Foreword

In July 1998, the Irish Council for Science, Technology and Innovation identified effective primary and second level science, technology and mathematics (STM) education in Irish schools as a priority area for its consideration. This decision was based on its awareness of the pervasive role of technology in modern life, on the increasing importance of science, technology and innovation in the knowledge-based society and on issues of competitiveness. The profound importance our educational system to Ireland's future well-being led the Council to initiate a study to benchmark school science, technology and mathematics education in Ireland against international good practice.

It gives me great pleasure to present the findings of that study. Much effort has been put into this work, by experts both in Ireland and in the four other benchmarking countries – Scotland, Finland, Malaysia and New Zealand – who have given extensively of their time and experience, for which, on behalf of the Council, I thank them most sincerely. In particular, I wish to acknowledge the assistance and guidance of the National Council for Curriculum and Assessment and the significant efforts of Professor Donald Fitzmaurice of ICSTI, who chaired the steering group, and Dr Jacqueline Allan of the Forfás Secretariat.

In undertaking this work, the Council aims to inform the debate in the areas of science, technology and mathematics education. It is not the purpose of this particular study to recommend actions to address perceived strengths and weaknesses of education systems. It is rather the aim, to the extent possible, to provide a factual, qualitative and quantitative description of STM in the Irish school system and to identify important issues that require attention. It is the hope of the Council that the information in the benchmarking report and supporting database will stimulate discussion and assist in the formulation of new policies for STM in Irish education.

The study highlights the attention that other progressive countries are giving to strengthening developing STM in the school system. As the knowledge age unfolds, it is recognised that national competitiveness and well-being becomes increasingly dependent on the scientific literacy of population.

This document should not be seen as an end in itself. ICSTI is drawing heavily on the benchmarking study, and the underlying work, in formulating its own recommendations, which it will be publishing shortly in its Statement on *Science in Second Level Schools.*

Edward M. Walsh
Chairman
Irish Council for Science, Technology and Innovation

September 1999

Executive Summary

The Irish Council for Science, Technology and Innovation (ICSTI), with the assistance of the National Council for Curriculum and Assessment (NCCA), has undertaken a benchmarking study of science, technology and mathematics (STM) education in Ireland, Scotland, Finland, Malaysia and New Zealand.

The aim of the study and of this report is to inform the debate on STM education in Ireland.

Objectives

The objectives of the study were as follows:

- to describe, under a common set of criteria, the provision and practice of STM education in the Irish school system and in that of other successful knowledge-based societies
- to raise awareness of issues in STM education and to stimulate informed debate, by disseminating the findings of this study widely among the social partners
- to provide the basis for advice to be given, by ICSTI to government and by the NCCA to relevant bodies, on this and related issues.

Approach

The approach used for the study was a combination of information gathering and consultation with educationalists.

In the first phase, education representatives in the five countries completed a questionnaire. From this information, along with material from consultations and examination of educational documentation, a Benchmarking Database was compiled under five headings: national education system; curriculum; pupil assessment; teacher recruitment and education; and education practice.

Through discussions with education representatives in Ireland and with experts in the selected countries, the validity and accuracy of the information in the database was confirmed.

This report summarises the material in the database and highlights three key issues, identified by ICSTI, which arise from it.

Key issues

The three key issues identified by ICSTI are as follows:

1. **How to develop and implement STM education policy on a time-scale that meets the rapidly changing needs of an emerging knowledge-based society, while continuing to meet individual students' long-term needs and ensuring a high level of ownership among the social partners**

   Consideration of the individual's needs and involvement of the social partners are strengths of the Irish system. However, it is important that the pace of and procedures for consultation should not prevent timely policy decisions and implementation.

2. **How to recruit, train and retain high-quality STM teachers, particularly in the physical sciences and mathematics**

   The effectiveness of STM education depends critically on teachers. Supporting them by means of an attractive career path, with opportunities for meaningful professional development and life-long learning, is essential to recruitment and retention.

3. **How best to teach and assess STM**

   In all the countries studied, STM education is moving from 'chalk and talk' to experiential methods with an emphasis on developing problem-solving skills and learning by doing. In this context, STM education needs to have appropriate resources. It is essential too that curriculum objectives are reflected in both the criteria for and methods of assessment.

If these key issues are addressed, STM education in Ireland will effectively contribute to equipping students for a meaningful and productive role in the knowledge-based society. Scientific and technological literacy, appropriate to the needs of the individual, is an essential life skill, which the education system must provide.

Introduction

1. Introduction

The Irish Council for Science, Technology and Innovation (ICSTI), with the assistance of the National Council for Curriculum and Assessment (NCCA), has undertaken this benchmarking study of science, technology and mathematics (STM) education in Ireland, Scotland, Finland, Malaysia and New Zealand.

Benchmarking is 'the use of systematic methods to compare yourself with others and find better ways to do your work'[1] . The aim of this benchmarking study is to inform the debate on STM education in Ireland and to assist government and its agencies, teaching professionals and representatives of parents in making the difficult decisions required to ensure effective ST M education provision in Ireland.

In particular, ICSTI hopes that the study will contribute to understanding the relative strengths and weaknesses of STM education in Ireland when compared with other open, knowledge-based societies, generally on the periphery of major economic blocs.

1.1 Objectives

The summary terms of re f e rence for the study are given in Appendix 1. The objectives are as follows:

- to describe, under a common set of benchmarking parameters, primary and second level STM education provision and practice in the Irish school system and that of other successful knowledge-based societies
- to raise awareness of the issue of STM education and to stimulate informed debate, by disseminating the findings of this study widely among the social partners
- to provide the basis for advice to be given, by ICSTI to the Minister responsible for science and technology and by the NCCA to relevant bodies, on this and related issues.

1.2 Approach

The five countries in the study were identified as open, knowledge-based societies, generally the periphery of major trading areas.

In order to meet economic and social challenges, there is an increasing need for the citizens of these countries to create and use new and existing knowledge, much of which will be scientific and technologically based. Education and employment statistics presented in Appendix 2 provide a context for the benchmarked countries in comparison with selected OECD countries. Economic indicators are given in Appendix 3 for the benchmarked countries.

The education systems of the selected countries were examined through a process of information gathering and consultation with educationalists. Representatives of the education systems of five countries validated the compiled material. (This process is outlined in more detail below in Appendix 4.)

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[1] *Benchmarking in the Australian Public Service, 1996*

An extensive questionnaire was developed, by Deloitte & Touche under the direction of the steering group, from a list of benchmarking parameters that examined the following main areas:

- national education system
- curriculum
- pupil assessment
- teacher recruitment and education
- education practice
- social and economic environment for education.

Following piloting and extensive discussions with the steering group and with representatives of the education community in the benchmarking countries, the questionnaire was revised by the consultants and circulated to a broad range of education representatives, for example, the Department or Ministry of Education, teacher unions, science and technology teacher associations and curriculum development bodies.

Following interaction between the consultants in Ireland, the steering group and international consultants, the questionnaires were completed by representatives in the benchmarking countries and compiled by the consultants into a benchmarking database.

This database was subsequently revised by the ICSTI secretariat, through contact with a second group of independent experts in the countries under study, including Ireland, to ensure the accuracy of the information.

This report summarises the material in the database and highlights three key issues, identified by ICSTI, which arise from it. Each of five topics is considered in turn, namely national education system, curriculum, pupil assessment, teacher recruitment and education and education practice. Information about the social and economic environment for education is provided in the appendices, as previously stated.

The Irish Council for Science, Technology and Innovation wishes to acknowledge the assistance of all those who contributed to the benchmarking project over the last year (see Appendix 5). As part of its continuing work in the area of education, ICSTI is preparing a statement on science education at second level, for publication in late 1999. The statement will draw on the benchmarking study and recommendations in it will seek to address the key issues identified in the benchmarking report.

1.3 Qualifications

In most fields of research, international comparisons are difficult to undertake and to draw any concrete conclusions from. In the case of education, cultural contexts, relative levels of resources, the philosophical basis and the structures of education systems, not to mention their operational characteristics, contribute to the difficulty of the task of comparison.

This study has been undertaken with full cognisance of these difficulties. Equally, it recognises that the outcomes of international comparisons are frequently applied in inappropriate ways within benchmarked countries. In many cases, studies of this kind have been used less to engage in a genuine process of understanding of education systems in other countries, less in the context of informed self-review, and more in efforts to find instant 'quick fix' solutions to particular issues or problems identified.

At the outset, it is important to emphasise that the database for this study should be used with due recognition of the realities of such international comparisons. In particular, the country-by-country responses in the database should be viewed as an informed summary and a country perspective on the education system. The database information ranges from the quantitative to the qualitative, with quantitative information often being unavailable or irrelevant, as it did not enable a comparison of like with like between the countries under study. In some cases, the summary is based on research findings; in some, on policy documentation; in others, on experience of the practical realities of the system.

As evidence of the reality of the education system in the countries under study, the summaries rest at varying points along a continuum between subjectivity and objectivity, between aspiration and reality. Where feasible, it follows that their main use should be to inform discussion and self-review in Ireland and to pr ovide a platform for further investigation and research in particular areas of interest.

National Education System

2. National Education System

2.1 Introduction

This is a critical summary of the information contained in the National Education System section of the benchmarking database. Information is also drawn from other sections of the database.

2.2 Key findings

Ministries

In each of the countries in the study, there is a ministry responsible for education. None of the countries has a specific section responsible for STM education within the ministry. In Ireland, the ministry for education also has responsibility for science, which makes it unique in this respect amongst the benchmarked countries, although it is not uncommon in global terms. As this is a relatively recent development, it is not yet possible to assess its effect on Irish STM education.

The greatest differences between the ministries are in their approach to formulating policy and in the level of devolution of responsibility for its implementation. Broadly speaking, the countries in the study fall into three categories.

The first category contains Ireland and Scotland. In these countries, the Minister, supported by the government department, agencies and specialist advisors, is responsible for developing education policy but consults extensively with the social partners. The development of education policy in these countries is, therefore, characterised by a process of consensus building and a sense of ownership. However, having entered into those discussions, the ultimate decision-making power rests with government.

The outcome of the consultative process is an agreed national curriculum to be implemented in all schools. Schools then have the opportunity to select and implement programmes appropriate to local and/or individual needs. In Ireland, programmes such as Transition Year and the Leaving Certificate Vocational (LCVP) and Applied (LCA) Programmes are particularly suited to this. However, the development and implementation of the national curriculum is largely a centralised activity.

The second category contains Malaysia and New Zealand. In these countries, the Minister, supported by the government department, agencies and specialist advisors, is responsible for developing education policy. There is consultation with the social partners in the course of this process but consultation does not preclude the Minister from taking unilateral decisions where it is seen to be necessary. Thus, development of the curriculum in these countries can lead to a more politicised approach towards achieving national economic and social objectives than in the first category and, in some cases, a willingness to impose change on the system. The process results in the development of a national curriculum, which is implemented in all schools.

The third category contains *Finland*. In this country, the Minister, supported by the government department, agencies and specialist advisors, is responsible for developing education policy and may consult broadly with the social partners. This process leads to the development of a national curriculum framework, which is used by the teachers in each school as the basis for a detailed localised and individualised curriculum. The teachers, in consultation with other staff, the pupils and their parents, develop the local curriculum, which is approved by the school board.

This level of commitment is worthy of note and an attractive feature of the 'bottom-up' approach adopted in this country. However, the approach leads to problems of unevenness in the implementation of the curriculum and its aims and objectives are not always met.

The perceived importance of STM in national educational policy in the benchmarked countries is increasing. In Finland, for example, there is a national initiative aimed at developing STM education at all levels, a response to a recent policy decision by government. Equally, government has placed a high priority on STM education at all levels in New Zealand.

On the ground

In all the benchmarked countries, there tend to be more and smaller primary schools and fewer and bigger second level schools. In Ireland and Finland, however, there is a much larger proportion of primary schools with fewer than 100 pupils. The great majority of these schools are state funded or state/private funded. A small fraction cater for special needs: STM subjects may not be provided in these special schools.

In all the benchmarked countries, the student–teacher ratio was between 14 and 24. In Ireland, the student–teacher ratio at primary level is among the highest (23) and at second level is average (17). Ireland was the only country showing a significant fall in the numbers entering the school system, due to a declining birth rate, although there is some evidence that this trend may be reversed in the short and medium terms, due to immigration and an increase in the birth rate respectively.

There is a growing acceptance of the importance of in-career development of teachers in all the countries in the study. This was particularly true in Ireland, Malaysia and New Zealand, where it now seen as essential to the development and motivation of good teachers. An objective is to increase the quality and quantity of in-career development to the point where it has the desired effects in terms of teacher development and motivation.

The provision of facilities for teaching STM in the benchmarked countries varies. At primary level, Ireland and New Zealand do not provide dedicated facilities for STM teaching. In Finland and Malaysia, newer schools have 'science rooms', although in older schools this may not be the case. In Scotland, the 'wealthier' schools have good facilities.

At second level, the laboratory situation in Scotland, Finland and New Zealand is described as satisfactory or good. In Malaysia, the situation in a third of schools is not satisfactory, but is being addressed. In Ireland, the Department of Education and Science has expressed concern about the level of investment in new STM facilities and about the deterioration of existing facilities: some remedial action is underway.

2.3 Conclusions

The benchmarked countries apply different, but not mutually exclusive, methods for formulating and implementing educational policy. Government may decide policy or it may oversee a process of consensus building. Government may develop and implement a national curriculum or it may permit teachers and others to develop localised/individualised curricula consistent with national policy objectives. In all cases, the emphasis placed on STM by the national education policy and curriculum may vary.

In Ireland, the Government oversees a process of consensus building on education policy and develops and implements a national curriculum consistent with this policy. While this ensures a strong sense of ownership, it may constrain policy development and curriculum reform in contested areas, on which it is therefore difficult to make progress. In New Zealand, such reform was seen as necessary when implementing government decisions to increase the emphasis on STM education.

The development of a national science and technology infrastructure is necessary to ensure a world-class capability to innovate. It is of key importance that the increased emphasis on such development is reflected by the education system in the development of effective, modern and meaningful STM education provision in schools.

Curriculum

3. Curriculum

3.1 Introduction

Most countries involved in the study are engaged in curriculum review and development as an ongoing process. Countries where there is an established curriculum agency ha ve much work in progress.

The information in the database is largely descriptive and based mainly on informed perspectives rather than, for example, directly on research findings. The main focus here is on the 'written' curriculum as opposed to that 'received' by pupils in schools, the latter being more fully addressed in the section on education practice. Significant gaps can emerge between the rhetoric and the reality. Some information in this summary is drawn directly from the curriculum documents of the benchmarked countries.

3.2 Primary level – current situation and trends

Aims and objectives

The countries give broadly similar definitions, aims and objectives of science and mathematics provision in the curriculum. The aims are to impart knowledge, to engender curiosity and to develop skills. These aims are achieved through providing opportunities for practical exploration and involvement in the prescribed topics. The development of scientific process skills is mentioned in the case of each country. Learning is child-centred at primary level in all the countries in the study.

Working scientifically

Mathematics courses are mainly seen as satisfactory, and the tendency is only to 'fine-tune' the content and methodology. In science, there is evidence of a distinct shift, characterised by a change in methodology to encourage working scientifically, a broadening of the content to include physics and chemistry topics and an understanding of science as a subject that can be taught to all primary school children and not just those at senior level.

The shift in the curriculum towards working scientifically requires considerable cultural and methodological adaptation by teachers. Each of the countries surveyed has recognised the need to engage with teachers and to assist them in this through in-career development as a critical success factor.

Science provision

With the exception of Malaysia and, currently, Ireland, science syllabi are designed for use with all children from their entry into the primary school. In the six-year cycle of primary school in Malaysia, science is introduced for the last three years. In Ireland, there is provision for pupils to study science in the final two years of an eight-year primary cycle. Some schools take the opportunity to introduce science at an earlier stage, but the extent of this is unknown and the focus is particularly on nature studies.

Significant and welcome changes in science provision are expected in Ireland in the near future. A re v i sed curriculum is being introduced which includes science at all primary levels. However, the position of science at primary level will not improve until the implementation of the relevant parts of the curriculum takes place. Furthermore, this implementation will have short- and long-term resource implications both in terms of teacher training and support and of equipment and consumables.

Biology dominated science in the past in all the benchmarked countries. There is a trend towards providing an equal balance of physics, chemistry and biology topics in science in recently revised syllabi in New Zealand. This trend is also apparent in the revised Irish primary curriculum.

Technology provision

A subject called technology is taught in New Zealand and Scotland but not in the other benchmarked countries. In New Zealand, it is focussed on solving everyday problems using technological practices and methods. In Scotland, the emphasis is on practical approaches and problem solving with some practical work and projects.

In Ireland, there is no technology subject but science in the proposed curriculum includes a strand called Designing and Making. In the past, designing and making has been experienced by pupils in the area of crafts. The strand in the revised Irish curriculum is almost identical to technology in the New Zealand curriculum, but on a smaller scale.

Mathematics provision

The mathematics syllabus in each of the countries is spiral in nature and is designed for pupils to learn mathematics from their entry into school. The success of using practical work and equipment, particularly with young children, is recognised. There is much similarity in the content of the curriculum at these early stages. Later, the content and emphasis varies from country to country. In Ireland, a wide range of mathematics topics is treated in depth. Each of the countries identifies a desire to move towards more practical, equipment-related work for senior pupils to aid understanding and learning. In Malaysia, there is a greater emphasis on the development of a high level of numerical computational skills than in the other countries. Problem solving, involving practical everyday challenges, is part of all the mathematics syllabi.

ICTs in education

For information and communications technologies (ICTs), the predominant pedagogical approach is the use of computers as learning aids. Even in Scotland, where computer studies is a school subject, it is reported that, in the future, greater attention will be given to computers as learning aids.

The problem of providing ICTs in schools is one that is shared by all the countries surveyed. Scotland's early entry into this field has left them with the problem of replacement of outdated equipment. The Schools IT 2000 initiative in Ireland provides both computer hardware and teacher training but, as evidenced by the experiences in Scotland, the requirement for ongoing provision of hardware, software and training must be monitored beyond the initial stages and necessary actions taken. There are concerns that there will be insufficient provision of ICTs in the future.

STM initiatives

STM initiatives frequently apply only to a very small proportion of schools and are therefore generally of minimal impact. An exception to this is the use of competitions in New Zealand to encourage schools to become involved in science and technology projects. Such a competition structure exists in Ireland, sponsored by industry, but participation at primary level is low.

3.3 Post-primary level – current situation and trends

Aims and objectives

The aims and objectives of both the mathematics and the science syllabi are broadly similar for the countries in the study.

Science provision

For science syllabi, the main differences in aims and objectives arise from the relative emphases across countries. Some countries place a strong emphasis on developing pupils' understanding of the interactions between science, technology and society (STS). For example, Finland includes geography with biology in lower secondary education and places emphasis on the environmental impact of scientific and technological activities. In Ireland, it is envisaged that the revised Leaving Certificate syllabi in chemistry and physics (to be introduced in schools from September 2000) and biology (to be introduced from September 2001) will devote 30% of content to STS.

From the database, the most significant finding about science teaching relates to teaching methodology. Traditionally science teaching in Ireland has been largely didactic (formal presentation) with teachers and students performing clearly defined experiments as prescribed. The 'cook book' metaphor for experimentation is apt.

New Zealand is now attempting to implement a pupil-centred methodology. Students are encouraged to take responsibility for their own learning, investigating real situations of interest to them and adjusting their perspectives as a consequence. They can become skilled practical investigators and problem-solvers. Teachers adopt a range of roles, as experts, demonstrators and guides, in facilitating the learning process. However, there are difficulties experienced by teachers in fulfilling all of these roles simultaneously and significant support for teachers, both to increase their own understanding and to enhance their skills, is required.

Technology provision

Technology has received widely different treatments in the countries surv eyed. New Zealand is beginning to implement an ambitious programme starting in primary schools. Malaysia provides vocational/technical education for less academically inclined students in upper secondary level. Scotland has a strong tradition in pr oviding technological education. This has helped to forge links there between schools and the wider society. In Finland, technology is not a stand-alone subject.

In Ireland, technology subjects (such as technical graphics and metalwork) are optional. Their practical emphasis is reflected in their popularity among those students opting for them. However, technology subjects have poor status and low uptake rates. Often they are viewed simply as 'craft' subjects that do not engage with the ‘cutting edge’ of technological developments.

In order to increase provision, a general technology subject was introduced in the early 1990s. It is envisaged that this will be followed through with the introduction of a Leaving Certificate subject. In addition, revised syllabi in the technological subjects, due for implementation shortly, incorporate more advanced technologies.

Mathematics provision

In Malaysia, it is a requirement that all students study mathematics up to the last two years of post-primary schooling. In the final 2 years, those in the science stream generally continue to take mathematics, although, since June 1999, it is no longer compulsory.

Mathematics courses in Ireland, where virtually all students study mathematics throughout, are, in general, broader and deeper than corresponding courses elsewhere, and there is concern that the current Junior Certificate mathematics syllabus is too broad to allow for the required depth of treatment in the time available.

Arithmetic, algebra, geometry, trigonometry and statistics are considered basic components by all the benchmarked countries. Ireland is unusual in that most students study some calculus. New Zealand and Scotland place greater emphasis on the collection, organisation and presentation of data.

Issues of concern

Concern is expressed across all the benchmarked countries about falling levels of uptake of the physical sciences. Factors that influence this include provision of these subjects in schools, allocation of subjects to students and choice by students of the science and technology subjects. Choice of subjects is further influenced by attitudes to, experiences of and perceived usefulness of STM.

There are also concerns regarding relative uptake of science subjects by girls and boys, girls predominating in the biological and boys in the physical sciences, although the uptake of chemistry is approximately equal for both genders. Initiatives have been taken in all countries to address falling uptakes and gender balance, many of them on a small scale. Their effectiveness is unclear. In addition, some STM subjects have been made compulsory up to a required level. However, after that level is reached, participation in STM is found to decrease dramatically.

ICTs in education

Across the benchmarked countries, there are few mainstream courses in ICTs. ICTs are viewed primarily as a learning tool and as an area of the curriculum where levels of competence need to be specified and attained through cross-curricular educational activity. Where ICT courses (such as computer studies) are in place or planned, there are concerns about their ability to keep pace with rapid developments in this area of technology.

STM initiatives

Details are given in the database of some major STM initiatives, including a global schools network programme and an IT camp in Malaysia; a project to facilitate distance learning for students in Finland; and, in New Zealand, a science roadshow, awards encouraging links between the scientific community and schools, science badges to motivate a verage or less than average 12–15 year olds and S&T fellowships for outstanding teachers.

3.4 Conclusions

The current trends at primary level are similar in each country with the exception of Ireland. They include an emphasis on broadening the science syllabus and on working scientifically. The task of retraining teachers in scientific teaching methodologies is common to all countries and is seen as necessary to the successful implementation of the new approaches envisaged. The situation in Ireland is expected to change in time with the implementation of the relevant parts of the revised primary curriculum when science will be taught to all pupils in primary schools.

All countries express general satisfaction with the content of the mathematics syllabi but each would wish to incorporate more practical work at the senior end of primary school. It is generally acceptable to use calculators in primary school at senior level. Technology as a subject is not widely available among the benchmarked countries. The cost in providing ICTs is recognised as an issue.

At post-primary level, challenges are presented in moving from a largely didactic approach to the teaching of science towards one where students learn by undertaking experimentation and investigation. New Zealand is going through significant change in teaching methodology for science and technology.

For all the benchmarked countries, low uptake rates and gender imbalance are a concern. All countries favour integrated use of ICTs in teaching. There are several initiatives being taken in other countries to address issues of awareness and competence in STM education.

Pupil Assessment

4 Pupil Assessment

4.1 Introduction

This section investigates the purposes, aims, modes and techniques of assessment in the participating education systems. In addition, it considers the contributory roles of the bodies responsible for this aspect of education.

4.2 Purposes of assessment Assessment of how the aims and objectives of curricula are achieved in the development and performance of pupils is a central activity of every education system. At primary level, teachers a s sess their own pupils for formative and diagnostic purposes. In this way, assessment is an integral, developmental aspect of the teacher–learner relationship. In Malaysia, at primary leve l , a s sessment of pupil performance is also a determinant of prog ression to schools with limited entry.

There is a growing trend internationally, as in New Zealand, towards the use of standardised testing for both diagnostic and summative purposes, particularly in basic learning activities such as reading, writing and numeracy. In some countries, for example New Zealand, this form of assessment is undertaken on the basis of sampling. In others, such as Scotland, all pupils are tested at regular intervals and the results of these assessments are used for the purpose of accountability as well as for summative and diagnostic purposes.

At lower second level, purposes are broadly similar to those at primary level. However, Ireland is unusual in retaining externally examined, summative assessment for national certification, and accountability, at the end of compulsory schooling (Junior Certificate).

At upper second level, the complete range of purposes is evident – formative, diagnostic, summative and accountability – with the emphasis on high-stakes examinations for national certification concentrated at the latter end of this continuum. In all countries, at this level, performance in assessment acts as a determinant of progression to further and higher education.

4.3 Modes and techniques of assessment and the role of teachers

The purpose of the assessment influences the modes and techniques employed. Thus, at primary level in the benchmarked countries, a broad range of techniques is used through school-based assessment to ascertain pupil development and performance. Moving towards upper second level, this range contracts significantly to a strong emphasis on externally examined terminal tests for national certification. Some countries use other forms of assessment (e.g. portfolios and projects) but Ireland mainly relies on written terminal examinations.

What is of interest at primary and post-primary level is the growing trend towards the establishment and use of national banks of standardised tests and examinations and the developing role of external moderation of school-based assessments. Both elements are used byteachers and schools, in the context of the curriculum plan of the individual school, in conducting school-based assessment of pupil performance. This reflects a trend (not as prevalent at upper second level) towards less centralised education systems.

Assessment related to pre-vocational and vocational qualifications, as in New Zealand, seems to provide a fruitful base for teachers to develop their role in assessment of pupils for the purpose of national certification.

4.4 Assessment of STM subjects

The practical dimension of STM is given less attention in assessment processes than the knowledge/understanding dimension. This is particularly so at primary level. Ireland, uniquely, does not provide for the assessment of practical work in most science subjects at post-primary level. This results in a significant lack of congruency between the aims and objectives of the relevant subject and its assessment.

4.5 System effectiveness

Commonly, national curriculum bodies, in co-operation with the relevant assessment/examination agency or government department, develop assessment criteria. It is interesting to note that in Finland, where this responsibility has been devolved to the school, it has given rise to the phenomenon of publishing houses providing sample criteria with textbooks in the absence of any centrally agreed criteria coming from the national education system. This has led to concerns that the curriculum can become textbook-led.

New Zealand has placed much emphasis on examination criteria being developed with the involvement of teachers and moderated with the assistance of the tertiary sector. This more centralised approach leads to increased ownership among the partners involved, greater integrity and consistency and ensuing public confidence. However, it also tends to be less flexible and responsive to major changes in society. The less centralised approach is more flexible and sensitive to local needs.

There are many similarities between the countries in relation to the writing of, marking of and assessment through examinations. Parallels can be drawn between Ireland and New Zealand, as many recent changes aimed at improving the effectiveness, efficiency and transparency of the Irish examination system have been based on models developed by New Zealand. The major differences surround the involvement of teachers in assessing their own pupils for the purposes of national certification and the differences this gives rise to in moderation procedures and sampling techniques.

4.6 Role of assessment in enhancing the quality of teaching and learning in STM

Assessment is central to the enhancement of teaching and learning in all subjects and programmes. The findings of the study indicate that, where the purposes of assessment are formative and diagnostic in the context of low-stakes assessment environments, they enhance teaching and learning.

Where the predominant purpose is summative for national certification and accountability, especially in high-stakes assessment environments, assessment processes often discourage the development teaching and learning processes. Commonly, in the latter case, the approach to teaching and learning is fashioned and determined by the terminal assessment rather than the starting point, the curriculum. This phenomenon is evident at upper second level in Ireland and is exacerbated in the case of most science subjects by the lack of a practical dimension to their assessment.

4.7 Role of assessment in enhancing employability

While contributing in general terms to a broad, balanced education, STM education does not seem to impact directly on employability of pupils. In this context, technology subjects seem have a greater perceived impact for pupils in terms of employability and relevance to life than science subjects.

Countries involved in the study stress the increasing importance of a qualification in higher education for access to attractive employment in the area of science and technology and other areas. New Zealand, through its system of 'unit standards', places emphasis on the development of a record of educational achievement by the end of formal schooling, for each pupil. This is to contribute to overall employability.

4.8 Conclusion

Comparison between Ireland and the other countries studied gives rise to the following areas for consideration.

Firstly, the study leads to the question of whether standardised testing has a role in improving monitoring assessment processes and pupil performance in STM education in Ireland. Secondly, raises the question of the need to retain summative assessment at the end of compulsory schooling in Ireland, in the form of the Junior Certificate, when assessment on this scale at this stage has been discontinued in most countries.

With regard to STM education in particular, the lack of congruence between the aims and objectives of curricula and their assessment is a matter of concern. This is particularly so in the science area, given the fact that the trend in curricula of the countries studied is towards greater emphasis on pupil investigation and experimentation. The practical dimension of science subjects should be reflected in their assessment.

Some particular developments in assessment in the countries in the study, which are of interest, include the following:

- using sampling of schools for the purpose of measuring student achievement in STM education nationally
- the provision of banks of assessment instruments for 'off-the-shelf' use by schools on an optional basis
- the use of a range of models of external moderation to underpin school-based assessment n the use of records of student achievement.

Teacher Recruitment and Education

5. Teacher Recruitment and Education

5.1 Introduction

This section examines the routes by which teachers qualify, the duration of their probation period and their age profile; the degree of their specialisation in the STM subjects; the provision of in-career development; and the issues of recruitment and retention of good STM teachers. Information is taken from the teacher recruitment and education section of the benchmarking database and from other sections, where appropriate.

5.2 Pre-service education

Teachers are predominantly female at primary level (60–92% female). At post-primary, the trend is less clear, ranging from 45% female (New Zealand) to 71% (Finland, lower secondary). There is a range of teacher qualifications. For primary, this varies from a three-year teaching qualification (Malaysia and Ireland) to a five-year Master of Education degree (Finland). For post-primary, all teachers except in Malaysia have a degree and post-graduate teaching qualification. Training is of between four (Ireland) and six and a half (Finland) years' duration. In Finland, an MSc or MPhil is required. The probation period for teachers varies from one (Ireland) to three (Finland) years.

In Ireland, teachers in the technology area were in the past predominantly recruited from industry and many still have considerable industrial experience. However, this is becoming less common and most now enter teaching by the degree route, the norm for second level teachers. In New Zealand, students entering training to become technology teachers increasingly have some years of work experience, often in industry. Technical teachers there traditionally have an Advanced Trade Qualification plus a minimum of 6000 hours of work-related experience. The typical entry age for teacher training varies from 17–22 years, including those entering after completing a degree course. In New Zealand, there is a bipolar distribution with most entering at age 18 for primary and 22 for second level, but a small number also enter aged 30–45 years.

5.3 Specialisation in STM

Primary school teachers are generalists in all countries. Modules in science, ICTs and mathematics are provided during pre-service education. In Ireland, modules in mathematics and information technology (IT) are provided and science-teaching modules are planned as a requirement for the implementation of science in the revised curriculum. Only in Ireland is it possible to graduate as a primary school teacher with no science training (by completing an 18-month graduate conversion course following a non-science degree).

Post-primary teachers are generally seen as experts in their subject, having completed an STM degree before commencing teacher training. However, teachers in Ireland and Scotland in particular may be required to teach STM subjects other than their own speciality. In recent years in Ireland, people entering teacher training to become science teachers predominantly have degrees in the biological sciences. In addition, teachers of mathematics, especially at lower junior level, are sometimes not mathematics specialists, which has given rise to concerns. Training in technology teaching in Ireland is a degree course, with one year of general engineering and the remainder a specialist teaching option.

There have been problems in several countries of low teacher competence, particularly in ICTs but also in mathematics.

5.4 In-career development

There is provision for in-career development in STM for all teachers in all the benchmarked countries at both primary and post-primary levels, but it is optional throughout. The exception to this is when a revised curriculum is being introduced or in specific cases (for example, programmes to improve mathematics teaching, to address gender issues in the sciences or to introduce teachers to and assist them with ICTs). In New Zealand, in-career development is optional but expected.

In Ireland, in recent years, the Department of Education and Science has invested significantly in the in-career development of teachers. The main focus has been on support for the introduction of new initiatives, programmes and subject syllabi. To date, STM has not featured strongly in the latter context, though initiatives are underway to address this.

Currently, the in-career development of many teachers of STM subjects in Ireland is provided through their professional involvement in subject associations and through education centres. As a consequence, many teachers express concern that in-career development takes place outside school hours and can be difficult for teachers to avail of. In general, teachers often view in-career development as focussed more on the implementation needs of the education system and less on the professional development of teachers for their changing working lives. These concerns are mirrored in the other countries in the study, with in-career development being optional, but regarded as of high importance for effective teaching and learning.

In some countries, there is no central budget for in-career development but local authorities or individual schools can opt to spend money on training (Scotland, Finland). Elsewhere, it is centrally co-ordinated.

5.5 Recruitment and retention

The average age of teachers is 41–47 years, except in Malaysia which recently had an initiative to attract people into teaching in response to a severe shortage at both levels. There, the average age is 23 for primary and 30 for post-primary.

At primary level, there is little difficulty in recruiting teachers. All countries identify a current or future problem in recruiting post-primary teachers trained in STM, especially in the physical sciences and mathematics. The shortage of teachers for these subjects is attributed to the opportunities in other areas (such as computing) and the lack of incentives to teach. In addition, in Ireland, a problem is identified in recruiting women to teach technology subjects.

Teachers from all subject areas are generally treated the same in terms of incentives such as additional pay allowances for people with higher qualifications. New Zealand offers a scholarship of US$5,000 to people with academic qualifications to teach mathematics, physics and technolog y (IT). Their immigration policy also favours teachers of science, mathematics and computer studies f rom other countries. In Malaysia, teachers who have contributed significantly to sc h o o l performance are re wa rded through a Master Teacher initiative. A Malaysian teacher training college has been established specifically to train primary school teachers of mathematics and science.

In post-primary science in Malaysia, there are prog ression courses for selected teachers to train to be school heads. There is no clear route of career prog ression for teachers there unless they become school principals, which is also true of other countries in the study, including Ireland. This a d vancement can result in their being lost to teaching as they concentrate on school administration.

5.6 Conclusion

All countries identify issues in teacher recruitment and education. In Ireland, it is seen that pre-service education in STM subjects is limited, sometimes with no science training provided, and that in-career development is optional and often aimed at supporting developments in education. The teaching profession in Ireland is characterised by low mobility, with long periods spent at one school, limited opportunities for professional development and limited scope for progression.

Teaching is not seen as attractive, particularly for people in the physical sciences and mathematics, leading to current or anticipated shortages at post-primary level in the benchmarked countries. Incentives to attract and retain STM teachers are found in only two of the countries, New Zealand and Malaysia. The age profile of teachers is similar in all countries except Malaysia, and concerns have been expressed that the retirement of experienced people will soon result in a shortage of STM teachers.

Education Practice

6. Education Practice

6.1 Introduction

This section explores developments in STM teaching and learning methodologies, particularly the impact of ICTs on teaching, learning and curriculum design. Practices relating to teacher and trainee-teacher assessment are also documented.

6.2 Teaching and learning

Teaching/learning methods

At primary level, all countries advocate a combination of theoretical and practical learning, including interactive group work, whole-class and group teaching, projects and field trips. At post-primary, all recommend a mixture of theory and practice, using demonstrations and experiments with simple equipment.

Effectiveness

At primary level, Ireland and Finland both see a need for increased emphasis on active learning and problem solving. New Zealand is moving away from 'what' and towards 'how' and 'why'. Malaysia identifies a need for better texts and improved teaching skills. Ongoing support for teachers, including in-career development, is identified as important for teacher confidence and competence in Ireland, Scotland and Malaysia.

The revised, but yet to be implemented, Irish primary curriculum, with its increased emphasis on science, contains many additions in the areas of active learning and problem-solving. The concept of working scientifically is developed throughout the primary years and students will be expected to observe, experiment, question and predict within this area of skills development.

At post-primary, practical work in science is viewed as important by New Zealand and Ireland in promoting enthusiasm and increasing effectiveness, but currently in Ireland there are concerns that insufficient practical work is being undertaken and that provision of facilities is variable. Technology is a new area in the New Zealand curriculum, but some schools have well-equipped work areas with CAD (computer-aided design) and other ICT supports. There is an intention there to expand technology teaching to all schools and to provide more teacher training. In technology, Ireland reports that the move to 'discovery learning' has increased effectiveness.

Mathematics teaching is still largely traditional in all countries that commented. In New Zealand, it is found that able students do well, but large numbers are 'turned off' mathematics by this approach. The Irish experience suggests that student-centred learning would be more effective, but would make course coverage significantly slower. Class-size and time limitations also affect the range of teaching methods that can be employed.

Education practice can be adversely affected by assessment. Some aims and objectives of the curriculum cannot be effectively assessed and others are not assessed. Thus there can be an emphasis, in teaching and learning, on the elements that are assessed and an identified neglect of those that are not part of the assessment. One illustration of this is when students are striving to achieve the grades required to reach third-level education by focussing only on what they expect to arise in the examination, a familiar phenomenon referred to in Ireland as the ‘points race’.

New methods

At primary level, all countries see the benefit of moving towards a more imaginative problem-solving approach in STM learning. In addition, Malaysia recognises the special needs of schools in disadvantaged and rural communities. As a result of research in the 1980s, New Zealand moved to a ‘constructivist’, problem-solving approach but is now aware that the importance of the teacher having sufficient understanding of basic scientific principles was underestimated. Teachers are now being supported by pre- and in-service education and development.

At post-primary level, all countries are moving towards more emphasis on practical, student-centred, active-learning models. New Zealand has developed a model based on three learning phases drawing from the student’s own experience: focussing – questions are put in context and ideas clarified; challenging – alternative theories are discussed, tested and compared with orthodox scientific concepts; and applying – problem-solving, exploration and the application of scientific principles. This method can be very time-consuming but leads to an emphasis on comprehension rather than on facts, through the application of theory in a meaningful context.

The vocational (LCVP) and applied (LCA) options at Leaving Certificate level in Ireland are examples of practical, student-centred, active-learning models. Work experience, projects and link modules are all aimed at making these courses attractive to and useful for students. Increased emphasis on practical work and on science, technology and society further enhances the student-centred approach. Transition year also provides scope for different learning models to be used. However, concerns have been expressed as to whether STM is sufficiently addressed in the locally designed Transition Year programmes.

Impact of ICTs on STM teaching

At primary level, the potential for use of ICTs as tools in teaching is acknowledged, but it leads to a need for training, facilities and equipment. In Scotland and Finland, nearly all schools have PCs and access to the Internet. Ireland, New Zealand and Malaysia all have programmes to increase the availability of ICT facilities. Scotland and New Zealand appear to have the most ambitious plans for integrating ICTs into the primary curriculum and the development of software for education as joint ventures with private sector.

In Scotland, Finland and New Zealand, ICT facilities are available in most post-primary schools. ICTs are woven into the core curriculum and used as a tool across many subjects. Ireland is moving in this direction, but there is significant work required to integrate ICTs into teaching and learning in schools. Malaysia recognises that ICTs are not yet fully harnessed in its post-primary curriculum.

At post-primary, Ireland and Finland recognise that not all schools offer the same opportunities for students to develop IT skills. The aims of the Irish Schools IT 2000 initiative, for primary and post-primary schools, include providing hardware, software and training, increasing the use of ICTs in teaching and establishing links between schools and higher education and industry. There are concerns that, while provision is currently being made for ICTs in schools, there will be insufficient provision of the necessary resources (hardware, software and training) in the future.

Most countries identify teacher confidence and competence as a limiting factor in the use of ICTs. There is also a need for teachers to identify the benefit in using ICTs in their teaching. All countries have programmes to increase access to facilities and identify an urgent need to enhance teacher confidence and competence.

6.3 Monitoring and inspection of teachers

Monitoring and inspection of teachers takes many forms along a continuum from assessment of the work of teachers and implementation of measures to address problems, at one end, to observation of teachers and the provision of advice to them, at the other. All the benchmarked countries are located at some point on this continuum. Techniques employed include self-assessment, peer observation and centrally co-ordinated monitoring. Ireland is currently moving more towards observation and advice as the preferred methodology.

There is assessment of teaching practice at both primary and post-primary levels in all countries. For trainee teachers, assessment is generally undertaken by the college or third-level institution responsible for the teacher training. All countries have classroom assessment of trainee teachers in schools.

In New Zealand, teachers have a two-year probation period after graduation and have to meet Teacher Registration Board criteria (on the approval of the school principal). Every three years, teachers are required to reapply for registration, again having to meet the criteria.

For qualified teachers, an external government body oversees assessment, except in Finland, where staff undertake a joint assessment in schools. In Malaysia, there is assessment by senior staff and observation by peers is encouraged. Malaysia also has a Master Teacher system to acknowledge teacher excellence. At post-primary level, Malaysia relies heavily on assessment by senior staff within schools, with criteria set out in a remuneration scheme. The other countries in the study lie somewhere between Finland and Malaysia.

In New Zealand, external review of practice, but not of individual teachers, is undertaken by the Education Review Office. All schools in New Zealand also operate a performance management system (which includes internal review of teaching practice) and a quality assurance cycle, with comprehensive whole-school assessment every five years, from which results are published.

Specific areas for assessment are identified centrally in Ireland and New Zealand. Ireland is currently engaged in the introduction of whole-school evaluation. In Ireland, the frequency of visits to post-primary schools by inspectors is low.

6.4 Conclusion

All respondents recognise the need to develop a more interactive, problem-solving approach to STM teaching and learning, to provide access to ICT hardware, software and training and to embed ICTs in the core curriculum, but the development process is at different stages in the five countries. The education systems in all countries aspire to giving young people the basic skills required in the modern world and to equip them to solve problems logically. All respondents identify teacher confidence and competence as a key factor and recognise the need for improved pre-service education and in-career development for teachers. The performance of teachers is assessed in all countries, but practices vary.

7. Key Issues

7. Key Issues

The evolution of the countries in the Irish Council for Science, Technology and Innovation's (ICSTI) benchmarking study into knowledge-based economies and societies depends critically on their education systems. STM education is an essential ingredient in equipping an individual for a meaningful and productive role in the knowledge-based society. Education systems in such societies must provide an appropriate level of scientific and technological literacy, equipping individuals to fulfil active and critical roles as citizens and to make well-founded decisions on issues affected by science and technology.

STM literacy also helps to realise the potential of individuals with aptitudes in scientific and technological subjects through increased learning opportunities and experiences. It will enable future scientists and technologists to produce the innovations critical to the creation of wealth and socio-economic well-being.

This form of literacy can be promoted through a system that

- enables timely development and implementation of appropriate policy
- ensures the recruitment, training and retention of high-quality STM teachers
- provides the best teaching and assessment of STM learning.

These are the three key issues identified following the study, and they are discussed in more detail below.

Developing and implementing STM education policy

The countries in the study are all emerging as open, knowledge-based societies located at the periphery of major economic blocs. As a consequence, a key issue facing those responsible for STM education policy in those countries is **how to develop and implement STM education policy on a time-scale that meets the rapidly changing needs of an emerging knowledge-based society, while continuing to meet individual students' long-term needs and ensuring a high level of ownership among the social partners.**

The development of STM education policy in Ireland is characterised by the high level of importance attached to the long-term interests of the individual student and by extensive involvement of the social partners. Ireland performs well in these respects when compared with the other countries in the study.

These strengths should allow Ireland to meet the challenge of developing and implementing appropriate STM education policy. Equally, it is these same strengths that may prevent us from doing so on a relevant time-scale.

The benchmarking study provided evidence that some other countries in the study were more willing to implement significant reforms of STM education driven by overall national policy. These approaches, particularly in New Zealand, are relevant to Ireland and warrant careful consideration. As the study shows, however, such reforms have not always been successful.

Recruiting, training and retaining high-quality STM teachers
STM education is growing in importance in all the countries under study. It is increasingly understood that the effectiveness of STM education depends critically on the capacity and commitment of teachers, individually and as a profession.

For these reasons, there is unanimity among these countries that a key issue facing STM education is **how to recruit, train and retain high-quality STM teachers, particularly in the physical sciences and mathematics.**

Across the five countries, there is agreement that a central component to addressing this key issue will be the provision, for the committed STM teacher, of a career path with meaningful opportunities for professional development and life-long learning, with potential for advancement.

Such opportunities will include adequate training and support before, during and after the introduction of new and revised STM curricula. They might also include further education in, for example, information technology, where change is especially rapid.

The task of preparing for the implementation of new and revised curricula is taken very seriously in Ireland. Many teachers at both primary and second level are now facing, possibly for the first time in their careers, the introduction of new and revised STM curricula. The benchmarking study indicates strongly that the training and support needed to ensure the smooth introduction of such curricula is generally underestimated. This was clearly the case during recent reforms of STM education in New Zealand.

The benchmarking study also indicates that comprehensive planning and provision of professional development for teachers, in a life-long learning context, is not as advanced in Ireland as in other countries, for example, in areas such as information technology. A country which performs well in this respect is Finland.

Teaching and assessing STM
The citizens of the countries in the study will increasingly need to create and use new and existing knowledge to meet economic and social challenges. Much of this knowledge will be scientific and technological in nature. At the same time, several of the countries are experiencing a decline in the proportion of students taking science subjects in their latter years at second level. This shared experience highlights the importance of effective teaching of science, technology and mathematics. Accordingly, the third key issue is **how best to teach and assess STM.**

All the countries in the study have indicated their intention to move away from a mainly ‘chalk and talk’ approach, focussed on the teaching of STM, and towards an experiential approach, focussed on the learning of STM.

Developing the practical aspects of STM education is central to such an approach. This in turn has implications for the methods used to assess STM learning, which have to be consistent with these new approaches.

The benchmarking study indicates that the infrastructure necessary for teaching the practical elements of STM courses in Ireland lags behind those in Scotland, Finland and New Zealand. Ireland does not provide for the assessment of practical work in most science subjects. It is unique among the countries in the study in this respect.

If this weak provision for practical STM education and assessment is not addressed (and properly resourced), it will be a significant impediment to effective teaching and learning of STM subjects in Ireland. There are some indications that measures are being taken to address this issue.

In assessing these subjects, it is essential that the approach be consistent with the objectives of the curricula. The benchmarking study suggests that the interests of STM subjects are not best served by ‘once-off’ assessment of student achievement through national examinations. The dominance of this practice in Ireland at Junior Certificate level is particularly questionable: in the other countries, the assessment that comes at the end of compulsory schooling involves a wider range of methods.

Further concerns in relation to reliance on terminal examinations arise from the difficulty of achieving high grades in certain STM subjects. Participants in the consultations which formed part of the benchmarking study expressed concerns about the impact this may have on the uptake of these subjects.

If these key issues are addressed, STM education in Ireland will effectively contribute to equipping students for a meaningful and productive role in the knowledge-based society. Scientific and technological literacy, appropriate to the needs of the individual, is an essential life skill, which the education system must provide.

Appendix 1

Terms of Reference

The Irish Council for Science, Technology and Innovation (ICSTI), with the assistance of the National Council for Curriculum and Assessment (NCCA), has undertaken this benchmarking study of science, technology and mathematics (STM) education in Ireland, Scotland, Finland, Malaysia and New Zealand.

Its aim is to assist government and its agencies, teaching professionals and representatives of parents in making the difficult decisions required to ensure effective STM education provision in Ireland .

Rationale for STM education

Effective STM education in the Irish school system is essential

- to contribute to the development of individuals with an interest in and a critical appreciation of science, technology and innovation as an important human activity

- to enhance the development of all individuals through STM education, as part of a balanced curriculum, by stimulating their curiosity, creativity, understanding and ability for logical and critical thinking

- to ensure a level of scientific and technological literacy that will equip individuals to fulfil active and critical roles as citizens in a knowledge-based society, able to make well-founded decisions on issues affected by science and technology

- to maximise the potential of those individuals with aptitude in science and technology through increased learning opportunities and experiences

- to equip future scientists and technologists with an understanding of the relationship between science and technology and the innovations leading to the creation of wealth and socio-economic well-being

- to ensure an adequate supply of individuals motivated and prepared to pursue further and higher education in science and technology.

It is reasonable that the methods adopted to achieve these objectives and the criteria used to assess their success should be acceptable to all the social partners. However, as the future of these individuals will, in the main, be as citizens of a small, knowledge-based society (Ireland), whose opportunities and challenges will increasingly be global in nature, it is imperative that the methods and success criteria adopted are comparable to those chosen by other successful and similarly sized knowledge-based societies.

Objectives of study

The objectives of this study are as follows:

- to describe, under a common set of benchmarking parameters, primary and second level STM education provision and practice in the Irish school system and that of other successful knowledge-based societies

- to raise awareness of the issue of STM education and to stimulate informed debate, by disseminating the findings of this study widely among the social partners

- to provide the basis for advice to be given, by ICSTI to the Minister responsible for science and technology and by the NCCA to relevant bodies, on this and related issues.

Appendix 2

Education and Employment Statistics

Introduction

This section provides an overview of education and employment statistics that have influenced the decision to benchmark school STM education in Ireland against Scotland, Finland, Malaysia and New Zealand.

Efforts were made to select countries for the benchmarking study with similarities to Ireland and also countries with significant differences from Ireland. All countries are continually re-evaluating their education system and have made significant changes in recent years.

The following factors are examined in this appendix:

- educational attainment among the adult population
- size of the school-age population
- expected years in employment
- educational expenditure both relative to gross domestic product (GDP)[2] and per student
- ratio of students to teaching staff n statutory salaries of teachers in primary and secondary schools
- teaching time and total intended instruction time
- participation in and completion of secondary education
- science and mathematics performance for students in 4th and 8th grades.

The data for the five benchmarked countries[3] are compared with the OECD country mean and the values for five other countries: Canada, Germany, Greece, Japan and the United States. Malaysia is not a member of the OECD but some statistics are available as it is a participant in the World Education Indicators (WEI) programme, co-ordinated by the OECD in co-operation with UNESCO.

The purpose of this appendix is to provide an educational and employment context for the benchmarked countries in comparison with selected OECD countries. For example, Ireland is shown to be:

- below average in the percentage of population attaining at least upper secondary level education; in the direct public expenditure on education as a percentage of GDP; in expenditure per student and in the ratio of upper secondary graduates to population;
- average in science and mathematics performance at 8th grade and
- above average in the proportion of people in school education; in the ratio of students to teachers; in teacher salaries after 15 years; in teaching hours per year and in science and mathematics performance at 4th grade.

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[2] *Gross domestic product is the value of goods produced within a country over a 12 month period*

[3] *UK statistics have been used in some tables instead of Scottish statistics. In these cases, the Scottish Office of Education and Industry Department (SOEID) has not compiled data to the Standards International Classifications (ISCED). The OECD uses the ISCED when collecting education data. Owing to the substantial differences in the methodology and definition, it is not possible to compare SOEID data with OECD statistics.*

More detailed information is given in the sections which follow.

Educational attainment among the adult population

The level of educational attainment in the population is commonly used as a proxy for the stock of 'human capital', that is, the skills available in the population and labour force. Table 1 indicates rising educational attainment: in all countries, the proportion of 25–34 year olds who have completed upper secondary level education is greater than the proportion of 55–64 year olds who have done so. The proportion of individuals who do not complete upper secondary education has decreased over time.

Table 1: Percentage of the population that has attended at least upper secondary level education, by age group (1996)

	% aged 25–64	% aged 25–34	% aged 55–64
Canada	76	85	56
Finland	67	83	40
Germany	81	86	71
Greece	44	66	22
Ireland	**50**	**66**	**30**
Japan	[4]n/a	n/a	n/a
New Zealand	60	65	49
United Kingdom	76	87	60
United States	86	87	77
Country mean[5]	**60**	**72**	**42**
Malaysia[6]	33	48	8

Source: Education at a Glance OECD Indicators 1998

Size of the school-age population The number of young people in a population influences both the rate of renewal of labour-force qualifications and the amount of resources and organisational effort a country must invest in its education system. The sharp decline in youth population which occurred in the OECD during the 1970s and 1980s has generally slowed down and population forecasts suggest that over the next decade the proportion of 5–14 year olds will stabilise in many OECD countries.

[4] *N/A = not available (in all tables)*

[5] *Country mean refers to an average of data values at the level of the national system and can be used to answer the question of how an indicator value for a given country compares with the value for a typical or average country. It does not take into account the absolute size of the education system in each country.*

[6] *WEI participant*

Table 2: Percentage of the population in basic (primary & lower secondary) or upper secondary education (1996)		
	% aged 5–14	**% aged 15–19**
Canada	13	7
Finland	13	6
Germany	11	5
Greece	12	7
Ireland	**17**	**9**
Japan	11	7
New Zealand	15	7
United Kingdom	13	6
United States	15	7
Country mean	**13**	**7**
Malaysia	23	10

Source: Education at a Glance OECD Indicators 1998

The proportion of 5–14 year olds in the total population who are typically enrolled in primary and lower secondary programmes for Finland, New Zealand and the UK ranges between 13% and 15%, close to the OECD country mean (13%). Ireland and Malaysia both have higher proportions, 17% and 23% respectively. Ireland is one of only two OECD countries in which the number of 5–14 year olds will decline by more than 20% over the next decade, the other being Poland. In Malaysia, only modest changes in the proportion of 5–14 year olds in the total population are expected over the next decade.

The proportion of 15–19 year olds that are typically enrolled in upper secondary ranges between 6% and 7% for Finland, New Zealand and the UK, close to the OECD country mean of 7%. Ireland and Malaysia both have higher proportions at 9% and 10% respectively. In Malaysia, the number of 15–19 year olds is expected to increase over the next decade, which will put substantial pressure on the financing of secondary education.

Expected years in employment

Each country in the OECD and those participating in the WEI demonstrate a strong relationship between educational attainment and time in the labour force.

Irrespective of gender, expected years in employment rises with the level of educational attainment for all the selected OECD countries except Greece. Malaysia shows a slightly lower level of years in employment with upper secondary attainment but a high level of years of employment in both categories.

Table 3: Expected years in employment for men and women with specific educational attainment and aged 25 to 64 years (1996)

	Years in employment			
	Below upper secondary education (men)	Below upper secondary education (women)	Upper secondary education (men)	Upper secondary education (women)
Canada	25.8	16.5	30.9	24.5
Finland	24.0	20.9	27.1	25.8
Germany	26.3	17.4	30.7	24.0
Greece	33.3	15.0	31.7	14.4
Ireland	**27.4**	**11.3**	**32.6**	**18.9**
Japan	N/A	N/A	N/A	N/A
New Zealand	29.6	21.4	35.2	27.7
United Kingdom	25.0	20.0	31.8	27.8
United States	26.1	16.4	32.2	26.9
Country mean	**28.2**	**18.1**	**31.7**	**23.4**
Malaysia	35.9	14.4	34.1	18.1

Source: Education at a Glance OECD Indicators 1998

For those who have completed upper secondary education, the expected number of years in employment among men is similar in Ireland, New Zealand, Malaysia and the United Kingdom, ranging between 31.8 and 35.2 years. Each of the benchmarked countries is above the OECD country mean of 31.7 years, with the exception of Finland, at 27.1 years. The impact of educational attainment on the expected years in employment is strongest in the UK and the USA and weakest in Greece.

For those who have completed upper secondary education, the expected number of years in employment among women is similar in Finland, New Zealand, and the United Kingdom, ranging between 25.8 and 27.8 years. These countries are above the OECD mean of 23.4 years, while Malaysia and Ireland are slightly lower at 18.1 and 18.9 respectively. The impact of educational attainment is strongest in the USA and weakest in Greece.

Educational expenditure relative to gross domestic product (GDP)

Expenditure on education is an investment that can help to foster economic growth, enhance productivity, contribute to personal and social development and reduce social inequality. The share of total resources devoted to education is one of the key choices made in each country. That decision is informed by a number of inter-related factors of supply and demand, such as demographic structure of the population, enrolment rates, national price levels for educational resources and the organisation and delivery of instruction. All OECD countries invest a substantial proportion of national resources in education.

Table 4: Direct public expenditure on education as a percentage of GDP for primary and secondary education and GDP per capita (1995)

	Public expenditure for educational institutions (% of GDP)	GDP per capita (US$)
Canada	4.0	20,991
Finland	4.2	17,921
Germany	2.9	20,509
Greece	2.8	12,173
Ireland	**3.3**	**17,201**
Japan	2.8	21,916
New Zealand	3.8	16,962
United Kingdom	3.8	17,862
United States	3.5	26,711
Country mean	**3.5**	**N/A**
Malaysia	3.3[7]	10,672

Source: Education at a Glance OECD Indicators 1998

Education remains primarily a public enterprise, with government spending continuing to be the main source of educational funding for the benchmarked countries and OECD/WEI countries.

Direct public expenditure[8] on primary and secondary education institutions in OECD countries ranges from 3% or below in Germany, Greece and Japan to 4% or above in Canada and Finland.

[7] *1996 figure*

[8] *Direct public expenditure on educational institutions can take the form either of purchases by the government agency itself of educational resources to be used by educational institutions or of payments by the government agency to educational institutions that have responsibility for purchasing educational resources.*

Direct public expenditure for primary and secondary education institutions in New Zealand and the United Kingdom is 3.8% of GDP, while in Ireland and Malaysia public expenditure is 3.3% of GDP. Apart from Finland, which is significantly higher, each of the benchmarked countries is close to the country mean of 3.5%.

Educational expenditure per student[9]

Effective schools require the right combination of talented personnel, adequate facilities, up-to-date equipment and motivated students ready to learn. The demand for high-quality education, which can translate into higher costs per student, has to be balanced against the necessity of avoiding undue burdens on taxpayers.

Spending per student in the OECD, as represented by the simple mean across all countries, amounts to US$3,546 per student each year at primary level and US$4,606 at secondary level. These averages mask a broad range of expenditure per student across OECD countries.

Expenditure per primary student in Ireland, the United Kingdom, Malaysia and New Zealand is below the OECD country mean. Ireland spends less than two-thirds of the mean. Finland is above the mean, but Malaysia spends just over one-third of the country mean.

Expenditure per second level student for Ireland, the United Kingdom, Malaysia and New Zealand is below the OECD country mean. Ireland spends just less than 75% of the mean. Finland is again above the mean and Malaysia spends half of the country mean. Though educational expenditure varies across the benchmarked countries, a common pattern emerges in that expenditure per student rises sharply with the level of education and is dominated by personnel costs.

Table 5: Expenditure per student (US dollars) on public and private institutions by level of education (1995)

	Primary education US$	Secondary educationUS$
Canada	N/A	N/A
Finland	4,253	4,946
Germany[10]	3,361	6,254
Greece	N/A	1,950
Ireland	**2,144**	**3,395**
Japan	4,065	4,465
New Zealand	2,638	4,120

[9] *The figures in this paragraph are based on purchasing power parities, not market exchange rates, and therefore reflect the amount of a national currency that will buy the same basket of goods and services in a country as the US dollar will in the United States.*

[10] *Public institutions*

United Kingdom[11]	3,328	4,246
United States	5,371	6,812
Country mean	**3,546**	**4,606**
Malaysia[12]	1,228	2,308

Source: Education at a Glance OECD Indicators 1998

Ratio of students to teaching staff

Although schools in many countries are making more use of computers and other educational technology, teachers are still the most important resource in student instruction. The ratio of students to teaching staff is therefore an important indicator of the resources countries devote to education.

Student/teaching staff ratios in primary and secondary education vary widely across OECD countries.

Student/teacher ratios at primary level for Ireland, United Kingdom, New Zealand and Malaysia are quite similar and are close to and above the country mean, while Finland is slightly below it.

Table 6: Ratio of students to teaching staff by level of education (calculations based on full-time equivalents) (1996)

	Primary education	Lower secondary education	Upper secondary education	All Secondary education
Canada	17.0	20.0	19.5	19.7
Finland	16.8	12.4	M	M
Germany	20.9	16.0	13.1	15.0
Greece	15.0	11.4	11.3	11.3
Ireland	**22.6**	**N/A[13]**	**N/A[13]**	**15.8**
Japan	19.7	16.2	15.6	15.9
New Zealand	22.0	18.1	14.1	16.1
United Kingdom	21.3	16.0	15.3	15.6

[11] *Public and government-dependent private institutions*
[12] *1996 data*
[13] *Not available: figures for secondary education are not separable into lower and upper secondary categories.*

United States	16.9	17.5	14.7	16.1
Country mean	**18.3**	**14.8**	**13.7**	**14.6**
Malaysia	19.4	18.5	18.8	18.6

Source: Education at a Glance OECD Indicators 1998

Student/teacher ratios at lower secondary for United Kingdom, New Zealand and Malaysia are similar and are above the country mean, while Finland is below it. Each of the benchmarked countries has a student/teacher ration for upper secondary greater than the OECD mean. The highest is Malaysia. For Ireland the figures for lower and upper secondary are combined.

Student/teacher ratios for each of the benchmarked countries are higher in primary education than secondary education.

Statutory salaries of teachers in primary and secondary schools[14]

Good teachers are vital for quality in education. Ensuring that there will be an adequate pool of skilled teachers to educate all children is an important policy concern in all OECD countries. The level of teacher salaries can affect both entries into the profession and retention of current teachers. Pressure to improve the quality of education and to increase access is under rising fiscal constraints. The remuneration of teachers is a critical component for policy-makers seeking to maintain the quality of teaching and a balanced education budget. Teacher salaries are the largest single factor in the cost of providing education.

Table 7: Annual statutory teachers' salaries in public institutions in equivalent US dollars (1996)

	Salary after 15 years (US$) (primary level)	Salary after 15 years (US$) (lower secondary)	Salary after 15 years (US$) (upper secondary)
Canada	N/A	N/A	N/A
Finland	23,384	27,758	28,936
Germany	35,885	38,826	41,081
Greece	17,156	17,156	17,156
Ireland	**35,061**	**37,154**	**37,154**
Japan	N/A	N/A	N/A
New Zealand	22,821	23,393	23,965

[14] *Statutory salaries refer to scheduled salaries according to official pay scales. It is important to note that teaching time and workload can differ considerably across countries. These factors should be taken into account when comparing statutory teacher's salaries across countries.*

United Kingdom	29,948	29,948	29,948
United States	32,533	31,327	33,953
Country mean	**25,360**	**26,649**	**29,114**
Malaysia	15,342	27,956	27,956

Source: Education at a Glance OECD Indicators 1998

In the tabled countries, the annual statutory salaries of primary school teachers with 15 years experience range from below US$18,000 in Greece and Malaysia to over US$35,000 in Ireland and Germany. This difference has a large impact on the variability in education costs per student. In Finland and New Zealand, the annual statutory salaries provided to teachers in primary education are similar and close to the OECD country mean of US$25,000. Ireland is considerably higher, at just over US$35,000 while Malaysia is considerably lower at US$15,000. The United Kingdom value is approximately US$30,000.

In Finland, the United Kingdom and Malaysia, the annual statutory salaries provided to teachers in lower secondary education are quite similar, ranging from US$27,000 to US$30,000. Ireland's annual statutory salary is considerably higher, at over US$37,000, while New Zealand's is significantly lower, at US$23,393. The OECD country mean is approximately US$26,500. Upper secondary salaries are the same as lower secondary for Ireland, the United Kingdom and Malaysia and are slightly higher in Finland and New Zealand.

Teaching time[15]

The amount of teaching time influences the financial resources that go into education. In addition, teaching time is an important element of the working conditions of teachers. It can influence the amount of time available for planning and other professional activities within the school day and can affect the relative attractiveness of the profession.

In primary education, teaching time in the United Kingdom, Malaysia and New Zealand are close to the OECD mean of 791 hours per year. Teaching time in Ireland is considerably higher, at 915 hours per year. No data is provided for Finland.

Table 8: Number of teaching hours per year in public institutions by level of education (1996)

Teaching hours per year (1996)			
	Primary education	Lower secondary education	Upper secondary education
Canada	N/A	N/A	N/A
Finland	N/A	N/A	N/A
Germany	772	715	671

[15] *Teaching time is defined as the total number of hours per year for which a full-time classroom teacher is responsible for teaching a group or class of students, according to the formal policy in the specific country. Periods of time formally allowed for breaks between lessons or groups of lessons are excluded.*

Greece	780	629	629
Ireland	**915**	**735**	**735**
Japan	N/A	N/A	N/A
New Zealand	804	776	747
United Kingdom	800	740	M
United States	958	964	942
Country mean	**791**	**700**	**633**
Malaysia	762	778	778

Source: Education at a Glance OECD Indicators 1998

In lower secondary education, teaching time in Ireland, the United Kingdom, Malaysia and New Zealand exceeds the OECD mean of 700 teaching hours per year. Teaching time does not change from lower to upper secondary education for Ireland and Malaysia and slightly decreases in New Zealand. No data is provided for Finland.

Total intended instruction time[16]

Policy-makers seeking to improve educational outcome often seek to increase the amount of time for which students are engaged in learning activities, although tight budgets and strong unions can limit changes in the time given to instruction.

In the countries set out in Table 9, the total intended instruction time for 12–14 year olds ranges from 856 hours per year in New Zealand to 1,064 and 1,230 hours per year in Greece and Malaysia, respectively. Among the benchmarked countries, Ireland, the United Kingdom and Finland are close to the OECD country mean of 929. Malaysia is considerably higher while New Zealand is slightly lower than the country mean.

Table 9: Total intended instruction time and intended instruction time for mathematics and science in hours per year for students 12 to 14 years of age (1996).

	Total intended time	Total intended maths and science time
Canada	N/A	N/A
Finland	911	219
Germany	905	212
Greece	1,064	223

[16] *Intended instruction time refers to the number of hours per year during which pupils are given instruction according to the compulsory and the flexible part of the curriculum. The actual amount of time that students spend in instruction does not fully correspond to the intended instruction time. Time can be lost because of lack of qualified substitutes for absent teachers, student absences or school closure for exams, teachers' meetings or inclement weather.*

Ireland	**957**	**200**
Japan	N/A	N/A
New Zealand	856	249
United Kingdom	945	221
United States	N/A	N/A
Country mean	**929**	**219**
Malaysia	1,230	273

Source: Education at a Glance OECD Indicators 1998

Table 9 also shows the total intended instruction time for 12–14 years for mathematics and science. Of the benchmarked countries, the United Kingdom and Finland are close to the OECD country mean of 219 hours per year. Ireland is the lowest, with 200 hours of intended instruction time per year while Malaysia is considerably higher with 273 hours.

Participation in and completion of secondary education

Rising skill demands in the OECD countries have greatly increased the importance of upper secondary qualifications for successful labour market entry. Upper secondary education is a foundation for higher learning and training opportunities. Upper secondary graduation rates are estimated as the number of all persons who graduated from upper secondary programmes in 1996 per 100 persons at the age at which students typically complete upper secondary education. These rates are influenced by completions of students at the traditional ages of upper secondary completion, as well as completions by older students (e.g. those in second-chance education programmes) (see Table 10).

Table 10: Ratio of upper secondary graduates to population at typical age of graduation for first educational programmes (1996).

	Upper secondary graduates as a percentage of population
Canada	73
Finland	98
Germany	86
Greece	80
Ireland	**79**
Japan	99
New Zealand	93
United Kingdom	N/A
United States	72

Country mean	**85**
Malaysia	41

Source: Education at a Glance OECD Indicators 1998

In all OECD countries, upper secondary graduation rates exceed 72%. Finland and New Zealand graduation rates are above 85%, while Ireland is slightly lower at 79%. Malaysia is very low at 41%.

Science and mathematics performance for students in 4th & 8th grades[17] TIMSS[18] is used to compare internationally the science and mathematics performance at grades 4 and 8 (ages 9/10 and 13/14) (see Tables 11 and 12).

Table 11: Science performance for students in 4th and 8th grades compared with international averages (1995).

	4th grade mean	8th grade mean
Canada	549	531
Finland	N/A	N/A
Germany	N/A	N/A
Greece	497	497
Ireland	**539**	**538**
Japan	**574**	**571**
New Zealand	**531**	**526**
Scotland	**536**	**517** [21]
United States	**565**	**534**
Country mean	**543**	**537**

[17] *Education at a Glance OECD Indicators 1997*

[18] *Third International Mathematics and Science Study, International Association for the Evaluation of Educational Achievement (IEA)*

Malaysia	**N/A**	**N/A**

Table 12: Mathematics performance for students in 4th and 8th grades compared with international averages (1995).

	4th grade mean	8th grade mean
Canada	532	527
Finland	N/A	N/A
Germany 12	N/A	N/A
Greece	492	484
Ireland	**550**	**527**
Japan	597	605
New Zealand	499	508
Scotland	520	498[19]
United States	545	500
Country mean	**537**	**526**
Malaysia	N/A	N/A

Source: Education at a Glance OECD Indicators 1997

The results of TIMSS reveal substantial differences in science performance between the top and bottom performing countries with a range of scores from 597 (Korea) to 480 (Portugal) for 4th grade and 574 (Czech Republic) and 480 (Portugal) for 8th grade. The performance of most countries, however, is in the middle ranges. The performance for Ireland and Scotland was not significantly different from the international average for 4th grade, although Scotland dropped below the average for 8th grade. New Zealand is below average for both grades. No results are reported for Finland and Malaysia did not participate.

There are also substantial differences in mathematics performance between the top and bottom ranked countries with a range of 611 (Korea) to 474 (Iceland) for 4th grade and 607 (Korea) to Portugal (454) for 8th grade. The performance of most countries is somewhere in the middle ranges. Ireland shows above average performance for 4th grade and average for 8th grade. Scotland and New Zealand are both below the international average. No results are reported for Finland and Malaysia did not participate.

The position of New Zealand is of particular interest. Following the publication of the TIMSS report, actions were taken to address the below average performance in both areas.

[19] *Scotland did not fully meet the TIMSS sampling requirements*

Appendix 3

Economic Indicators

Introduction

The purpose of this appendix is to outline the main structural economic characteristics of the countries chosen for this study and to provide a brief summary of recent economic performance in each case.

National economic structure and performance are likely to exert a strong influence, over time, on the development of national systems of education. Human capital represents a vital strategic asset for all countries and the quality of human resources is now recognised as a key determinant of economic success and dynamism, given the marked shift over recent years towards the so-called knowledge economy. Given the general appreciation at this time of the role of human resource development in national economic development, education has decisively emerged as a key priority in public policy. There is an increasing awareness internationally of the pressing need to ensure a higher degree of integration and coherence between national educational provision and national economic objectives.

While all five countries in this report have similar structural features, this appendix highlights so m e of the shared characteristics that, in the context of globalisation, have made all these economies successful. Since, increasingly, all small, open economies in the world are affected by essentially the same set of external competitiveness factors in trade and investment, a better understanding of the design and operation of systems of education can help to identify important issues for Ire l a n d in terms of constructing and enhancing the quality of human capital in the economy.

IRELAND

Background

Recent economic performance in Ireland has been remarkable. In the 1980s, Ireland's output stagnant, inflation was at 10% per annum and unemployment was close to 17%, and would been higher had it not been for emigration. Associated with this, real investment had fallen one-quarter, the current balance was in deficit of around 7% of gross domestic product (GDP) and, in 1987, government debt was at a high of 118% of GDP.

Several different but interconnected factors allowed Ireland to reap the benefits of economic reform. These factors included favourable demographics; a significant amount of foreign direct investment; a well-educated, relatively cost-competitive work force; EU membership; fiscal rectitude and the national wage agreement process.

The USA accounts for considerable amounts of foreign direct investment (FDI) to Ireland. The rate of return in Ireland for US FDI is almost double that of Europe or the world average and allowed Ireland to receive the fifth largest amount of US direct investment abroad in 1997[20]

[20] *OECD Economic Survey: Ireland May 1999*

These figures are all the more impressive given the size of the Irish economy, with less than 0.3% of the share of the world weight[21]. The US accounted for 38% of foreign investment in Ireland for 1997 and 1998. The EU accounted for 48.5%, mainly from the UK. Ireland's investment abroad shows just under 50% going to the US, and just over 50% going to the EU[22]. The political and institutional setting, and the favourable tax regime and financial incentives targeted at a small number of dynamic sectors that could provide potential spin-offs, made Ireland an attractive base for investors to use to enter the wider European markets.

Financial rectitude of the late 1980s and the national wage agreements, beginning in 1987, also helped to bring about significant improvements in the cost competitiveness of the economy. The budget surplus moved from a deficit of 7% in the early 1980s to a surplus of over 1.5% of GDP in 1998. The public finances were also brought under control with government debt of 118% of GDP in 1987 reduced to under 50% of GDP in 1998[23].

Table 13: Basic economic indicators for Ireland (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
Real GDP growth rate †	1.9	3.3	2.6	5.8	9.5	7.7	10.7	8.9	6.7	6.4	
Real GNP growth rate †	2.5	1.9	2.6	6.3	8.0	7.2	9.0	8.1			
Unemployment level	14.7	15.2	15.5	14.1	12.1	11.5	9.8	7.8	6.8	6.2	
Inflation rate	3.2`	3.1	1.4	2.4	2.5	1.6	1.5	2.4	2.0	2.0	

Source: IMF World Economic Outlook May 1999 †Data for GDP and GNP (Gross National Product) for 1991–98 from CSO National Income and Expenditure, 30 June 1999

The early 1990s showed signs that the deterioration of the previous decade had stopped. By 1994 economic growth had reached 6.3% of GNP and remained high for the next four years. The devaluation in 1993 helped increase Ireland's cost competitiveness and allowed for the economic growth of the following years. Unemployment fell from over 17% in 1987 to under 6.4% by the end of 1998. Inflation was low in 1996 and 1997, at around 1.5%, but this increased to 2.4% for 1998. However, these figures do not include house prices, which have increased significantly over the past year and can have serious effects on the cost competitiveness of the economy.

Since January 1999, Ireland has become a member of the euro-zone, with eleven

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[21] *This shows Ireland's economic weight compared to the world at 100 using purchasing power parity. Source IMF Database*

[22] *Eurostat News Release No 60/99 1 July 1999*

[23] *Dept. of Finance, 'Stability Programme 1999-2001'*

other EU countries, with monetary policy being set by the European Central Bank and not by the Irish Central Bank. It is important that inflation does not exceed the euro-zone average, as this would reduce the competitiveness of Irish goods abroad without the possibility of a devaluation to rebalance the costs.

Similarities with other benchmarked countries

There are similarities between Ireland and the other countries compared in this appendix. Some have followed similar policies; others have not followed all of them or have followed them to a lesser extent. This does not necessarily mean that these are the right policies for these countries. Some countries try to reproduce the best practices of other countries but policies should be introduced to suit their unique situation.

Ireland, like Malaysia, opened up to trade and investment and is now one of the most open economies in the world. The fiscal prudence of the late 1980s and the 1990s has helped Ireland to overcome many of the problems that were faced in trying to reduce the budget deficit and the government debt. Malaysia followed similar strict fiscal prudence, which helped them to overcome many of the recent problems of the Asian crisis.

The partnership approach (between government, business and labour unions) that has been followed in Ireland has helped to reduce unemployment significantly, from a very high figure in the early 1990s to a low one today. Finland has also had wage agreements, but this has not helped to reduce its high unemployment. There are skill shortages in Finland similar to Ireland in the high-tech sector and Finland still has a considerable amount of unskilled labour.

Table 14: Trade openness 1997 (US$ billion)

Country	GDP	Exports	Openness	Imports	Openness	Total
Ireland †	62.3	53.0	85%	39.3	63%	148%
United Kingdom	1326.7	281.5	21%	312.9	24%	45%
Finland	117.0	39.3	34%	29.8	25%	59%
Malaysia	72.6	78.7	108%	79.0	109%	217%
New Zealand	56.8	14.1	25%	14.5	26%	50%

Source: IMF Financial Statistics Yearbook 1998 † GNP used for Ireland instead of GDP

Trade and market structure

In 1998, Ireland's merchandise exports increased by 27% to 97% of GNP, while imports grew more slowly, at 20%, to 68% of GNP. This gives Ireland a trade openness of 165% of GNP, the second highest in the OECD behind Luxembourg. Ireland's trade surplus for 1998 was 30% of GNP compared with 22% in 1997 and 20% in 1996.

The top five export sectors account for 58% of Irish exports in 1998, compared with 53% in 1997. They also accounted for 79% of the export growth between 1997 and 1998. These sectors are computer equipment, organic chemicals, electrical machinery, medical and pharmaceutical products and essential oils.

The top five import sectors accounted for 44% of total imports in 1998 compared with 40% the year before. The top five sectors also accounted for 67% of the total increase in imports. These sectors are computer products, electrical machinery, road vehicles, specialised machinery and organic chemicals. There is therefore dependency in Ireland on a small number of sectors that are extensively owned by foreign multinationals where economic growth has been led by these sectors and multinationals.

The top five markets for Irish exports (UK, Germany, USA, France and the Belgian/Luxembourg economic union) accounted for 65% of exports in 1998 compared with 62% in 1997. These markets also accounted for 79% of the increase in exports between 1997 and 1998.

The top five import markets (UK, USA, Japan, Germany and Singapore) accounted for 68% of imports in 1997 and 1998. These five markets accounted for 68% of the increase in imports between 1997 and 1998.

Ireland is dependent both in terms of its trade markets and sectors. The other benchmarked countries have similar results, with the top five export markets accounting for 56% for New Zealand, over 60% for Malaysia, about 50% for Finland and over 95% for Scotland (excluding the UK, though the UK would obviously account for a considerable amount of Scottish exports).

In terms of sectoral trade, the other countries have experienced a similar move from dependency on traditional sectors to more high-tech, high-value-added, capital-intensive sectors. The electronics sector accounted for 46% of Malaysian exports and 28% of foreign direct investment. In Finland, this sector, which is dominated by Nokia, a large Finnish multinational, accounted for 26% of exports. In Scotland the electrical and optical engineering sector accounts for 53% of exports and receives 21% of the investment. The US accounts for 46% of firms in this sector and for 55% of total investment into Scotland.

Scotland

Background

Scotland is part of the United Kingdom and there is limited statistical data available for a useful comparison of Scotland and the UK as a whole. Scotland accounts for less than 10% of the total population of the UK. The UK accounts for over 5% of world trade, while Scotland accounts for 12% of UK manufacturing exports. Scotland accounts for over 8% of total UK GDP. The per capita GDP in Scotland is lower than the per capita GDP for the whole UK, at around 96% of the UK figure. There has been an improvement, up from 92% in 1989 to 99% in 1995; however, this has fallen again to 96% for 1997, the latest data available.

Table 15: Basic economic indicators for Scotland (%)											
		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Real GDP Growth rate	United Kingdom	-1.5	0.1	2.3	4.4	2.8	2.6	3.5	2.1	0.7	2.1
	Scotland†	0.1	1.4	2.4	2.4	2.6	2.1				
Scotland: GDP as % of UK		8.4	8.6	8.6	8.6	8.7	8.4	8.3			
Scottish GDP per head relative to UK (UK = 100)		95.6	97.1	97.3	97.9	98.9	96.8	95.5			
Unemployment level	United Kingdom	8.0	9.7	10.3	9.3	8.0	7.3	5.5	4.7	4.6	5.1
	Scotland				9.3	8.9	8.7	8.5	7.0	7.5	
Inflation rate United Kingdom		6.8	4.7	3.0	2.4	2.8	3.0	2.8	2.7	2.7	2.4

Source: IMF World Economic Outlook May 1999 and Scottish Economic Bulletin No 58 † GDP for Scotland excludes revenue for oil and gas.

It can be seen from the table that Scottish GDP has remained relatively constant at a growth rate of around 2% per annum, equating to the average growth rate since 1991. This has significantly differed from the UK real GDP growth rate, which is characterised by 'boom–bust' fluctuations, moving from –1.5% in 1991 to 4.4% in 1994 and expected to return to 0.7% for 1999. Due to the fact that the Monetary Policy Committee of the Bank of England, and previously the government, set monetary policy for the whole economy, there is no reliable independent inflation figure for Scotland alone.

Unemployment, on the other hand, has been significantly higher in Scotland than in the UK as a whole, being as much as 3% higher in Scotland in 1997 than the equivalent figure for the UK. The work force in Scotland is highly educated, trained and flexible and there are few restrictions on overtime, shift and evening work, which is a valuable resource for companies. Of a population of just over 5 million, there are 60,000 school leavers a year coming onto the labour market and 38,000 graduates leave Scottish universities each year. This is the highest number of graduates per capita in the EU. This is of significance for foreign firms seeking a location for their operations with a highly educated work force.

Trade and market structure

The manufacturing sector in Scotland is dominated by the electrical and optical engineering sector, with around 23% of gross value added (GVA) for total manufacturing in 1996. This sector accounts for 30% of gross output and 18% of employment in the manufacturing sector. The next most important sector for the Scottish economy is the food, drink and tobacco sector. This accounts for 19% of GVA, 20% of output and 17% of employment, of which 13% represents part-time jobs. Chemicals and man-made fibre and the metal and metal products sectors account for 10% of GVA each.

Scotland performs better than the UK as a whole for GVA per employee, output per employee and investment per employee. In relation to the net capital expenditure per employee, Scotland was nearly one-quarter higher than the UK average and the electrical sector was over twice the UK average.

Exports from Scotland amounted to Stg£19bn in 1998, which is an increase of 7% in real terms over 1997. This is a higher per capita figure than Japan. Electrical and optical engineering accounted for 53% of these exports, while the sectors with the largest increase were the metals and metal products sector and transport equipment sector. The largest markets for Scottish products in 1997 (excluding the rest of the UK) were France, the USA, Germany, Italy and the Netherlands.

The electronics industry accounts for 41,000 emplo yed directly and a further 29,900 indirectly, in the supply of infrastructure – this amounts to 1.7% and 1.2% of the labour force respectively. Output has increased by 16% in 1997 in the electronics industry with an average rate of increase of output of 20% per annum between 1993 and 1997. The US accounts for 46% of firms in the electronics industry, with the UK accounting for 42%, Japan for 10% and with only 1% accounted for by the rest of the EU .

The sector with the greatest foreign ownership is the electrical and optical engineering sector, where foreign owners own 49% of businesses. The USA owns the largest proportion of firms (39%), followed by France, Japan and Germany. Foreign firms account for 45% of employment in the electrical and optical engineering sector.

Between April 1991 and March 1999, foreign direct investment accounted for 650 projects, a total investment of Stg£8.3bn and 93,000 planned or secured jobs[24]. In 1998–99 FDI accounted for 78 projects, Stg£761m worth of investment and nearly 11,000 jobs. North America provided 37% of the projects and 28% of the employment, an average of almost 105 jobs per project. Expansions accounted for half of the projects and for over 40% of the employment created.

The sector receiving the largest investment is the services sector (37%), followed by electronics (21%) and the chemicals, plastics and rubber sector (17%). North America provided nearly 20% of total investment for the period 1998-99, creating nearly 48 jobs per Stg£100,000 invested. The UK accounted for 32% of the total number of projects, 45% of total investment and a third of total employment (i.e. 142 jobs per project and 96 jobs per Stg£100,000 invested). The rest of Europe accounted for 23% of the projects, 18% of total investment and 15% of jobs created (i.e. over 92 jobs per project and just under 85 jobs per Stg£100,000 invested). Asia accounted for less than 8% of the total projects, 18% of total investment and 24% of jobs created (i.e. nearly 440 jobs per project and 51 jobs per Stg£100,000 invested).

Excluding investment from the UK, the US accounts for 55% of projects, the rest

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[24] *'Locate in Scotland' Annual Review 1998/1999*

of Europe for 34% and Asia for 11%. Each of these areas accounts for roughly one-third of the total investment, while in terms of employment, the US accounts for 41%, Europe for 23% and Asia for 36%. This implies that Europe's investment is more capital-intensive than that of the other regions, as it accounts for less of the jobs for the same investment but also accounts for 85 jobs per Stg£100,000 invested, which is higher than the same figure for other regions. However, the dominance of the US as an investor into Scotland should not be overlooked: it is the single largest investor. These figures, associated with the fact that over 30% of UK enterprises that employ more than 250 people are located in Scotland, show that Scotland is an extremely attractive country for investment from abroad.

Finland

Background

The collapse of the Soviet Union caused a severe recession in Finland, one of the worst post-war recessions in the OECD. The recession bottomed out in 1993 and by 1994 the economy was once again in positive growth. An easing of monetary conditions and income policies, associated with moderate wages, price developments and fiscal consolidation, led to increases in domestic demand, which will be the main engine of economic growth in 1999. The forecasted GDP growth for the next two years is between 3% and 3.5%. Better job prospects, tax cuts fuelling private consumption and construction investment are expected to increase domestic demand. However, exports are expected to remain weak due to low international demand.

Table 16: Basic economic indicators for Finland (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Real GDP growth rate	-7.1	-3.6	-1.2	4.5	5.1	3.6	6.0	5.0	3.1	3.5
Unemployment level	6.7	11.9	16.4	16.6	15.4	14.6	12.6	11.4	10.2	10.0
Inflation rate	4.2	2.9	2.2	1.1	1.0	0.6	1.2	1.5	1.5	2.0

Source: IMF World Economic Outlook May 1999

Inflation remained low even through the recession of the early 1990s, with negative GDP growth of between 7% and 1%. Moderate central wage agreements have helped to keep inflation low. Fiscal policy has been restrictive in the past, with a slight loosening up in 1999, which has helped the government deficit as a percentage of GDP to move from –7% in 1993 to a surplus of 1.5% in 1998. The government has set a target of a surplus of 2.25% to allow for a movement of 5.25% in case of an adverse shock to the economy in line with the 'Growth and Stability Pact' in the euro-zone.

While structural reforms have taken place within the economy, unemployment has still remained high (even though there was a reduction from 16.6% in 1994 to a forecasted 10.2% in 1999). This is mainly due to the late introduction of labour market reforms and the time lag before these will take effect. The government wants to reduce income tax by a further 1.5% of GDP by 2003 by freezing central government expenditure in real terms. However, while these are needed in order to see real progress in reducing unemployment, there is also a need to reform the social transfer system in order to reduce the tax burden. The marginal effective tax rate exceeds 50% for one-third of the employed with a quarter of the lowest paid being affected by this rate. There are skill shortages for the high-tech sector, the sector showing the largest growth rates, while unemployment has remained high.

In 1950, over 40% of employment was in the agricultural sector. This has fallen to around 5% in 1997 and is estimated at 3% in 2017[25]. Manufacturing as a percentage of total employment is to remain constant at around 20%, until 2017, while the services sector takes up the slack left from the decline in agriculture. The services sector has increased from less than 30% in 1950 to between 65% and 70% in 1997 and is likely to remain at this level until 2017.

Labour productivity increased by over 50% between 1980 and 1997. This is above the EU average of just over 30%. However, this is only part of the story. Unit labour costs have tended to increase faster than the OECD average so that productivity gains have been eroded, but unit labour costs have risen more slowly than traditionally since 1991. About two-thirds of the population is of working age (15–64) and this is projected to remain so until 2030. However, the lower retirement age of 59 and the increase in the population of those over 65 means that there will be significant pressure on the pension system in the future[26].

Trade and market structure

Finland has embarked on a programme of opening the economy to international trade. The metal and engineering sector and the forestry sector dominated Finland's traditional trade structure. Metals, textiles and clothing were exchanged with the USSR for oil. There has been a move away from this to a third strand, electronics and high-tech products. The figures for January to October 1998 show that the largest export sector is electronics and electrotechnics, at 26% of exports. This is followed by pulp, paper and paper products at 24% and machinery at 11%. The export sector is dominated by large-scale industry. However, small and medium-sized enterprises are more likely to provide growth, and they accounted for 60% of private employment, over 50% of firm turnover but only 16% of direct exports in 1995[27].

The top five largest markets for Finland account for around 50% of imports and 44% of exports. The largest market is Germany (15% of imports, 12% of exports), followed by Sweden (12 and 10% respectively) and the UK (7 and 9% respectively). The USA accounts for 8% of imports and 7% of exports and Russia 7% of imports and 6% of exports, down from about 25% in the early 1980s. The rest of the markets are all around 5% each. Thus, Finland has a diverse export and import market by country and is not dependent on any one market.

The high-tech market (defined as telecommunications equipment, computers, instruments, space equipment and chemicals) accounts for 19% of Finland's exports, up from 4% in 1980. High-tech exports have exceeded imports since 1995, as Finland has become a net exporter of high-tech products. Nokia, one of Finland's largest companies, has a turnover equal to 12% of Finnish GDP and

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[25] *Forecast from the Finnish Ministry of Labour, www.eva.fi/english/julkaisut/indicat/luku5.htm*
[26] *Statistics Finland*
[27] *EVA, http://www.eva.fi/english/julkaisut/indicat/luku2.htm*

their profits equate to 2% of GDP. Deregulation of telecommunications has allowed for this growth in the telecom sector. In February 1999, mobile phone ownership in Finland was at 60% of the population, which is greater than the number of fixed lines. While exports in the whole economy are expected to be weak due to weak international demand, there should be some increase due to strong demand in the electronics industry, especially the telecommunications equipment sector[28].

Malaysia

Background Malaysia has achieved annual growth rates of between 8% and 10% over the past decade, with GDP doubling since 1987, while the Malaysian currency (the ringgit) has depreciated by 30–40% over the past year. This, coupled with a weakening of the stock and property markets in 1998, has meant that GDP for 1998 will be negative and forecasts for 1999 show slight growth (almost 1%).

Table 13: Basic economic indicators for Ireland (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
Real GDP growth rate †	8.6	7.8	8.3	9.3	9.4	8.6	7.7	-6.8	0.9	2.0	
Unemployment level	4.3	3.7	3.0	2.9	2.8	2.6	2.6	3.9	4.5 †		
Inflation rate	2.6	4.7	3.5	3.7	3.4	3.5	2.7	5.3	3.6	5.0	
Debt to GNP			44.1	42.1	40.8	41.3	65.4	60.9			

Source: IMF World Economic Outlook May 1999 and World Bank and National Statistics
† Malaysian Labour Force Survey March 1999

Inflation has been between 3% and 4% for most of the decade. However, this rose in 1998 due to the effects of the Asian crisis. The largest increase in prices can be seen in food, which has led to lower consumption. Both public and private consumption fell, by 14% and 17% respectively. This led to an increase in the incidence of poverty, from 6% in 1997 to 7% in 1998.

However, Malaysia's traditionally strong fiscal policy and prudent management of the country's external exposure and its well-developed supervisory and regulatory framework for the financial sector have helped it to withstand many of the economic problems that have faced its neighbours in the region. This can be seen in the unemployment record for Malaysia over the past decade, which has fallen from 4.3% in 1991 to 2.6% (which is considered to be full employment) in 1997. There was a minor rise in 1998, to 3.9%. The largest fall in unemployment can be

[28] *Ministry of Finance Economic Bulletin, June 1999*

seen in the construction sector, nearly 17%. Labour productivity has grown at over 5% over the last few years, while wage rates in the manufacturing sector are competitive with those of the other countries in the region.

The debt/GNP ratio was low at just over 40%. This remained the case until June 1997, when it was 44%. Since the Asian crisis broke, the debt/GNP ratio has increased dramatically, to 61% in 1998. However, the repayments have been prudently spaced out and the debt-servicing ratio as a percentage of exports has remained relatively constant, at 6.7% in 1998, comparable with the 1996 figure of 6.9%[29].

Tough corporate governance reforms are still needed in order for Malaysia to reach its full economic potential. As its neighbours opened their systems to further foreign competition and closed poorly managed businesses, Malaysia has maintained most of its barriers to foreigners, withdrawn its currency from international circulation and rescued over-stretched banking and corporate sectors.

Trade and market structure

In the 1970s Malaysia was highly dependent on agriculture and primary products. In 1976, agriculture accounted for 27% of GDP, while in 1997 this had fallen to 12%. Similarly, manufacturing has increased from 18% to 36% over the past two decades. The service sector has remained constant at around 40% of GDP. Malaysia has moved from import substitution and labour-intensive industries to export-oriented, high-technology and capital-intensive manufactured products. Early opening up to foreign direct investment and a business-friendly environment have meant that Malaysia has prospered and has received the lar gest share of FDI among developing countries. In order to attract high-tech firms, a 15km by 50km Multimedia Super Corridor, extending south from Kuala Lumpur, has been created to allow multimedia companies to benefit either from tax-free status for up to 10 years or from 100% Investment Tax Allowance.

The Malaysian Second Industrial Master Plan 1996–2000 identified eight sectors or industrial groups with potential to develop into ‘clusters’. These include the electrical and electronic industry, resource-based industry, agri-based and food products, the chemical sector, the materials industry, the transport equipment industry, the machinery and equipment industry and the textile and apparel industry.

The USA and Singapore accounted for roughly 20% of exports in 1997 and 1998 each, while Japan accounted for 10–12%. All other markets accounted for less than 5% of Malaysian exports. Japan, the USA and Singapore were the major importers into Malaysia. This means that Malaysia is highly dependent on a small number of markets.

Manufacturing accounted for 37% of GDP and 81% of Malaysian exports in 1998. Of these, electrical and electronics products account for 56% of total exports, by far the largest export sector. Similarly, manufactured goods accounted for nearly 90% of imports and electrical and electronics products accounted for 57% of total imports. Between January and May 1999, there were 65 approved investment projects in the electrical and electronic products area, of which 12 were new and

[29] *White Paper on the Status of the Malaysian Economy, National Economic Action Council, April 1999.*

53 were expansion and diversification[30]. Electrical and electronic products are dominated by semiconductors, air conditioners and recently, in consumer electronics, computer peripherals as well as telecommunications equipment.

Malaysia has been increasingly successful in attracting FDI into the high-tech sector, which is both knowledge- and capital-intensive. There is a move to higher-technology, higher-value-added products: 28% of total applications received for the establishment of manufacturing projects between 1993 and 1997 were in the electrical and electronics products sector, showing its importance for the Malaysian economy.

The largest investor in Malaysia is Singapore with 777 investment projects between 1993 and 1997. Japan follows this, with 775 projects, and Taiwan, with 452 projects. The USA and UK account for only 208 and 110 projects respectively for this period. Other EU countries account for 291 projects, including 78 from Germany and two from Ireland.

The importance of the service sector in Malaysia is obvious, as it contributed over 40% to GDP and nearly 50% of total employment in 1997. This sector is a catalyst for growth and the government has encouraged the development of shipping, reinsurance, tourism, education and health services and other transport services.

New Zealand

Background Since the 1980s, successive governments have pursued reforms that have turned this economy into one of the most open, market-oriented and lightly regulated countries in the OECD. These reforms were originally guided by the need for a medium-term economic strategy that was coherent, consistent, credible and transparent.

In the 1990s, a programme was put in place to maintain a stable macro-economic environment through human resource and business performance, built on strong international linkages, to enhance the productivity and economic growth of New Zealand. Recently, policies have widened their focus to include aspects of social responsibility and sustainable development.

Table 13: Basic economic indicators for Ireland (%)

Table 18: Basic economic indicators for New Zealand (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Real GDP growth rate	-1.7	0.9	5.1	6.0	4.0	3.1	2.1	-0.3	2.7	3.3
Unemployment level	10.3	10.3	9.5	8.1	6.3	6.2	6.7	7.5	7.6	7.4
Inflation rate	3.1	2.1	1.7	1.8	2.4	2.3	1.7	1.5	1.1	1.4

Source: IMF World Economic Outlook May 1999

[30] *Financial Times, Thursday June 24 1999 .*

It can be seen from the table that, from poor growth in the early 1990s, New Zealand achieved real GDP growth of between 4% and 6% in 1993 to 1995 but this has dropped again in recent years, albeit not to the previous lows. Strong demand in Australia and the USA offset the slackening of demand due to the Asian crisis in 1997. However, a slow-down in output in 1998 meant a negative growth rate of –0.3% for that year. A second drought in 1998 added to the weak economic performance.

There has been inconsistent progress towards achieving and maintaining prudent fiscal positions and sometimes a lack of focus on the quality of spending has undermined the credibility of the reforms introduced. In the early years of the reforms, the mid-1990s, unemployment came down dramatically, from 10.3% in 1991 to 6.2% in 1996. However, the Asian crisis increased this figure to 7.5% in 1998 and it is expected to remain at approximately that level until 2000.

Monetary policy was formulated on a longer time horizon and has evolved to adopt a wider inflation target and an official short-term interest rate. This has helped in maintaining low inflation, of between 1.5% and 2.5%. However, there is still a need to control expenditure while enhancing the quality of this spending.

Trade and market structure

Traditionally, New Zealand was a large exporter to the UK, especially of agricultural products. However, it now has an increasingly dominant trade dependence on the Asian market. The year up to June 1998 saw a rise in exports of 2.5%, and imports increased by 6%. In the past few years, imports have been growing faster than exports and the trade deficit has therefore widened.

The New Zealand share of world trade in 1997 was 0.3%. Trade openness[31] is 50% of GDP. The top five export markets account for 56% of New Zealand's exports while the top 20 account for only 83%. The smaller 15 markets, however, only account for a combined 25% of New Zealand's exports. Therefore New Zealand is highly dependent on a small number of markets. Of the top five markets, Australia, the number one market, saw an increase of 5% in the year up to June 1998. The USA increased by 21% and China, including Hong Kong, increased by 7%. The other two markets, Japan (the second largest) and the UK (the fourth), saw respective declines of 6% and 4%. Korea, the sixth largest, saw a decline of over 25%.

The largest export sector by far is the food and beverages sector, which increased 5% on the previous year. This sector accounts for 48% of exports, while other primary products account for a further 16%. However, primary product exports have decreased by nearly 8% as New Zealand tries to move up the value chain. Manufacturing exports account for only 25%, with strong growth especially in electrical machinery of nearly 20%.

[31] *Trade openness is defined by exports plus imports as a percentage of GDP.*

Appendix 4

Benchmarking Process

ICSTI Terms of reference

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Design and piloting of questionnaire

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Populating of revised questionnaire through consultants

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Compilation of questionnaire responses into database

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Further development of database with educationalists

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Validation of database by education experts in the five countries

↓

Preparation of summaries of database sections

↓

Workshops on database and summaries with Irish education representatives

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Identification of key issues Report of key issues and summaries

Appendix 5

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Irish Science Teachers' Association
Irish Vocational Education Association
Joint Managerial Board
National Parents' Council (Primary)
National Parents' Council (Post-primary) Teachers'
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Mr Steve Benson, Ministry of Education, New Zealand
Ms Robyn Baker, Wellington School of Education, New Zealand

Comments from independent experts who took part in the benchmarking study:

Robyn Baker
Director, School of Graduate Studies, Wellington School of Education, New Zealand

'Education is certainly a complex area - and there are no easy answers. However, it is refreshing to be involved with a project that has attempted to systematically gather relevant information so that subsequent policy decisions can be made on an informed basis'.

Maija Ahtee
Professor of Mathematics and Science Education, University of Jyväskylä, Finland

'Being involved in this comparative study has been highly thought-provoking. It has identified a need to look again at education in Finland in many areas including the nature of the relationship between science and technology'.

Steve Benson
Learning and Evaluation Policy, Ministry of Education, New Zealand

'It seems every country is looking over its shoulder to see how others are approaching education issues. Some are looking for readymade solutions to perceived problems but, assuming these can be identified, they are usually difficult to transfer as the context in which they operate is inextricably linked to their success. The benefits of a benchmarking study like this one is that the facts are there in detail. This helps to identify what features may be able to inform changes in policy and practice. The benefits accrue to all involved not just to the country that initiated the study. As always, the similarities between countries are more striking than the differences.'

Tan Sok Khim
School of Educational Studies, Universiti Sains Malaysia, Penang, Malaysia

'Your study is going to make me look harder at the outcomes of our science education.'