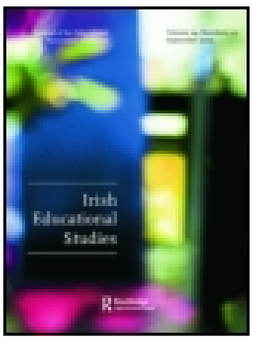

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Discovery and innovation in the undergraduate learning experience

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This article argues that an overhaul of undergraduate education in Ireland is needed. It asserts that at present most students leave university short-changed, never having been exposed to the riches of discovery and research. A framework founded on research and inquiry is designed to stimulate learning and innovation through action. It is argued that a coherent institutional mission is essential, with exploration, creativity and practice as the core of the undergraduate experience. An approach based on inter-disciplinarity, collaborative learning, identity and place as guiding features is developed along with a discussion of how this might be implemented so graduates are prepared for living and working in a knowledge-driven sustainable society.

Introduction

A major public policy goal in Ireland is to develop a knowledge or innovation society characterised by 'knowledge intensive networks as key agents of progressive development in all significant domains of activity' (Information Society Commission, 2005, p. 19). Under the Irish Government's latest National Development Plan (2007), a staggering €8.2 billion will be invested by the State in science, technology and innovation between the years 2007 and 2016. To boost research & development (R&D), Ph.D. graduate numbers will be doubled over the same period. This entails a huge shift in public policy since, as Johnston (1983), Wilson Foster (1991), Lysaght (1996), Attis (2000) and others show, the role of science and technology in Irish development had largely been neglected since the foundation of the State.

This article addresses a number of issues in third-level education within a policy context that has led to significant changes in recent years within this sector. Two external reports in particular, the Skilbeck Report (2002) and the OECD Review (2004), highlight the global challenges facing Irish universities and institutes of technology. While the emphasis in each is different, both recommend structural and institutional reform such as stronger links with industry and the wider community, developing an entrepreneurial ethos, broadening and enlarging the student intake, offering more access to the disadvantaged, focusing on quality and developing new funding sources. The OECD Review sees Irish third-level institutions as crucial to

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continued prosperity and to a smooth and rapid transition to a knowledge society. It warns that Irish universities could be marginalised in an increasingly competitive international environment unless there are sweeping internal changes such as new-style management, cost efficiency and more accountability. It recommends that in return for change, institutions would be supported by a significant leap in funding. In response, the government has increased significantly the resources devoted not only to third-level research but also to rewarding colleges that push through structural reforms that make them more responsive to economic and social needs.

Within this context, the recent publication by the Irish Universities Association (IUA), which represents the seven Irish universities, of a framework committed to 'produce a new breed of entrepreneurial 3rd level graduate entering and improving the workplace and the wider society' is worthy of note (IUA, 2005, p. 3). The government has already backed this with a €300 million Strategic Innovation Fund, a key goal of which is to develop the 'new graduate'. But can an innovation culture be generated without a fundamental revamp, a paradigm shift if you will, of Irish undergraduate education?

The main argument in this article is that a new kind of undergraduate experience, founded on research and self-exploration, is needed for the changed circumstances. In the innovation age, learning to learn, learning to transform information into new knowledge and learning to transfer new knowledge into applications is more important than memorising facts or specific information (Salmi, 2001). Primacy should be given to analysis, the ability to reason and problem-solving skills. Learning to work in multidisciplinary teams, thinking holistically, networking and the ability to cope with change are among the skills valued in a knowledge society. The learning process should be based on the capacity to find, access and apply knowledge to solve problems, especially those in local communities. Students must also be equipped with core values to live as responsible citizens in complex multicultural societies while upholding the richness and uniqueness of their own.

Research and innovation

Research is characterised in this article as knowledge created both in explicit form, such as scientific theories, and in tacit form that is personal and often difficult to express. Contemporary writers such as Hislop (2005) conceptualise the complex interactivities between diverse bodies of knowledge and relationships playing a central role in the dynamics of innovation. Creating new scientific knowledge in universities and disseminating this through commercial ventures is seen as a key objective in the proposed research agenda. Sweeney (2002) points out, however, that this linear model of innovation—namely, knowledge creation leading to applied research, development, new products or services and enhanced economic growth—has long been discredited. He argues that the innovative idea and its development have many inputs, of which the codified and theoretical knowledge produced by university research is just one.

Innovation is more about what is done with the knowledge than the knowledge itself, as Brown & Duguid (2000) illustrate. They hold that it is minds, not databases, that are the creators of and carriers of the most valuable knowledge. The tacit component of knowledge and the intangible processes embodied in human relationships, so-called networks of interaction, are often its most valuable contribution to innovation. The challenge in developing a culture of creativity is to create these rich social networks. Without them, innovation is unlikely to occur, as the government's Information Society Commission (2005) points out.

Undergraduate research and inquiry base

The most fundamental task of universities is to develop critical minds and to expose undergraduates to a process of discovery. A spirit of exploration must be at the core of the undergraduate experience if a knowledge-based society, individual and community well-being and a high quality of life are the goal. The OECD Review (2004), however, ignores the links between research activity, exploration, networks and the undergraduate experience. Students are entitled to be engaged in a spirit of inquiry and the excitement of creative endeavours, but many do not get any opportunity to do so. Most leave universities never having been exposed to the riches of research. Academics in general view research and undergraduate teaching as existing in two different worlds. Lessons and insights derived from research-based inquiry are often not shared with their students. Research in Great Britain shows, for instance, that while professors and lecturers read current journals for their research, their lecture notes are largely taken from textbooks (Sweeney, 2002, p. 19). While their own research offers deep personal satisfaction and recognition to faculty, undergraduate teaching is often seen as a chore. Many fail to imbue a passion, or indeed even an appetite, for exploration in young people during these formative years, as the high-level Boyer Commission (1998) on American undergraduate education points out.

Without exposure to the process of exploration and self-discovery, students are unlikely to emerge as creative, engaged and responsible citizens. They also miss out on an education that could be enormously beneficial to their personal development as well as to the communities in which they belong. If a proper culture of inquiry and exploration was initiated in the early years, it could enhance the creative output during the postgraduate period. Undergraduate research experience is not just for those interested in an academic career and students should not have to wait until they are postgraduates to enter the exciting world of discovery. Exposure to inquiry could prepare students for life and work in a range of sectors and occupations. As the Information Society Commission (2005) points out, more and more employers in both the public and private sectors will in the future seek graduates who are independent, inquisitive and can apply knowledge to one area of specialisation but with the flexibility also to work in others.

The problem is not confined to this country. This issue has plagued world-renowned American powerhouses such as Harvard and Stanford for many years. The high-level Boyer Commission (1998) advocated a new model of undergraduate education, urging that students become active participants not passive receivers, so that the skills of inquiry, analysis, synthesis and evaluation generated in the research process become the hallmarks of a good education. Calling most research universities 'archipelagos of intellectual pursuit rather than connected and integrated communities', the sentiments of the Commission members hit home:

> ... universities are guilty of an advertising practice they would condemn in the commercial world. Recruitment materials display proudly the world-famous professors, the splendid facilities and the ground-breaking research that goes on within them, but thousands of students graduate without ever seeing the world-famous professors or tasting genuine research. Some of their instructors are likely to be badly trained or even untrained teaching assistants who are groping their way toward a teaching technique; some others may be tenured drones who deliver set lectures from yellowed notes, making no effort to engage the bored minds of the students in front of them. (Boyer Commission, 1998, pp. 5–6)

Provocative critics such as Allan Bloom (1987) charge academics with abandoning their principles and their purpose. Often attacks come from outside the academy, as in journalist Charles J. Sykes's fiercely argued *ProfScam* (1990). He charges that university teaching has become a 'lucrative racket' where the most important responsibility—undergraduate teaching—has been abandoned in favour of 'trendy' research, the pursuit of personal or political agendas, outside consulting contracts, and the drive for tenure. Yet even an enthusiastic champion like NYU President John Sexton maintains that an unhealthy separation exists between the ideal and reality of the American research university. He argues that it would be difficult to classify most as communities of scholars and learners dedicated to a common enterprise.

While the situation in Ireland is not directly comparable to that in the United States, policy-makers here do appear intent on pursuing a model similar to that across the Atlantic, illustrated by the theme running through the government's research strategy called 'Strategy for Science, Technology and Innovation 2006–2013' (Government of Ireland, 2006). There is the danger that, as is common today in American research universities, Irish academics will come to view themselves as little more than independent contractors without any sense of loyalty to their institution or students, regarding their own discipline area as their primary source of allegiance. This phenomenon could accelerate even further as technological advances offer faculty membership in virtual communities that literally span the globe.

Mission and coherence

It is difficult for an outside observer to identify a consistent theme flowing through Irish undergraduate education. Programmes of study, even those within the same institution, appear to share no common mission or unifying narrative which can

inspire and give meaning to what the education there is about. Even though access to and the availability of information is now widespread on the Internet, acquisition of facts and traditional lecturing, sometimes to classes of hundreds of students, is still the norm. The assumption, as Abbott & Ryan (2001, p. 218) put it, is that 'no learning is taking place unless students are being taught'. The Boyer Commission (1998) asserts that what is learned often cannot be carried beyond the classroom, so even students with highly developed knowledge of a subject find it difficult to put that to use except in the artificial world of university examinations. Students often lack a coherent body of knowledge and fail to see connections or possess a clear sense of how one course is related to another. As the Boyer Commission (1998) says, many graduate 'without knowing how to think logically, write clearly or communicate coherently'.

Undoubtedly a lot of faculty experience, discussion and hard work are put into determining course content and combining individual modules to form a programme. However, as Neil Postman (1996) explains, the *means* by which young people learn is merely an engineering or technical problem. The more fundamental problem is a metaphysical one, the *why* or *reason* for education. All undergraduate students should clearly understand from the time they arrive on campus the reason they are at university: it is to become a *discoverer*. Inquiry, exploration and investigation must be at the heart of their education experience. Frank Rhodes, a former Cornell University president, argues as follows:

> The notion that you 'receive' [education] passively is just a total falsehood. Education is something you create for yourself. And you no more receive it than you can receive a career, you have to create it for yourself. And the student who prospers will be one who is endlessly inquisitive, endlessly curious, endlessly persistent in pursuing faculty members, in mining information from every source, from reaching out to the richness of experience that campus life provides. (Kreisler, 1999, p. 4)

Rhodes feels that while the undergraduate experience is potentially one of the most important areas to be taken seriously within academia, in reality it constitutes one of the great failures of the modern research-driven university. According to him, two factors are primarily responsible for this state of affairs. The first is that undergraduate education has become more 'pre-professionalised'—in other words, preparing students for careers in the areas of accounting or engineering, thereby narrowing, quantifying and squeezing curricula into a scientific mould. The second is that faculties have given up on any agreement as to what the purpose of an undergraduate education is, or what it should provide. This lack of attention is understandable given the burdens placed on academics to excel in publishing as they scramble for grants and struggle to keep up with the explosive growth in knowledge within their own disciplines.

Perhaps a good way to nurture creativity and innovation would be for each Irish third-level institution to pursue a clearly defined cross-disciplinary purpose, in effect a roadmap to guide all its research and learning activities. The key challenge for educators is to structure programmes that would connect to this shared institutional mission through a seamless web or network of exploration. Across the university,

whether in the arts, humanities, or social or physical sciences, this is a challenge if the academy is to respond appropriately to the education needs of the knowledge society.

Institutional and structural reform

Irish universities must strive to form stronger connections between faculty research and undergraduate teaching and learning. Yet without changes in the wider institutional and structural context, curricular reform or programme design in themselves are probably insufficient to ensure the provision of the proposed approach to undergraduate education. Rebalancing the weights allotted to research versus teaching in academic promotion decisions would undoubtedly make a difference.

There has been a change in recent years in the assumptions about what constitutes research, the way knowledge is conceptualized and the approaches to scholarship. The traditional definition of research was the discovery of true and objective knowledge, a perspective that sees 'real research' as requiring quantification. Rather than research as a species of science, it could be argued that 'science is one, and only one, species of research' (Eisner, 2002, p. 213). It would help, therefore, if institutions gave more recognition to other approaches to knowledge and understanding as embodied in action research. The scientific form of research has no monopoly on the ways in which humans inquire. Where once the aim of research was to discover knowledge that is true and 'objective', the way it 'really is', it is now recognised that there may be infinite ways in which something may become known. Another view increasingly under challenge is the perspective that it is only through research that we find out what works and once this is known, it will tell us what to do and how. The idea that research conclusions can be applied like prescriptions for action, independent of context, also 'underestimates the inevitable gap between theoretical knowledge and practical action' (Eisner, 2002, p. 214).

Ernest Boyer saw education as a seamless web that extends beyond the lecture room door and campus gate to embrace the larger community. Calling for campuses to be more energetically engaged in the pressing issues of communities, he suggested other elements to scholarship:

> We should recognize that scholarship means the discovery of knowledge through research but also we should recognize that scholarship means integrating knowledge, and let us also recognize the scholarship of applying knowledge, finding ways to relate information to contemporary problems, and above all let us recognize the scholarship of presenting knowledge though advising, counseling and teaching. (Glassick, 1999, p. 21)

Since innovation is about applying knowledge to create value, in order to stimulate institutional links between research or knowledge generation, teaching and practice, universities may need to give value creation a prominent role in the institutional mission. This would also likely lead over time to more integrated structures since it would clearly identify how the arts, sciences and humanities contribute to the

creation of value through interrelationships between financial, human, social, cultural, technological and natural resources.

Interdisciplinary perspectives

An approach that would generate a spirit of both engagement and inquiry among undergraduates might be for some to spend time, with faculty input and support, working on projects, assignments and problems identified in local industry or communities. It would help if the knowledge and expertise of faculty in a range of disciplines could be harnessed to address these issues. Such interdisciplinary perspectives that emphasise relationships, interconnections and teamwork would expose students to how value is created, traded and sustained over time.

Echoing the call by Snow (1998), science policy analyst Patrick Lynch (1979) argued that the humanities and sciences should be bound closer together so that society consists of people that can communicate intelligibly with one another. Lynch stressed the unity of all knowledge and the danger of seeing science as something apart. He regarded the divorce of technology from a system of values as one of the main explanations for the predicament facing mankind, and academic adaptation essential if universities are to humanise society.

Integrated programmes, drawing on the arts, social sciences and physical sciences, can play a crucial role in generating a culture of innovation at undergraduate level. However, as Capra (2002) argues, structuring knowledge into separate disciplines is one of the main barriers to nurturing an innovative climate. Breaking down these barriers between specialisations can foster academic diversity and thereby individual creativity. As the Welsh geographer E. Estyn Evans (1992, p. 2) put it, 'it is at the fences, along the borders, that discoveries are likely to be made'. Again, some institutional features may militate against interdisciplinary innovations. For instance, incentives favour faculty promotions and postgraduate research within a discipline, not undergraduate teaching and inquiry operating across several disciplines.

Collaborative learning communities

Experience is often the best teacher, and the best way to learn something is by doing it, as Dewey (1938) emphasised in his education philosophy. Understanding comes from the ability to make connections between existing knowledge and experiences and new inputs. Learning traditionally was associated not with the decontextualised setting of the classroom or lecture hall, but with a more integrated process. This involved the scholar working with the master, or the craftsman working with the apprentice, an approach still common today in medicine, for example. It recognised that once young people had acquired certain levels of skills, and real motivation, they needed to be given more responsibility for their actions.

College classrooms should be akin to the learning organisations or communities of practice championed by Senge (1990) and Wenger (1998), respectively. Rather than

an individual experience, learning should be a team effort. Peer-to-peer learning is especially important in this regard. Students should acquire knowledge in order to achieve group objectives or balance conflicting goals just as in most places outside the rarefied atmosphere of the college. The traditional roles of lecturers should become now closer to that of facilitators and coaches. The emphasis should be on creating a motivating culture of mutual respect, cooperation and idealism while de-emphasising the presentation of facts and acquisition of information.

Learning in order to attain personal goals, guided by one's own values, not the approval of a lecturer, appears to be the exception rather than the rule in undergraduate education. Students should ideally be placed in situations where they are required to find out more for themselves, performing research on issues, solving real-life problems and making decisions. Students in situated learning discover the appropriate circumstances in which to apply what they are taught. They learn where, when and why some concept fits or does not fit a particular situation. This, not passively 'taking' courses, should constitute the heart of the learning enterprise.

Identity and place

The pursuit of truth, beauty and the good is what gives a meaning, value and purpose to university education (McDonagh, 2005). This means more than simply preparing students for a job or cultivating their intellect. Universities should be concerned about students' personal values, ways of thinking, modes of learning, and interpersonal and intercultural skills. Fostering self-esteem, healthy relationships, and socially responsible behaviour are a priority. There is a critical requirement for opportunities that help students understand clashes between their own values and the values held by others. Too much emphasis on technical or quantitative skills rather than the formation of quality relationships is flawed as a foundation for innovation. If students have had experience in exploring their inner emotional world, their identity, they are more confident at creatively dealing with change and open to new possibilities. As educators Chickering & Reisser (1993) point out, in the global society of the twenty-first century where change is the only certainty, identity formation must be a central task of education.

The aesthetic faculty is weak in Ireland, as can be readily seen, for example, from littering, dumping, environmental desecration, and so forth. Sweeney (2002) argues that strengthening this faculty will not emerge from the individualist culture promoted within Irish undergraduate education. Indigenous enterprises will only reach their true innovative potential, he asserts, if aspects of native culture, place and creativity are linked. In the knowledge society, the sustainable or evolutionary organisation will be engaged in the design of products, services, processes, and systems to create a future that includes prosperity and the healthy co-evolution of human beings and nature. Innovation will increasingly require the integration of economic, social and environmental goals in the design of products and services.

Doing more and better with less, or redesigning products and services on industrial ecology models that mimic biological behaviour in order to minimise waste, should be central to the third-level ethos. A key challenge for educators of innovation is to help students appreciate that a trade-off between money and non-money goals is not inevitable and that it is by enhancing both that value is created in society.

The social animal innovates when there is room for individual commitment and a sense of belonging to a community (Capra, 2002). Influencing attitudes and values such as responsibility, tolerance, and ethical decision-making requires something different from what our examination-oriented system presently demands. In contrast to the situation in Ireland, Scandinavian and other progressive European countries place far more emphasis on helping students realise that they must utilise the world's natural resources without interfering with the balance of nature (Breathnach & Aylward, 1984). This helps them also to develop a critical and responsible attitude to social questions. They learn to respect the society and culture of their own country as well as those of other countries, tolerating different ways of thought.

Practical implementation

A programme based on the above framework would still permit specialization in, for example, business, science, engineering or technology while at the same time fostering the interdisciplinary and collaborative learning environment described above. Workshops designed to enhance learning that crosses many disciplines would assist them in seeing interconnections between the different courses they study. In order to ensure graduates are capable of stimulating ventures, either inside or outside organisations, they might be regularly exposed to presentations and seminars by leading entrepreneurs, industrialists, artists, community leaders, spiritual thinkers and others working in a host of creative arenas. Debates between class members on a range of societal issues would help students see connections between different subjects. This also means they might become more reflective, therefore perhaps stimulating their engagement in volunteer work with local communities, becoming involved in political action or the initiation of social ventures.

Students would also work with their academic advisors to develop a customized or specialized programme of study tied to their own particular skills and interests. The advisors might propose appropriate projects, assign readings or present short specialised courses on particular topics. Students would obtain an integrated perspective on the innovation process by demonstrating their ability to add value by means of either an entrepreneurial or an intrapreneurial venture. This could be done through a capstone or integrating experience where students present a technical, financial and commercial analysis including a comprehensive business plan for a venture, as either a product or a service. A student might also receive credit for a commercial enterprise involving a community development project in which he/she is engaged.

Changes would be necessary to assess student performance in such an environment. Innovative assessment methods based on subjective or qualitative criteria rather than on traditional testing by means of examinations should be more common. For instance, in the case of a collaborative project involving the local community, this might be assessed not just using quantitative criteria such as its economic return but also on the basis of its social and environmental contribution to the long-term sustainability of the community or society.

Signs of change

There are definite signs of change internationally. All teaching at Aalbourg University in Denmark, for instance, is interdisciplinary, problem-centred and project oriented. Interaction between theory and practice through cooperation with the external environment is emphasised. A project starts with a real-life problem. Students work in project groups under supervision, analyse and formulate a goal and solve the problem. During the first year, students are organised into main groups of 80 students, 6–10 teachers and a secretary. The students are then split up into sub-groups of 5–7 students which constitute the basic working unit, the project group. A group has its own room and each student a fixed working place. Students undertake three or four projects in their first year and this continues in a similar manner in subsequent years, but gradual specialisation is permitted.

In the United States, there is now an active debate within academic circles on the discovery processes possible at undergraduate level to stimulate new knowledge, interdisciplinarity and inquiry-based learning. Many innovative initiatives are being tried. For instance, so-called world-courses at the University of Maryland are team-taught and integrate natural sciences with humanities or social sciences perspectives. Undergraduates at the University of Chicago participate in a wide variety of research projects in many disciplines. The University of Delaware has adopted problem-based learning in all its basic science classes to promote active learning and connect concepts to applications. Students are not given all the information they need to solve open-ended 'real-world' problems but are responsible for finding and using appropriate sources. They work in teams with access to an instructor. Trained graduate or even undergraduate students help lead some groups.

Three years after the publication of its original report, the Boyer Commission (2001) surveyed 123 American research universities to gauge progress on implementation of its recommendations. The responses from 91 institutions showed that the topic of research had now become more embedded in the rhetoric of undergraduate education. While conversion to a new model is by no means complete, faculty and administrators are undoubtedly moving towards developing inquiry-based techniques. Yet substantial use of this form of learning remains limited in the United States. While opportunities to participate in research activities are becoming an established component of many undergraduate programmes, efforts have largely been directed at the best students. Moreover, the definition of research is still narrow

and laboratory-centred, excluding a host of other potentially creative and innovative activities. Not surprisingly, undergraduate research appears to be more developed in the laboratory sciences and engineering than in the social sciences and the humanities. In laboratory science, a total of 62% of respondents reported participation by half or more of their students, while in engineering and the social sciences, the comparable figures were 44% and 25%, respectively. Inquiry-based learning has been developed largely within departments, rarely as interdisciplinary or university-wide initiatives. There has also been a response to the Commission's call for undergraduate programmes to provide strong communication skills. Research universities now devote considerable attention to writing but much less to oral communication. While almost all research universities surveyed had freshman writing courses, only 19% of respondents reported that oral communication skills are taught in their university's introductory courses, while about 30% reported that they do not offer any courses or activities at all to promote development of these skills.

Conclusion

The approach to undergraduate education discussed in this article is timely in the context of the 1999 Bologna Declaration which called for the establishment by the year 2010 of a coherent, compatible and competitive European Higher Education Area. The Declaration placed particular emphasis on the need to consolidate and enrich European citizenship to face the challenges of the innovation age. The group of universities that examined in the Tuning Project the implementation of Bologna placed particular emphasis on the role of generic and subject-specific competencies (i.e. skills, knowledge, content) in determining the quality and nature of undergraduate education to meet forthcoming challenges throughout Europe.

Many commentators question the relevance today of the traditional model of university education described in, say, John Henry Newman's classic *The Idea of a University* (Turner, 1996). At the same time, there is general agreement that in the knowledge age the case for the value of the university has never been stronger. However, the university should not be a place where knowledge discovery and research is confined to elite postgraduate and faculty research. At its core it must offer an inquiring environment to all its community members, especially its undergraduate ones.

A knowledge society is ultimately one that is inclusive and participative, concerned about values, culture and quality of life. As Tuohy (2002) says, a liberal education is of particular benefit in preparing students for this society since value is created more by intangible assets such as ideas, ways of working, emotions and community than through either information or knowledge acquisition per se. The undergraduate experience should be characterised by a sense of purpose and excitement, developing in students a strong mission or vocation through which they can be motivated. It is only when young people believe their vision can change the world that they are willing to lead change and be innovative.

Some may argue that the considerable overhaul in both mission and operation of undergraduate programmes advocated is too expensive to implement since this will generally require small interactive environments. In fact, the opposite is likely to be true if innovative approaches are used to determine which courses might be delivered face-to-face and which online. Indeed, some might alternatively be taken by the students at another institution altogether, since many of the most crowded undergraduate courses, such as introductory modules, are the same ones taught at most higher education institutions. This could result in better inter-institutional collaboration, facilitating student mobility and thereby reduce overall costs.

A radical new approach to Irish undergraduate education founded on research and self-discovery is essential. Students graduate today to a world of global risk, environmental degradation, values conflict and cultural confusion. Great opportunity and wealth exist alongside deprivation and poverty. Natural resource depletion and the dangers of global warming offset the benefits of medical and biotechnology advances. Forming a culture of inquiry, research and innovation within a framework that stresses intercultural understanding, sustainability, equitable sharing of resources and enhanced civic responsibility is an enormous challenge for educators. The transformation proposed here could prove a significant competitive advantage internationally. It also would offer protection for Irish universities to ensure continued public support within the highly uncertain future environment they face. More important, it will ensure that these unique institutions will continue to make a significant contribution to society consistent with the special intellectual role offered them.

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