TRAINING THE FUTURE ICT INNOVATORS ON OPEN SCIENCE PLATFORM

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Abstract

Due to changes in the market positions of old companies caused by innovation in technologies, services, business concepts and global challenges faced by nations in terms of climate and safety, academic systems in Europe have started to look into new pedagogical models and strategic partnerships. The new systems that connect research, education and innovation can offer unique opportunities to explore different solutions that were not possible before. In this paper, we present concrete experiences and directions for creating innovative learning environments with stronger impact and excitement to all stakeholder involved. We describe a new approach that relies on three fundamental concepts: strong commitment and support of open science, challenge driven education model and physical co-location of partners. We give examples of applications of this approach and discuss various aspects that are involved.

Keywords: Innovation on technology, ICT, Engineering Education, Learning outcome.

1 INTRODUCTION

Our national industrial base is experienced very rapid and large scale changes where Old Corporation are losing their leading market position and at the same time new corporation are created based on new innovation on technology, service or business concept. At the same our nations and industrial infrastructures are facing global challenges in terms of climate, people's wellbeing, safety and security. This rapid change has pushed the academic system most recently in Europe, to start to work with new working models in terms of strategic partnership and pedagogic models.

During the last 25 years, KTH has been very active in innovating and implementing educational reforms at local and at global level for ICT with key focus on societal and industrial impact. Global challenges are often materialized locally and render solutions in a local context. In good circumstances, they may be scaled up into global solutions. The lack of investments in certain areas or lack of certain infrastructure in emerging and developing economies offers unique opportunities to explore entirely different solutions to problems that are beyond the horizon of our present imagination. They could thrive and develop rapidly in the fertile innovation ecosystem that is provided by universities and their interface to society. Thus, from a university perspective, connecting research, education, and innovation to an effective knowledge triangle is of paramount importance

Although over the last 25 years we have walked a long way from the traditional engineering education models, we still have a long way to go, especially in understanding the need and role of global partnership and possibilities to create significant impact to the society, university, students and involved faculty. We foresee that there will be no single "correct" model, but various models and best practices which a context and partnership dependent, but which at the same time fulfils the fundamental degree requirements and intended learning outcomes at the degree level both at international and national perspective in an explicit and transparent manner.

As summary, the new approach consists of three fundamental concepts forming the pillars for activities and actions:

- Strong commitment and support of Open Science and related transparency and global co-operation as defined in the recent Dakar Declaration on that. This is facilitated and empowered the recently development Open Science Platform with focus on integrating the knowledge triangle and providing Science Gateways

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- Introducing a new approach for societal stakeholder integration through the Challenge Driven Education model and Technology Transfer Alliance supporting a comprehensive multi-partner interaction.
- Physically co-locating the activities to university initiated co-creation, co-design, and co-drafting centres forming the local Open Labs and Maker Space meeting places and critical infrastructure resources for integrating problem owners to various solution provides especially from academia.

2 METHODOLOGY

2.1 Open Science Platform

An open science platform is conceived as an integrated set of arrangements that provide a policy, capacity-building and infrastructural framework for enhanced accessibility and impact of open data for science and society. It includes Open access, Open data, Open collaboration and ICT for open science and other initiatives as shown in Fig.1 [1]. The advancements in the open science platforms provide new interactions styles between research actors facilitated by new sharing approaches that lead to novel types of results and regulations, which include data and analysis platforms, scientific social networks and new forms of collaboration [2]. Its functions are sharing of research data, findings, tools, methodologies; platforms from the same or different disciplines for the purpose of reproduce, consolidate or discover new research results.

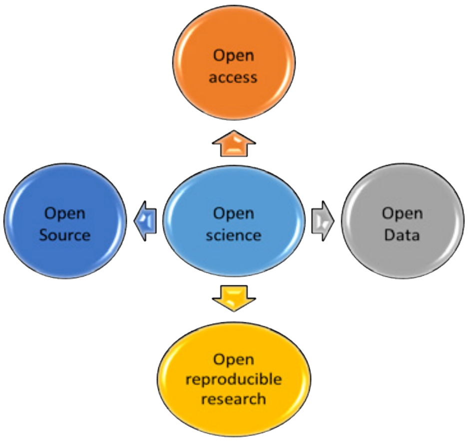

Figure 1. Open science concept.

Recently there is positive initiatives with numbers of new and different types of platform for open science. A good example of the open science is Sci-GaIA platform (www.sci-gaia.eu/) which was implemented in a Dakar Declaration to promote open science in Africa, [3]. The platform has different attributes such as federated authentication, re-use and publish their research products then link them to their ORCID profile to increase the visibility to African and European Science as seen in Fig. 2. Different tools and platforms for the support of open science have been summarize in Table 1

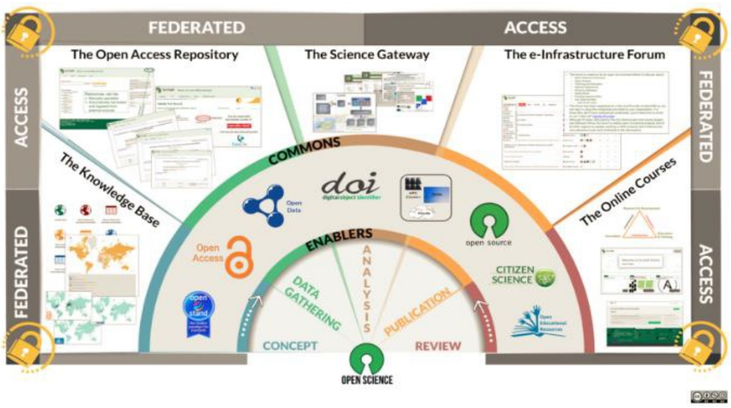

Figure 2. Layout of the Sci-GaIA federated Open Science Platform [3].

Table 1. Open science tools and platforms.

Sector		Tools, platforms, methods, and the like
Open access	Repository open source software	Dspace, Eprints, Fedora, Invenio, MyCoRe, OPUS, SobekCM
	Repositories (popular)	arXiv, ViXra, CogPrints, Espacenet, Directory of Open Access Journals (DOAJ), BioMedCentral, Sci-Hub, etc.
Open Source	Software	Github, Bitbucketm SourceForge, Launchpad, Assembla, Betavine, Buddy,CodePlex, GitLab,Gna!, Savannah,OSDN, ourproject.org,OW2,Rosetta Code, Tigris.org, etc.
	Hardware	Github, NetFPGA, OpenPicus, PowWow, SatNOGS, ArduCopter, Paparazzi UAV, etc.
	Education	Open source initiative
Open data		ArcGIS Open Data, ENGAGE platform, Freebase, Wikidata, open data kit, ODPi, dataverse, DataCite, CODATA, etc.
Open reproducible research		Madagascar, DataCite, Research Data Alliance, World Data System, EUDAT

The use of the Open Science Platform can be discussed in our results with the use cases such as integrated Grid (iGrid) and Technology Transfer Alliance (TTA) portals. These two use cases deployed the features and attributes of the Sci-GaIA platforms among the 35 use cases.

2.2 New ICT training approach

One of the biggest challenges in ICT training is to design a curriculum that best serves the needs and requirements of the associated society [4]. In addition, the education model needs to help ICT trainees acquire knowledge and skills that reflect the needs of the industry, both locally and globally in general. Trainees need to gain necessary skills that will go and fill up the gaps in the industry for the education to have the biggest impact in the society. In this context, the new approach for the ICT training is the implementation of Challenge Driven Education model, which focus on solving problems in a collaborative manner.

2.2.1 Challenge driven education model

Challenge Driven Education (CDE) is aimed for students and individuals who focusing on solving society problems in a skilled team with a collaboration manner. The approach is going through the learning cycles while at the same time serving the global society in the brightest way. Three aspects go hand with the practice of CDE, which are: (I) Project-based learning, meaning that the work is compiled into projects. (II) Team-based learning, meaning that learning happens in a team setting focusing on goals, open-ended problems that cannot be solved with the existing disciplinary knowledge. (III) Involvement of external partners and clients in the projects, whether businesses or public bodies. Several problems which have been solved based on CDE approach are defined by [5]. These are dry toilets in Dar es Salaam, unmanned solar powered boats in Japan; solar powered energy efficient router enables broadband in Tanzania and a market modified flood pump for a charging world. The projects involved the students of different levels, i.e. Master's and Doctoral degrees.

Same wise, University of Dar es salaam engaged in the use of CDE to solve problems related to electricity in Tanzania where by 4 Master's and 8 Doctoral degrees' students are involved on it in the 2016/17 Academic year. Stakeholders from TANESCO (Tanzania Electric Supply Company) and Instructors were also participating in the process. At the beginning, students identified eight challenges/problems related to electricity in Tanzania that were presented in the workshop involving stakeholders from TANESCO and their tutors. The aim for this workshop was to get feedback and inputs from the experts of that field. Out of eight challenges, two were selected to work with as they have an impact direct to the customer, which is of much interest, by many users. These are: Inefficient power system faults clearance (done by PhD students) and poor power quality (done by MSc students). Other challenges were left for future implementations and others were already implemented. Later, the students have to break down the challenge into individual tasks and work in a collaborative manner. The process does not have any lectures, rather the peer learning and peer feedback approach. At the end, the assessment is done on different forms, which are writing, prototyping and oral presentations. In this approach, there is no any paper-based examinations. This challenge-based approach is practiced with the use of TTA portal whose focus is on transfer of education through online platform.

Moreover, the author in [6] also elaborated on CDE as the means of making innovation and research design simple and clear. Any project should have a means of providing innovation so that the impact can be seen through. [7] Mentioned their experiences at the University towards the use of CDE. The authors provide common themes in which upon using the approach the participants have to follow. These are: (i) Learning is a social activity and is achieved by solving real-world problems, (ii) involves Interdisciplinary, (iii) starts from building blocks to thematic blocks, (iv) Innovative approach to assessments, (v) Openness and involves technology.

2.3 Physical co-location

This approach has been proposed deals with co-locating academia and industry in the same physical space. In order to promote more collaborative research, industry experts and university researchers share a common physical space. The motivation behind this idea is to try to facilitate exchange of ideas and minimize communication challenges due to separate physical locations. The approach forms the basis of collaboration and interaction between the different stakeholders involved. It encourages spontaneity and easy flow of ideas. In addition, this setup allows all parties involved to share costs and have access to high quality facilities that would otherwise be difficult. One example of this is the co-location setup of University of Colorado Boulder/Mosaic Biosciences forming the Bio Frontiers Institute [4]. They use co-location as a mechanism to improve the research process on complex biological problems.

Co-location not only improves ICT training, but also offers several advantages to the industry and other stakeholders involved. It helps companies accelerate research results and obtain a competitive advantage. In turn, this results in business impact. Companies can also take advantage of creativity and problem-solving skills available in the academic world. It allows companies to conduct research without interference from the business side. In many cases, the business side of companies dictate the kind of the research is given priority. This tends to shift the balance towards applied research, which has direct impact on the business; compared to pure research whose benefit is more long term.

The best practice of this physical location, which will be discussed, is the use of Open labs, Living labs and Space makers.

3 RESULTS

3.1 iGrid Project as Open Science platform

The goal of the iGrid project is to design and implement a smart autonomous solar-powered DC based micro-grid using state of the art information technologies such as the Internet of Things (IoT), wireless communication, distributed architectures and new sustainable business models. This is a big challenge that needs the involvement of different stakeholders together with a team of multi-disciplinary experts. As such, the project is a joint effort that involves two academic institutions; The Royal Institute of Technology (KTH) in Sweden, and University of Dar es Salaam, together with other important stakeholder of the electricity market in Tanzania.

One of the key decisions made by the iGrid project early in the process was to support the approach of open science and its related transparency. In order to facilitate the involvement of all stakeholders in the research process and achieve the goals of the project in the most efficient way, the use of an open science gateway was adopted. This approach had several benefits: (I) It acted as a platform to easily integrate all the different research tools used to solve challenges met. (II) It provided tools and mechanisms to facilitate coordination and collaboration among different stakeholders involved in the project. (III) It provided a platform to share raw research results and facilitate the involvement of other teams in the research process. (IV) It provided a stage to share progress and results to the public, and the intended community of practice in particular.

The portal is now hosted at KTH with the address: http://igrid.proj.kth.se/ and has been able to share the information of the project to the public and involve them in the research process. It hosts and provides access to documents and publications related to the project. The portal has increased awareness of project activities and has shared the progress made so far. Discussion and forum tools available on the portal have also helped to coordinate visits to pilot sites, making them more efficient and assisting with record keeping.

3.2 Technology Transfer Alliance (TTA) as ICT Training

TTA is a web-based platform containing an integrated set of tools, applications, data repositories that are accessed via the TTA Portal. The aim of it is to support collaboration and training from different Universities for the purpose of sharing resources and giving out results. The portal is hosted at the Royal Institute of Technology, KTH with the address: https://www.ttaportal.org/. It is a non-profit network of universities interested in: (i) Having an impact on the development of the societies in where they exist; (ii) Problem-oriented, project-driven learning with a focus on innovation and entrepreneurship; (iii) Offering students and faculty member’s opportunities to contribute to important projects for academic credit. The platform supports members in two aspects: (i) Internal Academic development of pedagogical models and examination methods for problem oriented, project-driven learning (Guidelines to Challenge Driven education); and (ii) External networking with external stakeholders to define, fund and implement projects.

The TTA portal has to be used as a platform for students, instructors and stakeholder for collaboration and learning purposes. The aspect, which goes in hand with TTA, is CDE. CDE is the guide produced by [1], which aimed at supporting the collaboration methodology on teaching and learning practice. The idea is to make students and instructors to participate together in the formulation of society problems and solve them. Several projects have been run and completed successfully upon using this guide at KTH and Dar es salaam Institute of Technology, Tanzania. The concept based on how the learning process can be shared and repeated in a cycle upon solving different problems.

The motivation of developing this platform is to support collaboration and training and to foster education among the partners, sharing all sorts of resources and dissemination of results. The platform allows each partner to submit content such as project proposals, project documents, news update, information sharing via content lists and other kinds of content such as video or other multi-media contents that cover in a secure manner. All collaborating partners have access to contents through proper authentication mechanisms based on Identity Federations and fine-grained access control and they are able to edit contents easily through web pages (content management system). Some of the events are included such as seminars, webinars and presentations. The platform is further integrated with social media such as Twitter, Facebook and LinkedIn. Moreover, the TTA portal serves as an entry point for repository and relevant services that can be used by all partners. Ultimately, the platform evolved into a full-blown Science Gateway as content and applications management system.

3.3 Open Labs/Maker space/Living Labs as Physical co-location

Open innovation is a means of innovating based on sharing and cooperation between businesses. It is impossible for a singular business to have all the internal resources necessary for the development of new products or new processes. The principal of open innovation encourages joint development with expertise that is external to the company as seen in Figure 3. In order to work with new concepts, we need flexible laboratory space as Open Lab/Maker space/Living lab / than the traditional labs. This change is needed because of the quick change of in the laboratory instrumentation, student/ researchers engagement and the most important is the concept of increasing collaboration with in the project partners from the idea to the final new product marketing.

The Open Lab in Stockholm, Sweden is a center where students, teachers and researchers from Karolinska Institutet, KTH, Stockholm University and Södertörn University are working on challenges of the different application of the area. The aim is to contribute to solutions for complex social issues for the growing region through new interdisciplinary cooperation between traditional knowledge areas. The vision is that Open Lab, in a few years' time, will be counted as one of the most innovative and attentive interdisciplinary environments in Europe, and which greatly contributes to placing Stockholm ahead of the development of knowledge about how to contribute solutions to meet the growing and sustainable city's challenges. The largest number of Maker space members in Sweden are working in the open place on 300 m^2 large local area in Stockholm[8]. The Maker space is often hosted by open evenings with lectures and workshops. Continuous operations are currently funded mainly through membership fees, while contributions from sponsors go to improve business.

Figure 3. Innovation value chain.

A living lab are centers for co-creation and open innovation centers to facilitate the collaboration between researchers, creators, entrepreneurs and users as well as private and public sectors (Liedtke, Welfens, Rohn, & Nordmann, 2015). The aim of the living lab is to stimulate social innovations, which is user-centric. Example of Living labs are Laurea Living Labs Network in Finland, Eindhoven Living Lab in the Netherland, and Botnia Living Lab in Sweden.

4 DISCUSSION

The projects, initiatives and setups described in this paper demonstrate examples of implementations of the new proposed ICT training approach. In each example, different aspects of the approach have been implemented at different levels. However, in practice the process was not a simple matter of just applying one-step after another. There were different challenges that needed to be overcome in order to achieve results. The lessons learnt throughout this process contribute to some best practice advice that can be used to achieve more successful implementations in the future.

In terms of co-location, separating the research part of a company and integrating it with researchers from academic institutions, allows other kinds of research to also be pursued. It enables the industry to have direct input on the direction of ICT research and education.

Academic institutions also obtain benefits from this approach. Co-location helps students interact more closely with industry experts, and better prepares them for life outside once they finish their studies. It also facilitates turning research products into business products much more easily. A lot of academic research usually just ends up in publications, never to be applied in the real world. Co-location helps with this problem and increases research impact.

Taking the example of Open Labs/ Maker space, a student and industry expert need to spend more time in lab in order to learn the further principle of their study beyond the existing model. Experimenting is the basic learning method of concepts and for that spending more time in the lab allows the student learn it and be able to design goods and services compatible with sustainable society.

Students and researchers from the industry nowadays want to extend their own learning activities, which is also the main objective of the process. Universities can deliver Engineers with the documented solid laboratory experience. In today's universities, there is free access of the laboratory for students with 24/7 for individual assessments and laboratory. Open Lab allows sharing laboratory resources among universities for example by use of most electronic instrument can be controlled remotely with the platform of online workbench and hands of session.

For students to in the higher level of thinking and to increase their focus in the practical things requires teachers to engage in a different way of teaching. Maker space sessions promote the student's professional development with confidence and shows their creativity with the concept. More engagement and on hands on participation by presenting and comments of their work during any Maker space sessions. It is method for collaboration and this kind of educational setting is more beneficial and can facilitate the learning process. Creating maker spaces for learning and invention can help students grow and subsequently enhance their potential.

However, there are also still some challenges with co-location that need addressing. There are issues of patents, copyright and right of ownership that still need to be resolved. Academic institutions may also lose potential partnerships with companies that are competing with co-location partners.

Looking at the open science aspect of the proposed approach, its impact has also been positive in terms of facilitating coordination of research activities for solving different societal problems. As an example of TTA, the first use of the portal is done with the PhD and MSc students of the University of Dar es Salaam (UDSM) in collaboration with Royal Institute of Technology (KTH) for solving problems based on electricity in Tanzania. The range of users varies from 50 to 100 users, where by the challenge driven education is the approach on this platform. In addition, the portal has been attached with different projects such as Community Healthy portal, Kista NOC, Environmental monitoring, iGrid portal, WimeaICT, Bioinformatics and Serengeti Broadband Network. All of these applications are linked in the TTA portal for users to access them.

5 CONCLUSIONS

Open science is an emerging concept that will surely enables the developments of innovative and sustainable societal ICT systems. The rapid advances in computing and communication technologies have fostered the development of open science platform. In this paper, we described our experience in developing a creative learning environment through challenge driven education and using several open science platforms such as TTA, and Sci-GaIA, open lab. The open-science is practiced at the IGRID project where the aim is to develop an innovative learning environment for young graduate students to build innovative system in green and sustainable energy.

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