STRENGTHENING EDUCATION FOR INNOVATION

Rationale and objectives

Education policies can increase national innovation capacity by equipping more people with the skills required to contribute to innovation and by inspiring talented young people to enter innovation-related occupations.

By raising attainment levels and the general quality of education, education policies can serve the need for diverse and complex skills in innovative activities. Still, the traditional focus of policies aimed at strengthening education for innovation is to improve, more specifically, the teaching of science and maths and to attract more people to science, technology, engineering and mathematics (STEM) at graduate level. This matches the emphasis of most innovation policies on technological innovation. Recently, a more comprehensive view of innovation has emerged, and has led to educational interventions that aim at fostering creativity and thinking skills, as well as non-disciplinary skills such as entrepreneurial capacities, in a wide number of contexts and for all pupils and students, irrespective of their field of study.

Major aspects

Formal education remains the main vehicle for improving the supply of skills for innovation. Some countries, for example Denmark and Estonia, set explicit graduation targets for young cohorts to ensure an adequate supply of advanced skills to the economy. More specifically, many countries invest in schemes to attract more students in STEM disciplines. There are several main types of schemes (also see Table 8.1).

Table 8.1. **Major policy options for increasing the quantity and quality of STEM (science, technology, engineering and mathematics) education, with recent examples**

Intermediate objective	Instrument	Examples
Increase tertiary enrolment in STEM disciplines	Financial incentives for students	Australia (see text); Argentina (undergraduate STEM scholarships and grants); Denmark (PhD scholarships).
	Free remedial classes or tutoring for marginal students	Sweden (see text); Denmark (2010-12) and Germany (2007-13) (MINToring project) have similar pilot schemes.
Improve instruction of science, technology and mathematics in schools	Increase in hours of instruction	Germany (in most *Länder*); Ireland re-introduced science into the primary curriculum in 2003; Norway increased hours of mathematics instruction at primary level.
	Introduction of new curricula, standards or assessments	Australia, Ireland and the United Kingdom (England) are reforming national school curricula. Austria and Norway recently introduced new national tests; Poland made the maths exam mandatory at the matura as of 2010. A German initiative provides early childhood STEM education (Little Scientists' House).
	New teacher education and training programmes	Australia, Austria, Belgium (Fl.), Ireland, Japan, New Zealand, Turkey, United Kingdom.
	Schemes to attract top STEM graduates into teaching	Australia ("Teach for Australia"), United Kingdom ("Teach First")

Source: Country responses to the *OECD Science, Technology and Industry Outlook 2012* policy questionnaire.

A first type of scheme lies in providing monetary and non-monetary incentives to study STEM at tertiary level. Australia's income-contingent student loans, for instance, provide incentives to study mathematics, statistics and science and take up related occupations by reducing the amount of an eligible graduate's compulsory repayments. In Sweden, the government offers free remedial classes to students with grades in science

and maths that are too low to enter a university science or engineering programme. Upon completion of the remedial year, successful students are guaranteed a place in university.

Another is investments in K-12 education (from kindergarten to secondary education) to increase pupils' preparation in science and maths and their interest in scientific careers. This includes curriculum reforms that give more time to science and mathematics, and the development of new teacher training programmes, of new standards or of new assessments to trigger changes in teaching practices.

Other programmes target groups that are under-represented in STEM occupations (*e.g.* women or disadvantaged ethnic groups). Prizes for women in science and anti-stereotype campaigns exist in many countries. Belgium (Flanders), Spain and South Africa also use public research hiring or funding mechanisms to promote diversity in STEM.

It is difficult to evaluate these programmes in terms of their contribution to innovation. There is a lack of evidence for many of these programmes even on the intermediate objective of increasing the number of STEM graduates. However, a few programmes have demonstrated encouraging results. Sweden's free remedial classes have helped increase the number of graduates in STEM fields by more than 60% over the last ten years.

Finally, there are programmes to support doctoral and postdoctoral education. While innovation draws on a wide set of skills, excellence in scientific research is the basis of science-based innovation and research competence plays a key role in successful co-operation by science, business and society. Provision of scientific research skills through doctoral and post-doctoral training is thus an important aspect of education policy. Supportive measures for doctoral and postdoctoral studies consist of various forms of financial support designed not only to support the various stages and activities of study and research, but also to take into account cost of living and social benefits, as postgraduate students may already be at the age of family life.

Recent policy trends

Many countries have recently broadened their policy focus to strengthen education for innovation beyond STEM fields.

Schools and universities often offer specific programmes for entrepreneurship education which tend to use active, learner-centred and context-rich pedagogies (imitating real-world situations). Even where specific programmes do not exist, "entrepreneurial skills" are often seen as a competency to develop across subjects and school levels.

Denmark formalised in 2009 a strategy for education and training in entrepreneurship (targeting all levels of education) and in 2010 ran a competition to establish a University of Entrepreneurship. Finland has issued Guidelines for Entrepreneurship Education (2009); Ireland's National Strategy for Higher Education (2011) promotes entrepreneurship training as part of curricula; Norway has developed an action plan for entrepreneurship in education (2009-14) and included entrepreneurial skills as a core competency in the National Qualification Framework for Higher Education; in Norway and New Zealand, moreover, how to set up and develop a business is part of the business or economic studies curriculum in secondary schools. Belgium (Fl.), Estonia, Germany (Exist), Luxembourg, Portugal and Slovenia also have state-funded initiatives to include entrepreneurship training in the school or university curriculum.

Introducing innovative learning practices into traditional disciplines may also be a way to foster in all students the non-disciplinary skills that enhance their capacity to contribute to

innovation, such as creativity, curiosity and collaboration, as well as entrepreneurial attitudes. However, teachers in traditional disciplines may face difficulties for adopting new ways of teaching in countries that rely heavily on traditional standardised testing for high-stakes evaluations of students and teachers. New assessments therefore need to be developed to encourage innovative teaching.

Supporting doctoral study and postdoctoral research remains a priority for government in many OECD countries and in non-OECD countries such as the People's Republic of China and Colombia. The new trends in this regard include: expanding and improving public financial support for postgraduate studies; reforming doctoral education and the relevant support programmes; and internationalisation of postgraduate study and support programmes, with a view to attracting international talent.

In terms of government support, Australia is in the process of doubling the number of Australian Postgraduate Awards in 2008 by 2012; Colombia doubled the number of doctoral grants from an average of 232 in 2002-08 to 500 in 2009 and will double again to 1 000 in 2012; and Denmark doubled the intake of PhD students between 2006 and 2010. Canada provided an additional USD 71 million (CAD 87.5 million) for three years in 2009 to expand graduate scholarship programmes and to attract excellent students, and Korea launched two new support programmes in 2011: a Global PhD Scholarship to support 300 doctoral students and the Presidential Post-Doc Fellowship with a budget of USD 2.7 million (KRW 2 250 million) in 2011.

Several countries have introduced reforms in their PhD education and support mechanisms. Finland, Germany and Ireland have adopted structured PhD programmes to enhance the quality and efficiency of doctoral education. In Canada, the three federal granting agencies have harmonised their policies on support paid to students and postdoctoral fellows from research grants and no longer restrict researchers from using some of their grant money to provide supplements to scholarship holders. France introduced the PhD contract system in 2009 to replace research grants with stable support for doctoral students in the form of salary coupled with entitlement to social benefits as for employees.

While doctoral education and support are already open to foreign students in many countries (Estonia, Greece, Hungary, Norway and Sweden) some have made efforts in recent years to internationalise their doctoral programmes with a view to improving quality and attracting talent from abroad.

Austria's Mariette Blau Grant, established in 2009, aims at producing more internationally competitive PhDs by enabling doctoral students to conduct scientific research abroad, and the German Academic Exchange Service promotes the creation of bi-national doctoral programmes. Canada allocated USD 37 million (CAD 45 million) over five years (2010-15) to establish a prestigious postdoctoral programme and attract top level talent to Canada.