Building a science and innovation culture

Rationale and objectives

Innovation requires developing and mobilising a broad range of skills throughout the workplace and society (Hanel, 2005; OECD, 2010; Toner, 2011). Considering the complex nature of the work required for innovation, desirable "skills" of individual and groups might be best understood as "capabilities" -- including the ability to synthesise relevant knowledge (from theoretical to practical expertise and know-how) and to think creatively -- and behavioural and social traits such as self-confidence, risk taking, leadership, teamwork, attitudes towards change. These capabilities and traits must operate within social contexts conducive to the growth and operation of such capabilities. Many countries seek to build "cultures" of science and innovation that will help develop these capacities in order to build public participation and support for science, as well as foster entrepreneurship. There is no single ideal "science and innovation culture" as it is the nature of national science cultures to be diverse (Jasanoff 2009). Yet many countries share this broader objective and aim to engage it through public policy.

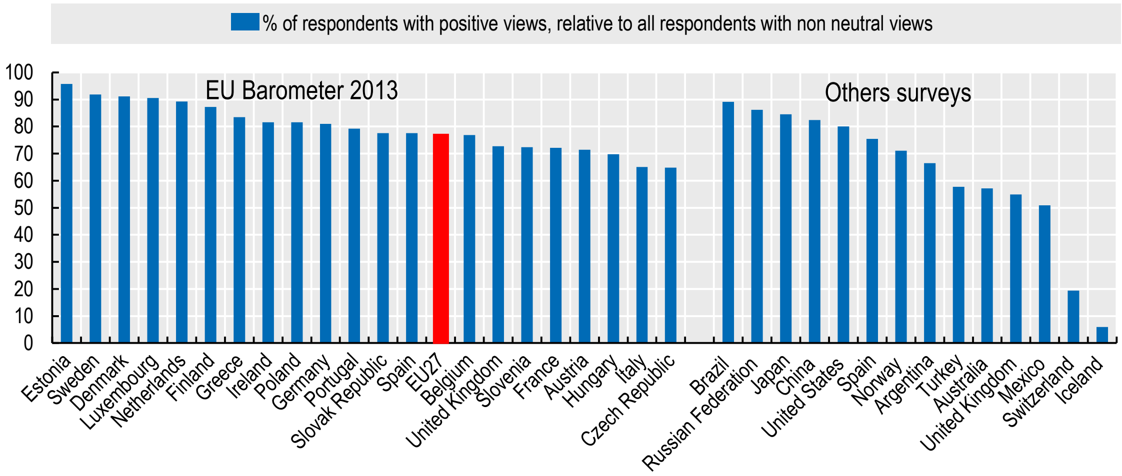
While the importance of innovation for sustaining economic growth and driving improvements in living standards is generally acknowledged, public support for science and technology remains mixed, an important indicator of the state of science and innovation cultures. Public perception surveys in a large number of countries indicate that, although most people have a positive view of the impact of science and technology (S&T) on their personal well-being, a significant proportion have mixed or negative opinions about the effects of scientific research (Figure 1) (OECD, 2013a; 2014 Eurobarometer). It can be difficult to make survey results internationally comparable (Bauer, 2012) but they do point to significant differences across regions. From the perspective of the adoption of new goods and services, a European poll found that nearly half of the EU25 population was significantly hostile to new innovations or very reluctant to try new products or services or pay a premium for them (European Commission, 2005).

Furthermore, public perceptions of science, technology and innovation indicate that existing systems of science and technology policy are failing engage the interests of individuals across age groups. More recent youth cohorts have shown less interest in science and innovation than was hoped for, and governments are concerned about how to motivate individuals to pursue science and innovation careers. The ageing of the population and labour force in most OECD countries also means that individuals in the middle of their careers and later need to deal with the challenges and opportunities created by technology developments and innovations. Furthermore, efforts to promote a science and innovation culture can be undermined not only by high-profile incidents and crises of confidence (e.g. Fukushima), but also by a less apparent erosion of trust in the decision-making process and in its use of science and evidence. This has triggered some serious rethinking about the impacts of S&T on the economy and society and a reassessment of the appropriate policy responses.

There is agreement across most countries that in part because of these challenges, governments can and should play a role in fostering a science and technology culture that deepens the capabilities of individuals and society understand, cope with, and contribute to vigorous innovation economies. This includes, but is not limited to, developing talent, fostering vocations, providing youth with the skills to participate in rapidly changing knowledge-based economies, and allowing the elderly to adopt solutions that can help them remain active and independent. Policy makers will need to analyse skills and public perceptions, and engage multiple stakeholders, in order to improve the science and innovation culture. Individual and collective customs, traditions, and values – the stuff of culture -- are complex and constantly evolving phenomena. But as the environmental movement shows, productive cultural changes are possible even in the short term. (see Chapter 1 on "Megatrends affecting STI").

Figure 1. Public perception of impacts of science and technology on society, 2013

Net relative balance in responses to: "Is the overall impact of science and technology on society positive or negative?"



Note: This is an experimental indicator. International comparability may be limited.

Source: OECD calculations based on European Commission (2013), Special Eurobarometer 401; and other national sources, June 2015.

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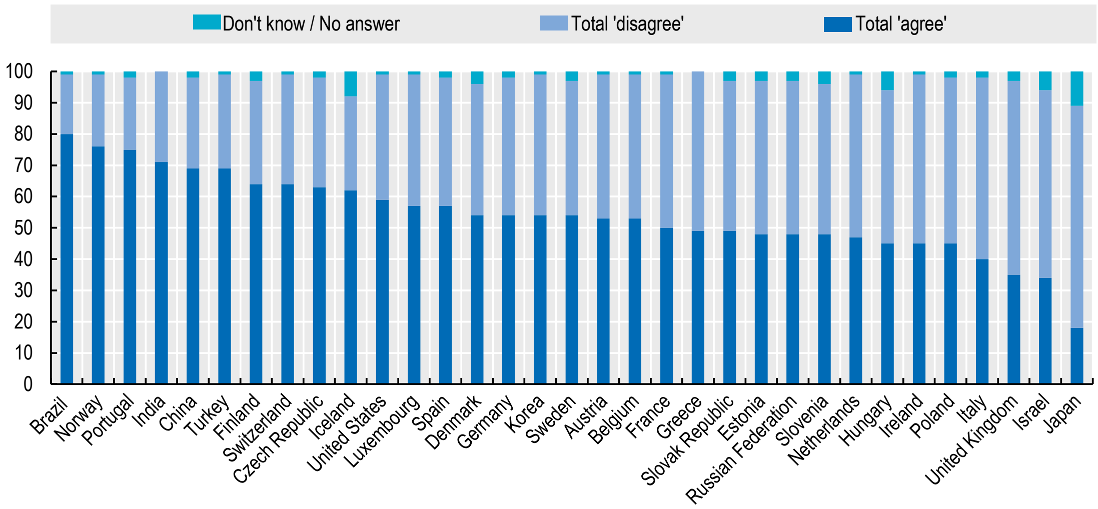
Figure 2. School helped to develop a sense of initiative and a sort of entrepreneurial attitude, 2012

Percentage of respondents, by degree of agreement with the proposed statement



Note: Results are based on sample surveys conducted by means of phone interviews. The survey was co-ordinated by the European Commission (EC), Directorate-General Enterprise and Industry, between 15 June and 8 August 2012 and targeted the population aged 15 years and over. The statement presented to respondents was: "My school education is helping me/has helped me to develop my sense of initiative and a sort of entrepreneurial attitude". Respondents indicate whether they totally agree, tend to agree, disagree or totally disagree.

Source: OECD (2013), *Entrepreneurship at a Glance*, OECD, Paris, http://dx.doi.org/10.1787/entrepreneur_aag-2013-en based on EC (2012), "Entrepreneurship in the EU and beyond", Flashbarometer 354, June, Brussels, http://ec.europa.eu/public_opinion/flash/fl_354_en.pdf.

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Major aspects and instruments

Governments make interventions to build science and innovation culture in numerous ways, and data points to the fact that this remains a dynamic area of policy development. One way to understand these policies is by the institutional location that they target. In particular, these seek to reach civil society, educational institutions, and workplaces (including universities and scientific laboratories).

Policy measures can be directed to civil society through mechanisms such as public dialogues, public consultations, and interactive science exhibits. Such policy measures seek to promote society's participation in policy design by improving public access to information on the future of science, technology and innovation. For over 30 years, the OECD has underscored the importance of raising awareness of S&T and recommended public participation in the definition of major technological orientations (OECD, 1981). In fact, policies aiming to engage publics on science and technology issues have therefore become more common (see the policy profile on Public Engagement in STI policy).

Other measures to engage civil society aim to raise awareness of and interest in S&T, especially among youth. Traditionally this has meant broad dissemination of scientific information, via the mass media, promotion of science events and other initiatives and support for the activities of science museums. The development and use of information and communication technologies (ICTs), the increasing access to digital infrastructures and the Internet, and greater interactive online communication – e.g. social media – have helped engage the public but have also reduced reliance on traditional sources. For example, it is common for individuals to consult health or technical information on Internet sites, the quality of which may vary.

Promotion of science and innovation among youth largely takes place in classrooms. However, the evidence suggests that individuals in many countries think that schools do not make a substantial contribution to promoting entrepreneurial competencies and attitudes (Figure 2). Major reforms of education systems seek to add new disciplines and new learning practices to curricula. They have concerned all levels of education, from primary schools to higher education institutions and have required building capacity in teaching and infrastructure (see the policy profiles on Strengthening education and skills for innovation and on Start-ups and innovative entrepreneurship).

Table 1. Enhancing a science and innovation culture: typology of policy initiatives and country examples

Spheres	Main target populations	Key policy instruments	Some country examples
Civil society	**Youth and Adult population**	Public dialogue (awareness workshops, conferences, standards)	Slovakia's scientific patisserie, France's Observatory of Biology
		Participation to STI policy design (public consultation)	Finland's national stakeholder conference, Great New Zealand Science Project, Spain's STI Strategy
		Science communication (science centre/ museum, science weeks/fairs/years/ exhibitions, science media (TV, radio, broadcasts, website and social medias), outreach programme by scientists)	Australia Questacon, Canada Science.gc.ca, Chile VA!, Korea Science Festival and Idea Festival, Start-up Expo and Start-up Fair, Germany BIOTechnikum truck, Spain FECyT summer camps
Classrooms and education systems	**Students at all educational levels**	Awards/prizes and competitions in science and innovation	China innovation and entrepreneurship race, New Zealand's Future Scientist prize, Slovak Republic's Innovative Deed of the Year (design)
		Formal education initiatives (lecture courses, new curricula)(*)	Danish Foundation for Entrepreneurship-Young Enterprise, Norway's Action Plan for Entrepreneurship in Education, Sweden's compulsory teaching of entrepreneurship
		New pedagogical practices and networking activities (hands-on exercises, experiment labs, participatory learning, role models and mentorship)(*)	Austria Young Science, Germany Little Scientists' House, Norway's IPRs educational scheme, Slovak Republic Scientific Patisserie
	Teachers	Capacity building for teaching, including the design of innovative teaching methods and materials	Austria's new teaching methods, Ireland's Project Maths
		Training opportunities, awareness conferences and workshops, financial incentives	Estonia's Training of academic teachers on entrepreneurship, New Zealand's fellowships for S&T teachers, Young Enterprise Norway
Workplaces	**Academia (researchers, doctorate students and postdocs)**	Training opportunities (e.g. IPRs, start ups etc.), awareness conferences and workshops	Technology Transfer Offices in many countries
		Support for commercialisation of public research results and industry-science linkages (remuneration schemes, performance criteria and promotion, industrial PhD)(*)	Innova Chile CORFO, Colombia's regional alliances, Germany's VIP and EXIST grants, New Zealand's Callaghan Innovation's R&D Student Grants
	Firms	Support to industry-science linkages, and technical assistance to firms (innovation vouchers, experts detachment, industrial PhDs, extension programmes)(*)	Technology Transfer Offices in many countries, Colombia's pilot program for training and advice in innovation management
		Training opportunities, seminars and information workshops and support, visibility	Costa Rica's CATI (IPRs) and National Portal of Innovation, New Zealand's Entrepreneurship Development Programme, South Africa's Science awareness awards, United Kingdom's Business Link

(*) See also the policy profiles on "Strengthening education and skills for innovation", "Start-ups and innovative entrepreneurship", "Commercialisation of public research results", and "Financing business R&D and innovation".

Note: This table draws upon recent analytical works on the innovation policy mix carried out for the OECD STI Outlook under the aegis of the OECD Committee for Scientific and Technological Policy. Country information is drawn from the EC/OECD International Science, Technology and Innovation Policy (STIP) Database, edition 2016, https://www.innovationpolicyplatform.org/topic-menu/sti-policy-database.

Source: Kergroach, S., J. Chicot, C. Petroli, J. Pruess, C. van OOijen, N. Ono, I. Perianez-Forte, T. Watanabe, S. Fraccola and B. Serve, (forthcoming), "Mapping the policy mix for innovation: the OECD STI Outlook and the EC/OECD International STIP Database", *OECD Directorate for Science, Technology and Innovation working paper series*.

Workplaces have sought to develop an innovation culture in view of the fact that innovation is science-, business-, practitioner- and user-driven (Vincent-Lancrin, 2012). Changes can be enacted in sites of scientific work such as academia through high level STI strategies and research orientations. These encourage a new research and innovation culture to help universities fulfil their "third" mission of transferring and co-creating relevant knowledge with the rest of society. Training, information workshops and revised remuneration and promotion frameworks seek to raise awareness of intellectual property rights (IPRs) and interest in the commercialisation of public research results in the research community. Researchers, especially early in their careers, are helped to launch start-ups (see the policy profile on "Commercialisation of public research results"). Firms receive technical assistance through financial and non-financial channels such as innovation vouchers, extension programmes and seconding of experts.

Recent policy trends

In recent years, policy efforts aimed at strengthening a science and innovation culture have also attempted to go beyond science and technology, narrowly defined, to reflect the broader and changing nature of innovation. One theme identified as a new trend in the last survey continues: a strong policy interest in fostering an entrepreneurial spirit and broader forms of creativity and to promote the exploitation of links between them. Another important trend is the increasing strength and number of programs of "responsible research and innovation", for which a major focus is the improvement of relations of science and society.

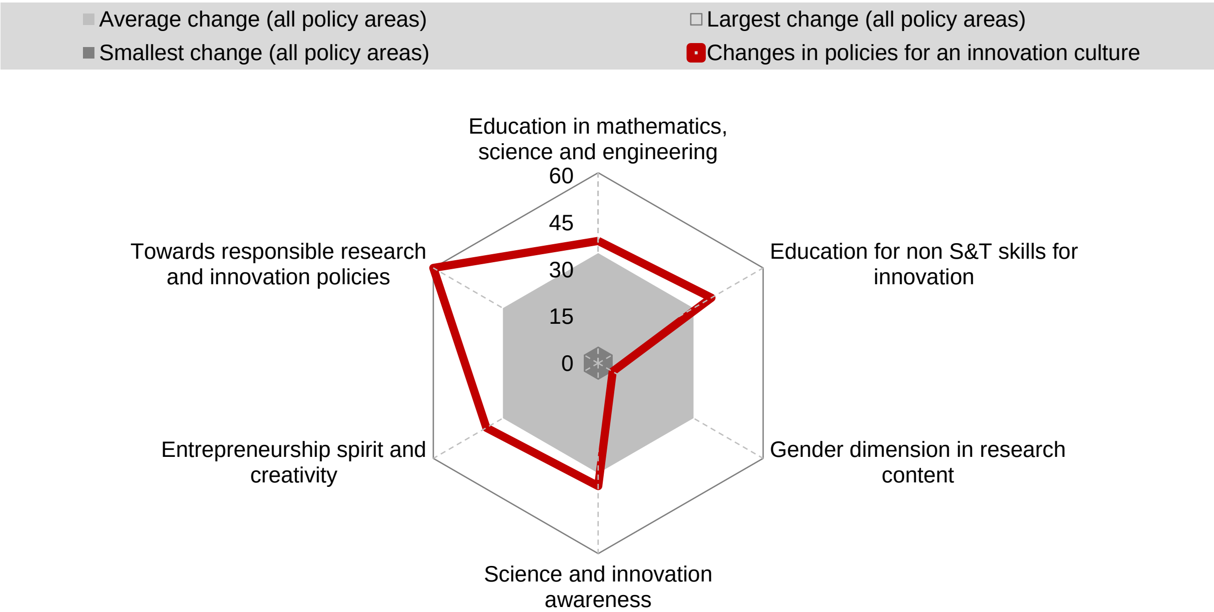
One of the most active areas of policy change in the STI survey has been the creation of new programmes on "responsible research and innovation," (Figure 2) and these should be seen in the light – at least in part – of the national objectives to build richer science and technology cultures (see also the chapter on the Future of Science Systems). In this sense, they reflect a real shift in thinking of the problem as one of simply educating the public, to one of better aligning science, technology and innovation with social goals. One way governments have been doing this is to find ways to engage the public early and often in processes of innovation and feed that into STI policy. In the last few years, a number of countries have put participatory and bottom-up approaches to setting STI strategies including the Netherlands, Greece, Argentina, and Chile (see also the policy profile on Public engagement in STI Policy).

Another avenue is to integrate social and ethical activities into funded research projects. Under Horizon 2020, the major funding program in the European Union, achieving "Science with and for Society" is an explicit objective. In practice, this objective is advanced through integrating research with activities like multi-actor public engagement in research and innovation. The program also promotes open access to scientific results, gender equality and ethics in the research and innovation content and process, and formal and informal science education under this banner. (Horizon 2020 Work Programme 2016-2017, Science With and For Society (2016)).Similarly, the Erasmus 4 Young Entrepreneurs 2016-21 helps provide aspiring European entrepreneurs with the skills necessary to start and successfully run a small business in Europe.

Recently, several countries have implemented new policy initiatives to build a science and innovation culture (Figure 3). Among the countries reporting new policy initiatives, this has been one of the most active policy areas in the overall policy mix for innovation and the most active on for human resources and education related policies. Most of these initiatives are large public events (Croatia's Science Festival, Australia's national science week, Greece's Research Night, Korea Science Festival, Start-up Expo and Start-up Fair), promotion campaigns (Chile's Year of Innovation and Imagine Chile initiative), competitions or awards (Australia's Innovation Challenge, Canada's awards for entrepreneurial culture, China's innovation and entrepreneurship race, and Costa Rica's Innovation Champions publication). In a new program in Spain, these kinds of projects are brought together under a funding program of USD 4.9 million PPP (EUR 3.3 million) administered by the Spanish Foundation for Science and Technology (FECYT).

Figure 4. Initiatives to build an innovation culture among other areas of STI policy change, 2014-16

Percentage of policy initiatives that have been newly introduced, revised or repealed over the period



Note: The EC/OECD STI Policy survey 2016 aims to review major changes in national policy portfolio and governance arrangements for STI. The survey builds on the conceptual work carried on under the aegis of the OECD Committee for Scientific and Technological Policy (CSTP) for mapping the policy mix for innovation and therefore covers a broad range of policy areas (Kergroach *et al.*, forthcoming-a). 52 economies participated in 2016, including OECD countries, key emerging economies (e.g. Argentina, Brazil, the People's Republic of China, Colombia, Costa Rica, Egypt, India, Indonesia, Malaysia, Peru, the Russian Federation, South Africa and Thailand), non-OECD EU Member States, and the European Commission. Taken together, countries covered in the STIP survey 2016 account for an estimated 98% of global R&D. Responses are provided by CSTP Delegates and European Research and Innovation Committee (ERAC) Delegates for EU non-OECD countries.

This is an experimental indicator that accounts for the number of major policy initiatives implemented, repealed or substantially revised during 2014-16 as a share of total policy initiatives active at the beginning of the period (Kergroach et al., forthcoming-b). Although simple counts do not account for the magnitude and impact of policy changes, this ratio reflects STI policy focus and activity in specific policy areas and over specific periods of time.

Source: Based on EC/OECD (2016) and Kergroach, S. *et al.* (forthcoming-b).

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Several countries have included developing a science and innovation culture in their strategic STI agenda (see the policy profile on National strategies for STI). In middle-income economies such as Colombia, Chile and Costa Rica, building an innovation culture is a key component of their national STI strategy. Colombia, for instance, made a new investment in its science centres (since 2015) which serve as a focal point for the generation, circulation and appropriation of scientific knowledge to serve social problems. Malaysia has identified this as one of its five main STI policy priorities for 2014. The same is true of more advanced economies with a traditionally high level of performance on STI indicators. Finland is broadening the scope of its Action Plan for Research and Innovation Policy (2012) to encourage experimentation and risk taking through longer-term basic research funding. A new proposal (Finland as a World Leading Country in Science and Education) from 2014 promotes children's and young people's science education development, ensuring the attractiveness of research careers. Korea has adopted a "Creative Economy" initiative to foster creativity, imagination, challenges and start-ups and has developed a new S&T culture programme.

Some countries are adapting their governance structures and building capacity in this area although it sometimes remains insufficient (European Commission, 2013). Following the USD 117 million PPP (EUR 100 million) allocated by the Investment for the Future Programme to develop projects of S&T culture, France recently established the National Council for Scientific, Technical and Industrial Culture. A comprehensive evidence-based strategy is also being prepared. The Russian Federation is devoting USD 164 million PPP (RUR 3.3 billion) over 2014-20 to finance activities to develop researchers' communication channels and popularisation of science: organisation of S&T communications events, museum creation, and creation and maintenance of Internet resources and mass medias. An additional USD 135 million PPP (RUR 2.7 billion) is granted in the form of subsidies to target youth at schools through information infrastructure, competitive incentives for science and education personnel, and traditional S&T communication channels.

The European Innovation Union has noted the need to strengthen links between universities and businesses and to create knowledge alliances that foster combining scientific, entrepreneurial and creative skills. New Zealand's Science and Society project is a joint education-science plan to increase engagement and achievement in science, technology, engineering and maths and improve the understanding, skills and adoption of S&T in society. Since 2007, Germany's "Exist_Business_Start_Up Grant" program has disbursed roughly USD 64 million PPP (EUR 51 million) per year through public-private partnerships in order to improve the entrepreneurial environment at universities. These funds help support research teams at universities or research institutes as they grow start-up projects. In 2016, the Netherlands launched a network of entrepreneurship centres in its public universities.

In the arena of education, Austria introduced a new teacher training model for pupils in primary and secondary schools in 2013 and the Federal Framework Law created the legal foundations of its implementation. The Czech Republic initiated a grant program aimed at efforts to popularize science and research for children and young students. In Finland a working group is examining the current state of national science education in order to formulate policy recommendations for new national curricula, learning materials, teaching methods, qualifications and training for the early childhood and pre-primary levels.

Some initiatives focus on specific fields: Germany's BIOTechnikum double-decker truck travels around the country to spread information on biotechnology and related career prospects; the Slovak Republic has an annual "Innovative Deed of the Year" competition to select the best young designer. Since 2009, Germany's Drive_E Academy opens its doors to 50 students from engineering or natural science programmes at German universities interested in electric mobility. In a two week program, the pupils get to hear presentations by experts from this field, demonstrate their own creative skills in workshops, visit big name car makers or small and medium sized enterprises to experience products, network with industry actors, and receive exposure to entrepreneurial culture.

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