What It Takes to Refine World-Class Research into High-Class Education

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INFORMATION AND EXPERTISE LIFECYCLE

The welfare society is founded on comprehensive research. The information lifecycle is a key aspect of both research and education. Wide-ranging popularisation, publishing and influence are necessary to the success of educational and research organisations. The ability of organisations and people to adapt and respond to the location and utilisation of information in their own work at any given time plays a crucial role.

Universities and institutions of higher education are gradually moving away from measuring knowledge with tests toward a functional concept of knowledge, whose goal is to apply strong theoretical expertise in variable situations as well as increase knowledge and expertise together by doing. It is vital for researchers to be skilled in applying scientific theories and research methods across a variety of disciplines and in different groups. Identifying the best practices for specific situations and showcasing one's own specialised expertise make it easier to work with actors at any given time.

The challenge facing the research and educational community is to serve as an active participant in the global knowledge network. Co-operation between multidisciplinary cultures is part of daily life of world-class research in which information must change hands as well as produce new, future-oriented activity. Success of research is highly linked to success in high-quality education and impact of both the research and teaching. World-class research also brings employment to industry and researchers themselves.

HIGHER EDUCATION INVOLVES MULTIDISCIPLINARY EXPERTISE AND THE APPLICATION OF PEDAGOGY

Multidisciplinary higher education requires that both the teacher and student have an understanding of the big picture. It is vital to identify how things being taught in different subjects are related to one another. Higher education should meet the demands of an ever-changing business sector as well as take globalisation and technological advances into consideration. The common need for managing large, multidisciplinary entities whilst maintaining one's own area of specialisation poses a challenge for actors in education, research, and business.

TOP RESEARCH AS A DRIVER

The theory on a new form of integration and utilisation comes from top-level research. Top research can be seen in the conventional conferment of doctoral degrees, publications in top journals in the field, and the increase and exposure of stakeholder expertise. Top research analyses leading information already existing on syllabi about technology, other research actors and companies. The use of published research results in relation to the actual number of publications has increased, playing a crucial role in the evaluation of top research. The role that more experienced post doc researchers play in interactions with novice researchers and students is emphasised in top-level research.

In top-level research, novel knowledge is primarily collected and obtained in an orchestrated manner, making use of the group's expertise and experience, by participating in and organising online events and fora, following publications and the Internet, conducting survey campaigns and various testing arrangements, and participating in a variety of social and scientific activities and organisations, among others. Top research always requires smart specialisation and choosing the right partners.

SUCCESS OF RESEARCH IS HIGHLY LINKED TO SUCCESS IN HIGH-QUALITY TEACHING AND IMPACT OF BOTH THE RESEARCH AND TEACHING

World-class research also brings employment to industry and researchers themselves. Good quality young students will turn out to be future key scientists and professors.

The Photogrammetry and Remote Sensing postgraduate courses and tutorials have been arranged annually since 1998. Their topics are chosen to meet the actual needs in the academic research and in the industry. Both internationally and nationally renowned academicians are invited to give presentations. World-class professors, like **Karl Kraus**, **Georg Vosselmann**, **Norbert Pfeifer**, **Derek Lichti**, **Wolfgang Förstner, Stuart Robson**, **Clive Fraser**, **Mark Shortis**, and **Hans-Gerd Maas** etc. have given presentations at these courses.

Thus, good science will not survive without good teaching, but this kind of teaching is most effective when learnt by doing. For example, one of the most important skill that researcher

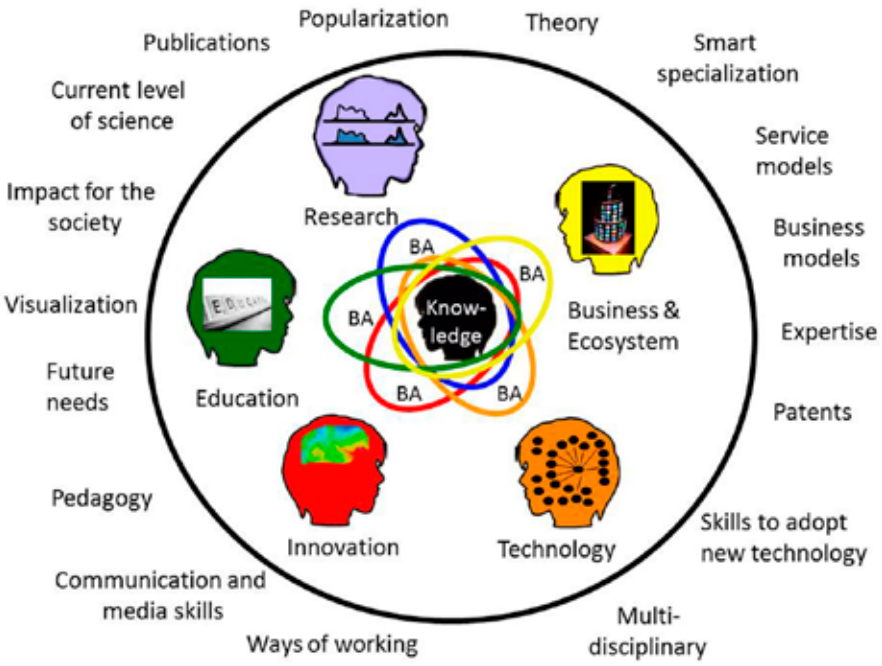
should have is reporting. This usually means that research results are published in peer-reviewed scientific journals. However, undergraduate students are usually unfamiliar with basic publishing skills or learned skills are poorly linked to the exact research field. This is problematic when student is starting to write Master's thesis or later when writing first article as a PhD student. As part of the new Centre of Excellence, publishing skills are taught as part of the practical exercises where traditionally only methodological skills have been learned. This is applied by giving all the instruction of the course exercise in format of a scientific article. Introduction is given and it provides the motivation and background to the exercise topic. Then material and methods sections are providing all the needed instructions. After that students analyse the data and write the results section. Places of the tables and figure captions are given to the result section in addition with some opening sentences to guide the student. Finally, student fulfills the article by writing the discussion and conclusions. This kind of teaching method was first tested during the spring 2012 and encouraging feedback was gained from the students.

Today, good science is also linked to research environments and multiple research teams. It is easier to attract young talents when the knowledge will result in good employment. That basically means good science is today planned and finished in co-operation with industry and third parties using the expert knowledge in the long run. The industry is giving their knowledge where the science is then contributing – but typically in a relatively long time perspective. Learning by doing is also main principle in the company co-operation.

Young researchers can be seen as a link between students and more experienced post doc researchers and teachers. Using young researchers in teaching this link can be formed and strengthened even more. Thus, teaching is also a good way for young researchers to ensure they fully understand and comprehend concepts and methodologies they are using in their own research.

THE TASK OF SCIENCE AND EDUCATION IS MOVING TOWARD POPULARISATION

Indeed, one of the researcher's and teacher's responsibilities has expanded: a more extensive presentation of one's own research and views in a variety of media and at events. There are plenty of active users and critics of research data. A pedagogical background alone is not enough to ensure the utility of research data. A top academic researcher may know how to make their research results more comprehensible for use in education, e.g. a university-educated pedagogue with qualifications in classroom or subject instruction. The challenge is to establish a dialogue between the researcher and teacher, where information truly changes hands.



The creative orchestration of co-operative partners also makes it possible to create an entirely new way of doing and sharing things in an interesting co-operative arrangement. Where can the necessary materials, images and videos, publications and other materials be found to serve as the basis for higher education? Who will analyse and make this information into educational materials, taking copyrights into consideration? Are the national teaching materials databank and wikipedia enough moving toward equal and updated learning?

VIRTUALITY AND MATERIALS

More and more materials are being moved online, thus allowing for independent study. Major deficiencies in, for example, educational materials are inadequate visual qualities as well as the lack of well designed, up-to-date Finnish textbooks. The remaining challenges in getting information into new, regional use are research data copyrights, entrenched hierarchies between organisations, co-operative approaches and practices.

Pedagogical education allows for the management of different student groups and employment of teaching techniques and psychology to support motivation and outcomes-based learning. The new teacherhood also involves the utilisation of generic abilities.

INTERNATIONAL VIRTUAL COURSES

Virtual studies have, in part, returned to courses based on classroom teaching. There are no available resources needed for online courses – the work is left to the teacher. Their benefits are often questionable, because, in reality, an online course will consume far more of the teacher's time than a normal course. The advantages of virtual studies include shared materials, the submission and checking of completed exercises, a feedback system and an electronic examination service. These all make the teacher's work easier and improve the quality of courses.

Since 2002 EuroSDR has organized international Eduserv e-learning courses. Annually, four distance e-learning courses are given within one Eduserv Module. In addition to e-learning material, courses include pre-course seminar in which students can meet each other and teachers face-to-face. In many cases, they are continuation from EuroSDR's projects which enables effective distribution of the latest research. Finnish Geodetic Institute and Aalto University from Finland has been active on giving Eduserv courses.

Although electronic textbooks, virtuality and international online studies are growing trends, they require active partnerships to realise them.

LIVING LAB ENVIRONMENTS

The idea behind the Living Lab is to develop products or services together with various local actors. Functional, shared Living Lab concepts can be created using high-speed network connections and efficient and secure digital markets. Our living lab methodology has been applied in the projects of Academy of Finland, Tekes, EU, Ministry of Agriculture and Forestry, EuroSDR, Aalto (Energy Efficiency Research Programme), and RYM Oy.

Demonstrations form the basis for city and environmental planning.

Online virtual reality hosting systems, like Adminotech's Meshmoon, are still fairly new technologies, but the potential is great. Demonstrations, where the physical and virtual worlds meet, provide an excellent foundation on which to present research results. A demonstration can be used to reify and clarify the possibilities offered by a technology (e.g. city planning in Espoo, flood modelling in Pulmanki, and forest management and measurement in Kalkkinen).

Game-based learning provides the student with a compelling and illustrative learning environment. The games allow students to practice co-operation, problem-solving and process-based thinking in a familiar, motivating environment. Virtual environments and motion detection offer new types of applications, which also allow teachers to employ new teaching methods.

RAISING THE PROFILE OF TACIT KNOWLEDGE

Tacit knowledge has received greater exposure and been put to more extensive use by educational and research organisations. It has become possible to model the development of expertise, using expertise surveys and a so-called *expertise portfolio*, in which an individual's current expertise and functional influence are described. *Knowledge portfolios* facilitate the systematic collection of the team's *expertise*. In addition to personal development and incentives, making tacit knowledge a competitive edge for an organisation by identifying information flows is an area of expertise utilised by the Centre of Excellence in Laser Scanning.

SUMMARY

Everyone has the right to learn and develop their expertise. Greater incentives should be given to operations. Movers and shakers are needed alongside traditions and administration.

FURTHER INFORMATION

The goal of the future is to teach, combine and research various cross-disciplinary measuring and modeling techniques at the international level. The need for new operating methods and innovations as well as the combination and multidisciplinarisation of this expertise requires integrative links at the national and international level.

The Academy of Finland has chosen the Centre of Excellence in Laser Scanning to represent the very top level of research in Finland for 2014–2019. The Finnish Geodetic Institute, Aalto University School of Engineering and Universities of Helsinki and Oulu are participating in the Centre of Excellence (CoE). *http://www.fgi.fi/coelasr/*.

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