stakeholders across Ireland. A comprehensive listing of science outreach providers, including, but not limited to, government policy makers, science teachers, museums and aquaria, science centres, science cafes, outreach officers and media, was synthesised from a number of existing professional categories drawn from the public sector, education, the communication sector, local authorities and industry (See, for example, <www.science.ie>, <www.

brigitsgarden.ie>, <www.w5online.co.uk>, <www.bco.ie> and <www.sciencegallery.com>). The aim was to reach any person or group that had a mandate to promote science to the general public. Therefore, those responding to this study were not simply providing predictable mandates to promote science, but rather drew together a variety of individuals and groups acting independently to create a clearer picture of the diversity of approaches and needs of such groups. In total, 165 active science communication outreach providers across the island of Ireland were identified with relevant names, addresses, telephone numbers and email addresses.

The research used a survey data collection method, incorporating an online questionnaire consisting of 38 questions, both multiple choice and open-ended. The construction of an online questionnaire initially drew upon the existing science communication outreach literature (Government and Scientific Advice Unit, 2006; National Institute of Standards and Technology, 2002; Evans and Durant, 1995; Miller, 2001; Edwards, 2004; Bauer et al., 2007; Cullen et al., 2007). In this way the questionnaire was both comparable and standardised with the existing literature. Two pre-tests were then conducted. The first was with key science communication outreach stakeholders, Discover Science and Engineering (DSE) and Science Foundation Ireland (SFI). A second revised pre-test was conducted with science communication outreach officers. After these two pre-tests, invitations to participate in the online survey were sent out. The online survey was active for two months, during which time participants were sent three personalised reminder notices. Seventy-nine usable or completed surveys were returned, indicating a response rate of 48 per cent. This high response rate is reflective of the common interest among diverse stakeholders in the need for such a mapping exercise to document the issues in science communication outreach activities.

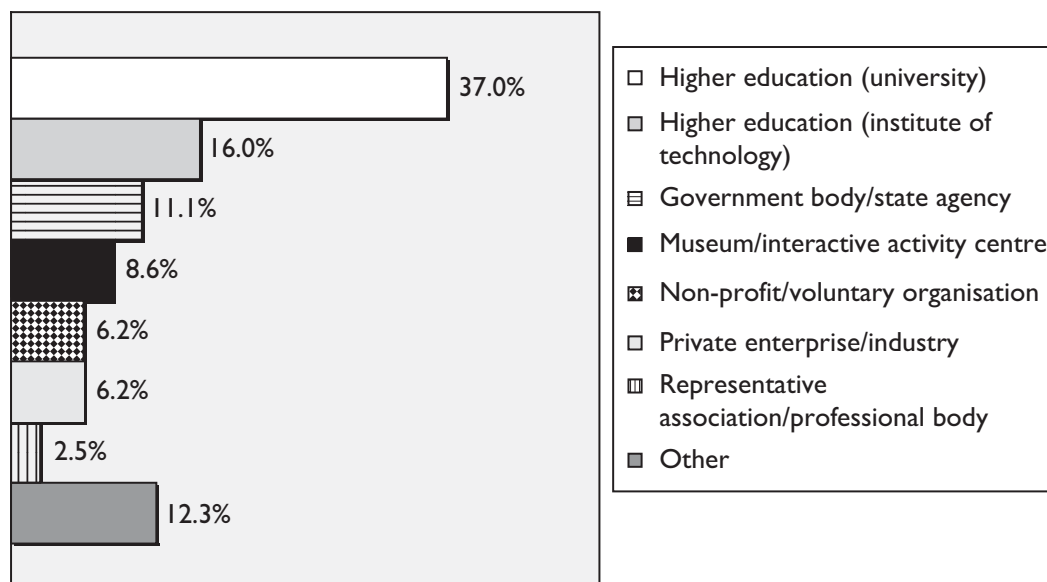
The findings presented in the next section are divided into two sections: i) a mapping overview of science communication outreach in Ireland and ii) barriers to providing science communication outreach in Ireland. We then discuss the key science communication outreach management and policy implications emerging from the findings from a social marketing perspective. Finally, in the conclusion, we draw lessons, identify opportunities and point toward a new behavioural and/or social change paradigm for science communication outreach in Ireland.

FINDINGS

Mapping Overview of Science Communication Outreach in Ireland

Organisational Profile

Results relating to the profile of science communication outreach providers and stakeholders show that the majority of the respondents identify themselves as educational providers, with third level institutions accounting for 53 per cent of science communication outreach work in Ireland. Industry – in particular multinationals – contributes 12.4 per cent of activities. Other survey participants include government bodies and state agencies (11.1 per cent), museums and interactive activity centres (8.6 per cent), professional bodies (e.g. a teachers' union) (2.5 per cent) and others (12.3 per cent) (see Figure 1).

Figure 1: Organisational profile of Science outreach in Ireland

Staffing and Income Profile

Following on from the organisational profile, our findings indicate that the majority of science communication outreach providers were established since 1998, with 22 per cent having no full-time staff and 36 per cent having one or two full-time staff. When larger organisations were asked about the staffing composition of their smaller units, it was reported that, on average, each unit contained just one part-time staff member, while 10 per cent of respondents have five volunteers.

Income for the vast majority of science communication outreach providers ranges from €100,000 to €3.8 million. While all are dependent upon multiple income sources, the government, through SFI and DSE, is the key funder.

Programme Aims

The primary objectives of all science communication outreach programmes surveyed were to 'increase the number of science students' and 'create positive science attitudes among the general public'. A list of all objectives in rank order is illustrated in Table 2, from most central (1) to least central (8).

Programme Delivery Mechanisms

The programme delivery mechanisms utilised by science communication outreach providers are shown in Table 3. The most popular options are through Science Week (57

Table 2: A Ranking of the Central Objectives of National Outreach Programmes

Increase the number of science students	1
Create positive science attitudes among the general public	2
Increase the number of people choosing science careers	3
Increase the number of scientific researchers in Ireland	4
Build public trust and credibility in science	5
Increase scientific literacy	6
Provide support to teachers	7
Host public debates/enhance the democratic process	8

per cent) and the internet (51 per cent), followed closely in rank order by lectures/open days, one-day workshops, public talks, science festivals, teacher/curriculum-based information and printed media.

Table 3: Science Communication Outreach: Programme Delivery Mechanisms

Science Week	57%
Internet	51%
Lectures, research seminars	49%
Open days	48%
One-day workshops	46%
Public talks/debates	44%
Science festivals	44%
Teacher/curriculum-based information	44%
Printed media: newsletters, magazines and newspaper supplements	44%
Traveling exhibits/kiosks	38%
Teacher training/in-service training	36%
Specialised media, e.g. cartoons, television programmes, radio shows, podcasts and virtual spaces	26%
Classroom course (e.g. a 30 minute class x 4/6 weeks)	25%
2+ days workshops	19%
Science shops	6%
Deliberative polls on public opinion	5%
Citizens' panels	1%
Others	16%

Target Audience

The audience profile that is currently targeted by the science communication outreach providers surveyed is illustrated in Table 4. The secondary school sector is revealed as the dominant target group, being targeted by 75 per cent of the outreach providers. There is also a strong focus on pre- (42 per cent) and post- (43 per cent) secondary schooling, in addition to targeting parents (39 per cent) and those defined as disadvantaged in society (39 per cent).

Table 4: Audience Profile of Science Communication Outreach Providers

Secondary schools	75%
General public	67%
Further and higher education	43%
Primary schools	42%
Disadvantaged people	39%
Parents	39%
Unemployed/low income	19%
Elderly/retirement groups	19%
Minority/ethnic groups	16%
Travellers	13%
Asylum seekers	10%
Others	20%

The 'general public' category is a close second target audience (focused on by 67 per cent of the providers), indicating that these two categories (secondary schools and the general public) are identified as the key markets for science communication outreach.

The target audience, for the most part, is secondary schools. This downstream perspective is predictable given the university profile of the majority of science communicators and their drive to increase the numbers studying science at third level. In keeping with this school focus, 66 per cent of survey respondents reported 'influencing policy makers' was *not* applicable to them. This lack of upstream engagement is expressed in the following words by one respondent:

Understanding among science communication and outreach policy makers of the issues and the approaches related to different forms of science communication remains low – this results in fragmented efforts, and in some cases programmes which are much less effective than they might be.

More than half of the respondents, 52 per cent, recognised that working closely with the media as an upstream stakeholder was valuable. It was understood that the media have

their own interests and aims, and science and science communication outreach cannot simply be 'imposed' on them. Therefore, the media must be seen as an interested partner included in the broadening of coordination efforts. More telling from an upstream perspective are the 48 per cent of respondents who reported no strong media relationship, or that the media was not applicable to them.

These downstream/upstream target audience profile results resonate with the communication findings. Fifty-eight per cent of survey respondents report using dialogue, two-way communication and feedback. Yet of greater interest are the 42 per cent who say they do not use dialogue, but rather a one-way communication approach or even no communication at all, as captured by one respondent: 'the main difficulty is trying to get my research colleagues involved in communicating their science to the public.'

Evaluation Techniques

The final insight is revealed in the reported use of summative evaluation. Of the survey respondents, 34 per cent measure change in knowledge and even less measure change in beliefs, only 19 per cent (see Table 5). Formative evaluation is undertaken more often, with 58 per cent regularly measuring awareness of science promoted by these programmes and 63 per cent assessing audience satisfaction with the science offerings.

Table 5: Measures of Assessment

Do You Routinely Assess the Following?	Yes	No
Audience satisfaction levels	63%	37%
Awareness of programme initiatives	58%	42%
Implementation of programme	57%	43%
Stakeholders' satisfaction levels	52%	48%
Media coverage	51%	49%
Reach of promotional material	49%	51%
Staff cost	47%	53%
Dissemination of materials	47%	53%
Website hits for outreach	43%	57%
Changes in attitudes	35%	65%
Changes in knowledge	34%	66%
Changes in policies or infrastructure	29%	71%
Changes in beliefs	19%	81%

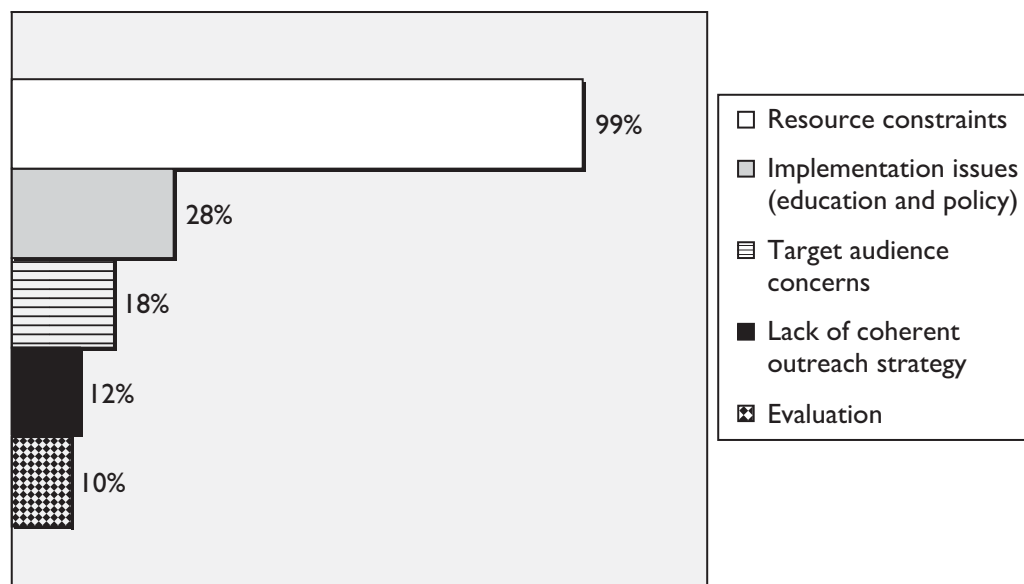
Barriers to Providing Science Communication Outreach in Ireland

As Figure 2 illustrates, the main barrier in providing effective science communication outreach is the lack of adequate resources (reported by 99 per cent of respondents). These resource constraints were further broken down into four key categories: financial support (53 per cent), staffing concerns (lack of staff and dependency on voluntary staff) (28 per cent), time constraints (13 per cent) and lack of space (3 per cent).

The second key concern, reported by 28 per cent of the sample, was in relation to implementation issues, both from an education (21 per cent) and policy (7 per cent) viewpoint. In terms of education-related concerns, the primary issues highlighted were the need for continuing professional development for teachers and a concern regarding the inadequate technological facilities available in their classrooms to support student learning. In terms of policy-related concerns, the primary issue raised was the need for an agreed national policy for science outreach across all sectors, with one provider highlighting the need for collaboration, stating that 'the rationale for outreach is not clear in Ireland and needs to be explicit for all outreach activities.' Another provider aired his concern regarding the lack of opportunities to debate these policy issues:

In terms of public communications, there is a definite lack of facilitated public debate, particularly with policy makers. Policy makers tend to shy away from debate on scientific research issues.

Figure 2: Barriers in Providing Science Communication Outreach



The third area of concern regarding barriers towards science communication outreach activities was related to the target audience (18 per cent). In terms of the target audience, the key issue aired was the difficulty in attracting the general public to partake in these science outreach events.

The fourth main barrier that was identified was the lack of a coherent outreach strategy (12 per cent). This was elaborated upon further in terms of 'the need for one central national network', 'an integrated approach across all education levels and sectors', 'lack of communication between informal science communication outreach providers', 'identification and sharing of successful practices' and the need to 'focus on key strategies, rather than all'.

The final barrier outlined by this survey addressed difficulties in carrying out effective evaluations (10 per cent). In terms of evaluation, the key concerns were lack of experience in this area and associated funds.

DISCUSSION

Organisational Profile

The organisational findings demonstrate a strong educational focus and context for Irish science communication outreach activities. This is entirely consistent with the establishment of Science Foundation Ireland (SFI) in 2000 and Discover Science and Engineering (DSE) in 2003.

SFI introduced science communication outreach in Ireland, directly modelled on the National Science Foundation (in the United States), where the management approach to science communication outreach is premised on the 'deficit model'. DSE also reflects this mandate. The deficit model works on the assumption that people and general public are lacking in either knowledge of, attitude towards or trust of science. The deficit model's *modus operandi* is based solely upon increased awareness and knowledge. It assumes changes in behaviour may occur as a result of awareness and knowledge but it is not directly charged with or responsible for such behavioural outcomes at either individual, community or population levels.

The deficit model, therefore, fundamentally underlies the current science communication outreach initiatives and policy in Ireland. In contrast to these findings, social marketing makes salient the importance of behavioural change objectives and focus. The deficit model's single biggest flaw lies in the fact that it perpetuates the myth that awareness, promotion and/or communication directly results in behavioural modifications or alterations.

Staffing and Income Profile

The staffing and income profile results are in keeping with an awareness/promotion mandate of a deficit science communication outreach stance. In effect, SFI's and DSE's awareness and promotion remit is aimed at the community and individual level. This both perpetuates and propagates the top-down uni-directional information exchange associated with a deficit approach to a passive, disinterested public. This restricts resource

coordination, integration, interaction or dialogue across and within levels, espoused by social marketing for multi-sector multi-intervention activities.

Programme Aims

The reported broad science communication outreach objectives are also consistent with a deficit model: they are awareness-/message-orientated 'science is fun' goals. However, these wide-ranging objectives suggest that science communication outreach is prone to the same pitfalls that health communication has suffered from, where only 5 per cent of all health communication messages are found to be effective (Snyder, 2007). Educational behavioural inertia is present here; there is no attention to the social marketing concepts of planned systematic actual behavioural change among specific targeted groups because it is believed that information or knowledge *alone* has the power to change behaviour.

Target Audience

Applying a social marketing analysis to the target audience findings, we interpret these results to show that Irish science communication outreach providers are more likely to concentrate on downstream efforts to the exclusion of the upstream. Greater collaboration with upstream actors may not be a priority for science outreach providers because upstream actors are not as strategically useful when working under the auspices of the deficit model. Upstream actors are, however, in a better position to influence and change the public's behaviour. Progress depends on greater dialogue between practitioners and their various stakeholders from a wide number of fields, downstream and upstream. Communication *between* practitioners and communication *with* target audiences and stakeholders is vital, and a means of fostering that communication is urgently needed.

Without upstream interaction and dialogue, science communicators and policy makers alike will continue to find difficulty in implementing solutions to solve the Irish youth's aversion to 'becoming a scientist' (Matthews, 2007). Nor will science communicators and policy makers be able to remove the existing barriers to behavioural change. This highlights an absence of a coordinated or integrated total market policy that addresses behavioural change at the individual, interpersonal, community or policy level through the active involvement of *all* citizens. Strikingly, there is also significant absence of key stakeholders, such as the media, cultural groups and policy makers, who are well-placed to support current outreach strategies, and also may be better able to target behavioural change in favour of science literacy. Furthermore, among both schools and key stakeholders, there is a distinct absence of targeting people most ready for change or action, often known as the 'low-hanging fruit' in social marketing. This illustrates another social marketing weakness for science communication – the lack of focus on the non-attentive science public and the lack of comprehensive engagement with scientists and policy makers. By not attending to those with the least connection to science (at the pre-contemplation stage to change), and by having limited engagement about outreach with those most directly connected to science, there is little choice but to rely on the historical and now inefficient deficit/educational model of science outreach.

Evaluation Techniques

The evaluations that are commonly used tend to evaluate the success of the activity in relation to the deficit model. In so doing they are unable to measure whether their outreach activity will have a long-term effect on school science subject choice and university course choice. As well as end-of-programme evaluation, programme design and implementation evaluation should also be considered throughout as social marketing acknowledges that the 'process' of evaluation is frequently as important as the evaluation results themselves, provided it is cycled back into decision making. There was no evidence of process-based evaluation among science communicators who participated in the research.

Barriers to Providing Science Communication Outreach in Ireland

The 'barrier' findings suggest that the key challenge for science communication outreach is the engagement of upstream policy makers and stakeholders, alongside the interaction of downstream audiences. For deep engagement to happen with science and technology in Ireland, it is essential to be strategic about the focus, coordination of activities and budgetary allocation. This study shows there is a need for a stronger, more integrated policy framework that includes the diversity of science outreach in Ireland. In the words of one respondent, 'I believe there is a need for a more systematic approach at a national level to the area of outreach and public engagement.' Schools and current outreach activities provide information about science and pathways to science careers, but how that information is acted on rests in influencing individual behavioural choice. Instead of struggling to maintain interest in science with students over a long period of time until they choose a science career, it may be more effective to influence the behaviour of students so that science literacy becomes a higher priority in a modern world of myriad choice and change.

The research findings, therefore, suggest a more comprehensive strategy needs to be applied in a way that is better able to influence behavioural change in people, so that they can see that an investment in science is worth their while. The traditional policy approach, of awareness and promotion, while necessary, is not sufficient. It ignores the wider environmental and community influences on behaviour, e.g. peer pressure and social capital, and is therefore limited as a tool to influence the behaviour of Irish citizens. Because the deficit model is a top-down approach it is unable to address upstream as well as downstream audiences. The deficit model's perspective is one of a 'science and society' stance, rather than 'science in society'. Science is seen as a technical specialist activity and not necessarily embedded in socio-cultural issues. Starting with the assumption that the public must passively wait until information is provided from elsewhere may limit the success of outreach as it does not draw on or build upon the public's current knowledge about science. Furthermore, the deficit model, with its presumption of a public deficient in attitude, knowledge or trust, leaves little room for individual choice beyond the level of general interest. If science communication outreach was broadened beyond its traditional deficit model, and if outreach strategies became an active dialogic co-creation participatory process, achieving a smart economy where all citizens enjoy a higher quality of life and well-being may well be achievable.

CONCLUSIONS

One of the presumptions of a well-functioning, viable democracy is that citizens are well-informed about community issues, they contribute to work around community issues, and quality of life is improved as a result of greater involvement (Wandersman and Florin, 1999). How can science literacy and positive dispositions towards science, technology, engineering and maths involvement be developed to empower Irish society and improve the quality of life of its citizens?

Furthermore, how can business management, and social marketing in particular, contribute to preparing science-oriented citizens? Successes with social concerns such as smoking cessation, obesity, drink driving, cancer screening and recycling point to social marketing as being potentially beneficial to the management of science communication outreach. Social marketing can assist science communication outreach by facilitating both behavioural and social change within and across different levels of society. It has the potential to mobilise a broad spectrum of stakeholders, such as researchers, scientists, science outreach officers, policy makers and the media, to engage citizens beyond awareness, in addition to producing future scientists.

This paper has examined how social marketing's concepts of behavioural change and exchanges, together with structural and environmental influences and partnerships, provide a broader context to understanding science communication outreach than has traditionally been present in its practice. Social marketing adds a new unit of analysis for science communication outreach to develop and manage – that of upstream factors consisting of the community, media, the corporate sector, policy makers and the general public. Furthermore, a social marketing approach allows science communication outreach to go beyond its traditional dyadic, interpersonal perspective and capture multiple, complex, organisational and structural contexts from a systems, societal and cross-national perspective. Social marketing, therefore, offers the potential to expand the boundaries of science communication outreach. The analysis of how social marketing can contribute to reaching these goals has the potential to strengthen the capacity of science communication outreach to achieve its objectives of a science-literate and engaged public.

If science communication outreach is to deliver the promise of continued economic development, value for society and improved standards of living, it will be necessary to consider a more strategic approach to identifying the most appropriate way to navigate and influence social engagement with science in society. Public policy has to integrate various stakeholders to develop and coordinate a strategic science in society policy that will successfully change the public's understanding of and engagement with science. The evolution of such a policy must extend beyond simply encouraging greater interest in the career choices of teenagers, and must consider behavioural modifications and change of a much broader audience, recognising the complexity of science in society.

The development of such a policy would also have to take into consideration the application of sociological and pedagogical theories and the light they may shed on new ways to rethink how science is taught and experienced as a social act. Strategies for science outreach may be incorporated into teacher education programmes, as well as the design of science

curricula. In this way teachers of science at all levels of education begin to see their role as not just that of the passing on of science knowledge, but also as active promoters of science in society. Furthermore, infusing such interdisciplinary theories into science communication outreach policy has the potential to create a life-long engagement with science across a greater percentage of the Irish population. While our research illustrates that outreach providers and stakeholders have strong partnerships with schools and teachers, education institutions in Ireland may have a potential to provide critical policy perspectives and partnerships in the quest to influence the behaviour of students to increase their engagement with science. Such policy development would also need to embrace innovation indicators, which are urgently needed for a complex social and economic system, supporting change and the growth of a knowledge society on the island of Ireland.

In conclusion, critical to the success of Ireland's economic development and improved standard of living is a need for *innovative* outreach and communication strategies, theories and policy development, since empirical evidence suggests that the effectiveness of traditional approaches is limited (Bauer et al., 2007). For the government to confer economic, social and community benefits to the Irish public, new tools and strategies to influence citizens' behaviour are needed.

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