CHALLENGE DRIVEN EDUCATION IN THE CONTEXT OF INTERNET OF THINGS

A. Kelati[1,2], V. Taajamaa[1], D. Rwegasira[2,3], A. Kondoro[2,3], N. Mvungi[3], H. Tenhunen[2], I. Ben Dhaou[4], S. Naiman[3]

[1] Turku University (FINLAND)
[2] KTH Royal Institute of Technology in Stockholm (SWEDEN)
[3] University of Dar es Salaam (TANZANIA)
[4] College of Engineering, Qassim University, (SAUDI ARABIA)

ville.taajamaa@utu.fi, dianasr@kth.se, amlkel@utu.fi, kondoro@kth.se, nhmvungi@udsm.ac.tz, hannu@kth.se, phd.imed.bendhaou@ieee.org, smakere@gmail.com

Abstract

The need for creative engineers using natural sciences as their approach has not drastically changed in the past 100 years. However, technology advances has created new challenges and brought new opportunities, which calls innovation in engineering education. Todays, and even more so tomorrow´s engineers need to be equipped with both technical and soft skills that make them creative, and team player in the complicated, often complex environment industrial and societal challenges. In this study, we examined the outcomes of a workshop that focused on a learning approach called Challenge-driven Education (CDE) in the context of Internet of Things (IoT). The data for the study came from the participant feedback and was analysed using frequency analysis. The results show that teamwork and collaboration, joint discussions and self-improvement were valued.

Keywords: Activating teaching methods, Challenge-driven education, Train-the- trainer, IoT in learning, TTA.

1. INTRODUCTION

Challenge-driven education (CDE) is aimed at enhancing a scalable working life skills such as problem solving and team collaboration skills [1,2]. These skills are widely acknowledged to contribute to the solving of complex and wicked engineering challenges both in the industry and in the societies. CDE an active learning approach that is based on repetitive learning cycles while keeping the focus on the needs of the global society. CDE aims to put the best and the brightest engineering potential to work on the problems most in need of solution [1]. This is a valuable and widely recognized and appreciated goal yet at the same time challenging for the learner and the educator. Challenge driven courses including phenomena-, problem- and project –based courses which are seen to support the students learning through a constructive learning model [3,4,5]. This emphasizes conceptual understanding from the very beginning and is the basis for CDE as well. The ability to improve both skills and competence is strengthened through a process where students are working in a team-based, real-life, open-ended situation where they need to observe, conceive, design and implement solution.

Based on the previous research we define CDE to be:

- Problems are defined by the external stakeholders addressing real life problems and challenges with an open-ended formulation. The students need to develop a working relation to the problem owner towards co-creation and co-innovation and integrating pieces of knowledge and experience beyond what they have learned in their basic courses. Thus, the students will develop skills to handle the ambiguity to co-create and co-crafting to provide solutions to the challenges.

- Problems may have a multidisciplinary character resulting by the need to co-locate students to environments where expertise and experiences in other disciplines can be met. Typically, the theoretical knowledge and conceptual framework is moved to the more practical engineering context with hands-on work on designs and crafting the solutions.

- The students will be exposed to peer learning in addition to team work skills and project management issues through interaction with other students with different discipline background. This is fostered by the target for large project teams requiring self-organization and discipline among students.

1.1 The world of IoT from the view of Learning

Engineers develop and produce solutions for systems, services, and products that are fundamentally based on engineering principles and the laws of natural science, typically initially stemming from the mechanical and electrical base laws and from these engineering disciplines. Hence, all engineering based product development can be seen to be either mechanical or ICT-based [6].

Every system is integrated into the context in which it interacts. Hence, no action can be thought of without taking into consideration the environment that it belongs to. This is especially important when thinking of ICT (please see figure 1). Already today, but even more so in the future, complex technical systems will crossover into traditional disciplines. Computers are moving into cars through embedded electronic devices that are connected to the Internet. Mechatronics, embedded electronics, IoT, neurosciences, biotechnology, biology, to mention a few, all need to be connected and collaborate. This calls for unprecedented capability to design and develop solutions and systems that can interact together, while combining knowledge gained from the humanities in the puzzle [6,7,8].

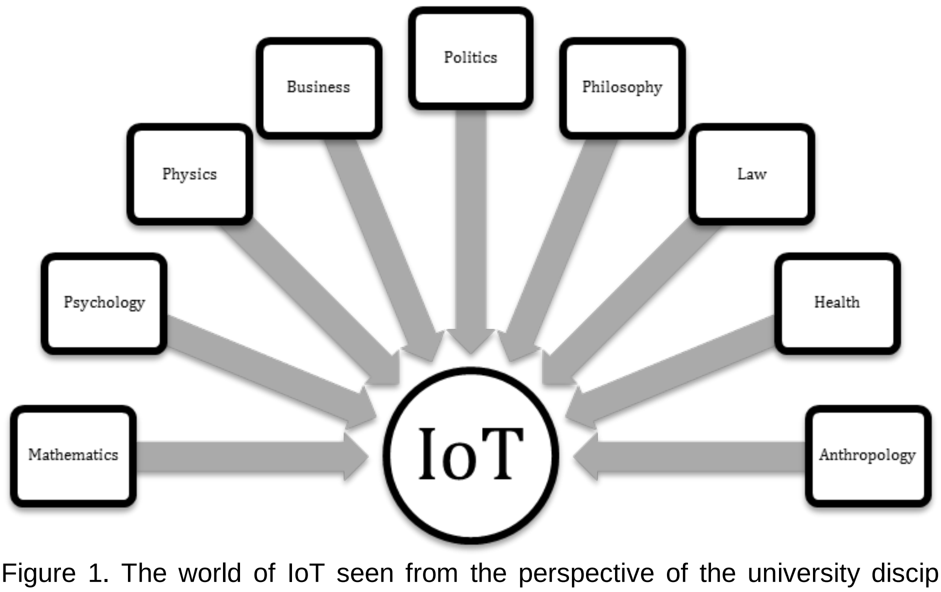

Figure 1. The world of IoT seen from the perspective of the university disciplines. IoT is a combination of several disciplines and always connected to context that it is in.

As there is always a context where a complex technical system operates, there is a person or a group that uses the system as seen in Fig.1. This group can be for example either society or industry. All systems aim to facilitate a hoped for a model of adoption and behavioral change. Social acceptance by users as well as stakeholders is of conclusive importance; hence the approaches such of “user-centered design”, and “need-finding”. Both of these engineering design tools borrow from several different disciplines including cultural as well as physical (the human being as a biological entity) anthropology. Storytelling can be another powerful tool that can initiate the purpose-driven process. All this sets both demand and emphasis to the learning system used. CDE can be seen to take the abovementioned into account [9].

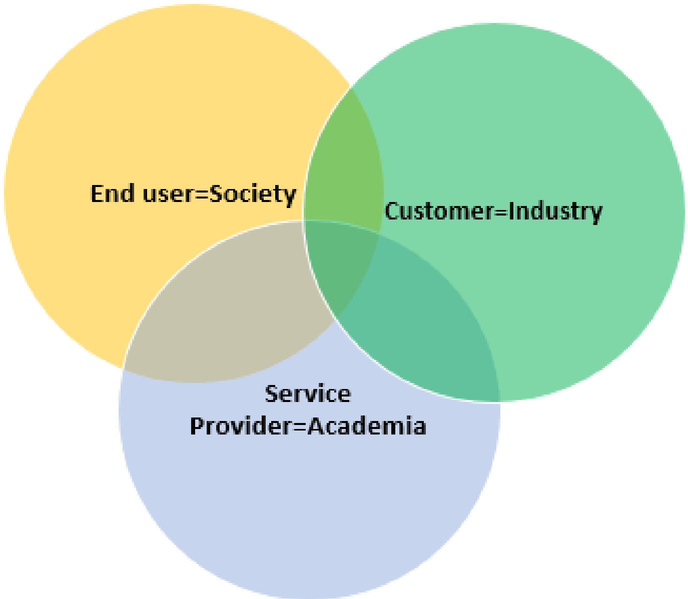

Figure 2. The social world of IoT. From the broader perspective of IoT it is always serving a need.

The world is getting more complex and the learning approach used must cope with the rising complexity as shown in Figure 2. The usage of open-ended and divergent approaches to both problem identifying, creating the design challenge, and the actual problem solving, through the user-centered and purpose-driven design, can create more questions than actual answers. The possible solution space can be both broad and open. In order to find a radical new approach the existing solutions, the need or the function and the starting point needs to be redefined. Whatever the approach, the system will always be complex. Thus, the design team needs to understand the new design changes existing and prevailing boundaries. The assumptions and interface – including its adaption and integration issues, are all important elements [6].

People are reluctant to change. Yet change is what drives progress, innovation and development – admittedly, change can be disastrous and lead to failure as well [10-14]. Therefore, risk is ever present, that the use of wrong approach process or learning will elicit fear and the fear of shame in students hence it is of paramount importance to use the correct methods [15]. This means that learning paradigms and methods should also help students to go through these emotions during their studies.

Carleton 2011, found out that the factors that facilitate change arise because [16]:

- People are vision driven,
- There is a distinctive focus on prototyping and workshops,
- There are no formal project management rules or formal process documentations
- Importantly the process is leadership-driven
- There is no reliance on peer review or communal decision-building mechanisms.

This setting lead to the idea that CDE could be a valuable learning method for learning IoT.

2. METHODOLOGY

2.1 CDE Workshop in Tanzania

The implementation of CDE was first introduced in Tanzania through in a workshop, which was held in September, 2016 under the theme “Open Science in Support of Education in Practice”. The focus of the workshop was to make participants familiarised on how to use CDE to solve societal problems. The three days workshop had different topics on each day as (i) Open science for education, (ii) Technology transfer Alliance (TTA) in practise: governance and how to organise CDE and (iii) How to do it and create impact and success. The people involve included: workshop facilitators, students from different institution, instructors from different Universities and stakeholders. The workshop also provided presentations and materials on how to make CDE process success upon implementation.

The first workshop focused on Impact of concepts like Science Gateways and Open Science on Teaching and Learning, Open Data, Open Access, Open Educational Resources, Impact of open innovation and co-creation/co-crafting to learning, LivingLabs, campus based OpenLabs and Innovation and Business creation hubs, innovation ecosystems, Innovation and entreprenuerial education models, Stakeholder integration and IPR issues and African examples which can be solved by CDE.

The second day dealt with intended learning outcomes qualifications for degrees to practical work on campus, Fitness to local degrees, governance, credits, and assessment practices, Industrial expectations to degrees and student skill for employability, Day’s project team work: local specific degree and curricula issues, marketing to local stakeholders, student engagement and recruitment for CDE work.

The last day involved examples of “success” and various concrete models, examination, grading & assessment individual against group, ILOs, study/learning diaries, contracts, handling IPRs, handling funding and external resources, How to organize the groups for the course, How the groups need to organize themselves for the projects, selection and identification of good projects, Project team work: Course organization and implementation, student couching and mentoring. Also, How to create impact, interaction and utilization of Living Labs, OpenLabs, MakerSpace, Innovation Hubs for courses, examples from partners (Africa & EU), IPR issues in practice, embedding and integrating innovation and entrepreneurship to the projects, Project team work: Discussion, presentation, and review team results from day 2 and 3.

In all of the workshop days, there were breakout group discussion sessions on choosen topic issues.

2.2 Data Collection and Analysis

The data for this study were collected from 31 participants who attended the three days’ workshop continuously. At the end of the workshop, participants were required to fill the questionnaire for the purposes of getting the feedback on how they understood and fill on using CDE approach on solving challenges. The 11 questionnaires were in the form of 5 points Likert scale where 1 was categorised as strongly disagreed while 5 was strong agreed and 4 questions were open ended questionnaire. The results were analysed using MS Excel software through calculating the mean values by frequency analysis.

3. RESULTS

The feedback consists of questions out of which some of the preliminary quantitative results have been reported by a poster of Sci-GAIA workshop in Ethiopia Winter 2017. The quantitative results are presented in this paper based on frequency analysis. The answers were then summed and the mean was calculated. Results above 4,5 out of 5 were considering having a positive significance and results below 4,0 were considering having negative significance. Table 1 shows the main results.

Table 1: Mean Result from the workshop

Question	Mean (scale 1 to 5)
The workshop motivates my teaching forward	4,53
The value of Joint discussions	4,55
The value of Teamwork & Collaboration	4,58
The value of Organizers & Coaches	4,52
I understood the concept of Open Lab	3,7
I understood the concept of Open Science	3,84

The main outcome of the workshop is the fact that the participants valued teamwork and collaboration during the process. Participants also appreciated how problems were identified and broken down into active modules during the workshop. The various joint discussions were valued highly as well, and the workshop motivated the participants to further develop professional skills such as teaching. The process of evaluating the success of the project was also understood by the majority of the participants, while the concepts of Open Lab and Open Science were not understood. This gives impetus to further communicate the importance of these concepts. This is not, however, in the scope of this paper, which focuses on learning from the perspective of CDE and IoT.

4. CONCLUSIONS

In the complicated, even complex world of future engineering challenges CDE provides a valuable addition to the plethora of learning approaches. This is especially valuable when looking at the interdisciplinary and context driven world of IoT. IoT can be seen as always serving a specific need, it does not exist without a purpose that it serves. This means that building IoT system starts with a challenge of problem or a need of some sort.

From the workshop results it can be seen that teamwork and collaboration were as the main result. This is especially important because it is aligned to CDE principles and approaches. This result is valuable in two ways. First, as a pragmatic outcome of the sessions during the workshop and secondly, and more importantly, as a hands-on learning approach to appreciate the importance of teamwork in the context of CDE. Also joint discussions were appreciated and this resonates well with the abovementioned. All this makes it logical that participants valued the workshop and motivating them to further develop their teaching skills. Open lab and Open science terms were not altogether understood and although those results are not in the scope of this paper and can be concluded that this poses a challenge as these terms are connected with the world of IoT as well. Future research should look into the applying of CDE in real-life student projects.

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