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Entrepreneurship education, innovation and capacity-building in developing countries

Note by the UNCTAD secretariat

Executive summary

This note highlights the important role that education at all levels plays in developing entrepreneurial attitudes, skills and behaviours and in building innovation capabilities. It presents an overview of approaches to entrepreneurship education to enable policymakers to formulate, monitor and evaluate national policies to inspire and enable individuals to start and to grow entrepreneurial ventures. It discusses main issues that need to be addressed to ensure efficient integration of entrepreneurship education into entrepreneurship strategies and policies, and outlines some guiding recommendations in this area.

It also raises awareness about the role of education and research institutions in encouraging science, technology and innovation, and explores some of the challenges that education institutions face in developing countries with regard to their operation as players in the national system of innovation. While policies and practice from developed countries provide some examples, the focus of this note is on strategies and programmes for developing countries.

Contents

I. Introduction

1. Entrepreneurship and innovation are increasingly recognized as important drivers of economic growth, productivity and employment, and as a key aspect of economic dynamism. In the issue note entitled "Key components of entrepreneurship and innovation policy frameworks",[1] prepared for the second session of the multi-year expert meeting, education and skill development was highlighted as one of the key policy areas in UNCTAD's entrepreneurship policy framework. The ultimate objective of entrepreneurship education policies should be to facilitate the creation of an entrepreneurial culture, which in turn, will help potential entrepreneurs to identify and pursue opportunities. Government policies on entrepreneurship education are critical for ensuring that entrepreneurship is embedded into the formal educational system, and offered through partnership with the private sector, the informal community, and rural and apprentice training programmes. Entrepreneurship education policy should also include a focus on specific segments of the population (e.g. women, minorities, youth etc.) in which entrepreneurial training could have a significant impact. For the purposes of this note, the focus will be on the types of skills that could be built through entrepreneurship education.

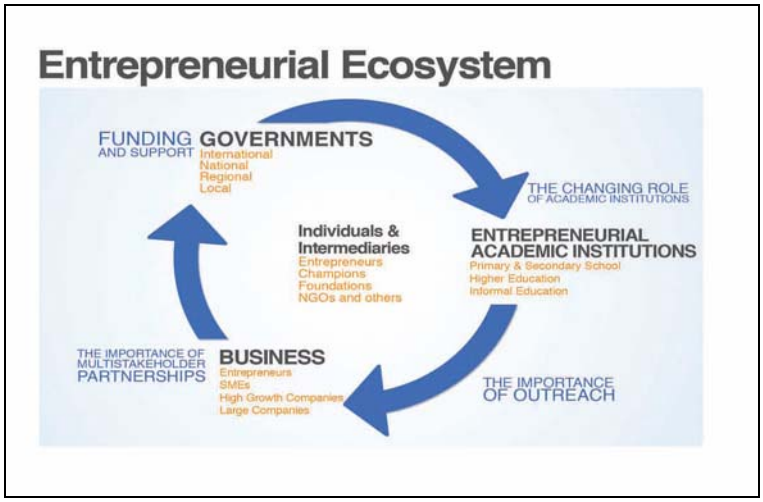
2. In addition, it suggested that a systemic approach to innovation and STI policymaking, whereby entrepreneurs would be supported by a national innovation system, could be more appropriate to the needs of developing countries. Education and research institutions, as producers, repositories and diffusers of knowledge and technology, play a central role in such systems. In addition to developing skills required in the twenty-first century, entrepreneurship education policies and programmes can contribute to generating jobs, and fostering innovation and poverty reduction through the empowerment of marginalized members of the community. Education policies, therefore, are crucial in order to materialize the potential contribution of entrepreneurship and of innovation to social and economic development.

II. Developing the entrepreneurial ecosystem

3. One of the key success factors for entrepreneurship education is effective development of the entrepreneurial ecosystem, in which multiple stakeholders play a role in facilitating entrepreneurship. It is a system of mutually beneficial and self-sustaining relationships involving institutions, people and processes that work together with the goal of creating entrepreneurial ventures. It includes business (large and small firms, as well as entrepreneurs), policymakers (at international, national, regional and local levels), and formal (primary, secondary and higher education) and informal educational institutions. The different stakeholders are involved in a series of symbiotic actions which include awareness and outreach, the development of human capital and critical talent, public–private partnerships, multiple sources of innovation, intellectual property and funding. In a dynamic and growth-generating entrepreneurial ecosystem, there is a high degree of interaction and coordination among these key elements (fig. 1).

[1] UNCTAD (2009). TD/B/C.II/MEM.1/6.

Figure 1. The entrepreneurial ecosystem



Source: World Economic Forum 2009.

4. The role of government is crucial in creating the proper regulatory framework and incentives to catalyse the involvement of the private sector, education institutions, individuals and intermediaries within an entrepreneurial ecosystem. However, in many developing countries, each of these groups of actors may be at an early stage of development in terms of entrepreneurship, or perhaps not yet focused on it due to other priorities and the allocation of scarce resources. Each stakeholder in the ecosystem needs to recognize entrepreneurship as a key element of its strategy, thereby creating win-win networks of entrepreneurial relationships. In this regard, links between the private sector and academia should be encouraged, as should the development of networks between various potential actors in the ecosystem. “Social networks” and trust provide the essential glue in such ecosystems.

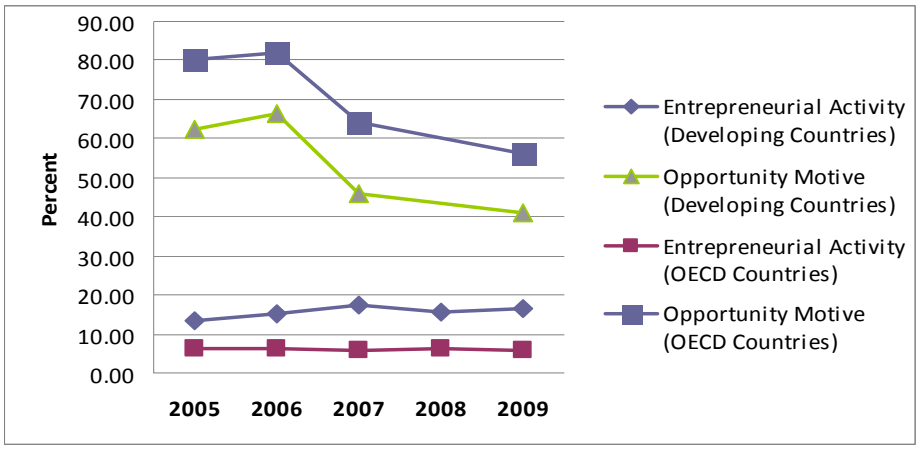
III. Overview of policy approaches for entrepreneurship education

5. Entrepreneurship education policy is closely interlinked with overall entrepreneurship policy as well as economic and social development objectives. It should be therefore reflected in a country’s national economic and social development plans or strategies. It is a lifelong learning process, starting as early as elementary school and continuing through all levels of education, including adult education. It should build positive attitudes towards business and develop entrepreneurial competencies to successfully plan, start and manage a business. To effectively implement entrepreneurship education, both top down and bottom up approaches are necessary. Top down approaches require the commitment of the most senior policymakers. Building this commitment is not easy – often entrepreneurship education has to be framed within the context of its contribution to economic and social growth to attract the proper attention. Bottom up approaches require champions at the local or regional level who can help drive initiatives on the ground.

6. In designing policy approaches to entrepreneurship education, it is also important to recognize the type of entrepreneurship and to make a distinction between “opportunity” and “necessity” entrepreneurship. The Global Entrepreneurship Monitor (GEM) measures levels of entrepreneurial activity, and shows that overall activity is higher in developing countries than in developed, and opportunity (and high-growth entrepreneurship) is more

prevalent in developed countries.[2] Given the high rates of necessity entrepreneurship in developing countries (informal and micro-entrepreneurial activity), it is important to establish policies which can not only help transition successful necessity entrepreneurs (often with low levels of formal education) into opportunity entrepreneurs (with social and basic business skills necessary to run their own small business), but also encourage more high-growth-oriented entrepreneurs. This often means that coordination on entrepreneurship education policy between ministries within a country is critical.

Figure 2. Entrepreneurial activity in selected countries



Source: Global Entrepreneurship Monitor 2010.

1. Entrepreneurship education strategies and policies

7. The launch of a national strategy for entrepreneurship education should call for the active involvement of all relevant actors and define concrete actions for the inclusion of entrepreneurship into national curriculums, providing support to schools and teachers, and should encourage the involvement of private partners through funding and contributions in kind for entrepreneurship and business development. Countries can have a specific entrepreneurship education strategy, or can embed it into the education strategy (see box 1). The first sends a strong and clear message about the importance of entrepreneurship education, while the latter ensures that it is treated as an integral part of the long-term educational system rather than as a standalone, and potentially short-term, initiative. In developing countries, the latter seems to be the most adequate option. Various entrepreneurship education policies may be associated with different policy objectives, with different ministries taking the leading role. In a number of countries, issues of coordination have been dealt with by setting up a working group that includes representatives from various ministries and also from other stakeholder groups – business, academia, and non-governmental organizations (NGOs). In addition, a high-level office to coordinate entrepreneurship education policies across ministries is often useful, which can help to facilitate the development of a more comprehensive entrepreneurship education strategy and set of policies.

[2] Global Entrepreneurship Monitor reports, 2008 and 2009.

Box 1. 2006 Law for the Promotion of a Culture of Entrepreneurship (Colombia)

Colombia has made several efforts to mainstream entrepreneurship issues – including entrepreneurship education – into its national policy framework. Its 2006 Law for the Promotion of a Culture of Entrepreneurship, for example, includes a commitment towards "training for entrepreneurship" through entrepreneurship skill development in both the formal and non-formal education systems. This law is part of the normative framework that gave way to the 2009 National Policy for Entrepreneurship, whose National Strategic Plan involves the promotion of entrepreneurial activities, capacity development, and awareness. Among other things, it involves the Ministry of Education and institutions of both basic and higher education. The 2006 law also served as a backdrop for the ongoing presidential programme entitled "Young Colombia".

Source: Ley 1014 de 2006 (26 de enero) – Fomento a la Cultura del Emprendimiento – Programa Presidencial Colombia Joven. http://www.colombiajoven.gov.co

8. In developing countries, it is important to integrate entrepreneurship education into the overall poverty reduction strategy. Malaysia has for many years included the development of entrepreneurship skills in its economic plans, with the goal of contributing to the eradication of poverty in the country, and entrepreneurship education continues to be on the national agenda. Its recent poverty eradication plans, and the New Economic Agenda (2010), include entrepreneurship skill development programmes as a means to combat poverty in disadvantaged communities, particularly targeting ethnic minorities.[3]

9. Unfortunately, many of the least developed countries (LDCs) do not mainstream entrepreneurship education into their poverty reduction strategies. However, there are some notable exceptions. Rwanda has made efforts to target entrepreneurship education to women and rural populations, as part of its economic development and poverty reduction strategy.[4] Other countries, such as Mozambique, have begun to address entrepreneurship education as a poverty alleviation strategy through technical cooperation projects involving the United Nations and donors.

10. National policies and programmes facilitating entrepreneurship education can set the strategic framework in which schools, universities and private sector bodies can work to implement programmes and activities within their institutions. They often include a focus on specific segments of the population (e.g. women, minorities, youth etc.). However, the difficulty is in the follow-up and ensuring that implementation is carried through effectively. In this regard, governments often set up agencies, foundations or other bodies to implement programmes outlined in the strategic plan. For example, government support for the development of entrepreneurship centres has proved very useful for necessity entrepreneurs, particularly in LDCs, to create a hub or a central coordination point for entrepreneurship education. Entrepreneurship centres also facilitate the long-term sustainability of entrepreneurship education. Over time, government funding for these

[3] *Source:* http://www.parlimen.gov.my/news/eng-ucapan_rmk9.pdf
[4] http://planipolis.iiep.unesco.org/upload/Rwanda/Rwanda_EDPRS_2008-2012.pdf

centres can be supplemented with funds from the private sector and foundations, however government funding is often needed to catalyse other funding sources.

11. While entrepreneurship education policy is often coordinated by education ministries, it can be covered by one or more ministries – including ministries of education, culture, industry/enterprise, research, and science and technology. For example, the Danish Government has developed a Strategy for Education and Training in Entrepreneurship, with specific goals set for 2015. All of this work comes under a new Foundation for Entrepreneurship, which plays a key role in teacher training, curriculum reform, and the assessment of entrepreneurship education. A partnership initiative between the public and private sectors is also a key pillar of the entrepreneurship education strategy in Singapore (see http://www.ace.sg). A growing number of countries have developed national entrepreneurship education strategies to provide a roadmap to ensure that the necessary players are engaged and that appropriate budgeting and financing is made available to implement those policies.

2. Regional and local governments

12. Regional and local governments also play a key, and often more direct, role in catalysing entrepreneurship education. In addition to having the ability to target policies and funding more specifically to needs at the local level, local and regional governments can work on developing other necessary elements of the entrepreneurial ecosystem (see, for example, the city of Johannesburg, at http://www.joburg.org.za/content/view/5525/266/).

13. As regards Europe, the European Commission has been extremely active in encouraging countries to adapt national strategies and in highlighting the role of various stakeholders. It made entrepreneurship a priority in its previous Lisbon Agenda, and again in its new Europe 2020 strategy. Following the development of the Oslo Agenda, the Commission embarked on a series of activities focused on entrepreneurship in higher education, and produced an expert report as well as a mapping of entrepreneurship education in universities across Europe.[5] Another example is the proposed ASEAN Policy Blueprint for SME Development, which includes human resources development and capacity-building as part of its focus area of projects and activities.

14. National, regional and local policies will vary by country, depending on the local context and the level of current provision of entrepreneurship education. But it is important that relevant impact indicators are defined according to the specific objectives of each target of the entrepreneurship education policy. Collecting indicators is critical, because many publicly funded programmes are limited in duration and the results should be adequately demonstrated to secure other sources of funds and/or for programmes becoming self-funding.

IV. Key policy and programme areas for entrepreneurship education

15. Key areas of entrepreneurship education could be specified as follows: (a) embedding entrepreneurship into education and training; (b) curriculum development; (c) teacher development; and (d) engagement with the private sector.

[5] http://ec.europa.eu/enterprise/policies/sme/promoting-entrepreneurship/education-training-entrepreneurship/reflection-panels/index_en.htm

1. Embedding entrepreneurship into formal education and training

16. Embedding entrepreneurship into the formal educational system at all levels requires a strong commitment from the government in terms of policy and resources, since most schools, universities and training programmes are overseen by the government. It is never too early to start exposing students to business and entrepreneurship. Perceptions and attitudes about entrepreneurship start at a young age. By the time students reach secondary and higher education it can be "too late", particularly if they do not pursue further education or if they have developed some negative perceptions about entrepreneurship. Entrepreneurial learning should be integrated into the curriculum, rather than only being offered as standalone courses, in order to change the mindset among students. For example, in 2007, Nigeria included entrepreneurial skills in the new basic education curriculum for its primary and secondary schools.

17. In primary education, the adoption of school books, interactive games and online tools has proved to be particularly useful. For example, the award-winning Disney-Kauffman online game teaches young people (aged 9–14) about the excitement and opportunity of entrepreneurship. The Junior Achievement programme, present in 19 African countries, includes six sequential themes for pupils from kindergarten level up to fifth grade, plus one capstone experience. Students learn the basic concepts of business and economics, and how education is relevant to the workplace. External evaluators have found that elementary school students who participate in the Junior Achievement programme demonstrate significantly higher critical thinking and problem-solving skills than their counterparts.

18. At the secondary and vocational school level, the implementation of awareness campaigns and extracurricular activities designed to help students to understand the world of work, including visits to businesses, is suggested. For example, initiatives such as Global Entrepreneurship Week help improve attitudes about entrepreneurship, and encourage young people to consider entrepreneurship as a potential career path.

19. At higher education level, attending elective and/or compulsory courses on entrepreneurship, and participating in more focused activities and projects, has proven particularly effective. An example of this is Enterprise Development Services (EDS), established in January 2003, a centre within the Pan-African University in Lagos, Nigeria. EDS focuses on entrepreneurship education and on the provision of support services to small and medium-sized enterprises (SMEs) in Nigeria. Within the university context, entrepreneurship centres can play a key role in catalysing entrepreneurship education both within and outside of the curriculum. Some of these centres are focused on training (i.e. students and/or entrepreneurs), while others are focused on research.

20. As already discussed, there are also entrepreneurship centres that can serve as hubs or coordinate activities across institutions. They often go beyond what is provided through formal education, for example targeting specific segments of the population, such as youth, women, and other potentially underserved groups.[6] The work of these centres might include the coordination of after-school programmes or activities in community centres.

[6] Goldman Sachs: 10K Women Initiative. Launched in March 2008, the programme will, over five years, provide 10,000 underserved women around the world with a business and management education.

2. Curriculum development

21. Another key area to be addressed in entrepreneurship education is curriculums that are tailored to the local environment, by leveraging existing resources and by creating new local materials, case studies and examples of role models that entrepreneurs can relate to. Tailor-made curriculums should include appropriate representation of gender, youth, indigenous people, people with a disability, informal enterprises, and enterprises based in rural areas. They could also engage students, since students have a growing interest in entrepreneurship education, and student-led initiatives provide effective models.

22. Entrepreneurship programmes should be developed across disciplines, not just in business schools or economic departments. In higher education, most of the provision of entrepreneurship education is centred on business schools or economics departments, which are increasingly offering specializations and even degrees in entrepreneurship. While this may seem a natural place to start, evidence has shown that the majority of entrepreneurs do not come from business schools but from science, engineering and technology schools. In fact, entrepreneurship can be in any discipline or sector – from medicine, to the arts, to public service.

23. This makes it imperative that entrepreneurship be taught in a cross-disciplinary manner and not confined only to business and economics. In developing countries, some of the areas that should be included in entrepreneurship curriculums, depending on the educational level, include: basic skills (financial literacy etc.), opportunity recognition, business planning, start-up, managing the SME, managing the transition from necessity to growth firms, and exit/transition of ownership, particularly family-owned. The younger the target audience, the more the curriculum needs to be focused on basic skills and awareness-raising about business and entrepreneurship. Effective entrepreneurship education programmes focus on developing entrepreneurial attitudes, skills and behaviours. This includes building self-confidence, self-efficacy, and leadership skills, particularly at the primary and secondary levels.

24. In the area of curriculum development, international organizations are increasingly playing a catalytic role. The European Commission has been focused on entrepreneurship education in secondary and higher education for the past 10 years and has provided significant funding for programmes across Europe. The United Nations, through organizations such as UNCTAD, UNESCO and ILO, has been developing and supporting programmes for entrepreneurship training and education (box 2). In addition, technology and media provide mechanisms for reaching greater economies of scale, and for providing greater access and sharing of practices. Not only can technology and media facilitate the development of innovative interactive programmes and materials, they can also help to reach larger audiences, including those in developing countries or regions that might not otherwise have access to entrepreneurship education.

Box 2. UNCTAD's Empretec methodology

Empretec is an integrated capacity-building programme of UNCTAD which is currently operating in 32 entrepreneurship centres across the developing world. Empretec distinguishes itself from other trainings by offering a behavioural approach to entrepreneurship. Research undertaken has demonstrated that there is a series of 10 key personal entrepreneurial competencies represented by 30 behaviours associated with successful entrepreneurs. The Empretec programme reinforces and strengthens these competencies through an Entrepreneurship Training Workshop (ETW) which involves self-assessment, individual transformation and business stimulation activities. The ETW encourages individuals to focus on their role as entrepreneurs, and challenges them to critically examine their personal strengths and weaknesses. The training method is highly interactive and experiential, and is combined with other services.

Source: http://www.unctad.org/enterprise.

3. Teacher development

25. Teachers are the key to entrepreneurship education. Strategies and plans will not have any impact without effective educators to develop the necessary enthusiasm and understanding among students. There is a need to increase the number of entrepreneurship educators, and to further develop them by providing training, particularly in interactive teaching methods (see box 3). Networks and the sharing of best practices among educators are critical, too.

Box 3. The International Labour Organization's Know About Business programme

Know About Business (KAB) is a training programme for trainers and teachers in vocational education, secondary education and also higher education, which relates to a 120-hour course for young students aged between 15 and 18 years. KAB's general objective is to contribute towards the creation of an enterprise culture in a country or society, by promoting awareness among young people of the opportunities and challenges of entrepreneurship and self-employment. The course is divided into several modules, and includes a business game. The aim is to integrate the KAB programme into the national curriculum of the country. The International Labour Organization (ILO) offers many other products and services to developing countries in this area.

http://www.ilo.org.

26. Often, entrepreneurship starts with a commitment by one individual – whether a teacher or another champion – who starts to develop programmes and/or activities from the ground up. If successful, such individuals attract others to join them, and begin to build momentum. However, the proper incentives and rewards need to be in place to ensure that others engage as well. Professorships or Chairs are a very effective way of providing both recognition and resources to key entrepreneurship faculty champions. Awards provide incentives, too. In Brazil, a national award has been created for entrepreneurship educators, with the participation of 46 universities in 16 States.[7]

27. To date, most of the teacher training initiatives and networks developed have been at the higher education level. More needs to be done at the primary and secondary levels, by providing entrepreneurship training in teacher training institutes. Entrepreneurship education should be very closely linked with practice. Teachers should be encouraged to reach out to the business community and to integrate it into the learning process. For example, the Aflatoun teaching methodology encourages "learning by doing". This includes school-wide savings clubs, financial and social enterprises, and group activities within the community.[8] Many systems of schooling around the world are based on old teaching models – the lecture method – whereas the skills needed today and in the future require interactive, experiential learning methods. This includes the need to expose students to entrepreneurs and real business situations.

4. Partnership with the private sector

28. One of the key success factors for entrepreneurship education is the effective engagement of the private sector in facilitating entrepreneurship. This includes business and private educational institutions. In addition, it means developing networks across sectors to spur partnerships and create an environment of trust and cooperation in the local ecosystem and beyond. There are many examples of partnerships with educational institutes and the private sector. For example, through partnership with the University of California at Berkeley, Intel provides entrepreneurship theory-to-practice seminars at universities around the world. In addition, an "entrepreneurship challenge" seeks business plans that commercialize new and truly innovative technologies. Private entrepreneurship centres and foundations also play an important role, both in funding and in serving as centres of expertise on entrepreneurship.

29. It is also important to highlight the role of large domestic and foreign firms in business development. Large corporations are increasingly concentrating on their core operations and outsourcing those in which they do not have a competitive advantage. Thus, they have a strategic interest in developing the competences of local suppliers, and often take part in cost-sharing in local skills development and upgrading programmes. There are many examples of such programmes, as shown by recent UNCTAD publications.[9] With the increasing importance – also as a competition factor – of corporate social responsibility, it is becoming more prevalent for transnational corporations (TNCs) to see how they contribute tangibly to the local economy. One way of doing this is to work with potential local suppliers in helping them to establish businesses that can provide basic services, and, in some cases, goods, to the TNC.

[7] Endeavor Brazil. http://www.endeavor.org

[8] http://www.aflatoun.org

[9] UNCTAD (2009). *Creating Business Linkages: A Policy Perspective.* UNCTAD/DIAE/ED/2009/1.

V. Building capacity for STI-led development: the role of academic institutions

30. The development and implementation of STI capacity-building policies should be buttressed by sound educational and academic institutions with strong linkages with firms and policymakers through a functional national system of innovation (NSI). Developing coherent STI policies adapted to the realities and opportunities of developing countries also requires a dialogue with all stakeholders and factual feedback, facilitated by the NSI framework. As was suggested in the first session of this multi-year expert meeting,[10] in order to effectively promote innovation in developing countries, capacity-building policies need to focus on supporting interaction among development stakeholders at all stages of innovation, i.e. conception–dissemination–adoption. This underscores the importance of an NSI and the role of academic institutions within it.

31. An important underlying notion is that a positive STI policy needs to work at all levels, including measures aimed at educating the public at large about the importance of science and technology for social and economic development. STI awareness activities can enhance interest in STI vocations and stimulate creativity and innovation while broadening social and economic opportunities. General education about STI can also help improve awareness and critical thinking about important governance issues, and can thus improve public participation in democratic and decision-making processes, in particular on key issues such as technology access, sustainable development and climate change.

1. Development through collaboration

32. It is increasingly recognized that the linear model of innovation, which gave prominence to research and development (R&D) as the key phase in innovation (a "technology push" strategy) is failing the exigencies of technological learning.[11] Increasingly, firms and universities are deepening their relationships, and this is leading to a hybrid STI community that engages scientists, researchers and entrepreneurs in an environment more akin to a network than a hierarchical or compartmentalized structure. The mobility of people between academia and firms is an important element in supporting the collaborative knowledge networks between industry and university. Given this move towards increased cooperation and greater openness, developing-country policymakers need to seize all opportunities to sustain the growth of local innovation collaboration and to support the efforts of local firms and educational institutions in participating in global STI networks.

33. Advances in technology and globalization have led to an increasing diversification of demand for expertise produced by universities and research institutions in the form of human capital, as well as in practical research and innovation outcomes. Given rapid global economic changes, academic and research institutions are ever more faced with the demand to continuously improve and re-skill students and professionals, including their own staff and experts. This development has been supported by the growing access to and capacity of ICTs, with their potential for widening and deepening networks of expertise and collaborative STI and R&D platforms.

[10] UNCTAD (2008). TD/B/C.II/MEM.1/3

[11] Lam, Alice (2004) Work Roles and Careers of R&D Scientists in Network Organizations, Brunel University, Brunel Research in Enterprise, Innovation, Sustainability, and Ethics.

2. Partnering and networking

34. The central issue for universities and research institutions in developing countries is to understand the challenges and opportunities created by changes in the global economy, and, in cooperation with firms and government, to adjust their activities in order to increase their commercial and developmental relevance. Rebalancing their role from researchers to innovators is heavily dependent on establishing a successful partnership framework among development stakeholders, as innovation activities must be linked to development goals. This is doubly important in firms and institutions that are tasked with solving a problem or delivering better value more efficiently. Thus, collaborative activities and knowledge flows are increasingly complex and have come to resemble networks of knowledge systems.

35. The convergence of higher education, scientific research, and applied research and innovation is strongly supported by information and communication technologies (ICTs). Thus, the capacity to access and participate – and eventually benefit – from global STI activities is closely linked to access to ICT infrastructure, and, even more so, to enabling and incentivizing change in business and institutional cultures to see it as a development opportunity rather than a threat. Firms and academic and research institutions that fail to become part of any formal or informal STI networks may risk marginalization.

36. STI networks can function at national, regional and international levels. Beyond providing a conduit for collaboration, their economic effect may become increasingly meaningful as policymakers are often tasked to share resources for funding university education, with demands for scientific research and applied research and innovation. Yet, with improved interaction among researchers working in academia and those in public enterprises and private firms, the scope for collaborative research and, consequently, its financing, can grow to meet current and future demand for STI. The leading universities of the future in developing countries will necessarily be those that have strong research activities which are performed and funded in close collaboration with local and national firms and public and private service providers.

3. Knowledge application and development

37. Policy support and resource allocation aimed at boosting STI activities can reap positive developments. However, the critical question for many universities and research institutions is how relevant they are to the local economy and how strong their commitment is to developing cooperative activities with firms and public service institutions. A number of issues can trigger increased cooperation. An obvious question is that of financing of STI and R&D: a common and well-defined research objective can incentivize joint private–public financing. Another important issue is opening the process of determining secondary, higher education and professional training curriculums to inputs and feedback from private and public firms and service providers. Economic agents and STI institutions need a common conduit to exchange information on the nature of content of capacity-building activities, especially in smaller and less developed economies where labour markets do not generate timely or discernable feedback.

4. Facilitating technology transfer from universities to the productive sector

38. An important practical intersection of education and enterprise is the so-called business incubator, which can be based in an academic institution. The objective is to establish and grow firms that will become commercially viable, and in doing so, to create

jobs, commercialize innovation, and strengthen local and national economies. The success of a university business incubator will depend on the quality of the linkages it develops between itself, its academics and researchers, and the hosted firms and entrepreneurs. From the point of view of resource allocation and distribution, business incubators provide an identifiable locus of innovation that can readily cooperate with investors and funding institutions. Beyond offering its STI and other academic competencies (economics, finance, business studies etc.), the most important value added is in developing a network for cooperation and exchange of knowledge. Finally, business incubators may help to increase the success rate of start-ups and SMEs, and therefore can contribute to a better utilization of financial resources, which are often deficient in developing countries and LDCs (box 4).

Box 4. Business incubators: TREC-STEP India

Established in 1986 at the Regional Engineering College of Tiruchirappalli, India, TREC-STEP was the first entrepreneurs' park in the country. Since then, it has been working to promote firms and entrepreneurs, in particular those venturing into technology-based fields and business growth. TREC-STEP is the part of a national initiative to develop knowledge-based enterprises that can positively affect the lives of young scientists and technologists, and improve the cooperation between educational institutions and emerging entrepreneurs. TREC-STEP supports innovation, science and technology and entrepreneurship through training, development and consultancy initiatives. Apart from cooperation with firms, TREC-STEP is evolving cooperation with other business incubators, and has engaged UNIDO and UNDP in project activities.

39. Cooperation in actual research activities, between university scientists and technologists working in business, can improve the scale and complexity of the research and thus improve the chances for successful and meaningful innovation. More formally, IPR policy needs to enable public STI and R&D organizations to be equal partners with private firms in joint filling and application, and ownership, of copyrights and patents. Box 5 provides an example of the results that such policies can achieve.

Box 5. IP and cooperation between academic and research institutions and firms: the case of MIT

The terms and conditions that MIT offers to sponsors, i.e. entities that finance R&D activities, are diverse. Patenting with MIT acting as the sole inventor, or joint patenting with an R&D sponsor, are both possible. At the same time, sponsors can negotiate the terms and conditions of the licence that they wish to receive once the patent has been filed. The scope of the licence may vary considerably – from a commercial, exclusive, royalty-bearing, sub-licensable (tradable) licence, to a non-exclusive, royalty-free, non-tradable licence or one designating the IP in the patent as available only for further internal use for research purposes. An example of the workings of such mechanisms was the development of the public-key encryption system, the security technology of the Internet, by Ronald Rivest, Adi Shamir and Leonard Adleman, three students at MIT. In United States patent number 4405829, issued in 1982, Rivest, Shamir and Adleman were named as inventors, while the patent assignee was named as MIT. MIT then issued an exclusive license to RSA Data Security, the company formed by Rivest, Shamir and Adleman. From modest beginnings, RSA became an industry leader and was eventually sold to EMC Corporation for $2.1 billion in 2006.

40. While the management of IPR is fundamental to public–private R&D partnerships and activities, transfer of technology can be dependent on and motivated by several specific circumstances. One would be the technological proximity between firms and their academic counterparts: the better the match, the greater the possibility for cooperation. The policy advice to improving proximity is fairly straightforward: entrepreneurs and educators need to consult each other on potentially useful research areas and profit from each other's inputs. In those cases where there is an identifiable practical outcome, technology transfer has the best chance, and therefore one can expect cooperation in fields such as agricultural, chemical or information technology. Another important issue is comparable skill level: experts in firms and those in academia need to be able to cooperate in order to conduct meaningful technology transfer. Finally, policymakers need to use the NSI framework to assess whether development priorities are better served by strengthening R&D in fields where it is plainly lacking, or by focusing academic R&D around existing R&D areas established by firms.[12]

41. While enhancing collaboration to improve the responsiveness of STI and R&D activities presents interesting opportunities for middle-income developing countries, for many LDCs the future of their university-level STI programmes lies in maximizing the use of knowledge that is openly accessible or has liberal intellectual property restrictions. The amount of learning tools for science and technology that are either in the public domain or under public or common licences is vast and increasing daily, and must be taken advantage of in order to maintain and improve the quality and relevance of academic institutions.

[12] Woerter M et al. (2009). *Knowledge and Technology Transfer (KTT) Activities Between Universities and Firms in Switzerland: The Main Facts.* Swiss Federal Institute of Technology. Zürich.

5. Skills and competencies for innovation

42. In order to improve the application of acquired science- and technology-related knowledge and skills in the economy, curriculums would need to emphasize the importance of science and technology both as a creative input to the development of goods and services, and in its role in enterprise management, primarily through the application of information technology.

43. Economics and business curriculums would – beyond core issues – underscore the value of acquiring quantitative skills and competencies and applying these in entrepreneurship. Factual observation, gathering and organizing data, developing indicators and analysing them to determine options for action – whether these relate to a firm's market environment or its internal workings – are vital for its success. Secure instantaneous electronic communications and computing power are scalable resources: they can be used at levels of intensity appropriate for any type or size of enterprise. Therefore, basic skills training in electronic communications, data storage and processing, and using computing for financial calculations, need to be offered to potential entrepreneurs.

44. Entrepreneurs fuel innovation by developing new or by improving existing products, services or processes. Entrepreneurship education develops skills in creativity, opportunity identification, problem-solving, self-efficacy and leadership. In addition, science, technology, engineering and maths (STEM) are critical for developing the innovative breakthroughs of the future, but are losing popularity with young people. More must be done to ensure that both entrepreneurial and technology-based skills training is provided to students at all levels of the education process.

45. Entrepreneurship education will also need to introduce a diversity of management skills related to innovation. These issues may include skills related to product development, employee management and training, marketing, and public relations. Much of the knowledge presented would fall under the category of soft or process technologies and innovation. Entrepreneurs need to stay on top of developments in process innovation that affect their firms, and correctly judge when, how and at what cost to invoke process change in order to improve their competitiveness.

46. As government regulations and commercial law have an impact on the commercial outcome of a firm, entrepreneurs need appropriate knowledge and skills to understand their legal and regulatory environment, and to have the confidence to delegate their concerns to legal experts and implement their advice. Many governments and local authorities have introduced some form of e-government policy that delivers, among other things, information on business law and regulations. To benefit from it, potential entrepreneurs need to be able to access and use online resources in a focused and productive manner. While these would necessarily include local resources, in the case of firms aiming to trade internationally, knowing how to access and understand export markets' regulations, as well as international provisions governing trade in a particular sector, is of great importance.

VI. STI capacity-building and globalization

47. The internationalization of high-tech businesses and the shifting geography of R&D and innovation bodes well for middle-income developing countries that have a strategic STI perspective. However, this can only be accomplished if policymakers accept that scientific and technological education is a strategic priority and an indispensable component of an STI-led development strategy. In spite of the move away from "science-pushed" models of innovation, a commitment to investing in scientific and technological capacity-building (in terms of both human capital accumulation and STI infrastructure provision) remains a

common factor in the success of those developing countries that have made faster progress in technology catch-up. In this regard, while North–South linkages and partnerships will continue to play an important role, the critical opportunity at hand is to move forward with South–South STI cooperation and partnerships. Policymakers' role in designating STI priorities and incentivizing such partnerships is important.

48. As STI activities are becoming an increasingly international endeavour, academia, R&D institutions and firms are moving towards higher levels of interaction and openness. This trend is buttressed by the increasing globalization and mobility of experts as well as finance. Governments are in competition in making their countries attractive for research and innovation activities, and this means developing and supporting partnerships among science, technology and development stakeholders, nationally and internationally, in order to develop a favourable STI environment.

49. The role of developing countries' universities and research institutions in global innovation networks is growing, however unevenly. The most notable examples come from the BRIC group of countries (Brazil, the Russian Federation, India and China) and from a number of medium-income developing countries (e.g. the China–India–United States Workshop on Science, Technology and Innovation Policy; or JELARE, the Joint European–Latin American Universities Renewable Energies Project). However, we can observe that many, if not most, LDCs have insufficient capacity and resources to generate knowledge, and are equally ill-equipped to adopt, adapt and diffuse existing technology and innovations.

1. Creating a critical mass of STI capacities

50. An important issue hindering STI and R&D activities in many developing countries is the lack of a critical mass of scientists and researchers. This is fundamental for the success of strategic STI-led development. The number of active scientists and researchers can have a strong positive effect on STI outcomes. Many researchers or several teams can assist in verifying the validity of a certain research or technological development path. Also, the open exchange of ideas among researchers with broad and varied experience can lead to effective solutions (or the avoidance of dead ends). A key example of critical mass is the development of so-called "open source" software technologies, where technologists forfeited intellectual property ownership in order to achieve a super-critical mass of collaborators, on a global scale.[13] In addition, policymakers who can appreciate the close relationship between STI and development policy are crucial to developing a long-term vision and commitment.

51. While policy can support and provide resources for STI activities, actual innovation outcomes are often unintentional and a result of serendipity and cross-fertilization of research between scientific and research areas and disciplines. Given the resource constraints in LDCs and low-income developing countries, one positive policy direction is the intensification of South–South cooperation. International cooperation can help achieve the required scale of STI activities. However, in LDCs, the weaknesses of the academic and research base, poor communications, and geography and language barriers, render LDCs less attractive as partners for STI activities.

[13] UNCTAD (2003). *E-Commerce and Development Report.*

2. International collaborations

52. It is of critical importance to link up and partner in collaborative STI activities. As international collaboration has a positive impact on the quality of science, and STI activities that are based on international cooperation are more widely recognized, the challenge is to kick-start an expansion of effective public–private cooperation, such as the example presented in box 6. Such efforts may require that both sectors reexamine their traditional roles in STI activities and move away from rigid roles that hinder the scope and level of technological change that is becoming pervasive in the global economy .

Box 6. Policy support for STI education cooperation: the case of UNIBRAL

UNIBRAL is an interesting example of an STI education policy being put into practice. Established in 2001, as a programme of cooperation between Brazilian and German universities, UNIBRAL has been supported by the Education Minister of the Federative Republic of Brazil and the German Federal Minister of Education and Research, and has been hosted by the German Academic Exchange Service (DAAD) and by Coordenação de Aperfeiçoamento de Pessoal de Nivel Superior (CAPES) as the partnering organizations.

UNIBRAL promotes exchange among German and Brazilian students, post-doctoral candidates and professors, and enables collaboration on courses, subjects or faculties in Brazil and Germany. The programme is open to departments of applied technology and to interdisciplinary study programmes. Student exchange programmes aim to integrate and combine courses and curriculums in a way that takes advantage of the strengths of the partnering universities. Work on course development and teaching and research visits at the partner university are encouraged.

3. The challenges of international competition for STI talent

53. A key challenge for educational institutions in developing countries is the increasingly competitive global education market. With a steady decrease in student interest in science and technology fields in developed countries,[14] developing countries may find it increasingly difficult to retain their best future STI leaders as universities from developed countries seek out local talent. In addition, international schools and universities establish affiliates and franchises in developing countries and deprive local institutions of their best students. In addition, innovation takes place within networks across national boundaries, therefore higher education institutions in developing countries need to be better prepared to participate in global innovation flows, building linkages with international players in academia and business.

[14] http://www.acer.edu.au/documents/RC2006_Fensham.pdf , http://www.oecd.org/dataoecd/16/30/36645825.pdf

54. Against this global trend, the range of STI human capacity available in developing countries varies considerably. While some developing countries are facing shortages in this area as students increasingly prefer to take up liberal arts (law, business, social studies etc.), other developing countries seem to be able to maintain good enrolment rates in science and technology fields of study. The drain in STI capacity has implications on gender and on achievement of one of Millennium Development Goals, as STI activities remain a male-dominated field. This consistently leads to wasted talent, sub-optimal development of STI capacities at a national level and, finally, a lack of innovation in solving problems that are highly relevant for women.

55. Given the strong financial, educational and career incentives for future STI graduates from developing countries to seek possibilities to study in developed-country institutions, it is not foreseeable that the gap between demand and supply for science and technology graduates, and the resulting brain drain issue, will disappear anytime soon. One potential compensatory solution may be to improve "brain circulation". This would involve improving linkages and participation of developing country institutions in global STI flows. A critical factor would necessarily be the establishment of strong linkages between academia and local industry – in particular firms with international operations and clients, together with successful STI leaders in diaspora.

VII. Conclusions and issues for discussion

56. Entrepreneurship is a great enabler, which can help level the playing field between developed and developing countries and regions. Embedding entrepreneurship in education and providing greater access are important steps for building an innovative culture and creating entrepreneurial individuals and organizations which, in turn, can create economic growth and jobs, and can help to improve quality of life around the world. Despite the tremendous growth in entrepreneurship education, many challenges remain. One of the predominant challenges is to change the culture and mindset in countries and regions in which business and entrepreneurship are either not viewed favourably and/or are not understood.

57. The low level of exposure to business and entrepreneurship, combined with the lack of role models, seems to be making the shift from necessity to opportunity entrepreneurship in many developing countries difficult. In today's financial environment, and for developing countries in particular, funding and compatibility with education, technology and innovation policies can be significant challenges. At the same time, there is no "one size fits all" solution for entrepreneurship education. The challenges and opportunities for entrepreneurship vary dramatically in different parts of the world, as well as for different segments of the educational journey. Local context must be taken into account in devising and tailoring a set of programmes and initiatives relevant for each area.

58. More effective measurement and evaluation of the long-term impact of entrepreneurship education programmes on economic growth and job creation is needed. These should be based on a broadly defined set of outcomes, not only on narrow measures such as the number of start-ups created. For comparable data across countries, there needs to be agreement on the definition of entrepreneurial education and on the scope of what should be measured, and agreement on the process of data collection and on coordinating mechanisms.

59. Reinforcing the role of STI in entrepreneurship education is only part of the task. Assessing students' learning habits and using real-world case references that are relevant to their immediate environment could help to improve the understanding and application of

any acquired knowledge. Academic learning may be complemented by practical training outside schools. Productive cooperation between schools and firms and their business associations, with the positive policy support of government, greatly enhances the potential for success in reinforcing STI in primary and secondary education curriculums.

60. STI human capacity development policy needs to fully embrace a lifelong learning philosophy. This is an imperative in today's fast-paced economy, which is subject to a swift rate of technological change and requires continuous foresight and enhancement of human capital. However, in order to develop a lifelong learning ability, investment is needed in the development of skills such as learning to learn, advanced literacy, mathematics and ICTs. This would not only require adapting curriculums, but also evolving teaching and learning skills so that they become self-sustaining even after formal education and training.

61. Enabling legislation, and in particular incentives and other instruments that promote greater interaction and mobility between public and private academic and R&D institutions, and between those and the productive sectors, can help increase coherence between the activities of the education and research base and national development needs. Demand-driven education models can develop strategic collaboration between educators and employers to produce human capital that is relevant to growing sectors and trade opportunities. Private sector involvement should extend to funding joint/partnership activities promoting scientific and technology curriculums in education and training.

62. Government should play a leading role in developing reforms in STI education that need to feed back into curriculum development, including through the better use of information technologies. Educational institutions that adopt a systems approach to reforming their STI faculties should have priority in STI funding.

63. As scientific and R&D institutions in developing countries are facing growing competition from developed countries, policies aimed at improving linkages, both locally and globally, are needed to improve human capital retention. Interactions between universities, research centres and private sector firms can be supported by increasing the mobility of researchers and academics between universities and firms, and encouraging greater involvement by firms in the development of STI education strategies and planning for STI human capacity development.

64. Developing-country firms and entrepreneurs need to be aware that the ability to absorb technologies, and use to these to their competitive advantage, will determine their commercial success and mark their contribution to national economic development. Therefore, STI policy needs to review the effectiveness of incentives for acquiring scientific and technological knowledge. Access to technology and knowledge in the public domain or under public licence needs to be addressed as a singular issue.

Areas for further discussion:

(a) How can governments develop coherent and effective policies for entrepreneurship education? What is the role of the various ministries? How can other stakeholders be engaged?

(b) What changes are required in educational systems to provide students with the entrepreneurial skills needed for the future? Which are the priority action areas? How can policymakers facilitate these changes?

(c) What STI skills and competencies, and at what levels, are crucial for innovation-driven development, and how can policymakers ensure that education institutions respond to those needs?

(d) What combination of incentives is at play in developing a preference to engage in an STI educational programme at graduate and postgraduate level, so that a critical mass of STI skills can be developed?

(e) How can STI education requirements be related to the requirements of the national economy? How can policymakers enable educational institutions to better connect with the productive sectors?