DANISH
TECHNOLOGICAL
INSTITUTE

Policy and Business Analysis

Denmark – a Country of Solutions

Entrepreneurship and Innovation in Higher Education

For the Danish Ministry of Science, Innovation & Higher Education

September 2012

September 2012

Authors: Hanne Shapiro, John René Keller Lauritzen, Sisse Resen

Contact person: Hanne Shapiro, hsh@teknologisk.dk

Danish Technological Institute,
Centre for Policy and Business Analysis

Kongsvangs Allé 29

DK-8000 Aarhus C.

Denmark

Suggested citation

Shapiro Hanne; Lauritzen, John and Resen Sisse(2012) "Denmark a country of solutions - Entrepreneurship and Innovation in Higher Education"- contribution to the Danish Innovation Strategy- Denmark- A country of solutions, Danish Technological Institute for the Danish Ministry of Science, Innovation and Higher Education.

1 Introduction 1

2 Entrepreneurship and innovation in higher education 2

2.1 Introduction 2

2.2 The changing roles of higher education 2

3 International experiences 4

3.1 Broadening the definitions of entrepreneurship and innovation - EU 4

3.2 Emerging trends in entrepreneurship education outside the EU 8
3.2.1 China 9
3.2.2 USA 9

3.3 A changing landscape - managing complexity 15

4 Competences, entrepreneurship, and innovation 18

4.1 Innovation competences -What are they? 19

4.2 Summing up 22

5 Trends in entrepreneurship education 22

5.1 The changing learning environment 22

5.2 Developments in learning paradigms 23

5.3 Balancing technical expertise with leadership insight 25

5.4 Interdisciplinary learning 26

5.5 Challenge-based innovation 27

6 Building a culture of innovation 28

6.1 Community based innovation as a learning model 28

6.2 Increasing collaboration with external partners 29

6.3 Interdisciplinarity - ways of embracing challenge-based innovation 30

6.4 Integration of partnerships in the organisation of teaching and learning 31

7 Institutional Strategies 32

7.1 Strategies that promote entrepreneurship 32

7.2 Exploring the potential across the university 33
7.2.1 Country example - Ireland 33
7.2.2 Country example - USA 35
7.2.3 Country example - Finland 36

8 Summing up - and conclusions 37

8.1 A strategic framework for a higher education agenda 40
8.1.1 Policy framework 40
8.1.2 Institutional strategies 40
8.1.3 Project- and practice-based learning 41
8.1.4 Assessment 42
8.1.5 Monitoring of progress 42
8.1.6 Institutional competences and capacity 43

9 Annexes 44

9.1 Innovation competences 44

9.2 Entrepreneurship and innovation - a European agenda 46

9.3 Metrics and indicators of entrepreneurship: initial overview 48

9.4 Other measures 51

9.4.1 GEM (Global Entrepreneurship Model) 51

10 The Annual Population Survey (APS) 51

11 The National Expert Survey (NES) 51

12 Indicators across the logic model 51

12.1.1 OECD 53

12.1.2 What makes innovators different? 53

12.1.3 Institutional strategies 54

12.2 Interviewed organisations and companies **Fejl! Bogmærke er ikke defineret.**

13 Literature List 57

1 Introduction

Denmark as a country of solutions- an innovation agenda for the higher education sector

The Danish government has formulated an ambitious vision for how Denmark can become a hot- spot for innovation, building on the specific Danish innovation DNA. The strategy entails that Denmark becomes a country of solutions to great global challenges such as clean water or sustainable energy to kick-start enterprise start-up, job creation, and sustainable growth. The higher education sector can accelerate this change, and the 250,000 Danish students constitute a unique potential resource of innovation if more of them are given opportunities to gain authentic experiences with innovation during their studies. This report has been prepared as a contribution to the Danish innovation strategy for higher education. It builds on a global analysis of emerging next practices in higher education institutions.

The study first presents the overall rationale for why such a transformation process is an imperative, but also an opportunity for higher education institutions to rethink their strategies, practices, and partnerships for an entrepreneurial campus-wide transformation. Though there is a growing recognition that innovation in practice can be characterised as a collaborative learning process, the transformation of innovation to teaching and learning processes remains a challenge for many institutions. Challenge-based innovation often requires an interdisciplinary and collaborative effort, but many higher education studies are still presented in terms of disciplines and at best with a multi-disciplinary perspective.

Students may learn about innovation and entrepreneurship, or they can learn through innovation. Strong external partnerships can present a framework within which students can tackle complex challenges and develop new or improved artefacts for "the real world". Institutions such as the university of Aalto, the relatively new higher vocational centres of excellence on the Netherlands (CIVs), and MITs global sustainable energy initiative MITE in the USA are just a few examples of innovative institutional practices. Digital technologies and in particular open education resources can accelerate campus-wide transformation and partnership models strategies that Stanford, MIT, and Georgia Tech for example have pursued.

Strong institutional leadership is one part of the equation for developing an entrepreneurial institutional culture. The other part is the involvement of staff, student representatives and external stakeholders in formulating the vision, the implementation framework, and targets. Alumni constitute also in this context a rich resource that should not be forgotten. Among other crucial success factors are a culture and incentives that promote rich knowledge sharing, inter-faculty collaboration, experimentation, systematic piloting, and recognition that change does not occur overnight; and incentives and staff policies must be aligned with transformation targets.

Accountability cultures that do not allow for learning and fail to openly address challenges hamper an institutional innovation culture. This applies in particular to accreditation and monitoring frameworks. However, a monitoring framework is needed to track progress, to dynamically adjust efforts according to lessons learned, and to ensure inter-ministerial coherence in innovation efforts.

At a policy level a strong implementation framework supported by a task force with internal and external members can enable inter-institutional knowledge sharing, dissemination of the global emerging and rapidly growing knowledge base, development of grant schemes that are designed so they build on global evidence, and a systemic approach to change - in particular when other policy agendas emerge.

The international message is uniform and clear: an institution-wide innovation agenda for the higher education sector is a multi-level continued and complex effort; it requires commitment, but it is an effort that pays off for the students, for the society both in economic and welfare terms, and for the diversity of institutions that already have committed to a broader innovation agenda.

2 Entrepreneurship and innovation in higher education

2.1 Introduction

The Danish government has initiated a number of structural reforms to ensure sustainable growth, welfare, and competitiveness in the years to come.

As a small open economy, Denmark is crucially dependent upon companies being geared to changing patterns of international competition and cooperation, and the renowned Danish welfare model could not have developed without ongoing innovation efforts. The ability to understand emerging demands and fuzzy trends and creatively and efficiently translate these to new solutions is what innovation is about- and is also what learning is all about. The essence of higher education is expertise, but the context for deployment of expertise is fundamentally changing. Today, higher education institutions operate in a world fundamentally different from when higher education institutions first were established – and that poses the question of whether we need rethink assumptions about the purpose, processes and outcomes of higher education.

Complex challenges and emerging opportunities require the ability to situate and apply deep and comprehensive expertise to real life contexts. The government has therefore set ambitious education targets to raise the qualification levels of the Danish population. However, as a new major initiative of the OECD shows (Schleicher 2011), formal qualification levels can be a poor and incomplete proxy for the type of expertise needed in the society of today and tomorrow where entrepreneurial capacity increasingly is called for in all professions, whether school teaching, nursing, or engineering.

Complexity and change can be imposed upon an individual; or an individual can explore, exploit and impact change and benefit themselves and the wider society. This is the changing context of expertise, and shows why entrepreneurship education is now reconsidered as a much broader concept and as a key competence (OECD 2012).

This report is a contribution to the Danish innovation strategy in a connected world. The Danish higher education system is today highly internationalised. This report therefore draws on international lessons and practices and is written in English as the basis for an open approach to re-situating entrepreneurship education as an integrated feature of the Danish innovation strategy.

2.2 The changing roles of higher education

Entrepreneurial and innovative, knowledge-based economies driven by talent and creativity are increasingly seen as the pathway to sustainable growth. Innovation within nation-states is highlighted in both economic, education, and social policies as fundamental to regional, national and international sustainable competitiveness, as countries reposition and re-structure in response to the global financial crisis and to

wider societal challenges (Thorp & Goldstein)[1]. The OECD has even argued that advanced economies such as the Danish should not waste the opportunity for transformative change. Transformative change is also a matter of finding new growth models that build on sustainability.

In many ways Denmark has competitive advantages. Denmark is often at the very top of international innovation benchmarks. Both the public sector and the private sector have launched new services and products in recent years through user and employee driven forms of innovation and complementary to R&D-based models of innovation. Open and collaborative forms of innovation- between the public and the private sector and between companies - are increasing in importance in a Danish context, and social innovation is becoming part of the agenda for a renewed public sector. Innovation is enabled by talented and creative people. That situates higher education in the very core of a future-oriented innovation strategy for Denmark.

There are a number of trends that will likely impact future demands in quantitative and qualitative terms:

- Current and future graduates will increasingly be leaving higher education institutions to take jobs that may not exist yet. There is furthermore evidence that Danish students will compete internationally in a rapidly changing global job market – as the global talent pool is expanding (OECD 2012a).
- With the advance of the internet and WEB 2.0 technologies, start-up business in all parts of our economy have new opportunities for international market penetration, which some graduates have been quick to exploit. However, globally the proportion of graduates with a tertiary qualification is rapidly increasing – not least within science, technology and engineering. A business idea that was innovative some years ago is likely to be under much more international competition if it is not concurrently adapted and transformed (Shapiro & Divine).
- Advanced technologies, in particular automation technologies, are beginning to reshape labour markets for higher education graduates, both in the public and in the private sector. Automation software is increasing in terms of capacity so that it can undertake more advanced analytical work (Brown et al.).
- Traditional assumptions about growth are being re-examined in the context of a growing concern about global challenges pertaining to such issues as climate, energy consumption, water, health, welfare, and youth unemployment. Challenges may be seen as opportunities if Danish enterprises and the public sector in collaboration with research environments can find new and innovative ways to overcome the increased pressures on our natural resources and societal services.

Policy makers are therefore looking to higher education institutions to undertake a broader mission in society (Forskningspolitisk Råd, Gibbs & Hannon). Part of the debate about the future role of higher education is also concerned with what graduates should learn in order to be prepared for a more complex and rapidly changing future. Different stakeholder groups advocate a number of generic competences that students should acquire regardless choice of study and future career orientations. There is however little common understanding of the underlying skills, knowledge and competences that characterise an entrepreneurial minded individual, or what recent research has identified as the Innovators DNA (Dyer et al., Patterson et al.). That is, while there is a shared recognition that professional expertise must still characterise higher education, general and personal competences and capabilities are growing in importance regardless of future career. Among the general capabilities proposed as important, the capacities for being both innovative and creative are seen as fundamental.

[1] See also the agenda and discussions from World Economic Forum Davos 2012: http://www3.weforum.org/docs/AM12/WEF_AM12_ProgrammeWeb.pdf

3 International experiences

3.1 Broadening the definitions of entrepreneurship and innovation - EU

Entrepreneurship education has been addressed by a several initiatives at EU level, including:

- **The Oslo Agenda for Entrepreneurship Education in Europe** (2006)[2]: the Agenda provides concrete proposals which can be adapted by stakeholders in accordance with local contexts;
- **Reports and research** on entrepreneurship education: "Entrepreneurship In higher education, especially within non-business studies" (2008), and "Best procedure project on education and training for entrepreneurship" (2002) explore key issues regarding the teaching of entrepreneurship and identify best practices and solutions.

Moreover, the Commission**'s High Level Reflection Panels on Entrepreneurship Education**[3] brought together policy makers at European and national levels from both the education and the enterprise departments with a view to facilitating the exchange of best practices between Member States, EEA countries, and candidate countries. The work undertaken by the High Level Reflection Panels on Entrepreneurship Education has resulted in further studies and recommendations, as entrepreneurship education policies are practices are still patchy in nature in the EU and highly varied in quality. One of the issues raised is that policy frameworks tend to be very broad and without specific targets and indicators to track progress and as the basis for adjusting implementation frameworks.

In April 2011, a **High Level Symposium on Entrepreneurship Education** took place in Budapest.[4] This symposium was dedicated to entrepreneurship education in teacher education. Preliminary results of this study have been presented at the Symposium. The policy strategies and initiatives mentioned above also touched upon the issue of teacher education for entrepreneurship education. However, the European Commission also emphasises that the provision of specific education to teachers remains insufficient (DG Enterprise 2007). The need for increased support to teachers and educators in several key areas has also been outlined in the Oslo Agenda for Entrepreneurship Education in Europe, which recommends the following:

- To provide education opportunities to teachers and link this to the national curriculum reforms embedding entrepreneurship in curriculum;
- Adopt innovative methods to train teachers in entrepreneurship;
- Support the mobility of educators across Europe.

A report from the European Commission from March 2012 concludes that entrepreneurship in higher education has a positive, measurable impact on motivation for business start-up, on developing competences, knowledge and skills conducive to innovation, and on employability. The report recommends that entrepreneurship should be integrated in all higher education programmes, and that it is important that students acquire entrepreneurial competences through learning by doing (DG Enterprise 2012). This illustrates that the concepts of "entrepreneurship" and "innovation" in recent years have developed from simply referring to a number of specific skills

[2] http://ec.europa.eu/enterprise/policies/sme/documents/education-training-entrepreneurship/index_en.htm
[3] http://ec.europa.eu/enterprise/policies/sme/promoting-entrepreneurship/education-training-entrepreneurship/reflection-panels/
[4] High Level Symposium on Entrepreneurship Education – Teacher Education as a critical success factor, Budapest, 7 – 8 April 2011: http://ec.europa.eu/enterprise/policies/sme/promoting-entrepreneurship/education-training-entrepreneurship/teacher-education-entrepreneurship/index_en.htm

valuable only in a business context into being a much broader set of meta-competences that can be utilised in all organisations and facets of life. A number of specific trends have spurred this.

In a European policy context entrepreneurship is part of the key competences that all individuals should acquire through education and lifelong learning[5]. This development is aligned with global tendencies as expressed by the World Economic Forum (2009): "*We are defining (entrepreneurship) in the broadest terms and in all forms – entrepreneurial people in large companies, in the public sector, in academia and, of course, those who launch and grow new companies*", and by the Kaufman Foundation (2007) , USA: "*Though entrepreneurship can involve […] invention, creativity, management, starting a small business, or becoming self-employed, it is neither identical with nor reducible to any of them."*

One of the challenges in Europe is that many micro enterprises close when there is no successor. Entrepreneurship is not only a matter of starting a new enterprise. It also concerns contributing to innovation in existing enterprises in the private and public sector, and it also concerns successfully taking over and driving growth through innovation in micro companies, as the case below illustrates.

The **Lahti University of Applied Sciences** (Finland) created a programme called "Business Succession School" linking students with business owners who are looking for a successor. This is a training programme for universities of applied sciences, providing students with the skills to plan and run a controlled transmission of the enterprise so that they will be able to continue the profitable business and ensure business regeneration. This practice — piloted in the Lahti University of Applied Sciences — is being extended to ten other universities of applied sciences in Finland.

Innovation is not just a question of business creation and economic growth. More recently there has been a growing policy interest in innovation within the public sector, and in particularly the UK and the USA a range of new business are emerging which build their business model on social value creation whilst also contributing to employment creation. A growing number of higher education institutions are developing social innovation programmes.

The Higher Education Social Entrepreneurship (HE SE) Awards (UK) was launched in 2009, and ran over an 18 month period until June 2011. Of the initial investment of £1 million, £625,000 was awarded directly to social entrepreneurs through financial awards. Awards were aimed at staff and students in higher education institutions in the UK who have an entrepreneurial solution to a social problem. Apart from start-up financial support, award winners were offered one-to-one coaching from an UnLtd Development Manager, tailored to project and skills development needs. They also got access to a network of experienced business professionals from all sectors, who volunteer to provide direct one-to one mentoring and specialist services such as legal advice.
Unlocking the potential of social entrepreneurship in higher education[1]

A study from Sweden from 2009 shows that entrepreneurship is offered in the broader context of innovation in around 20 programmes and 40 courses. At an advanced level there are just a few courses and programs. Innovation based programmes are offered from institutions such as the university College in Gävle, Karlstad University, Mälardalen's University College, and at the tertiary vocational colleges. Innovation components are found in arts programmes, music, dance, and film, in engineering programmes linked to product design, and in health across the entire higher education sector. Blekinge Technical College was at the time planning a new course for researchers in innovation methodologies. New master's programmes were also in the planning stage in interaction design and in product and service innovation. The College in *Dalarna* was planning a new course with focus on innovation in health care and in cultural tourism.
Hôgskoleverket 2009

[5] http://www.creative-city-challenge.net/sv/events/518-european-creativity-and-innovation-day.html

It is increasingly recognised that innovation and entrepreneurship cut across sectoral, industrial and professional boundaries, because innovation often depends upon collaborative processes. The innovation potential in one sector, industry or profession may well depend on the capacity and innovation attitudes in other sectors. A representative of a large Danish company states: "*The education institutions should not just aim to promote innovation in companies. It is too narrow. We also need an innovative public sector - an innovative society as a whole. They are interlinked".*

Nursing – Arizona State University, U.S.
The College of Nursing and Healthcare Innovation at Arizona State University has teamed up with the College of Design and Hugh Downs School of Human Communications to create a programme where students from very different strands come together to find new ways to problem solving and innovation in healthcare. The programme accepts both nursing and non-nursing students, who participate in an intense programme where learning is team-based and practice-oriented and where healthcare is approached from different angles, hereunder business, technology, leadership and system design.

Innovative and entrepreneurial capability is a product of skills, knowledge and attitude, all within a context. Skills often mentioned as important are creativity, adaptability, networking, and result orientation. Knowledge is both a matter of deep discipline based, and increasingly- interdisciplinary knowledge that can be applied for practical purposes.

In 2012 a survey was initiated by the European SPACE network's Entrepreneurship Committee and within the EU-funded project House of Entrepreneurs, in order to 'take the temperature' of entrepreneurship education in 280 higher education institutions in the EU (European House of Entrepreneurship).

Most of the institutions that responded offered short-cycle, medium-cycle and long-cycle higher education across several disciplines. The survey shows that among the responding HEs, 91% offer curricular or extra-curricular activities focusing on the development of entrepreneurial behaviour, skills and mindsets. About half of the respondents offer courses that can be credited to students' degrees regardless of which faculty/discipline they are connected to.

Main extracurricular activities offered are seminars/workshops (55%), business plan/venture capital competitions (53%) and company visits (53%).

The EU survey reveals that most of the institutions (55%) have a rich exchange of curriculum and teaching methods between HEIs, but fewer have formalised exchanges of good practice. Of those that have some sort of formalised exchange, the majority import good practice on a national level. About one third get inspiration from abroad in a formalised way. It seems to be a clear tendency that the longer the institutional experience with entrepreneurial education, the more formalised the exchange of experience.

Most of the institutions that responded have specific goals for entrepreneurship. The most common goals are "to inspire students toward seeking an entrepreneurial career or life" (81%) and "to foster entrepreneurial behaviours, skills and mindsets" (71%). An interesting fact is that 48% of the institutions want "to embed awareness of entrepreneurship through all the curricula provision". This means that entrepreneurship should be present in all programmes according to the respondents, not only in specially designed courses. This was also concluded by the European Commission in its impact analysis from 2012.

UK
The introduction of successive rounds of government funding for universities significantly impacted institutional behaviour and new developments in supporting enterprise and entrepreneurship in a broader definition, including curricula innovation. The UK landscape has changed immensely and there has been huge growth in supply, in engagement and in demand. Now the significant majority of higher education institutions in the UK (estimated around 80-90 90%) are engaged in the provision of different forms of entrepreneurship education to their students, though at times only as extra-curricular activities.

Several European studies have been undertaken about different aspects of entrepreneurship education, framed by a broadening focus on innovation. Entrepreneurship in higher education should contribute to all students developing entrepreneurial mindsets regardless of programme choice and qualification levels (Hofer et al.). Different initiatives to stimulate interest have been implemented across the EU based on different underlying models such as the French and the UK cases below show:

UK- linking entrepreneurial students and SMEs
Enternships.com provides an online platform to match students and graduates looking for work placements with SMEs looking for entrepreneurial interns or 'enterns'. Since formally launching in 2009, more than 4,000 companies in over 20 countries have used Enternships to find graduate talent, including companies like Groupon, PayPal and well-known business figures like James Caan and Peter Jones of Dragons Den and Martha Lane Fox of LastMinute.com.
http://www.enternships.com/en/site/about

The Observatory of Pedagogical Practices in Entrepreneurship, Observatoire des Pratiques Pédagogiques en Entrepreneuriat (OPPE), functions as resource centre for professors, educators, higher education institutions and entrepreneurship support structures. Its main goal is to promote and enhance an entrepreneurial spirit within the education system. OPPE is an information data base on entrepreneurship education in secondary and higher education that facilitates development of and learning from good practice in teaching methods, contents and pedagogical tools. OPPE was founded in 2001 by the French ministries of research, education, economy, industry and SMEs and a broad range of stakeholders including the French external corporate venturing association, and higher education institutions. The annual budget is approximately EUR 150,000; two full-time staff are involved. Working groups exist in various fields and benefit from the contribution of numerous professionals. OPPE provides on-line information on around 300 entrepreneurs, on around 300 entrepreneurship education initiatives in higher education, on more than 100 entrepreneurship education actions in secondary education, and on 30 initiatives that involve secondary and tertiary education institutions. Also, more than 30 on-line pedagogical tools are downloadable. On a yearly basis, OPPE organises conferences to generate and develop new pedagogical ideas and to facilitate networking amongst professors, educators and other stakeholders.
Observatoire de pratiques Pedagogigues en Entrepreneuriat

Though a number of institutions in the EU have adopted new pedagogical approaches to accommodate for a wider approach to entrepreneurship (Technopolis), there tends to be a gap between the underlying theories and models of innovation and how it is translated into organisational and pedagogical practices (Blenker et al., Shapiro & Lauritzen). The issue of bringing to scale and mainstreaming in a systemic manner remains. If more students are to acquire entrepreneurial mindsets, then experience-based, interdisciplinary, and problem based teaching and learning models are crucial, as it will be discussed in some of the following chapters.

The Swedish short cycle higher education programmes – *kvalificerat yrkesutbildning* - is an example of a country wide approach to driving regional innovation through another type of education design. The programs span a range of industries from hard core technological fields to music and creative industries. The programmes are developed in close partnership with regional industries and authorities within a national governance framework. It is also highly flexible in terms of the type of providers that can be accredited to offer the programmes.

Short cycle higher education degree programs for the Swedish paper cluster. In Karlstad, Sweden, the *Paper Province* coordinates and develops cooperation between participants in the pulp and paper technology business in Värmland, northern Dalsland and the county of Örebro in central Sweden. The cluster is one of Europe's largest clusters of competence in pulp, paper and packaging. Around 200 companies with approximately 12.000 employees are active in the sector. Karlstad Technology Center has been in operation since 2004. The college has gradually developed further education technicians and engineers programs and other services central to the innovation performance of the industry. The KY programmes are partially practice based. In the enterprise-based training periods, students work on real-life problems and challenges in industry to learn to apply inter-disciplinary methods in practice. Many KY programmes have embedded innovation and design in the curriculum.

Crossing boundaries between disciplines and collaboration with the external environment are essential elements in building enterprising abilities. Getting **real entrepreneurs** involved as part of the learning environment can make up for the current lack of practical experience among higher education teachers. One of the ways forward, which is seen in many US higher education institutions, is a closer collaboration with alumni, whether they are employed in companies with a central innovation function or are successful growth entrepreneurs. Alumni can also provide valuable contributions to development and revision of programmes. Alumni remain an underutilised resource in Denmark

A broader entrepreneurial framework requires commitment and appropriate teacher qualifications, which is also perceived as a key issue by interviewees, particularly if in order to bring to scale and mainstream practices (NESTA 2008). If teachers are to design programmes with more authentic opportunities for students to engage in challenge-based innovation, teachers need additional competences apart from subject matter expertise. Several interviews mention the lack of incentives for teachers who wish to engage in new approaches to entrepreneurship education (Kauffman Foundation). In this connection several institutional leaders and practitioners who have successfully kick-started and implemented a broad based entrepreneurial culture at their institution underline the need for allocating specific funding to experiment with new forms of interdisciplinary action- and challenge-based approaches to developing students' entrepreneurial mindsets (GHK). It is both a matter of rethinking budgets in support of institutional transformation and a matter of public programme funding or funding from foundations.

3.2 Emerging trends in entrepreneurship education outside the EU

Institutional transformation to an entrepreneurial culture requires experiementation. A high stake accountability culture where funding and promotion depend upon how institutions and individuals are ranked does not align well with an innovation culture. Quality assurance processes, and especially external quality assurance processes such as accreditations, are usually connected to demands for at times rigid accountability processes (European University Association). Several sources point out that it is difficult not to fall into the trap of "playing it safe", developing a zero fault culture and creating structures that hamper risk taking and experimentation.[6] Thus, institutions and agencies have to balance many factors of the way quality is approached on the one hand and institutional innovation culture on the other.

The debate on high stake testing and the criteria for accreditation is not new (Tepper). However, if higher education is to be transformed so that it genuinely provides a learning environment and a culture that foster innovation, then accreditation, moni-

[6] Interview with Proefssor Philip Brown, Cardiff University, co-author of *The Global Auction - The Broken Promises of Education, Jobs, and Incomes* (2010)

toring and exam forms have to be thoroughly addressed, as expressed by an expert in a European debate.

> If we want vibrancy, vitality and variety in our institutions, should we not take steps to ensure that our quality evaluation procedures match these aims? Should we not allow for a certain degree of chaos and interdisciplinarity to promote creativity and innovation?
> Dr. Andrée Sursock, *Accreditation and quality Culture*

The Annex includes a first proposal for an indicator framework, and also some examples of how self- assessment can be developed and used in a pedagogical context. Internationally a growing number of institutions are working on developing digitally based learning portfolios.

3.2.1 China

In China universities are looking into new ways to enhance student learning and research experience with a view to promoting entrepreneurship and innovation, particularly because the rapid growth of graduates with a tertiary qualification poses challenges in the labour market. Especially the elite universities are moving towards an interdisciplinary approach. Students are encouraged to take courses, even majors, in fields outside of the universities' strong areas, such as business management in engineering-oriented institutions. Partly as a result of the rapid growth in Chinese higher education, graduate placement has become a critical issue facing colleges and universities. In response, one of the policy initiatives adopted by the Chinese government is for higher education institutions to emphasise entrepreneurship education.

In 2002, the Ministry of Education launched a pilot programme on entrepreneurship education in nine prestigious higher education institutions in China. Since then, many colleges and universities have adopted this innovation in education. However as a whole, standardised exams as an admission mechanism continue to emphasise codified knowledge and overlook students' creativity. Once admitted, students have limited choice and autonomy in selecting courses and directions of research, apart from in the elite institutions. They have few opportunities to engage in joint research with outside institutions such as enterprises. Higher education curricula as a whole tends to be narrowly designed and delivered, rather than covering a broad range of knowledge, skills and competences linked to problem solving. A global conference organised jointly between UNESCO and the Chinese government in spring 2012 nevertheless suggests that the broader innovation agenda in particular is beginning to impact short cycle and medium cycle professional education in China.[7]

3.2.2 USA

Entrepreneurship education became a visible component in business schools in the early 1970s. The University of Southern California launched the first MBA in entrepreneurship in 1971, followed by the first undergraduate concentration in 1972. From there the field of entrepreneurship began to take root. By the early 1980s over 300 universities were offering courses in entrepreneurship and small business start-up, and by the 1990s that number had grown to 1,050 universities and colleges.

In the late 1980s the concepts of entrepreneurship education began to evolve with more emphasis on know-how and know-who, the latter being about the relational aspects of entrepreneurial processes. Today, a range of interdisciplinary programmes have been implemented designed for students of arts, health, engineering, and science. Whereas some programmes focus on business start-up and growth, entrepreneurship programmes have also become wider in scope in the USA with emphasis on how higher education can contribute to the development of knowledge, skills and competences conducive to an enterprising economy - or what in the USA has been called 21st century skills.

[7] Information gathered during conference

Babson College, located in Wellesley, Massachusetts, is recognised internationally for its entrepreneurial leadership in a changing global environment. Babson has over time adopted a challenge-based approach to entrepreneurship rather than teaching entrepreneurship as a discipline. That implies that undergraduate students work on real-life problems from day one. The multi-disciplinary pedagogical approach adopted for entrepreneurship builds on principles that entrepreneurship can be applied in a range of circumstances and situations other than new ventures, is a powerful societal change agent, and that it provides for the simultaneous consideration of social, economic, and environmental issues.

It is not just universities that contribute to innovation and entrepreneurship in the USA. The impact of community colleges on new business creation is enormous. It is estimated that the USA has 1,200 community colleges with a total student population that represents 46% of all US undergraduates (around 11.5 million community college students). They serve students seeking a 2-year degree, those who want to transfer to a 4-year programme, and those interested in vocationally-oriented programmes or 9-12 week non-credit courses like FastTrac, not to mention all the students who simply take spot courses to fill knowledge gaps.

An increasing number of community colleges are transforming programmes to drive a regional entrepreneurial economy, as community college leaders recognise their role in preparing students to be able to create jobs. Because of their ability to reach a large number of people, President Obama has been quite explicit about the role of community colleges as drivers of growth, and community colleges have become major partners in Start Up America8.

As part of their commitment to the Startup America Partnership, community colleges, through the American Association of Community Colleges (AACC), launched a pilot programme to establish a Virtual Incubation Network at 11 colleges in 11 states in collaboration with the National Association of Community College Entrepreneurship (NACCE) and the U.S. Small Business Administration. NACCE, as a founding affiliate of the Startup America Partnership, has also launched a President's for Entrepreneurship Forum programme9 to help leaders of 170 community colleges throughout the country to increase the focus on entrepreneurship at their institutions.10

[8] Start-Up America Initiative: http://www.s.co/
[9] http://www.nacce.com/?page=Commitments
[10] See for example Innovation and Job's Accelerator Challenge http://www.grants.gov/search/search.do?mode=VIEW&oppId=96013

Successful start-up - US Community College system
There are many examples of community college entrepreneurship education that go beyond classes for credit to hands-on experience and support for entrepreneurship. Lorain County Community College in northeastern Ohio has developed a model for entrepreneurship education and early-stage funding for startups. Lorain's on-campus incubator has advised more than 2,600 entrepreneurs and formally mentored over 100 companies through its Innovation Fund, a pre-seed fund that has awarded $5.6 million to 80 early-stage, technology-based companies. The LCCC effort is seen as so effective that the Kauffman Foundation awarded a $1 million Innovation Fund America grant to scale the model to more schools around the country and to build a national network to support them.
Edison Community College in Ohio, in turn, partners with the city´s small business development centre and offers to its students an entrepreneurship boot camp. Many small business development centres actually operate on community college campuses.

In addition to programmes and courses focused on preparing the future entrepreneur or intrapreneur, programmes are also beginning to target those who manage entrepreneurs in organisations; potential resource people (accountants, lawyers, managers in the creative industries). In the community college system there are a variety of programmes and courses. Some target small business owners specifically and start-up of small businesses, and a range of programmes and courses have been developed with focus on raising the creative and innovation content in products and services from crafts to the food industries, as a way to drive innovation in the economy (Sandeen & Hutchinson).

UCLA Extension
The Design Communication Arts Program at UCLA Extension recently developed two courses in the area of innovation: "Integrative Thinking" and "Your Idea as Innovative Solution." The courses challenge students to combine seemingly disparate elements in new ways, work with opposing ideas, carry out rapid prototyping through physical projects, and learn the process of "failing often" to move toward innovative solutions. These courses not only target design students, but are appropriate for students from all disciplines. Both courses aim to create students as "T-Shaped" people, described by Tom Kelley in *The Ten Faces of Innovation*. This type of person is not overly specialised, but has broad and empathetic skills across disciplines, as well as deep knowledge in specific areas (Breadth + Depth). Martin adds the idea of movement to this model to create an ability to move between deep and broad-based information in order to realise opportunities.

The sustainability agenda is another driver of innovation in the higher education system in the USA.

Haywood Community College (HCC) in Clyde, North Carolina, has built a Research Demonstration House on campus in cooperation the USDA Forest Products laboratory as a model of sustainable building practices, low impact development, and green building technology. The aim is for two year associate degree programmes to build on experiential learning in order to drive business start-up and innovation opportunities in existing industry through energy efficient technologies. The programme has a distinct community orientation in that it also covers aspects linking affordable housing with green build technologies. The college received the top ranking in North Carolina and placed 19th in the nation in the Waste Minimisation category in the RecycleMania 2010 competition. RecycleMania, a friendly competition and benchmarking tool for college and university recycling programmes, promotes waste reduction activities to their campus communities. The green campus focus is part of the institutional strategy to embed green innovation in all parts of the institution.

The third sector has always been a feature in the US economy. Social innovation has become prominent in higher education, as programmes and as a framework for offering students authentic learning opportunities – contributing to solving "wicked problems" or contributing to raising students' global social awareness. Georgia Tech is one example of an institution that has implemented entrepreneurial activities which specifically focus on social value creation through technological innovation.

Ideas To Serve (I2S) competition
The I2S is for current Georgia Tech students and recent alumni who have a very early stage product/service idea or venture concept that is focused on creating a better world. The I2S is a competition of ideas; where creativity, imagination, and technology are applied to:

- Solving community and social issues (for example reducing the effects of poverty, alleviating hunger, promoting physical and psychological health and wellness); and/or
- Sustaining our environment (for example improved water management, improved air and water quality, reduction of the rate of depletion of natural resources, developing alternate sources of energy).

These ideas should eventually lead to sustainable organisations that are able to generate sufficient income flows to provide returns for investors (in case of for-profits) as well as to sustain over time the mission of the organisation (for both for-profits as well as non-profits). Simply put, organisations today need to be focused on the triple bottom line and be concerned with economic, social and environmental return on investment. In the I2S Competition, teams develop an idea/concept, an initial business model, and a feasibility analysis. The idea must be based on either an innovative approach/technology to solving a social problem or the use of technology to sustain the environment.

http://www.ile.gatech.edu/i2s/index.html

In recent years the Kaufmann Foundation has played an enabling role in transforming entrepreneurship education in many institutions and through collaborative initiatives, in order to present students with opportunities to learn in ways that emulate challenge-based innovation by being presented with problems that require a "novel solution under conditions of ambiguity and risk".[11]

The Kaufman Foundation has also for many years played a prominent role in promoting innovation in entrepreneurship education in the USA through studies and publications and by funding a number of transformative initiatives. One of these initiatives has a global scale:

Kaufman Global Scholars Program, USA
The Global Scholars Program is a recently launched six-month course for students who have just graduated from their ordinary college programmes. The students are carefully selected to study, exchange ideas, and work with entrepreneurial experts. Students meet and engage with leading scholars and thinkers, policy leaders, innovative researchers, and business founders. They learn from fellow aspiring entrepreneurs from other countries who likewise aim to build companies with global vision and global reach. They learn to think systematically about entrepreneurship and visit leading universities to exchange ideas with faculty, students, and those engaged in innovative, entrepreneurial work.
http://www.kauffman.org/entrepreneurship/kauffman-global-scholars-program.aspx

The health sector in the USA has been under increasing innovation pressure, particularly due to rising costs. The National Council for Nursing is very active in innovation policies- also to promote nursing innovation career opportunities:

NCSBN Nursing
The National Council for State Board of Nursing have developed a tool kit to promote innovation in nursing education. In order to create an educational system that is responsive to a challenging and changing environment, we need to transform the culture within nursing education from one that is traditional, safe, and rooted in the past, to one that is innovative, audacious and guided by the future. Innovators take risks, make mistakes, and persevere. Perhaps, the first step in promoting innovative practices is giving permission for faculty to take risks and make mistakes. Faculty need to be the leaders in this process. Institutions should provide incentives and rewards for innovative teaching.

[11] https://www.ncsbn.org/1927.htm

Arizona State University is well known for its broad innovation agenda applied to all programs they offer- including nursing. The case below is just one example of how the University is approaching the innovation agenda for practice based professions, and also as a means to create attractive career pathways to a nursing career, according to the university.

Practice driven health care Innovation
Arizona State University is one of the institutions in the USA offering nursing education, and linked to its education activities is the Nursing and Healthcare Innovation Unit. It teamed up with the College of Design and the Hugh Downs School of Human Communications to offer a new professional programme aimed at creating innovators who can transform the way problem-solving and innovation occur in healthcare practice. Unlike traditional approaches to nursing, this programme teaches both nursing and non-nursing students to think beyond the status quo by encouraging them to approach systemic issues in healthcare from multiple perspectives involving users and deploying technology in the service design. Students participate in four-to-five day immersion sessions at the beginning of each semester, followed by two-day sessions mid-semester. The rest of the coursework is delivered over the Internet, using voiced-over lectures, discussion boards, and other online course delivery and management tools.
http://nursingandhealth.asu.edu/mhi

Rising costs of higher education combined with rising unemployment among higher education graduates and the financial crisis have provoked a major debate in the USA about how the USA can reposition higher education on the path to innovation and entrepreneurship. The recent Kaufmann publication (2012) *College 2.0: An Entrepreneurial Approach to Transforming Higher Education* challenges and showcases ambitious ideas for reinventing higher education, focused on making better use of technology, developing a culture of measurement and performance incentives, and creating smarter regulation:

College 2.0 Transforming Higher Education Recommendations

- **Tackle campus-level obstacles to innovation.**
  Faculty should be considered as enablers of innovation and provided incentives such as research funds to encourage development of innovative teaching models and relevant partnerships in support of this.
- **Rethink accreditation.**
  Accreditation should place the fewest possible restrictions on both new and existing providers to encourage innovation. It should focus much less on inputs and much more on outcome measures, such as student performance and loan default rates. Online learning should be largely deregulated as long as minimum course-level outcomes are specified.
- **Streamline state and federal regulations to improve outcomes.**
  States should relax existing rules to make it easier to start charter colleges, including community colleges. Like K-12 charter schools, charter colleges should be given great flexibility in exchange for improving student outcomes. Also, Pell grants for low-income students should be staggered, providing fewer dollars up front and more as students advance toward degree completion. Colleges' and universities' eligibility for enrolling students who receive federal loans should be tied to bringing down costs.
- **Improve incentives to boost academic productivity.**
  Universities should identify and financially incentivise those professors whose time would be more productively spent in the classroom rather than conducting and publishing scholarly research.
- **Fill information gaps about student-learning and job-market outcomes.**
  To provide prospective students - and taxpayers - better metrics to assess higher education institutions, all states should provide information on labour market outcomes by creating "unit record" data that link information on individual students' college experience to how they fare in the job market.
- **Overcome barriers to taking innovative models to scale.**
  Clear and accessible information about prices and student outcomes, both in the classroom and in the labour market, will introduce greater competition in the higher education sector, creating more opportunities for new entrants to introduce new models and take the most successful ones to scale.

The following cases give some examples of how challenges identified are addressed by specific institutions in the USA. It should be noticed how digital technologies for these institutions in combination with open education resources (OER) play a central role in promoting a more open collaborative culture, also to attract and service new learners in flexible and affordable ways. MIT, Stanford, Georgia Tech and other prestigious universities and consortia of community colleges are pursuing similar strategies.

Ways to lower institutional barriers to innovation: Olin College

1. Strategic institutional coalitions— such as Claremont Consortium, Five Colleges, Inc. to stimulate innovation from the creative tension between institutions with different cultures and approaches to innovation.
2. Co-opted accreditation processes—Rather than debate or battle with accreditation processes or organisations, develop partnerships that embed accreditation and the accreditors in the development and deployment of innovation. In other words, do not make after-the-fact conformance with existing criteria a limiting factor. Instead, partner with the agency to ensure that the innovation—no matter what its level of success—does not jeopardise the institution's ability to function. In fact, this approach may lead to more proactive and value-added accreditation functions.
3. Embedded experimentation—Make curricular and programmatic changes expected occurrences, encouraged and rewarded by the institution. Conversely, question the lack of the activity by individuals who avoid this aspect of institutional life. The responsibility for embedding experimentation lies with the leadership who should employ the three principles:

a. seek out new ideas and try new things,
b. do it on a scale where failure is survivable, and
c. seek out feedback and learn from your mistakes as you go along.

These principles imply three critical institutional characteristics— expectation of innovation, rational risk assessment, and enlightened management.

Developing an institutional learner-centred culture of innovation

The University of Minnesota Rochester (UMR) is the newest campus of the University of Minnesota. The University has developed a strong inter-disciplinary culture of innovation. An example is a BS in health sciences (BSHS), developed across several campuses and in close partnership with the Mayo Clinic. The BSHS is a four-year programme which admitted its first students in Fall 2009, and has grown to about 240 students. UMR has no departments. A single academic unit, the Center for Learning Innovation (CLI), houses all faculty and instructors who teach in the BSHS.

Faculty and instructors across disciplines in the CLI design, implement, and deliver an integrated curriculum that emphasises collaboration, communication, group work, and making connections across the curriculum. Classroom activities are built to engage students actively in constructing knowledge. Classroom technology facilitates collaboration and active engagement. Laptops provided to all undergraduate students at UMR give instant access to the curriculum inside and outside the classroom. A curriculum development system, iSEAL, facilitates faculty and instructor collaboration in the design, implementation, and delivery of the curriculum.

Data-driven research on learning: CLI faculty conduct data-driven research on learning. Research is translated into the classroom as part of continuing curriculum improvement. The curriculum development and assessment system, iSEAL, has been designed to collect student usage and assessment data in real time, which will yield extensive longitudinal data over the ensuing years. These data will serve as the foundation for the development of learning analytics at UMR to tackle the multidimensional and complex problem of student retention and achievement. Key factors in the ultimate success of UMR's model are faculty and staff who realise the potential of implementing a cohesive curriculum as opposed to a collection of independent courses.

Learner-centred innovation through ICT – Personalised Learning
Emerging technologies not only provide data to institutions that can enable learner-centered innovations. Part of the learner-centred model is also that students can see the data and consequently have the opportunity to become a more self-efficate learner.
What follows are examples of technologies that can improve student performance of students and create data that can help build better systems.

OLI, at Carnegie Mellon University brings together evidence-based research in learning, science, and technology to create web-based learning environments. All courses are online and free of charge. The courses are offered in student-centered learning environments and have measurable learning objectives and built-in tools to support students in achieving them. Each course contains small amounts of explanatory text and many activities that capitalise on the computer's capability to display digital images and simulations and promote interaction. Many of the courses also include virtual lab environments that encourage flexible and authentic exploration. The aspect of OLI that most expresses the precision education ethos is its embedded "mini-tutors." These intelligent tutors are computerised learning environments that provide context-specific assistance throughout the problem solving. OLI also includes instructor and student dashboards so that both can have real-time feedback on how and why learning is occurring. The "mini-tutor" generates robust data on how learning is actually happening across students, which can be used to improve individual performance and enhance course design.

Another example of personalisation in the process of course enrolment is provided by **Saddleback College**, in the South Orange County Community College District of California, which enrols nearly 40,000 students. Saddleback has developed software called **SHERPA**, or Service-Oriented Higher Education Recommendation Personalization Assistant. SHERPA works similarly to the recommendation services on Netflix and Amazon. Student preferences, schedules, and courses can be stored to create profiles that are responsive to student needs.

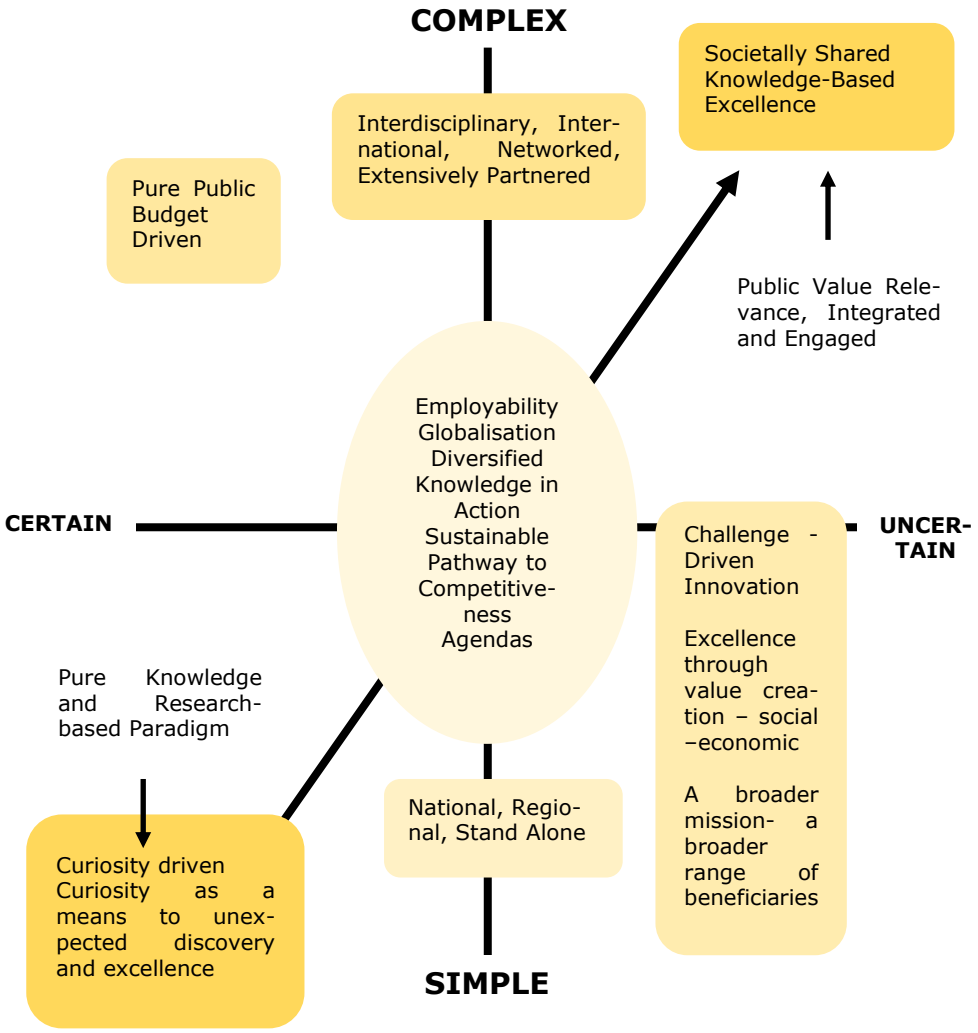
Building on SHERPA's course selection tools, **Purdue University** developed **Signals**, an early warning system for college course-taking success. The Signals software monitors students' behaviour patterns and academic performance to determine if they are at risk of earning a low grade, and allows faculty to intervene with suggestions on actions they can take to help students improve their grades. An intuitive stoplight dashboard provides indications to students on their course homepage if they are underperforming and prompts the students to take action.

The report about College 2.0 transformation from Kaufman Foundation with the case examples above was created as part of a Kauffman Foundation retreat in December that brought together a panel of 30 education analysts and practitioners to examine the challenges facing higher education and generate ideas to overcome them.

3.3 A changing landscape - managing complexity

The figure below illustrates how a more complex external environment characterised by rapid change and a high degree of uncertainty is beginning to shape a changing paradigm for higher education. The figure also illustrates some of the tension and choices that have to be made in higher education systems if innovation is to genuinely underpin a culture of innovation

A CHANGING HIGHER EDUCATION PARADIGM



Source: Adapted from Gibbs et al.

Several paradigms exist in entrepreneurship education (Nab, Jan; Lans, Thomas (2012)), one of the distinctions being between 'entrepreneurial' and 'enterprising' (Hannon, P.D. (2005)). Another distinction is the difference between learning *about* entrepreneurship versus learning *for* entrepreneurship (Honig, Benson (2004)).

The following briefly summarises the changing paradigms as discussed in recent literature (Nab, Jan; Lans, Thomas (2012)).

Entr epreneurship as subject matter: This involves theory about entrepreneurship that has its roots in economics, management or (personality) psychology. It may include personality theory, network theory and theory on opportunity identification. Entrepreneurship education in this model is taught particularly in business colleges and departments of economics, management and business schools. Case-based education, business competitions and simulations often form part of this educational model.

Developing an entrepreneurial mindset: This is increasingly connected to and embedded in a broader notion of innovation having an economic or a social purpose or both. The main aim is for graduates to develop an eye for opportunities, be proactive, creative and self-directed, and be able to thrive and innovate in environments increasingly associated with uncertainty and complexity. This conception of EE has also strong connection with modern views on work, employment and learning, and is

promoted in key policy documents on lifelong learning and innovation by the EU, The World Economic Forum, and the OECD. The challenge-based focus has implications on teaching and learning processes, which aim to offer students opportunities to work on real challenges that are complex in nature, and therefore often interdisciplinary. Some of the key arguments are that students immersed in authentic and challenge-based learning activities cultivate the kinds of "portable skills" that newcomers to any discipline have the most difficulty acquiring on their own:

- The judgment to distinguish reliable from unreliable information;
- The synthetic ability to recognise relevant patterns in unfamiliar contexts;
- The flexibility to work across disciplinary and cultural boundaries to generate innovative solutions to complex problems

As one enterprise frames it: "*Of course we need all of our employees to be able to think out of the box. But we also need the doers, those who can programme a particular software application. When it comes to incremental innovation, out experience is that our people automatically think about how they can continuously optimise functionality.*"

Entrepreneurship education is thus providing students opportunities to work with complex challenges or ideas in order to find innovative solutions, but it is also a matter of being able to improve ways of doing things. Examples of such activities are the development of business models, prototyping of products, or a service with external partners.

Aalto University in Finland offers a unique interdisciplinary learning environment that in many ways emulates how innovation processes occur in industry. The university has developed what are known as 'learning factories'. Learning factories are workshops designed to facilitate new forms of multidisciplinary collaboration focusing on teaching and learning through the production of artefacts in partnerships with external companies. The pedagogical philosophy is based on Aalto University's notion that higher education needs to educate what they call "T-shaped" people, i.e. high-level experts in their own specific fields who possess partial knowledge, skills and competences from other disciplines and are able to co-operate with experts from these disciplines.

Aalto University has introduced a programme of continuous professional education of the academic teaching staff and professors, mainly in the field of pedagogy to enable the staff to be able to deploy the new pedagogical principles in practice.

The dynamics in the knowledge triangle - that is, the linkages and dynamics between research, innovation and education - are being reconfigured as challenges in the external environment set new research agendas and as students become involved in these applied research and innovation projects, developing new artefacts and solutions in a particular market context or for a particular purposes (MacMahon et al.). The Dutch CIV (*Centres for Innovative Kaufmanschift*) offer short-cycle and medium-cycle professional education. They are typically organised in networks also involving enterprises. They operate in a model where students learn through applied development projects with enterprises.

The Netherlands has established several regional interdisciplinary centres of excellence that offer professional vocationally oriented education. The centres have been set up to promote sustainable competitiveness in the Dutch economy through technological excellence and open innovation. The centres have been developed based on identified economic strengths and through competitive bidding in areas such as water technology, food and green technologies, life sciences, transportation and mobility The close collaboration with enterprises offers opportunities for students to work on authentic tasks and development projects in an integrated learning environment.

The initiative targets students who wish to pursue a technical innovation career. The programmes and the learning environment emphasise deep technological expertise applied in different innovation contexts so that students acquire experiences with the different phases of an innovation process from the early prototyping phase to fine-tuning and adapting to different user and market contexts. The need for advanced innovative craftsmanship has driven the start of the CIVs with a strong involvement of industry reflected in the composition of the consortia. The notion of innovative craftsmanship relates technical knowledge and skills to the actual realisation, installation and maintenance of innovation applications (systemic thinking) in different user contexts.

Numerous lessons can be deduced from international emerging practices and from research on learning and innovation. Yet, the Danish higher education system has to embark on a transformation process which cannot just be replicated from international best and next practice.

Entrepreneurship has gradually gained a more prominent role in higher education in Denmark through a range of policy measures and institutional priorities, but it is far from an integrated feature in institutional strategies, programmes and practices. In the USA the Kaufman Foundation plays a strong role in promoting a broad based entrepreneurial focus in policies and institutional practices, and in keeping momentum in a critical and creative debate about a widening entrepreneurial agenda. In a Danish context it is worthwhile considering to which extent the Danish Foundation for Entrepreneurship through on a smaller scale could and should be repositioned to this widening agenda of challenge based innovation.

4 Competences, entrepreneurship, and innovation

Entrepreneurship education is transforming from its hitherto primary concentration on equipping a limited number of graduates for enterprise creation to practices which entail that all students acquire entrepreneurial skills, whether they wish to become an entrepreneur in the classical sense or hope to gain employment in the private or public sector as social innovators. Entrepreneurial knowledge, skills and competences are becoming synonymous with a person's ability to contribute to and participate in innovation.

The Oslo manual from the OECD defines innovation as "*a new significant improved product (good or service) or process, a new marketing method, or a new organisational method, business practices, workplace organisation or external relations.*"

4.1 Innovation competences -What are they?

Patterson (2005) argues that creativity and innovation are overlapping constructs, but that the main distinction is with regard to novelty and value creation. Creativity is exclusively concerned with generating new and entirely original ideas. Innovation is a broader concept, as it also encompasses the application of new ideas to produce something new and useful (in the context of groups, organisations, or societies). Innovation is often referred to as a process, because implementing new ideas necessarily involves influencing others (whereas creativity could be achieved in isolation). Further, an innovation is also a matter of novelty applied in a particular context, and it can therefore also be a re-combination of existing knowledge or technologies in novel ways.

Idea Lab - Aalborg Hospital
They have to be curious in the professional sense. They must pose questions. It is not good if you begin to perceive yourself as the expert. Attitudes are really important - the wish to make a positive difference. The most innovative doctor we ever had was originally a car mechanic. He invented the transportable heart-lung machine. He has this solution-based approach to things. Whenever he runs into a problem, however complex, his attitude is *there must be a solution*. He has this solution-based outside-the-box way of being.

A key feature of innovation capability is the ability to combine knowledge across fields – from science and technologies to art and design, "thinking outside the box". Knowledge and skills linked to collaborative processes are seen as crucial 21st century abilities, and that has implications on teaching and learning processes. Invention and innovation are not the same: invention is the first occurrence of an idea for a new product or process, while innovation is about implementation leading to recognised new gains.

The distinction implies that innovation is a complex process involving more actors and more sources of learning. Innovation can take place at any time in all parts of the economy – including the public sector and the voluntary sector, which in fact in recent years have led several international higher education institutions to broaden their entrepreneurial focus to also include programmes and courses on social innovation. This is worth considering if all students in Denmark are going to be offered opportunities to learn through practice-based innovation. A municipality or an NGO are potential partners for a higher education institution, on equal footing with private enterprises.

The skills needed for innovation tend to be contextual, and there are differences in approaches to innovation between and within sectors. Innovation competences will also differ depending upon whether they are in the context of a radical innovation leading to breakthrough new products and services (such as for example SKYPE) or if it they are deployed for incremental innovation purposes. The latter is in particular associated with organisational and services innovation.

Innovation processes are often networked, multidisciplinary and problem-oriented, setting even higher demands for competences. Complex and rapidly changing circumstances increase the demand for creative problem solving. Since most of the knowledge that companies use for innovation comes from outside, *'absorptive capacity'* – the ability to recognise the value of new, external information, to assimilate it, and to apply it – becomes key to performance.

The British organisation NESTA has initiated several studies on innovation and factors that influence innovation performance including knowledge, skills, and competences.

According to a literature review undertaken by NESTA, most research concludes that immersion in domain-specific knowledge is an essential prerequisite for innovation, as one must have an accurate sense of domain in order to contribute to innovation. Innovation on the other hand is based on the ability to combine previous disparate elements in novel ways, which suggests a balance between breadth and depth of knowledge.

Other competences seen as crucial are the ability to thrive with ambiguity, including an intrinsic motivation to deal with problems that are fuzzy in nature, the ability to cope with and handle disagreements, and the ability to collaborate and communicate across disciplines.

The exact definition of entrepreneurial competence remains difficult because of the changing notions of what entrepreneurship is, and furthermore because the broader definition tends to be associated with different forms of innovation which require different sets of competences. However, five areas of entrepreneurial competence are frequently described in different studies. These areas could be seen as the backbone of entrepreneurial competence:

1. ***Opportunity competence***. Entrepreneurship in its essence relates to the identification of opportunities. Opportunity competence is more than just opportunity recognition; it focuses on the systematic development of adequate solutions to complex problems, thus emphasising the ability to view a problem from a different perspective.
2. ***Social competence***. This refers to interactions with others. Networks play an essential role in the entrepreneurial process, fostering the collaborative generation and development of new ideas. This requires the ability to communicate across professional boundaries.
3. ***Strategic business competence***. This competence involves the organisation of different internal, external, human, physical, financial and technological resources as well as setting, evaluating and implementing the strategies of the enterprise. These competences are critical to driving employment growth in a start-up.
4. ***Industry-specific competence***. This involves domain-specific competence (know-how) and know-what. To be able to identify and exploit opportunities, entrepreneurs need knowledge of the market, of clients' needs, of resources and of competitors. Market knowledge is constructed by participating in the market and in networks.
5. ***Entrepreneurial self-efficacy***. This is a broad domain of meta-level competences: competences which influence other competences positively. This area comprises those constructs that have close conceptual links with more classical entrepreneurial psychological constructs. Recent meta-analyses show that entrepreneurial self-efficacy in particular is one of the strongest individual level predictors for entrepreneurial success.

More recently, researchers from Brigham Young University, INSEAD, and Harvard (Dyer et al.). have analysed the behaviours of successful entrepreneurs and have found that their success rests on what they call associative thinking. Associative thinking is based on the following skills, and the authors argue that these can be learned through practice.

- **Questioning** – Developing a question about a problem, company, or industry, and then working off that question to come up with new ways of solving it. *Example*: Peter Thiel and Max Levchin, founders of Pay-Pal, asked the question "How can we be money to other people?" This led to the idea of attaching money accounts to email, ultimately resulting in Pay-Pal.
- **Observing** – Going out and looking at different things: cultures, stores, people, and then finding a way to adapt what you see to your business. *Example*: Howard Schultz travelled to Italy, and fell in love with the atmosphere of romance and the pleasure of coffee shops, and brought it back to America to create Starbucks.
- **Networking** – Keeping in touch, finding newer, quicker, easier ways to communicate with associates and/or potential clients. *Example*: Mike Lazaridis, founder of Research in Motion, maker of the Blackberry, was intrigued at the fact that coke machines could communicate to head-quarters, telling them that they needed to be restocked. He took this idea and twisted it so that people could send information wirelessly through their mobile phones.
- **Experimenting** – Deconstructing and then rebuilding a product, a process, or an idea, whether it is yours or a competitor's, and then testing it in the marketplace. *Example*: Michael Dell took what he learned from taking apart computers and applied his knowledge to his future business, creating the Dell Direct Model.
- **Associative Thinking** – putting new ideas or products together to form one cohesive conglomerate. *Example*: Steve Jobs, after taking a calligraphy class, took that and applied it to computers, creating the great typography of the Macintosh computers[12, 13]

Harvard University is one of the US Universities that have taken steps to transform entrepreneurship within the emerging understandings of the characteristics of innovation processes. Challenge based innovation has become a central feature in one of the MBA programmes offered, which formerly included more traditional approaches to "real life activities".

[12] https://www.bluesteps.com/blog/5-Skills-of-Disruptive-Innovators.aspx
[13] For a wider discussion on skills for innovation in the Workforce see source list, Toner

Field Immersion Experiences for Leadership Development (FIELD), is a curricular innovation introduced by Harvard Business School in January 2011 as part of an MBA. It is a compulsory first-year course that spans a full academic year. The objective of the Global Immersion portion of the course is to increase students' global intelligence - an awareness of the variation in business processes and capabilities, customers, and the institutional environment across different markets. Students work with organisations and focus on a new product or service development project designed to help them study business opportunities primarily in emerging markets.
During the January global immersion, students travel to their immersion location; work in their teams to complete the design of a new product or service for their Global Partner; validate their proposal; and, share the final proposal in a formal presentation.
The academic goals of the course require that the new product or service project involve interaction with existing or potential customers. Projects focus on accessible consumer groups in the local market. The target for the project must be a tangible product or service. Students should be able to make suggestions without extensive background training (such as medical or engineering knowledge) and do so within the time given for the course. Students remain in the immersion location for the duration of the international project.
Project Examples from 2011-2012
Consumer Products (Brazil): What new differentiated luxury cinema experiences can be developed that are also economically viable?
Service (Vietnam): Your partner organisation seeks to create a product or service that encourages local residents in flood-prone areas to invest in preventative safety. In addition, the organisation would like to create a product or service that encourages homeowners to build a savings account for these same potential disasters.

4.2 Summing up

To sum up, there has been a gradual convergence of the nature and type of skills and attributes required of effective innovators. The ability to generate an idea that is innovative is not only the first essential step in the process of innovation, but it also requires the skills of imagination and creativity. Imagination means the ability to envision the development of the idea into the future. Creativity subsumes imagination and includes abilities to connect ideas, to tackle and solve problems, and curiosity. There is a consensus that creativity is a necessary condition of innovation. Creativity alone is not sufficient to foster innovation. The common denominator among innovators, entrepreneurs, and innovative entrepreneurs is the initial process of conceptualising an idea that may go on to be exploited either by the innovator or by others - and that requires other competences such as self-efficacy and collaboration. Increasingly, entrepreneurial processes are collective in nature in the sense that complex problems and challenges require multiple perspectives. As the recent study on disruptive innovation suggests this ability can to some extent be learned and strengthened with associative thinking being the key differentiating ability (Dyer et al.).

5 Trends in entrepreneurship education

The following sections provide an overview of how a broader concept of entrepreneurship in higher education can be supported through the design of the teaching and learning environments. The chapter builds on recent international research.

5.1 The changing learning environment

As the size and number of entrepreneurship education programmes has grown, the definition of "entrepreneurship" has transformed. In a paper from 2010 the World Economic Forum states, "When we speak about entrepreneurship, we are defining it in the broadest terms and in all forms – entrepreneurial people in large companies, in the public sector, in academia and, of course, those who launch and grow new companies." Entrepreneurship education therefore comprises quite different approaches and philosophies when it comes to the organisation of education and training processes in higher education.

The traditional view of the nature of academic disciplines as discrete and autonomous began with the development of universities in Europe. The earliest universities began with only four disciplines: medicine, philosophy, law, and theology. The Department of Physics at Oxford still retains the name "Department of Natural Philosophy" in recognition of this heritage. The "sciences" as they are known today did not exist, but increasing specialisation has resulted in new disciplines emerging and old disciplines growing in terms of the underlying knowledge base.

Traditionally, the role of education has been to give knowledge-based readiness, which later would be applied in practice to various innovation processes in working life. Innovation pedagogy frames how the development of students' innovation skills from the very beginning of their studies can become possible. The aim of innovation pedagogy may be for students to have real opportunities to create artefacts as part of the learning process; but more broadly, that students through the way the education is organised have genuine opportunities to develop an entrepreneurial mindset in the broadest sense (Kairisto-Mertanen, Kanerva-Lehto, Penttilä 2009).

The content and underlying pedagogy in the entrepreneurial curriculum vary substantially from being taught within a specific programme to being fully embedded in a programme. The goals below from the University of California, Berkeley are typical of many of the programmes.

- To recognise opportunity; know the problem worth solving.
- To know how to acquire resources.
- To be able to communicate (to customers, investors).
- To know how to work within and build global virtual teams.
- To be leaders in a global economy, not "commoditised contributors."

5.2 Developments in learning paradigms

Reviews of entrepreneurship education in the EU and in the USA show that there is a growing debate about how the broadening innovation agenda can be approached by higher education. As a whole, entrepreneurship is becoming a more prominent feature in a broader range of programmes. However, a recent comparative study on how higher education institutions in Europe and in the USA are approaching innovation in teaching and learning practices - including in transatlantic pilot projects - indicates that progress is slow when it comes to the transformation of teaching and learning processes conducive to innovation (Shapiro & Lauritzen).

Though teachers and professors from higher education institutions all recognised that students regardless of future career aspirations would benefit from a learning environment with richer opportunities to learn through authentic and challenge-based learning experiences, they found it difficult to see how they could go about this in practice. Learning researchers have distilled the essence of the authentic learning experience down to 10 design elements, providing educators with a useful reference framework that can be applied across different fields of study (Lombardy).

- **Real-world relevance**: Authentic activities match the real-world tasks of professionals in practice as nearly as possible. Learning rises to the level of authenticity when it asks students to work actively with abstract concepts, facts, and formulae inside a realistic— and highly social—context mimicking "the professional practice."
- **Ill-defined problem**: Challenges cannot be solved easily by the application of an existing algorithm; instead, authentic activities are relatively undefined and open to multiple interpretations, requiring students to pose questions, experiment, and see a problem from different perspectives.

- **Sustained investigation**: Problems cannot be solved in a matter of minutes or even hours. Instead, authentic activities comprise complex tasks to be in-

vestigated by students over a sustained period of time, requiring significant investment of time and intellectual resources.

- **Multiple sources and perspectives**: Learners are not given a list of resources. Authentic activities provide the opportunity for students to examine the task from a variety of theoretical and practical perspectives using a variety of resources, and require students to distinguish relevant from irrelevant information in the process.
- **Collaboration**: Success is not achievable by an individual learner working alone. Authentic activities make collaboration integral to the task, both within the course and in the real world.
- **Reflection (metacognition)**: Authentic activities enable learners to make choices and reflect on their learning, both individually and as a team or community.
- **Interdisciplinary perspective**: Relevance is not confined to a single domain or subject matter specialisation. Instead, authentic activities have consequences that extend beyond a particular discipline, encouraging students to adopt diverse roles and think in interdisciplinary terms.
- **Integrated assessment**: Assessment is not merely summative in authentic activities but is woven seamlessly into the major task in a manner that reflects real-world evaluation processes.
- **Polished products**: Conclusions are not merely exercises or substeps in preparation for something else. Authentic activities culminate in the creation of a whole product, valuable in its own right.
- **Multiple interpretations and outcomes**: Rather than yielding a single correct answer obtained by the application of rules and procedures, authentic activities allow for diverse interpretations and competing solutions.

The MIT case below provides a leading edge example of how challenge-based innovation in practice has been approached and integrated in the institutional strategy, in the teaching and learning environment and in partnering up with the external community.

The MIT Energy Initiative (MITEI) at Massachusetts Institute of Technology was established in September 2006. It is an institute-wide initiative designed to tackle global energy and climate challenges by transforming the global energy system to the needs of the future. From the outset the initiative was multi-disciplinary, involving all the departments and schools at MIT which span engineering, management, architecture & planning, and humanities & social science. The initiative has also aimed at that the campus environment should reflect MIT's commitment to sustainable energy practices as part of their brand. The aim of the MITEI is to function as a centre of learning offering an environment in which students work on technologically, socially, and politically challenging problems closely linked to MIT's energy research.

Many student groups on campus offer creative activities related to energy, including lectures and discussions, community service, extracurricular design projects, energy advocacy, and academic work. Clubs include graduate and undergraduate students.

One example of a student group is **Biodiesel@MIT**, which works to establish a campus biodiesel system, incorporating the collection of used vegetable oil (UVO) from dining locations, the processing of the UVO into certifiable biodiesel, and the usage of the biodiesel product in campus transportation. Biodiesel@MIT is also developing educational materials and seeks to be an information resource on biofuels to promote the greening of Boston.

Another example is the **MIT Global Energy Outreach**. Students have been offered the opportunity to design a classroom in rural Cambodia with natural lighting, no air conditioning, natural ventilation, no glass, and low noise level between classrooms. During the fall semester, students worked on analysing a building and designing a campus. During their January break, students travelled to Cambodia for 15 days to see how well their building plans would work on location and how a structure can be built from scratch. During the project, the 15 students in the class and their three instructors collaborated with a Cambodian architecture firm along with people from the local school. Because the school had to function in a very different climate from Boston and with the use of other materials, students were forced to think outside the box. The professors believe that the project offered cross-boundary learning as students also had to incorporate new kinds of design objectives.

MITEI also offers a range of shorter courses for professionals mirroring the multidisciplinary approach adopted as well as hard core technology courses.

5.3 Balancing technical expertise with leadership insight

The interdisciplinary and multidisciplinary focus poses is a new challenge for higher education institutions in terms of balancing the core curriculum with entrepreneurial components to ensure on one hand sufficient programme depth and on the other hand avoiding curriculum overcrowding. Programmes cannot simply replicate pedagogical approaches and material used business schools, because the professional context of innovation of different occupations has to be taken into account, including time limitations and how the notion of entrepreneurship is embedded and can transform different professional profiles and opportunities. UC Berkeley's Fung Institute of Engineering Leadership is one of the engineering environments that have aimed to strike this balance and teach the engineering leaders of the future.

Fung Institute of Engineering Leadership

The Fung Institute of Engineering Leadership at Berkeley University was created to set a new standard in engineering education. The new institute prepares engineers and scientists – from undergraduates to seasoned professionals – with the multidisciplinary leadership skills necessary to become leaders in industry, government, and the nonprofit sector. The Institute teaches leadership to engineering students via a format that aims to optimise students' learning in the more broadly focused technology leadership studies with the depth of study in an industry specialisation. This integration is designed to develop leaders who can make insightful decisions with the confidence that comes from a synthesised understanding of technological, marketplace, and operational implications in enterprises of all scales.

The Institute aimed to close the gap between engineering theory and business practice with an emphasis on experiential learning with a solution-oriented methodology that drives students to incorporate societal issues, business models, and political ramifications into their thinking. Another important component of the curriculum is teaching engineers (who often focus on removing risk in the design or production phases) to take calculated risk – a skill necessary to leadership.

5.4 Interdisciplinary learning

Particularly in technological fields such as engineering there is a growing debate about how education in practice can and should be designed to find a proper balance between the hard core of the field of study and the broader professional soft skills. For leading Danish enterprise Coloplast, innovation is critical to success. The company has become a global player due to its broad innovation strategy. Coloplast emphasises that complex problem solving skills are only of value when they are founded on deep professional expertise within a particular domain.

Coloplast has a very close cooperation with the higher education sector. Both undergraduate and graduate students are engaged in projects at Coloplast as part of their study. Coloplast would like to expand the collaboration further as it often has identified projects with big potential, but where it lacks resources. It is particularly in the early phases of product development that Coloplast engages students, to avoid any complications when it comes to the patent phase. Coloplast first and foremost emphasises that graduates who will be involved in product development must have deep engineering core competences pertaining to materials technology, as these are the foundation for product innovation in Coloplast. The company is aware that the soft side of innovation has become part of engineering curriculum, but from its point of view this must not be at the expense of the core of engineering.

A company such as Grundfos underlines that deep professional knowledge and skills are the critical foundations for innovation. Inter-disciplinarity is increasingly seen as a means to overcome the explosive growth of domain-specific knowledge on the one hand and the demand for softer skills among a growing number of employers (Bourn & Neal). Many terms, definitions, and interpretations confound interdisciplinarity.

One of the most frequent distinctions in the literature contrasts the term multidisciplinarity and interdisciplinarity. Typically it is argued that multidisciplinarity brings two or more disciplines to bear on a problem but fails to integrate disciplinary components into a seamless whole, thereby also easily leading to curriculum overcrowding, whereas interdisciplinarity is marked by a synthesis of disciplinary knowledge and methods to provide a more holistic understanding (Lattuca et al.).

An argument for interdisciplinary learning is that students get more opportunities for personal construction of knowledge, as the learning will draw on different disciplinary methods and underlying knowledge domains (Schommer), although interdisciplinary study may not equally serve all educational purposes. While knowledge structures are not exclusively interdisciplinary phenomena, the capacity to create meaningful connections across the knowledge domain is significantly facilitated by the introduction of an interdisciplinary perspective.

By focusing on an issue or core theme, interdisciplinary approaches encourage students to perceive the connections between seemingly unrelated domains, thereby facilitating a personalised process of organising knowledge. Critical thinking is another outcome of interdisciplinary programmes. If students are adept at thinking critically, then they are adept at collecting, analysing, synthesising, and assessing information, as well as identifying misinformation, disinformation, prejudice, and one-sided argumentation.

To a higher degree than traditional, single topic approaches, interdisciplinary learning fosters a problem-focused integration of information consistent with more complex knowledge structures. In addition to higher-order cognitive processing and critical thinking, interdisciplinary programmes facilitate students' metacognitive skills. Metacognitive strategies include connection of new information to previous knowledge, deliberate selection of thinking and problem-solving strategies, and

planning, monitoring, and evaluation of complex problem solving processes. Furthermore, emerging research findings suggest that innovations in teaching and learning processes with emphasis on integrative curriculum approaches not only are conducive to entrepreneurial behaviour, but also help students to cope with increasingly complex and multifaceted work environments.

However, international research on the design of interdisciplinary teaching and learning environments shows that the research field is still in an early phase of attempting to deepen the understanding of the nature of interdisciplinary higher education and its implication for practice. Some of the lessons that emerge from international reviews are the necessity to find the proper balance between disciplinarity and interdisciplinarity within each field of study, and that the institutional culture should positively promote interdisciplinarity.

One of the challenges facing the use of interdisciplinary education to promote innovations based on real life problems is that higher education institutions are not businesses, and that the purpose of developing real life problem-based education is first and foremost to improve learning outcomes with a view to expanding opportunities following graduation.

5.5 Challenge-based innovation

In an increasingly interconnected and globalised world, challenges also increasingly become a common concern. "Wicket problems" has come to denote complex problems such as global warming, terrorism, water allocation and health that require the perspective of different disciplines. The problems of the world today need more than a few discipline experts operating independently, and the entrepreneurial mind-set is increasingly seen as precondition to challenge-based innovation.

In 2007, the Chancellor for Health Affairs and CEO of Duke University Health System and the Board of Directors of Duke University Health System created an endowment to provide new funds to encourage Duke Graduate Medical Education (GME) Innovation. This fund allows programme directors, faculty and trainees to develop sustainable short-term initiatives to enhance Duke's learning environment and contribute to quality patient care. Funding is up to $100,000 per year for 1-3 year projects with the option to re-apply for an additional 3-year period. The intent is to provide sufficient seed money to fund innovative programmes/curricula/assessment/faculty development which ideally facilitates programme competitiveness to obtain additional resources (grants, foundations, donors). Proposals must include a clear plan for measuring educational impact and sustainability. Grantees must be willing to present findings, internally to Duke colleagues as well as in peer reviewed venues.
Many of the projects involve programme/department collaboration in addition to collaboration with the School of Business Health Sector, the GME Office, Hospital Administration, and other departments/entities within and outside of Duke. It is anticipated that with careful stewardship, money will be available for at least 10 years.
http://gme.duke.edu/innovation

6 Building a culture of innovation

The international move towards "being" entrepreneurial and acquiring entrepreneurial competences puts more emphasis on learning for and through entrepreneurial behaviour. This requires the use of active learning methods that enable students to take responsibility for learning and to experiment, push boundaries, and learn about themselves. Reflections and opportunities for "real life" feed-back are important, because without insight into their experiences students may not be able to draw lessons from their experiences. Students should have opportunities to undertake different roles, work on projects and tasks, work in teams, and be assessed accordingly. Critical experiences and failures have an influential role in entrepreneurial learning. Education becomes a means to develop future innovation agents in companies and in societies at large. This becomes an essential way for higher education institutions to fulfil a core mission of value creation.

In 2010 the Turku University of Applied Science began defining innovation competences with a comprehensive theoretical review. The work continued through workshops to gather further ideas embedded in the strategy of Turku University of Applied Sciences. Members from different faculties were involved in the process, which guaranteed that ideas from different fields of education were heard. Several seminars and a special innovation forum were organised where ideas were shared between students, local companies, and faculty members, and ways to implement innovation pedagogy were demonstrated. As a result of the development work in TUAS, three categories of innovation competences were defined: *Individual, communal and network scale* innovation competences. *Individual scale innovation competences* include independent thinking and decision-making; target-oriented and tenacious actions; creative problem-solving and development of working methods; and self-assessment and learning to learn. *Communal scale innovation competences* include the ability to co-operate in a diversified team or work community; the ability to take the initiative and to work responsibly according to the targets of the community; the ability to work in research and development projects by applying methods of different fields in an ethical manner. *Network scale innovation competences* include the ability to create and maintain working connections and work in multicultural environments.

6.1 Community based innovation as a learning model

International trends increasingly show that authentic elements of entrepreneurial reality are being introduced across different types of programmes. Löbler et al. (2006) advocate an authentic perspective that brings students in an entrepreneurial context where students learn through collaboration and by solving tasks that are characteristic for the profession. The campus environment becomes part of these broader and enriched learning opportunities in some cases.

Oklahoma State University- residence based learning
Oklahoma State University is a national leader in residence-based learning communities as a conduit for enhancing its students' social and intellectual growth. The Creativity, Innovation & Entrepreneurship Living and Learning Community (CIE) was launched at OSU in the fall of 2009. The focus of the CIE is for students to see themselves as agents of change in the arts and sciences, commercial activities, technology, and also in social engagements. The CIE accomplishes this by creating an environment for, and sustainable model of, student immersion in creative and entrepreneurial endeavors through collaborations, activities and channeling their entrepreneurial potential into all facets of their lives and the greater OSU community throughout each of OSU's Colleges and Schools.
"To be in CIE is to acknowledge that one does not need to simply accept that conventional ways to doing things are the best ways, and to understand that one learns through active engagement. "
Ref: Learning Community Oklahoma[1]

University of Sheffield
Live Projects is a core module for students in the fifth and sixth years of the Master of Architecture (MArch) course. A multi-level mix of home and international students work together in groups of ten during six weeks to complete a real community project. Live Projects were born out of a desire to open up opportunities for students to work with community groups out in the city and further afield while still being supported by the School of Architecture. The module has run over 100 projects, teaching students how to build relationships and how to test their hypothetical work on real projects.

Clients are often from the public sector or from non-profit organisations that otherwise wouldn't be able to afford to fund an architectural project. Students are encouraged to explore how people can effectively participate in the design and construction of the buildings that affect them. In the beginning of September, students are introduced to the clients and each project has a mentor who becomes a link between the school, the students and the client. The mentor is not there to solve problems for the students as it is important that the project is student-led. The mentor watches the project happen and gets students back on track if they go off on a tangent. When the Live Project finishes after six weeks, the students return to the design studios and their work, once again, becomes much more based in the school.

The University of Sheffield was very much the first in terms of this type of Live Projects. Other schools have set up similar modules since and there is now a network of Schools of Architecture that share ideas around the Live Projects.
The Live Projects and the way that MArch is run mean that students leave The University of Sheffield with an unusual blend of design skills. Being able to talk to clients, work collaboratively, develop briefs, and work with people in a real project, all help students to stand out.

Stockholm Konstfack
Master's in Experience Design at Stockholm Konstfack is a two year programme with focus on inter-disciplinary practice-based innovation. Students work on real-life topics and challenges. The programme is founded on principles that students learn by also implementing and scaling there solutions.
One example of a student project is a computer simulation to train doctors in the coordination of eye and hand movements. Other students have worked on the theme of End of Life Experiences involving dying patients, their relatives, and people working in hospice.
http://www.konstfack.se/en/Education/Masters-Degree-Program/

6.2 Increasing collaboration with external partners

The development of closer linkages between higher education institutions and external partners has implications on the teaching and learning environment. In the Netherlands and in Finland, educational models are evolving with blurring boundaries between the learning environment and applied research and development projects with external partners. These evolving models of co-creation offer students genuine opportunities to learn through inter-disciplinary cooperation – and by producing artefacts and services for a real life context.

High-tech Automotive Campus NL
The High Tech Automotive Campus is rooted in the historically strong automotive cluster of the South-East Netherlands. This cluster consists of global leaders in the automotive industry, including DAF, NXP and TomTom, as well as innovative SMEs. There is an extensive automotive knowledge base at universities, institutes and companies.
In 2002, the Dutch automotive sector entered a new phase of sector maturity. Before this period, companies and institutes operated fairly independently of each other. Since 2002, the players in the Dutch automotive sector have increasingly joined forces to tackle challenges and capture market opportunities that benefit individual players as well as the sector as a whole.
The High Tech Automotive Campus (HTACampus) in Helmond (Brainport region) is an integrated environment that demonstrates vocational excellence bringing together the industry and vocational education and training at different levels and applied research and training and test facilities. As such the Campus Model is also an innovative example of how co-location can stimulate open innovation with fluid boundaries between education, collaborative applied research, and entrepreneurship.
The leading international companies present include TNO Automotive, TTAI (TÜV Rheinland TNO Automotive International) and PDE Automotive. In addition, the educational institutions present on the campus – such as ROC and Fontys (higher vocational education) – make use of the facilities of the companies within the campus.
http://www.htacampus.com/

6.3 Interdisciplinarity - ways of embracing challenge-based innovation

The interdisciplinary approach to teaching and learning, described in section 5.5, focuses on the methodologies, interpretive tools, and language of several disciplines on a central problem, issue, or theme. As a consequence, students engaged in interdisciplinary programmes are more likely to acquire integrated perspectives and solution-focused strategies, rather than content-specific knowledge derived from a single discipline. In this way higher education becomes an innovation laboratory where promising approaches are modelled and tried out in real user contexts.

The interdisciplinary approach becomes the means for higher order learning. Students gradually acquire the underlying theories, methods, and language of different disciplines and effective ways of combining these and applying these appropriately to the challenge at hand. The institutions that have implemented interdisciplinary learning as a means to promote learning conducive to innovation and entrepreneurial mindsets argue that students this way acquire a more comprehensive and holistic approach to key topics, which results in learning that is transferable to different contexts. This is because the interdisciplinary approach when appropriately organised promotes the development of students' associative thinking - or what has also been called meta-cognitive maps.

InnovationSpace
When a group of students from Arizona State University interviewed female fire fighters, they discovered that most of the equipment and clothing fire fighters wear is typically too big for women and smaller-sized men. In response, they developed Aeroflex, a lightweight, streamlined, ergonomic backpack-oxygen system designed to be fully adjustable to fit men and women fire fighters of all sizes. These students are part of Arizona State's two-semester, trans-disciplinary InnovationSpace program co-taught by faculty from industrial design, visual and communications design, engineering- entrepreneurship, industrial engineering, and marketing. In this program, senior-level students work in teams to create unique, real-world, money-making products that contribute to a better society. In addition to preparing a comprehensive proposal, they also present their products to private sector groups and university researchers with the hopes that someday their products will be commercially available to those who need them most.
http://innovationspace.asu.edu

Together, these higher level learning outcomes contribute to a personalised integration and assimilation of knowledge transferable to other contexts, issues, or problems.

One of the concerns at times raised about broader innovation partnerships in higher education is ensuring that students' educational experience is well aligned with industry's objectives, while at the same time assuring that learning outcomes remain in focus. A clear understanding of how external partnerships can contribute to enriching the learning environment and the learning outcomes for students will in most cases need to be piloted, as for many higher education teachers this will require substantial changes from current practice.

"Providing a solid framework for industry-facing research is an important piece of this puzzle. The multidisciplinary projects allow us to cross-cut the deep vertical knowledge in specific disciplines with a shorter timescale. I think that the possibilities of interdisciplinary projects focused on real-world problems are very interesting, but again, we don't want our projects to become consulting projects. We don't want to say to every firm that is out in the world, come, and we'll do your research for you. On the other hand, we don't want to solve useless problems that have no business models attached to them, that have no way of going anywhere in the real world. We're caught between these two boundaries, and I don't have an answer for it, but I think this is the real issue for the discipline. When we solve it, I think we are going to get to a whole new level of how universities interact with the industry in very meaningful ways. And if we have the scale of the undergraduates and the masters and the Ph.D. population against these problems, and if we figure out how to do this right, we can have a huge impact in the world."
Ikhlaq Sidhu, Ph.D., CET Director, University of California, Berkeley, http://cet.berkeley.edu/dl/Global_Venture_Lab_Network_Summit_Brief_072710.pdf

6.4 Integration of partnerships in the organisation of teaching and learning

Higher education institutions can collaborate with external partners in many ways that have socio-economic benefits locally or in a global context and in ways that can provide rich learning experiences for students. Several higher education institutions have for example in the last couple of years developed distinct social innovation programmes such as INSEAD, and social innovation has become embedded in curriculum design and through broader partnerships.

Better Place, a provider of electric vehicle (EV) services, is building a network and services that make an electric car affordable to buy and use. Subscription packages will give drivers access to a network of charge spots, battery switch stations, and systems that optimise the driving experience and minimise environmental impact and cost. Better Place has worked extensively with universities on co-operative research toward analysing the challenges inherent to their business model. The research project started with several meetings between point people at Better Place and the directors at the Center for Entrepreneurship & Technology (CET) at the University of California, Berkeley.

Once the innovation challenges were defined, the Center recruited in the College of Engineering, the Haas Business School, the School of Information, the Goldman School of Public Policy, and key departments within the College of Letters & Science to compile a group of 9 graduate students. The students were split into teams and assigned the problems as part of their learning experience. Weekly work sessions were set up. Each week students presented their research in its initial phases and received input from the academic advisors and Better Place executives. Often, the students' work would generate more research questions. Over the course of that initial semester, the team developed three technical briefs, which were published on the Center's website and promoted widely. Better Place also received copies of the briefs to use as an aid in working with their constituencies. The students received a hands-on experience working with industry as well as research credit.

During the second semester, this model was scaled to become a regular course within the College of Engineering and Haas School of Business graduate curriculum. Thirty students from various disciplines within the College of Engineering and the Haas School of Business participated in the class. The result was six teams of students, answering six more research questions, resulting in six more papers. Teams presented the papers at Better Place at the end of the semester and had very rich discussions. The economic analysis report, in particular, turned out to be relevant to mainstream media as well as to green energy media. Anecdotal reports indicate that this economic analysis white paper was carried around quite a bit in Washington by policy-makers. Although the class format was a positive experience, the previous semester's research team format seemed better aligned with the project's goals, since the students were less concerned about grades and credits.
http://cet.berkeley.edu/dl/Global_Venture_Lab_Network_Summit_Brief_072710.pdf

7 Institutional Strategies

The new and broader mission for higher education institutions is set in a context framed by the notion of "global wicked problems" that require new approaches and forms of collaboration to enable innovation and sustainable growth. The transformation of higher education systems needs to be aligned and interacting with the external environment to become part of a wider eco-innovation system.[14] The focus on the external environment must not however lead to a situation where value debates are not taken openly between the higher education sector and the policy system - and internally in institutions.

[14] OECD Thematic Review of Tertiary Education
http://www.oecd.org/document/9/0,3746,en_2649_39263238_35564105_1_1_1_1,00.html

7.1 Strategies that promote entrepreneurship

Numerous studies have been undertaken about entrepreneurial higher education institutions.

One of the more recent studies was undertaken in Sweden comprising all programmes offered by the university colleges and the institutions that offer *kvalificerat yrkesutbildning* (KY), a tertiary vocationally oriented programme. The analysis found that the concept of entrepreneurship has gradually broadened as is the tendency in many other countries. Entrepreneurship is still most visible in programmes in commerce and trade. In health and social services entrepreneurship features are much less prominent than in other programme areas.[15]

A range of studies have been undertaken by governments to assess how entrepreneurship can be further integrated in education from early childhood to higher and further education. All studies point to teachers' competences as a critical success factor. In Norway a programme has been implemented with focus on the pedagogical aspects of entrepreneurship and innovation in compulsory and youth education.

Teacher Education – Pedagogical Entrepreneurship in Norway
The programme Pedagogical Entrepreneurship has been implemented with the aim that teachers can plan and organise teaching and learning processes that are conducive to creative and entrepreneurial competence development. The target group includes teachers in compulsory education and in youth education programmes. The programme has three modules and was developed in cooperation between the three university colleges in Bodø, Narvik and Nesna. During the project period 100 teachers, some from higher education, completed the programme. After the pilot period the programme has been implemented as an ordinary activity at the Bodø University College, which is renowned for its entrepreneurship activities, and at Nest University College.

See source list, Nordic Council of Ministers

Key factors found to facilitate entrepreneurial behaviour include: the levels of decentralisation of decision making and responsibility for strategies as well as operations; the associated flexibility in integrating strategies and action, and; the degree to which individuals bottom-up are encouraged to and rewarded for innovating. In larger institutions, heads of departments and faculties must therefore be prepared to support risk taking and share responsibility for that risk. Furthermore, reward systems such as the basis for promotion can hamper or facilitate an innovation culture. The level of support, operationally and strategically, also in terms of incentives available for cross-departmental and interdisciplinary education and other forms of cooperation, has a major impact on shaping the motivation and culture conducive to innovation.

7.2 Exploring the potential across the university

Leading edge higher education institutions internationally are expanding the notion of entrepreneurship as a whole–campus model and in the broader context of innovation. Some institutions have in this process created specific units, whereas others have taken a more bottom-up approach based on a gradual implementation. Based on international findings, there are in particular five key areas that emerge as being central to an institution-wide implementation of education practices conducive to innovation[16]:

- Creating a shared vision for what innovation is and could be in the particular institutional context;
- Strong leadership culture combined with incentives that promote an innovation culture among staff;

[15] Entrepreneurskap i yrkeshöskola utbildningarne och I kvalifucered yrkesutbildnbing (2010) Ky myndigheten. http://www.yhmyndigheten.se/vagledare/nyhetsrum/entreprenorskap/
[16] See also model in annex

- A culture that rewards experimentation, sharing of practices and cooperation across disciplines;
- Developing capacities to embed the delivery of these competencies contextually within the curriculum and pedagogy of different departments throughout the institutions. Some institutions have developed international training programmes, and many make use of interdisciplinary pilot initiatives to learn through practice. Others make use of international mobility programmes to learn from best practice. The UK NCEE has developed educator programmes designed to stimulate staff from any department in a university to develop entrepreneurial and innovation approaches to their curriculum and programme development.
- Building strong linkages nationally and internationally with other institutions, with alumni and the external community both enterprises and public institutions.

The following three sections provide recent examples of how a broader entrepreneurial agenda has been taken at a country policy level and at a strategic institutional level as a source of inspiration.

7.2.1 Country example - Ireland

Ireland is one of the countries in the EU that has implemented a number of initiatives to drive the transformation of the higher education sector in recent years based on bottom-up and top-down processes of innovation. Though enterprise start-up plays a prominent role in the strategy, also as a part of sustainable recovery from the financial crisis, the strategy in practice takes a broad perspective on entrepreneurship emphasising the need for all graduates regardless of future choice of career to be able to contribute to an innovative and entrepreneurial economy.

One of the initiatives was the Accelerating Campus Entrepreneurship (ACE) Initiative, which ran from 2008-2011. It was partially funded under the Strategic Innovation Fund by the Higher Education Authority (HEA) in Ireland and co-funded by the Partner Institutions: Dundalk Institute of Technology, Institute of Technology Sligo, Institute of Technology Blanchardstown, Cork Institute of Technology, and the National University of Ireland in Galway. The Accelerating Campus Entrepreneurship (ACE) Initiative explored how the Higher Education Institutions in Ireland (HEIs) could develop and deliver a framework with the aim of "Creating the Entrepreneurial Graduate" across disciplines. The ACE Initiative evolved from a growing perception that the traditional approaches to teaching entrepreneurship are not suited to the challenge of creating the entrepreneurial graduate for a number of reasons, including:

- Most entrepreneurship courses are underpinned by the 'business plan'. Growing evidence suggests that successful entrepreneurs depend more on their ability to be able to adjust flexibly to the marketplace and less on formal business planning.
- Traditional faculty structures and programmes are at odds with the cross-faculty approach required to support entrepreneurship.
- Entrepreneurial learning is acquired on a 'how-to' basis through the processes of 'doing', 'problem-solving', 'learning from others', 'making mistakes', 'risk-taking' and 'pursuing opportunities'; real-world and problem-based learning need to be incorporated into entrepreneurial education.
- The traditional pedagogical approach does not teach 'know-who', i.e. the management of relationships, nor does it give the student a sense of what it 'feels' like to be an entrepreneur.

The ACE Initiative was designed around four phases:

- **Research**: the research phase has helped to create a richer picture of entrepreneurship education in Ireland, with an emphasis on non-business disciplines. The aim has also been to learn through the study of national and international cases.
- **Development**: the development phase built upon the research findings to prepare and define the specifications and parameters for key pilot activities at each institute.
- **Implementation**: each institute implemented several innovative pilot activities in an identified non-business discipline, designed to enhance the pedagogy of entrepreneurship education using diverse tools such as real-life experience, peer-to-peer learning, multi-disciplinary collaborations, and formal links with technology transfer structures.
- **Evaluation**: the purpose was to enable the collaborative group of institutions and other national and international HEIs to learn from the ACE Initiative process, using criteria defined by best practice and literature.

More recently, the Irish government published the National Strategy for Higher Education to 2030 (also known as the Hunt Report). It recommends widespread reforms of the higher education system at all levels. The *National Strategy for Higher Education to 2030* highlights the central role to be played by HEIs in Ireland in nurturing creativity and entrepreneurship. The strategy frames a renewed and broader approach to entrepreneurship in higher education in Ireland at both programme level and in institutions.

Irish Higher Education Strategy 2030
Undergraduate curriculum needs to place more emphasis on generic skills, especially those required for the workplace and for active citizenship. Creativity and entrepreneurship must be encouraged to a much greater extent, and institutions should facilitate reflective learning, applied knowledge, practical laboratory experience, and scientific skills. Various surveys, nationally and internationally, show that students, academics and employers believe that higher education has an important role to play in preparing students for the workplace and for their role as citizens, and that undergraduate education should explicitly address the generic skills required for effective engagement in society and the workplace.

Policy support to the institutional transformation processes

The Higher Education and Training Council in Ireland has developed guidelines[17] for higher education institutions to support the transformation of education practices so as to enhance creativity and innovation in higher education strategies and practices.[18] Institutions can use the guidelines for self-assessment purposes or as a framework for new development initiatives. The guidelines were developed with the help of an advisory group composed of representatives from the Institutes of Technology (including Department of Industry and Trade), the university sector, the independent provider sector, an independent consultant on entrepreneurship, and an overseas expert, all working closely with the UK National Centre for Entrepreneurship in Education (NCEE, formerly the National Council for Graduate Entrepreneurship [NCGE]). The structure of the guidelines and key criteria introduces the context for the definitions of entrepreneur and enterprise education and provides a brief outline on the national and international developments in enterprise and entrepreneurship initiatives and strategies. The second half of the guidelines introduces criteria and self- evaluation tools.[19]

[17] Irish Higher Education and Training Awards Council (2012) Draft Guidelines and Key Crietria for the Review of Enterprise and Entrepreneurship Education . http://www.hetac.ie/publications_con.htm
[18] See also source list, NESTA 2008
[19] See also: Bengtsson Lars (2011) Vad är entreprenöriella universitet och ”best practice**”?** http://entreprenorskapsforum.se/wp-content/uploads/2011/12/ESF_EntreprenöriellaUniversitet-WEBB.pdf

Also the Swedish government has published their strategy for entrepreneurship and innovation in 2009, comprising the entire education sector[20]. The strategy is much less elaborated than the Irish strategy.

7.2.2 Country example - USA

The current cycle of strategic planning at North Carolina State University began with the arrival of its fourteenth chancellor in April 2010. He initiated the strategic planning process in July at a University Council retreat where participants identified critical issues. The provost and the chair of the faculty were charged with directing the strategic planning process with advice from an eleven-member steering committee.

The provost and the chair of the faculty formed nine task forces in the content areas of the critical issues, and charged them with developing white papers that recommended broad university strategies, specific initiatives, and metrics. Composed of faculty, staff, and students, the task forces were:

- Undergraduate Student Success
- Graduate and Postdoctoral Program Development
- Faculty Excellence
- Research and Scholarship
- Comprehensiveness and Interdisciplinarity
- Global Engagement and Competitiveness Partnerships, Innovation, and Entrepreneurship
- Campus Culture and Community
- Resource Strategies

The next step was to form a larger strategic planning committee with membership from the steering committee, the task force co-chairs, and trustee and alumni representatives. The chancellor's motto—Locally Responsive; Globally Engaged—provided a theme for a series of campus forums held by the Strategic Planning Committee on North Carolina State's strategic direction during the following fall and winter. Committee representatives also held conversations with the University Council, Board of Trustees, and Board of Visitors.

After the task forces completed their white papers, the papers were posted online and the campus community posted comments on the white papers, which were directed back to the strategic planning committee. This institutional strategic plan is informed by the white papers and feedback from the community on the work of the nine task forces. Examples of the goals that framed the strategy process at North Carolina State University can be found in the annex.

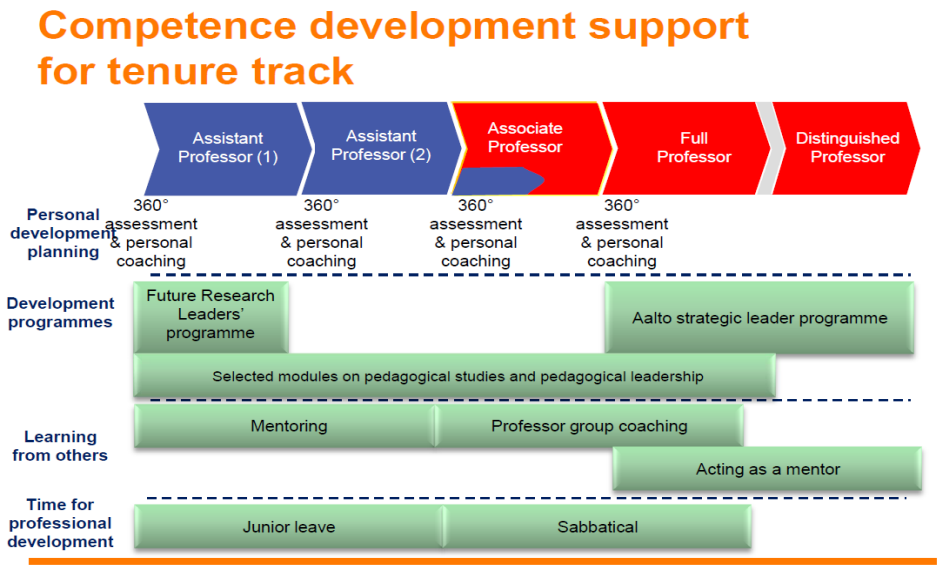
7.2.3 Country example - Finland

The motivation and competences of teachers to undertake these more challenging forms of education is pointed to as a key issue in interviews and in studies. Some institutions have set aside funds so that staff in practice through pilots and experimentations can find new ways of organising teaching and learning processes. The Aalto University in Finland, which has created a highly innovative interdisciplinary learning environment organised around learning factories (see section 3.3 above), has developed a very comprehensive career development framework depicted below as a source of inspiration.

[20] Strategi for entreprenørskap innnenom utbildningsområdet (2009) Rigskanseliethttp://www.regeringen.se/content/1/c6/12/69/09/22b6e680.pdf

Aalto University has introduced a programme of continuous professional education of the academic teaching staff and professors, mainly in the field of pedagogy to enable the staff to be able to deploy the new pedagogical principles in practice.

Moreover, the creation of the recruitment system and the tenure track for professors with focusing on both research and teaching is opening up for the new perception of the role of university teachers. The competence development support within the tenure track is illustrated below.



Source: Aalto University

The change of titles from lecturer to professor is not merely symbolic; it signals a change in the roles of university teachers from lecturers to active participants in collaborative interdisciplinary learning processes. Lecturing is still a valid tool in teaching according to the Vice President of Aalto. However, it is important to rethink this method and develop complementary ways of teaching such as the Design Factory methods.

Specific competences which are not embedded in specific academic disciplines or fields are needed to participate in interdisciplinary work. The staff at the Design Factory identified new competence requirements linked to challenge and problem based teaching. Two further education programmes have been developed for the continuous professional development of professors and associate professors:

1. *Forum* - designed for teachers that already have some pedagogical practice. This course consists of a monthly network activity meeting to discuss a specific topic in the area of learning.
2. *Opekumppani* – Pedagogical support for Aalto teachers. The programme offers the teachers at Aalto University theoretical and practical support to encourage continuous development of teaching practices. The programme includes:
    - The pedagogical knowledge base of a Master of Education
    - Additional work force and support in planning, executing and evaluating a teaching and learning session
    - Introduction to the Design Factory as an experimental platform of co-creation and of its teaching philosophy

The aim is for these teachers to become change agents as the programme provides them with better tools to kick-start change in their own environment and influence the learning approach within their specific field.

8 Summing up - and conclusions

Higher Education in Denmark has undergone a number of reforms in recent years. An increasing number of students undertake work- and practice-based learning and traineeships as a formal part of their education or as a supplement to the formal education programme. All enterprises interviewed highly welcome this collaboration. They see it as a source of recruitment and they generally find that students are motivated and have a lot to add.

In particular, high–tech firms are however also realistic about the type of innovation projects that students can be involved in as parts of their studies. When it comes to the launch of new products involving patents and in a highly competitive environment, students will only be involved in the very early phases of innovation.

Companies underline that students may have the tendency to understand innovation as creativity and the development of break-through products and services, and wish to be part of that. Some companies also report that they try to stress that the bulk of innovation efforts is related to constantly improving products, processes and relations to markets and customers, which cannot be done without very solid and deep professional core competences.

Some companies in high- tech fields are concerned that the policy focus on innovation could as a consequence lead to students not acquiring a sufficiently deep professional base of competences. As stated in an interview, "*you cannot identify innovation opportunities just by being creative and being a good communicator and process facilitator*". Interviews show that the knowledge triangle - the dynamics between education, research and innovation - is changing in many ways.

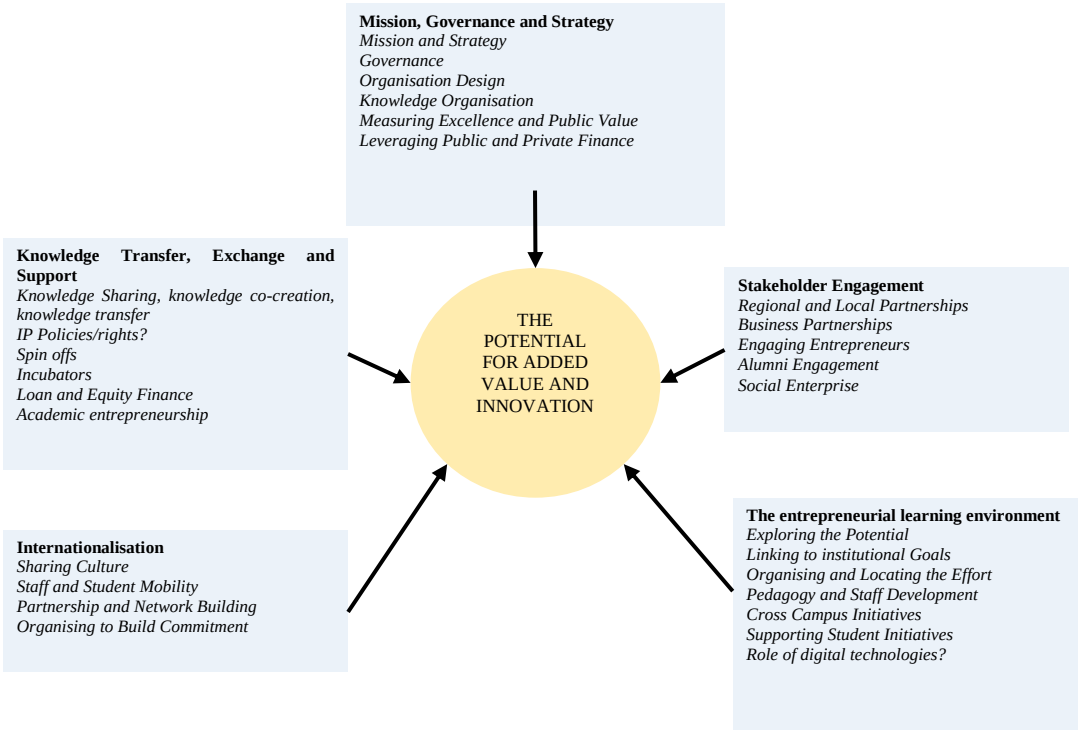
Entrepreneurial teaching and learning processes in forefront institutions increasingly imply that students are involved in applied research projects with external partners and with a view to creating new artefacts and services. Students do not just absorb disciplinary knowledge with a view to applying it later; they become co-creators in collaborative innovation processes. Interviews with institutions that apply such practices show that student involvement is beneficial to everyone engaged.

Day-to-day innovation has become an imperative for both the private and the public sector. Still, innovation performance is uneven. Students can bring new insights and will often as part of a learning process pose questions regarding existing practices. As such, the 250,000 Danish students represent a real potential innovation accelerator that can strengthen and expand collaboration between higher education institutions and the private and the public sector and NGOs.

As several company interviews indicate, one of the growing challenges is to juggle break-through and radical innovation efforts in a company together with the majority of innovation efforts which target maintaining a competitive edge through incremental innovation. The complexity of innovation processes and the fact that innovation often builds on a knowledge base from different disciplines makes it difficult to emulate innovation in a formal education context without a praxis component.

This is why an innovation agenda is a must for the Danish higher education sector:

- To speed up the time from which new knowledge is generated and how knowledge is generated and turned into innovations of economic and social value;
- To encourage more enterprises through collaboration with higher education institutions to find new ways to working with "wicked and challenging problems" and turning these into opportunities;
- To improve employability and transition rates to the labour market for higher education graduates;
- To encourage more students to become acquainted with entrepreneurial processes and through that become motivated to start their own business at some point;
- To encourage even wider public-private innovative partnerships on innovation;
- To transform teaching and learning processes in higher education so that students are better prepared to participate in and contribute to innovation regardless of their employment destination;
- To encourage more SMEs to work systematically with innovation through an improved competence base and partnerships;
- To encourage more higher education institutions to see an entrepreneurial culture as the core of their strategy and value proposition.



Source: Gibb (2012)

8.1 A strategic framework for a higher education agenda

The transformation of institutional strategies and practices in order to promote education and training conducive to innovation can take many different avenues, as illustrated and discussed in the previous pages. There is no one size and shape that will fit all. A strong institutional commitment will need to build on a number of strategic decisions. One such decision is that of *organisation design*, namely the degree to which ownership and practice of concept and delivery should be embedded in individual departments, and what the role should be of any central support group, as many institutions have decided to create such a central unit - some with success and some without. The framework as shown above can therefore be used to assess key aspects of the strategy for a higher education institution.

The model above provides a framework for how institutions can explore how a broader concept of entrepreneurship can contribute to wider strategic goals of enhancing innovation, strengthening and building stakeholder relationships, and enhancing student employability. Institutional transformation does not happen overnight – a coherent strategy, the level of staff involvement, and how the transformation process in practice will be addressed will vary from institution to institution.

Lessons from international leading edge institutions point to staff involvement and engagement as critical to an-all-of – campus approach to entrepreneurship and within the wider context of innovation. Interviews with institution representatives and stakeholders furthermore underline that an entrepreneurial institutional culture is unlikely to emerge from a blueprint strategy if not invigorated by bottom-up approaches to institutional innovation.

In a Danish context a comprehensive innovation strategy for higher education should consider these following key issues:

8.1.1 Policy framework

There must be a clearly communicated vision and rationale for the higher education innovation strategy with a clear indication of a time framework and the type of support mechanisms and possible funding and incentive measures to drive the transformation. A ministerial task force with internal and external appointed members can ensure focus on the implementation and transformation agenda and enable knowledge sharing, collection of global emerging practice, and alignment of public funding with the wider agenda.

A coherent monitoring framework needs to be in place to support institutional prioritisation processes and to track outcome and impact over time.[21] Many country efforts suffer from weak implementation frameworks. To build institutional commitment and a joint vision, the government should consider some form of involving consultation process that could kick-start the agenda.

8.1.2 Institutional strategies

A strong visible and committed leadership must explicitly demonstrate the institutional commitment to a campus–wide entrepreneurial and innovation culture. This implies:

- A shared and integrated institutional vision and framework for entrepreneurship and innovation with clear goals, targets, and division of responsibilities;

[21] A draft monitoring framework is included in the annex.

- A strong vision that clearly articulates why an entrepreneurial and innovation culture is crucial to repositioning the role of higher education in the economy of the future;
- Faculty-level recognition in career development and promotion, resource allocations, rewards and incentive systems, and recruitment policies - otherwise the message about the necessity of an innovation culture will not be taken seriously;
- Knowledge sharing, learning from trial and error, and learning from national and international best practice;
- Institutional targets, timelines, and monitoring arrangements to promote institution-wide learning and progress;
- Strong bottom-up involvement of internal and external stakeholders such as staff and students, community representatives, enterprise partners.

The approach will vary from institution to institution according to size, programmes offered, international institutional capacity, prior experiences, and current partnerships. Lessons show that the most successful transformation strategies are enabled by a strong bottom-up involvement and initiative, knowledge sharing and learning from emerging best practice, and incentives to try out and share new practices. Some institutions have established a cross-disciplinary task force involving student representatives and external stakeholders, while others have initiated a series of pilot projects or have established entrepreneurial units to drive an all-of-campus transformation.

The transformational model proposed by Gibbs, the experiences from Ireland, and especially the experiences from University of North Carolina can act as sources of inspiration for developing a strategic framework with clear goals and targets that can be communicated internally and externally. The Kaufmann Foundation (USA) and NESTA and NCEE (UK) have published a number of studies that may also function as sources of inspiration.

8.1.3 Project- and practice-based learning

Entrepreneurial learning will not flourish disconnected from the broader environment. A broad-based institutional innovation strategy implies that more students get opportunities to work on authentic problems. The key issues are that students learn to work in and with user contexts and user-feed back, and the realism in the value proposition.

For higher education institutions it implies that partnerships will likely have to be expanded. Links with businesses and the community also extend to alumni. Former students may function as role models, be guest lecturers, or host student projects, as lessons from the USA and the UK show. A coherent institutional strategy for engaging external stakeholders around a shared vision for entrepreneurial learning and innovation promotes the development of a coherent innovation eco-system[22].

To scale opportunities, a nationwide digital infrastructure may also be formed where public and private companies can post student projects. This will require companies to formally commit to this as an educational effort, meaning that they will have to offer qualified feed-back during the process, possibly giving access also to their end users. It also must be specified how many hours students can contribute to contribute to such a project. In many cases company projects will require students from different disciplines to work together.

External collaboration on innovation projects therefore also requires new institutional routines so that students across fields of study can connect with a view to mutual cooperation. There may be legal and economic considerations that will have to be

[22] See for example the on-line network for supporting entrepreneurs in the creative industries. WWW. Dreamstake.NET

considered so that student initiative is not perceived to be competing against the private sector. Product liability could also be an issue in certain cases. Publically funded applied research projects could also as reward criteria include student project opportunities, as innovation consortia for example today are often used as a framework for PhD students.

In those programmes where work-based learning is part of or complementary to the institutionally based education, students have rich opportunities to learn through practice-based innovation. It will however likely require a mental and cultural shift in how these practice-based learning periods are perceived by the hosting institutions and companies - no longer primarily with the purpose of being introduced to a community of practice and its working routines, but also to improve and possibly transcend practice. As part of the International Educator Leadership Programme, an outcome-based framework of entrepreneurial learning was developed, which could be a source of inspiration in a Danish context. [23]

8.1.4 Assessment

There is a growing consensus that traditional assessment approaches do not adequately support students as learners, nor do they adequately measure a student's ability to engage in creative assignments, teamwork, or in challenge-based learning involving the complex problem-solving tasks that are characteristic of the 21st century learning and working environments. The problem is twofold. The more complex the outcomes to be achieved and ultimately to assess, the more complex the instrument needed and, conversely, the less likely it is that traditional face-to-face forms of exams or written assignments will suffice.

Denmark has an advantage because many institutions have concrete experiences with assessment forms that are better suited to measuring the outcomes of entrepreneurial processes. Approaches will have to vary depending upon whether practice-based education forms part of a formal programme or not. In practice, students should get an opportunity to demonstrate both their academic knowledge acquired as well as their innovation skills and competences applied to a genuine practice-based problem. Students should also be given opportunities to propose improvements or solutions to particular challenges and the underlying rationale for proposing such solutions.

E-portfolios or prototypes may be relevant as part of exams, and will likely also require involving more external examiners in the final assessment process, but with a different perspective and role than that of professional teachers. Since innovation is often a collaborative effort it will be relevant to further develop group exams. INSEAD and the Canadian Conference Board have developed self-assessment tools that could be used or adapted to support entrepreneurial teaching and learning processes.

8.1.5 Monitoring of progress

A strong implementation framework will include a monitoring framework that institutions can use to track progress and that policy makers can use to dynamically adjust support mechanisms and monitor progress. Within the framework of the AHELO project, the OECD is working on developing a large scale assessment framework to measure the outcomes of higher education with focus on some of the competences that are associated with innovation behaviour. To ensure that statistics collection will be used not only to monitor progress but also in the higher education institutions' own strategic efforts to develop an entrepreneurial culture, it will be important that higher education institutions be involved in defining and selecting the appropriate data to be collected to avoid documentation overload and to ensure that the data col-

[23] International Entrepreneurship Leadership programme
http://www.heacademy.ac.uk/assets/bmaf/documents/events/introieep.pdf

lected serve their purpose. These indicators should be in such a format that they can provide information about outputs and results with a view to medium-term impacts.

They should be aligned with the overall innovation monitoring framework. It is worthwhile considering international developments and trends for benchmarking purposes. Possible indicators could be: number of students who during their study have opportunities to work on an innovation project with involvement of external partners; students' perceptions about the extent to which the study has contributed to development of their innovation competences, and; the number of students that start own enterprise and/or work with innovation on the job after graduation.

8.1.6 Institutional competences and capacity

Experiences from international institutions show that the most important factor to drive an entrepreneurial culture is to ensure that promotion, reward mechanisms, incentives, and recruiting are aligned to promoting an entrepreneurial culture. Opportunities to test out new educational models in practice seem to play a stronger role in developing an entrepreneurial capacity in practice than formal training of staff, particularly when it is part of a top-down, bottom-up strategy rollout. Knowledge sharing across faculties plays a central role. Many international higher education institutions, such as the University of Illinois, allocate specific resources to networking and knowledge sharing (NESTA). In that context it is worthwhile considering how national and EU funds can be used for such purposes. Lessons, particularly from the USA from universities such as Georgia Tech, MIT and Stanford, show that ICT technologies may play a transformative role in accelerating campus-wide innovation.

9 Annexes

9.1 Innovation competences

Within the European initiative InnoPro, the following core skills have been identified pertaining to innovation based on an empirical analysis of innovation processes at the firm level.

Classes of Innovation and Associated Core Skills

Classes of Innovation	Skills
Product and Technological	Scientific and Technological Engineering Design and Packaging Market and User Research
Process	Technical Project Management Organisational and Workflow Design Interaction and Relationship Management
Organisational	Opportunity Recognition Systems Design Leadership Communication Delivery and Interface
Marketing,	ICT & Systems Development Web Design and Content Development Data Analysis Language and Communication

Source: Mini Study 02 INNOPro- Skills for Innovation *Ian Miles, Lawrence Green, Barbara Jones*), September 2007.

As the report underlines, several studies conclude that inter-disciplinary learning promotes knowledge, skills and competences conducive to innovation as shown in the table below:

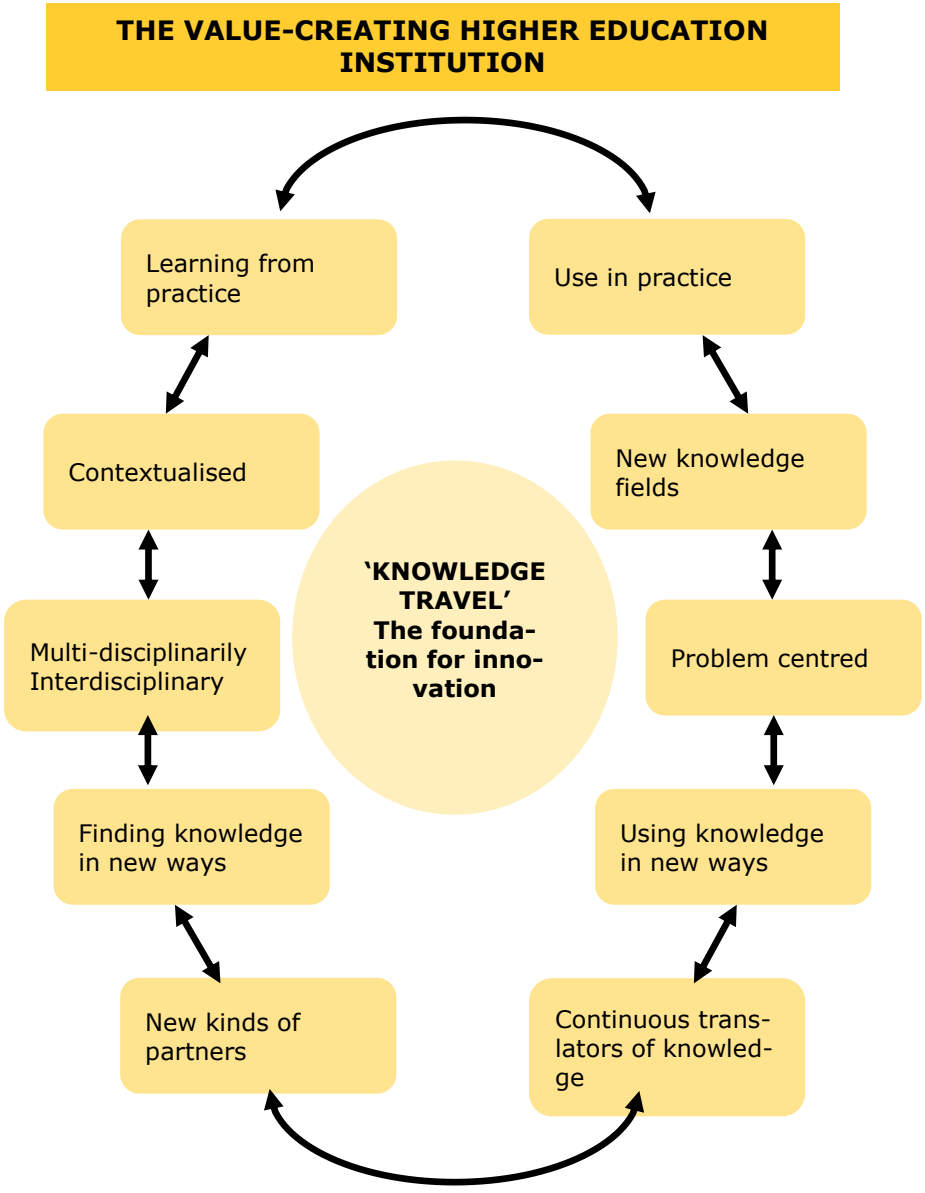
Learning outcomes of interdisciplinary learning

Author	Outcome
Ackerman (1989)	Flexible thinking Ability to generate analogies and metaphors Understanding of the strengths and limitations of disciplines
Ackerman & Perkins (1989)	Enhanced thinking and learning skills Improved higher-order cognitive skills Improved content retention Capacity for proactive and autonomous thinking skills Ability to devise connections between seemingly dissimilar contexts

Author	Outcome
Field, Lee, & Field (1994)	Ability to tolerate ambiguity or paradox Sensitivity to the ethical dimensions of issues Enlarged perspectives and horizons Ability to synthesise or integrate Enhanced creativity, original insights or unconventional thinking Enhanced critical thinking Capacity to perceive a balance between subjective and objective thinking Humility, sensitivity to bias, and empowerment Ability to demythologise experts

Ref: Ivanitskaya et al.

The model below provides the wider rationale for why an all-of-campus entrepreneurial higher education institution may become part of a widening innovation agenda as discussed for example in the OECD Innovation Strategy- getting a Head Start for Tomorrow.



Adapted from Gibb et al.

9.2 Entrepreneurship and innovation - a European agenda

As part of the study an analysis has been made of recent or ongoing initiatives to monitor institutional progress and outcomes.

The European policy goals of fostering an entrepreneurial culture and mindset across Member States took a further step forward through the Oslo Agenda for Entrepreneurship Education in Europe and the Commission Communication 'Fostering entrepreneurial mindsets through education and learning'(COM (2006) 33 Final).

At this point also the benefits of entrepreneurship education beyond start-ups, innovation, and new jobs were promoted futher through the Recommendation of the European Parliament and the Council on Key Competences for Lifelong Learning which identified 'the sense of initiative and entrepreneurship' as one of eight key competences which should be instilled at all stages of education and training:

> "Sense of initiative and entrepreneurship refers to an individual's ability to turn ideas into action. It includes creativity, innovation and risk-taking, as well as the ability to plan and manage projects in order to achieve objectives. This supports individuals, not only in their everyday lives at home and in society, but also in the workplace in being aware of the context of their work and being able to seize opportunities, and is a foundation for more specific skills and knowledge needed by those establishing or contributing to social or commercial activity. This should include awareness of ethical values and promote good governance."

(*Recommendation of the European Parliament and of the Council (18.12.06) on key competencies for lifelong learning*, 2006/962/EC p.8)[24]

The Strategic Framework for European Cooperation in Education and Training up to 2020 (ET2020) further reaffirmed the need for entrepreneurship at all levels of education and training with proposals for further elaboration of indicators and benchmarks.

The issue of definitions is central to the development of indicators. The outcomes of entrepreneurship education have increasingly broadened to the following definition:

> "Entrepreneurial mindset refers to a specific state of mind which orientates human conduct towards entrepreneurial activities and outcomes. Individuals with entrepreneurial mindsets are often drawn to opportunities, innovation and new value creation. Characteristics include the ability to take calculated risks and accept the realities of change and uncertainty. "[25]

Nevertheless, recent developments - and the emerging consensus ion the definition, aims, and objectives of entrepreneurship education in the EU – have allowed the production of an intervention logic as a useful reference point to consider the subsequent development of indicators of entrepreneurship education.

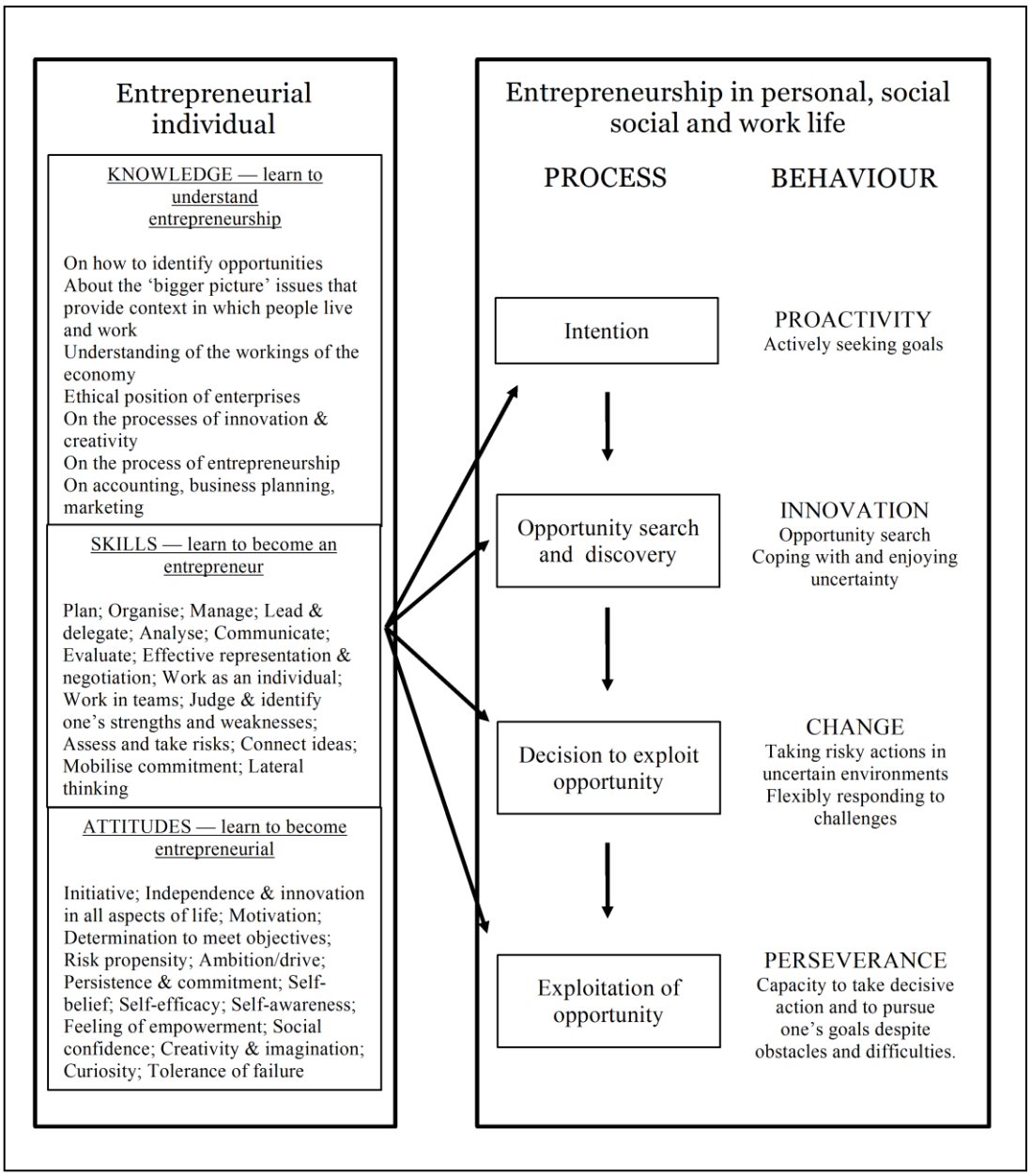
The figure below is a development of the logic model created during the High Level Reflection Panels (DG Enterprise 2012, p.43). It provides a draft logic model for entrepreneurship education (whilst recognising that any such generic logic framework is flexible in respect to individual member state contexts).

The logic model specifies what activities will be undertaken with what expected results and impacts - showing the different stages in the chain of events surrounding entrepreneurship education - and serves as a possible reference point in the development of indicators. One of the issues to clarify and communicate to the relevant stakeholders is the purpose of indicators - are they developed to support the transformation of the higher education system and to foster learning between institutions

[24] Recommendation of the European Parliament and of the Council (18.12.06) on key competencies for lifelong learning, 2006/962/EC, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF Accompanying document to COM(2009) 640 - Key competences for a changing world , Progress towards the Lisbon Objectives in Education and Training, Analysis of implementation at the European and national levels, SEC(2009) 1598, http://ec.europa.eu/education/lifelong-learning-policy/doc/joint10/sec1598_en.pdf

[25] Financial Times lexicon

as the primary objectives, or are they developed to be used primarily for monitoring arrangements and with implications on funding arrangements?



Though the major rationale for entrepreneurship education traditionally has been economic (enterprise and job creation), the social dimension of entrepreneurship has gained prominence as has the emphasis on innovation outcomes. In this sense, researchers and policy makers are increasingly reluctant to associate entrepreneurship education strictly with new venture creation as a sole educational objective, and that has implications for indicators.

Conference Board Canada is possibly one of the only organisations to have developed a self-assessment tool based on thorough research on skills pertaining to innovation. The methodology can be accessed via the net.[26] This methodology could be adapted so it could be used to follow up on students' perceived outcomes of higher education in a self-employment or employment context and regardless of the type of education chosen.

[26] http://www.conferenceboard.ca/Libraries/EDUC_PUBLIC/GISAT.sflb

9.3 Metrics and indicators of entrepreneurship: initial overview

In turn, the stages of the logic model act as a framework whereby metrics and indicators can be defined to identify activity and progress within each stage of the logic model. Subsequently, each column provides example indicators which allow measurement of progress in empirical implementation of the logic model. The indicator examples given are drawn from international studies on entrepreneurship education and from different sources that more recently have tried to understand the soft side of innovation such as OECD 2012a, Toner 2011, Canadian Conference Board and NESTA (UK).

INPUT	OPERATIONS	OUTPUTS	RESULTS	INTERMEDIATE IMPACTS	GLOBAL IMPACTS
Common understanding by relevant stakeholders of definitions, objectives and targets of 'entrepreneurship education' in the national context	% of education institutions with an explicit entrepreneurship/ innovation strategy in place (services and activities, partnerships, programmes offered) % of institutions that have explicit institutional outcome and performance targets regarding entrepreneurship/ innovation	% of programmes with innovation competences embedded in the learning outcomes or % of programmes with entrepreneurship competences embedded in learning outcomes	% of Institutions/ programmes that have implemented summative/formative assessment forms with the aim of assessing competences conducive to entrepreneurship/ innovation	A shared understanding and framework for how the indicator system is to be used to encourage excellence and drive challenge based innovation in the Danish society Annual survey of the HE system as accelerator and catalyst of innovation, see for example http://www.conferenceboard.ca/e-library/abstract.aspx?DID=3853	CIS innovation scoreboard World Economic Forum Annual Competitiveness Analysis OECD-
Entrepreneurship Education Strategy in place	% of education institutions/ departments offering entrepreneurship education	% of students gaining a qualification in entrepreneurship education % of students with a module in entrepreneurship as part of qualification	% of students that plan to -or start own company after graduation % of graduates that are social entrepreneurs (as volunteers) as occupation	% of students that 3-5 years after graduation have started companies that have led to additional job creation	Institutional international benchmarking on entrepreneurship education performance International institutional collaboration on entrepreneurship education

INPUT	OPERATIONS	OUTPUTS	RESULTS	INTERMEDIATE IMPACTS	GLOBAL IMPACTS
Entrepreneurial innovation- conducive education action plan in place	% of institutional departments/programmes with entrepreneurship/ innovation being a feature of the programme % of institutional departments/ programmes with entrepreneurship/ innovation modules as electives or extracurricular activities	% of students that during or by the end of education get opportunities to demonstrate that they have developed knowledge/ skills and competence conducive to innovation (final exams, particular modules or projects, a challenge based assignment during a period of practice	% of graduates that assess that they have obtained knowledge, skills and competences conducive to innovation through their education AHELO- Generic skills - OECD	% of graduates that regularly undertake innovative work assignments on the job, that collaborate across teams, problem-solve…. % of students that have completed a programme with entrepreneurial components that are employed 3months after graduation- (can be defined according to firm size) (Canada self -assessment survey) http://www.conferenceboard.ca/topics/education/learning-tools/isp.aspx	Number of PhD/Industrial PhDs awarded in a topic related to innovation Ranking of DK on International Innovation scoreboards (OECD, World Economic Forum, IMD)
Education monitoring framework in place	% of institutions that explicitly monitor the teaching and learning environment in terms of teachers' and students' perceptions of the overall entrepreneurial and institutional innovation culture	% of students engaging in entrepreneurial activity Survey methodology DG Enterprise 2008	Alumni survey one year after graduation (broad perception of entrepreneurial mindset and abilities as self employed or employed) Survey perceptions of relevance and effect Methodology DG Enterprise 2012	Employer panels % of students that work or study abroad for a period with focus on innovation	Alumni liaisons to the HE institution on innovation topics Developments in placement schemes- collaboration on innovation with student involvement

INPUT	OPERATIONS	OUTPUTS	RESULTS	INTERMEDIATE IMPACTS	GLOBAL IMPACTS
Transformation of teaching and learning processes to accommodate for the development of entrepreneurial competences	% of education institutions/ departments that have adapted teaching and learning processes to support the development of entrepreneurial competences	% of students that have had opportunities to work on challenge-based innovation during their study with an external partner	% of institutions that work with externals to further the innovation culture in teaching and learning (external lectors and professors, external guidance on exams or on projects)	Procedures and methods in place to use collected data and input from employer panels for ongoing quality improvement	Number of international partner institutions collaborating on the promotion of innovation in teaching and learning processes Number of international companies collaborating on the promotion of innovation in teaching and learning processes
Private funding	% of institutions that generate funding from programmes or courses on innovation targeting private and public enterprises	% of institutions that have obtained external private funding to promote innovation cooperation		Diversification of funding sources	Growth in Innovation activities
Institutional incentives	% of institutions that annually have specific budgets for promoting an innovation culture in teaching and learning - grants, seminars, seed funds for interdisciplinary cooperation……. Internally conducted research on didactical and pedagogical matters pertaining to innovation	% of institutions that have implemented particular facilities to further interdisciplinary innovation-intensive learning opportunities	Support structures in place to encourage innovation culture in teaching and learning processes	Employee satisfaction. Perceived relevance of programme	Ability to attract students and staff with the desired profile. Quality in external partnerships

9.4 Other measures

9.4.1 GEM (Global Entrepreneurship Model)[27]

10 The Annual Population Survey (APS)

The Annual Population Survey across participating countries is led by a central co-ordination team from the GEM consortium. As previously mentioned, 59 countries were engaged with the GEM consortium in 2010. In each of these countries, a national team commissions the APS which is then supervised by the team to ensure that the quality is maintained and methodology followed to enable internationally comparable data to be compiled. For each country, at least 2,000 people aged 18 to 64 are surveyed (Bosma et al.).

The national teams are subject to strict guidelines and methodology; the survey is undertaken at the same time of the year across all countries

11 The National Expert Survey (NES)

GEM National Teams undertake the National Expert Survey (NES) to gain an overview into the key factors which impact entrepreneurship in each country. As part of the expert review, at least 36 experts are consulted; in each area, at least 4 experts are interviewed, typically an entrepreneur, two providers of the specific entrepreneurial framework conditions, and one expert advisor.

12 Indicators across the logic model

GEM acknowledges that there is an array of project-level supply side studies which have evaluated entrepreneurship education, but that a gap exists in the measurement of who is engaged with training and how these individuals benefit from training. Through surveying of individuals, GEM can establish the extent and impact of entrepreneurship education from those who receive it and ensure that individuals in formal and informal entrepreneurial activity are included (i.e. those who are involved in registered and un-registered businesses). The APS survey is based on a sample of the population aged between 18 and 64 and collates information on the demographics of those surveyed including gender, age group, education and working status.

The following indicators are included as part of the APS:

- % of individuals who have taken part in school in training to start a business (and whether the activity was compulsory/ non-compulsory, formal or non-formal);
- % of individuals who have taken part outside of school in training to start a business (including who it was delivered by and whether it was compulsory/ non-compulsory, formal or non-formal);
- % of the working age population in the process of starting a business (nascent entrepreneurs) and the % of the working age population who are the owners of new businesses (under 42 months old), deemed to be an indicator of early-stage entrepreneurial activity (TEA). This enables assessment of the ratio of trained entrepreneurs to trained individuals.

[27] http://www.gemconsortium.org/What-is-GEM

- % of working age population involved in TEA who are necessity-driven (no other alternative work option);
- % of working age population involved in TEA who are improvement-driven (such as independence or increasing income, rather than maintaining their income); and
- % of the working age population who are the owner-managers of a new business but for not more than 42 months.

The following indicators are collated relating to aspirations or attitudes:

- % of those involved in TEA who expect to employ at least 5 people in 5 years time;
- % of the working age population (excluding those involved in TEA) who intend to start a business within three years;
- % of the working age population who agree that 'most people consider starting a business as a desirable career choice' in their country;
- % of the working age population who agree that 'successful entrepreneurs receive high status' in their country; and
- % of the working age population who believe they have the necessary skills or knowledge to start a business.

GEM has consolidated a number of questions from the APS to estimate the "Gain from Training". The measure enables a comparator to be established which illustrates:

- "the increase in the proportion of people in the country who have a characteristic such as a particular attitude because of compulsory training in starting a business", and,
- "the increase in the odds that individuals with a given set of demographic characteristics will have a particular entrepreneurial orientation if they have ever taken compulsory training versus individuals with identical demographic characteristics but without such training".

As part of the NES, experts are interviewed across nine key areas including entrepreneurship education and training. More specifically, experts are asked to state their level of agreement with the following statements on a scale (i.e. 1 representing "strongly agree" to 5 representing "strongly disagree"):

- The adequacy of formal entrepreneurship education (and training) provided at primary and secondary schools in their country; and,
- The adequacy of entrepreneurship education and training offered through a variety of sources beyond primary and secondary schooling (such as colleges, universities, government and professional programmes).
- Such indicators could provide a useful indicator of the extent to which entrepreneurship education varies across the Member States.

12.1.1 OECD

The OECD AHELO project aims to develop a framework for measuring the outcomes of higher education with focus on some of the competences that are associated with innovation behaviour in the theoretical literature – namely analytical reasoning, problem solving, and written communication - drawing on the United States' Collegiate Learning Assessment framework. The AHELO assessment is pilot for the professional field of engineering and economics - and it also includes data collection on background variables on the individual student and the learning environment (OECD 2012b).

12.1.2 What makes innovators different?

Researchers from INSEAD, Harvard, and Brigham Young University have undertaken a six-year study to uncover the origins of creative - and often disruptive - business strategies in particularly innovative companies. The habits of 25 innovative entrepreneurs were studied in depth, and more than 3,000 executives and 500 individuals who had started innovative companies or invented new products were surveyed. The researchers have found that innovators engage both sides of the brain as they leverage the discovery skills to create new ideas.

In thinking about how these skills work together, the researchers chose to apply the metaphor of DNA. Associating is like the backbone structure of DNA's double helix; four patterns of action (questioning, observing, experimenting, and networking) wind around this backbone, helping to cultivate new insights. And just as each person's physical DNA is unique, each individual studied had a unique innovator's DNA for generating breakthrough business ideas.

As an outcome of the study the researchers have developed what they call "the Innovator's DNA 360 Assessment report". It provides a self-assessment framework plus an assessment framework for supervisors and peers to evaluate an individual's performance on each of the skills listed below. The assessments are designed to help identify an individual's current areas of strength and potential areas of improvement.

The assessment will show an individual's percentile ranking across all of the Discovery Skills and Delivery Skills, as well as a percentile ranking for each Discovery and Delivery Skill. These overall scores give a proxy for whether a person is more discovery-driven, delivery-driven, or balanced in terms of personal orientation. For each of the fields there are suggested strategies for improvement depending on where a person is placed on the matrix. The model could potentially support the development of students' soft skills.

For the different groups of skills, there are a range of questions to be answered as the basis for the score. Each assessment measures the following specific skills:

Discovery Skills

- Associational thinking
- Questioning
- Observing
- Experimenting
- Networking
- Challenging the status quo
- Risk taking

Delivery Skills

- Analysing
- Planning
- Detail oriented
- Self-disciplined

Leading Innovation Skills

- Encourages associational thinking
- Encourages questioning
- Encourages observing
- Encourages experimenting
- Encourages networking
- Encourages Challenging the status quo
- Encourages risk taking

12.1.3 Institutional strategies

North Carolina State University is just one example of a higher education institution which has successfully developed and implemented an institution wide strategy to drive a broad based entrepreneurial culture and institutional practices on campus. The following provides examples of goals and metrics developed in an open innovation process involving professors, external stakeholders and student representatives.

The Goals

- Enhance the success of students through educational innovation;
- Enhance scholarship and research by investing in faculty and infrastructure;
- Enhance interdisciplinary scholarship to address the grand challenges of society;
- Enhance organisational excellence by creating a culture of constant improvement;
- Enhance local and global engagement through focused strategic partnerships.

During fall 2011, the draft reports submitted by the five Implementation Planning Teams[28] were integrated into a single Implementation plan. Metrics to assess NC State's progress toward meeting its strategic goals were also selected.

The Implementation Plan has been revised and updated periodically as progress has been made through the years covered by Strategic Plan, was originally created as a matrix[29] and is outlined below in a linear format.

[28] http://info.ncsu.edu/strategic-planning/implementation/
[29] http://info.ncsu.edu/strategic-planning/files/2011/11/ip-11-2011.pdf

The following provides a few examples of targets and metrics of specific relevance to the innovation agenda of the university.

Increase the number of tenure and tenure track faculty.

- Action: Develop a program for targeted and competitive hiring of lead scholars who build opportunistic areas of strength to increase the research capacity of interdisciplinary programs/research collectives.
- Action: Support interdisciplinary and/or cluster faculty hires.
- Action: Reallocate resources to strategic interdisciplinary programmes.

Develop and implement strategic funding models.

- Action: Develop funding models that ensure investment in university strategic priorities.
- Action: Create a central pool of funding to allow university administration the resources to invest in strategic priorities.

Create opportunities for strategic educational and scholarship partnerships that cross traditional academic units.

- Action: Expand the use of broader umbrella degrees to reduce the number of graduate degrees and to allow for more flexible programmes of interdisciplinary study with focus on challenge based innovation.
- Action: Establish policies and review promotion and tenure processes that facilitate and encourage teaching and research across units on campus.

Metrics

The metrics below provide some examples of how the university is following up on the strategy and implementation plan using both hard and soft metrics.

Goal 1: Enhance the Success of Students through Educational Innovation.

- Enrolment Profile: percentages of undergraduate, graduate, NDS students;
- Post-docs: number and national rank;
- Admissions Profile: mean SAT and percentage in top 10% of high school class;
- Distribution of students by geographic origin;
- Degrees awarded by level;
- Undergraduate 1-year retention rate;
- Undergraduate 6-year graduation rate;
- Master's and doctoral students' completion rate;
- Alumni: How well-prepared were you for graduate/professional school?
- Alumni: How well-prepared were you by NC State for your first full-time permanent position?

Goal 3: Enhance Interdisciplinary Scholarship to Address the Grand Challenges of Society.

- Extramural research expenditures in Centres and Institutes;
- Intramural research expenditures to promote interdisciplinary research (e.g. seed money);
- Number of funded proposals with multiple departments involved;
- Number of proposals funded that map to strategic areas of emphasis;
- Faculty response to question: Interdisciplinary work is rewarded in the promotion, tenure, and merit process.

Goal 5: Enhance Local and Global Engagement Through Focused Strategic Partnerships.

- Number students participating in international activities such as study abroad and international alternative spring break;
- Number of students participating in co-op and other internship activities;
- Number of non-university partners on campus;
- Students' perceptions of NC State's contributions to their ability to solve complex problems and to contribute to the welfare of the community;
- Students' perceptions of skills and perspectives gained through various co-curricular experiences;
- Number of patents, licenses, and start-ups;
- Number of faculty engaged in international activities.

13 Literature List

Blenker, Per; Dreisler, Poul; Kjeldsen, John. *The New Challenge Facing the Universities*. Pile Group Aarhus University. http://old-hha.asb.dk/man/cmsdocs/WP/2006/2006-02_ENG.pdf

Bosma, Niels; Wennekers, Sander; Amorós, José Ernesto (2012): *Global Entrepreneurship Monitor 2011 Extended Report: Entrepreneurs and Entrepreneurial Employees Across the Globe*. GEM, http://www.gemconsortium.org/docs/download/2200

Bourn, Douglas & Neal, Ian (2008): *The Global Engineer - Incorporating global skills within UK higher education of engineers*. Engineers Against Poverty, London. http://www.engineersagainstpoverty.org/_db/_documents/WEBGlobalEngineer_Linked_Aug_08_Update.pdf

Brown, Phillip; Lauder, Hugh; Ashton, David (2011): *The Global Auction. The Broken Promises of Education, Jobs, and Incomes*. Oxford University Press

DG Enterprise (2007): *Entrepreneurship Education: Enabling Teachers as a Critical Success Factor*. http://ec.europa.eu/enterprise/policies/sme/promoting-entrepreneur-ship/files/education/teacher_education_for_entrepreneurship_final_report_en.pdf

DG Enterprise (2012): *Effects and impact of entrepreneurship programmes in higher education*. http://ec.europa.eu/enterprise/newsroom/cf/_getdocument.cfm?doc_id=7428

European House of Entrepreneurship (2012): *Survey of Entrepreneurship Education in Europe*. http://www.space-eu.be/uploads/documents/members%20only/Survey%20of%20Entrepreneurship%20in%20Education%20in%20Europe-EUROent.pdf

Dyer, Jeff; Gregersen, Hal; Christensen, Clayton M. (2011): *The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators*. Harvard Business School Publishing.

European University Association (2009): *Improving Quality, Enhancing Creativity - Change Process in European Higher Education Institutions*. http://www.eua.be/typo3conf/ext/bzb_securelink/pushFile.php?cuid=400&file=fileadmin/user_upload/files/Publications/QAHECA_Report.pdf

Forskningspolitisk Råd (2011): *Det værdiskabende Universitet*. http://www.fi.dk/nyheder/arrangementer/2011/danmarks-forskningspolitiske-raads-konference-november/konference-om-det-vaerdiskabende-universitet-og-forskningens-rolle-ift-vaekstdagsordenen

GHK (2011): *Mapping of teachers' preparation for entrepreneurship education*. For DG Education and Culture, http://ec.europa.eu/education/more-information/doc/2011/mapping_en.pdf

Gibb, Allan (2012): "Exploring the synergistic potential in entrepreneurial university development: towards the building of a strategic framework." In *Annals of Innovation & Entrepreneurship*, Vol 3 (2012). http://www.innovationandentrepreneurship.net/index.php/aie/article/download/16742/pdf

Gibb, Allan & Hannon, Paul (2010): *Towards the Entrepreneurial University?* https://webspace.utexas.edu/cherwitz/www/articles/gibb_hannon.pdf

Gibb, Allan; Haskins, Gay; Robertson, Ian (2009): *Leading the Entrepreneurial University*. http://www.ncee.org.uk/publication/leading_the_entrepreneurial_university.pdf

Hannon, P.D. (2005): *The Journey from Student to Entrepreneur. A review of the Existing Research into Graduate Entrepreneurship*. National Council For Graduate Entrepreneurship Policy papers Series.

Honig, Benson (2004): *Entrepreneurship Education. Towards a model of contingency based Business planning*. Academy of Learning, management and Education. Vol 3 p 258-273. http://www.unc.edu/~jfstewar/Oct%2020%20papers/Honig%20paper%20AMLE%202004.pdf

Hofer, A. et al. (2010): *From Strategy to Practice in University Entrepreneurship Support: Strengthening Entrepreneurship and Local Economic Development in Eastern Germany: Youth, Entrepreneurship and Innovation*. OECD Local Economic and Employment Development (LEED) Working Papers, 2010/09, OECD Publishing. http://dx.doi.org/10.1787/5km7rq1xvnxp-en

Ivanitskaya, Lana; Clark, Deborah; Montgomery, George; Primeau, Ronald (2002): "Interdisciplinary Learning: Process and Outcomes." In *Innovative Higher Education*, Vol. 27, No. 2, Winter 2002 (C ° 2002). http://www.umaine.edu/sustainabilitysolutions/faculty_resources/pdfs/Ivanitskaya.pdf

Kauffman Foundation (2012): *College 2.0 An Entreprenurial Approach to Reform*ing Higher Education. http://www.kauffman.org/uploadedFiles/entrepreneurial_approach_to_higher_ed_reform.pdf

Lattuca, Lisa R.; Trautvetter, Lois C.; Codd, Sarah L.; Knight, David B.; Cortes, Carla M.: *Promoting Interdisciplinary Competence in the Engineers of 2020*. Paper presented at the 2011 ASEE Annual Conference & Exposition. http://www.ed.psu.edu/educ/e2020/asee-conference-presentations/asee-2011-id-competence-final-3.8.11.pdf

Lombardy, Marilyn (2007): *Authentic Learning for the 21st Century – an overview*. Educause, ELI paper 1, 2007. http://net.educause.edu/ir/library/pdf/ELI3009.pdf

Löbler, H.; Maier, M.; Markgraf, D. (2006): *Evaluating the Constructivist Approach in Entrepreneurship Education*. University of Leipzig,

http://www.smile.uni-leipzig.de/fileadmin/smile2006/website/arbeitspapiere/SMILE-AP02-Evaluating_the_Constructivist_Approach.pdf

MacMahon, Cormac; Coleman, Maébh; Colman, Lewith (2010): *Accelerating Campus Entrepreneurship (ACE). A Sectional Analysis of Practices to Embed Entrepreneurship Education into Engineering at Irish Higher Education Institutions*. http://www.ucc.ie/ucc/depts/foodeng/isee2010/pdfs/Papers/MacMahon%20et%20al.pdf

Nab, Jan; Lans, Thomas (2012): *Practice what you preach. A literature review on roles and competences for the entrepreneurship teacher.* http://www.ord2012.nl/NR/rdonlyres/4A0374A4-2524-46F7-ABA2-3B98192CD06A/166203/251hoPracticewhatyouJanNab.pdf

Nordic Council of Ministers (2010): *Kreativitet, innovasjon og entreprenørskap i utdanningssystemene i Norden*. http://ntsnet.dk/sites/ntsnet.dk/files/Nordisk-raad.pdf

NESTA (2008): *Developing Entrepreneurial Graduates.* http://www.nesta.org.uk/assets/documents/developing_entrepreneurial_graduates

OECD 2012a: *Better Skills, Better Jobs, Better Lives- a strategic Approach to Skills Policies* http://skills.oecd.org/documents/oecdskillsstrategy.html

OECD 2012b: *Highlights the AHELO feasibility Study*: http://search.oecd.org/officialdocuments/displaydocumentpdf/?cote=edu/imhe/ahelo/gne(2012)6&doclanguage=en

Patterson, Fiona; Kerrin Dr. Márie; Gatto-Roissard, Geraldine (2009): *Characteristics & Behaviours of Innovative People in Organisations*. NESTA, City University, London

Sandeen, Cathy A.; Hutchinson, Scott (2010): "Putting Creativity and Innovation to Work: Continuing Higher Education's Role in Shifting the Educational Paradigm". In *Continuing Higher Education Review*, v74 p81-92 Fall 2010. http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=EJ907252

Schleicher, A. (2011): Presentation of findings from pilot study of PIAAC OECD at Lisbon Council Brussels. http://www.lisboncouncil.net/initiatives/human-capital.html

Schommer, M. (1994). "Synthesizing epistemological belief research: Tentative understandings and provocative confusions." In *Educational Psychology Review*, 6(4), 293.319

Shapiro, Hanne & Lauritzen, John Keller (2011): *Comparative study USA-EU - New Skills for New Jobs in Higher Education*. For DG Education.

Shapiro, Hanne & Divine, Jim (2012): *Open Education - new learning spaces for the 21st century*. Staff working paper, pre draft for DG Education.

Technopolis & Danish Technological Institute (2012): *Emerging dynamics in the knowledge triangle* (working title), for the European Commission, DG Education.

Tepper, Steven (2004): "The Creative Campus: Who's No. 1?" In *Chronicle Review*, October 2004. http://chronicle.com/article/The-Creative-Campus-Who-s/4870

Thorp, Holden & Goldstein, Buck (2010): *Engines of Innovation - The Entrepreneurial University in the 21st century*. The University of North Carolina Press.

Toner, Philip (2011); *Workforce Skills and Innovation - an overview of major themes in the Literature*. OECD- CERI http://www.oecd.org/science/innovationinsciencetechnologyandindustry/46970941.pdf