Innovation in ICT course provision: meeting stakeholders' needs

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Abstract ICT companies face problems in recruiting a workforce with ICT skills to meet an increasing demand driven by business growth and innovation. Typical degree courses offered by universities have failed to keep up with this demand, with the number of graduates failing to provide a sufficient supply of suitably-qualified employees. There is also often a mismatch between the degrees offered and the requirements of companies in the ICT industry. There is a need to develop new approaches to address these challenges with sustainable effect. This paper presents three case studies from three different countries. These case studies describe approaches taken by universities, government and industry in developing ICT courses using co-creation method. We consider the role of the different stakeholders and identify areas of commonality and challenges for the future.

Keywords: ICT courses, co-creation, digital skills

1 Introduction

In recent decades the role of higher education institutions has changed dramatically. Generation and communication of knowledge is no longer seen as the sole preserve of the university, while at the same time knowledge-based innovation has become integral to the success of business and of regional and national economies [11]. A number of different stakeholders are involved in the relationship which seeks to both support and drive this knowledge-based economy. Important among these are the universities which both conduct research and deliver courses; businesses which require knowledge and an increasingly highly skilled workforce to innovate and develop; and governments which can support and legislate to provide greater impact. There is currently considerable interest in the development of these roles and relationships, particularly in the area of course development and delivery.

A further central component in this (although seemingly not always at the forefront of course development models) is the learner. They are the basic resource that must provide the necessary skills for industry; they are the raw material at the heart

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of a course and the potential co-creators of knowledge through their own skills and life experiences. They are also individuals with competing demands who need to maintain a successful work-life balance [2]. Any model which ignores this dimension is unlikely to succeed.

This paper uses a case study approach to investigate different models for course development which incorporate various stakeholder perspectives. We present three separate cases from different countries and consider which stakeholders are primarily involved and how each seeks to address the needs and motivations of the different groups. We compare and contrast these models on the dimensions of stakeholder involvement; their support for students' work-life balance; and the extent to which they are successful as a useful model of course provision. Initial conclusions are presented based on these findings.

2 Background

In a knowledge-driven society, companies internationally have an increasing demand for employees equipped to contribute to continued economic performance and growth through on-going innovation. However, a continuing shortage of suitable workers and mismatch of skills is seen as directly damaging economic growth and societal well-being [4, 6]. This is despite the fact that many countries are now producing more graduates than ever before. For example, Davenport et al. [8] comment on the UK context in which there is a huge shortfall in the predicted industry requirements for skilled workers in the digital sector, while at the same time noting surprisingly high rates of unemployment amongst graduates of computer sciences. The obvious question is, why are such discrepancies arising? In order to address these concerns and to better meet existing needs, new models for course provision are being introduced.

Successful innovation in the area of course development, as in other areas, does not come from the university alone. Etzkowitz introduced a "Triple Helix" framework which views innovation as being increasingly based on the interaction of government, industry and academia [10]. This is not just a dialogue between three interested parties but an increasingly intertwined relationship resulting in an interactive model of knowledge transfer innovation. In the context of course development, such a model would suggest that in order to find creative solutions to problems such as the skills shortage the different stakeholders should be contributing to new approaches. In considering new models of course provision it may therefore be instructional to consider the extent to which the different stakeholders have been involved and how this has influenced the model and its operation.

In some cases, a new approach may be strongly dictated by one of the stakeholders with less input from or consideration of others. For example, a study by Zheng and Hu [21] considered initiatives in Singapore and Taiwan to increase national skills capacity as part of a "catch-up" industrialisation programme. As part of this, highly orchestrated government-led initiatives created new education institutions

committed to teaching programmes that could provide the necessary skilled workforce. On many measures, the up-skilling initiative was seen as hugely successful. However, the authors report that there was a high level of attrition after the workers had been recruited. The authors point to what they refer as the "missing link": that is, the failure of the government-driven approach to meet industry requirements at the company level. As this example suggests, it seems likely that a model in which one stakeholder predominates will not be completely successful.

The triple helix model identifies three important actors but fails to take account of one central group of stakeholders - the learners. Meeting a skills gap is not just about creating an efficient production process that can offer the right range of skills for industry. It is increasingly acknowledged that students have a valuable role to play in the co-creation of content and mutual investment in curriculum [20, 9]. Further, in purely practical terms the mode of delivery must make courses accessible to learners. There can be many constraints on learners (in terms of finance, time, location, learning support, family support and so on) which render good courses unsuitable or inaccessible. It is therefore also necessary to consider the perspective of learners and the approaches to course development, provision and support which can promote participation and contribution [2, 3].

3 Methodology

This paper adopts a case study approach to investigation of emergent approaches for innovative course provision. Case studies examine specific instances and can provide unique understanding of real examples in real situations [7]. They are set within organisational and institutional context and provide description with analysis. They can contribute to knowledge via analytic rather than statistical generalisability, that is, in their ability to contribute to the compass and expansion of theory [1].

Three separate approaches to innovative course provision from three separate countries are presented. Each approach is targeted at different situations and in different contexts. However, each is motivated by a desire to meet the skills gap and with consideration for learner participation and contribution. The questions we seek to answer are:

- to what extent are the different stakeholders involved;
- in what ways do the models seek to involve the learners' perspective and support a sustainable work-life balance;
- how successful are the models (so far) in providing a sustainable model to meet stakeholders' needs;
- what recommendations are suggested by the experience in these case studies.

We describe each approach under consideration, followed by a discussion comparing and contrasting the individual approaches.

4 Case studies in innovation

4.1 ICT courses in Finland

In Finland, as in many countries worldwide, there is a noted lack of applicants with suitable digital skills [15] with ICT companies facing problems in recruiting in many areas [17]. Typically, traditional degree courses were found not to be solving the problem as the curricula offered were failing to meet the needs of industry. One response to this has been a national scheme to introduce innovative Masters level programmes at Universities of Applied Sciences [16]. Developed in close cooperation with industry these courses are intended for students who have at least three years' work experience. They complete their degree in 18 to 36 months, studying alongside their job.

The programme has proved successful with both students and companies, with 13,000 graduates in 2015 [16]. However, ICT graduates form only a part of this number and the skills gap continues to be a problem [15]. Seinajoki University of Applied Science has engaged in the programme and runs a variety of successful Masters courses. However, they have also sought other means by which to address the on-going skills shortage. In particular, they have introduced a new ICT education programme (offered at both Masters and undergraduate level). The initiative is based on the principle of co-creation of knowledge.

Taken from management studies, co-creation brings together different interested parties to produce better results [13]. In education, the focus shifts away from the idea that the university is the sole creator and disseminator of knowledge. Companies and students become partners in the creators of knowledge [20]. The initiative was taken forward on a regional basis, by identifying and working with local industrial partners to co-create Bachelor/Master level provision. The first step in this process was a joint business meeting to form an initial idea of needs in ICT areas, with key local companies invited to contribute. Following this a web survey on ICT competencies was conducted amongst regional companies. Of the 49 respondents, 12 were identified to participate in a series of "co-creation workshops" in which business and academia collaborated on the needs and requirements of a curriculum. Company's immediate needs must be balanced with the requirement to provide a sound theoretical basis and understanding. The workshop provided a meeting point where ideas could be discussed face to face. Following the workshop, on-going discussion and development continued online.

The co-creation workshop was not just a talking shop: it was carefully structured to encourage meaningful collaboration, bringing together drivers from industry ("we need to have...") with the curriculum perspective and pedagogic knowledge of the academic members ("students need to know..") [3]. A further feature is the on-going nature of the collaboration, giving industry joint ownership in steering and developing the courses. A number of companies were willing to contribute to teaching, either through guest lectures or by contributing a whole module. Connections to

places of work were also offered (such as locating teaching and project work in a company).

4.1.1 Involvement of university, industry and government

In this case study, government were not involved as part of the proposed solution. The initiative worked through close cooperation of specific academic and industrial partners. It was achieved on a regional basis, allowing specific needs in a particular locale to be addressed. As a result, the companies involved were able to see themselves as meaningful contributors to the creation of the syllabus and the running of the course. Their feedback indicated that they were happy with the curriculum, feeling that it met their needs. The on-going collaboration ensures that developments of changing requirements can be incorporated through a process of continuing dialogue [3].

4.1.2 Involvement of learners

Students were not involved in the initial development of the course. However, a further central motivation of the approach was to consider students' work-life balance and to see how they could be involved in co-creation of knowledge at a module level. One example of how this was achieved was in the use of novel technology to support distance seminars [2]. Given that the course involved several separate centres over 100km apart, students previously taking a traditional version of the course needed to do a great deal of travelling. Practical approaches such as this were shown to make a large difference to students and their ability to juggle life, work and study.

The students on this Master course brought a good deal of experience and knowledge to their study. Technology was used to support an approach in which sharing of individual experience was a central part of knowledge creation. The management of the software was again very important, as was the teachers' role in ensuring that the sharing process happened in an organised and structured way and that the contribution to the learning objectives of the module were clear [2].

4.2 Degree apprenticeships in the UK

In the UK the digital skills shortage is being addressed at government level as one of the key objectives in its Degree Apprenticeships scheme (Graduate Apprenticeships in Scotland). For many years, employers have been expressing dissatisfaction, both at the number of qualified applicants and at the skills of graduate applicants [18]. The government has consulted groups of employers representing sector areas (known as trailblazers) to develop standards for different degrees, both at undergraduate and Masters level. In computing, the Digital Technologies standard ap-

plies, which has variant specialities covering Software Engineering, Security, Data Science etc [14].

Individual universities work with industry to develop degrees accredited against the appropriate standard. There is considerable flexibility in how the standard is interpreted allowing each specific degree to be tailored and shaped by the joint discussions between university and industrial partner(s). A degree may be "closed" (available only to the intended partner companies) or "open" (other companies may negotiate to send students).

Students are identified by the companies from their existing workforce or recruited as degree apprentices to meet both the requirements of the company and the degree. The company commits to paying the degree apprentices at least a minimum wage (most pay more) and to allow them at least 20% of their contracted hours for study. Each degree standard carries an agreed level of tuition funding and this is paid to the university provider by the industrial partners for each degree apprentice.

The mode of delivery is decided by agreement between the university and the company (day release or block teaching, distance learning, blended learning, combinations of different methods for specific modules). An undergraduate degree should take between 3 and 5 years to complete. With only a guaranteed 20% of time off the job students obviously do not have as much time as traditional students to devote to their studies and in order to fit a degree into the required time the focus of Degree Apprenticeships is on work-based learning. Specifics of this for each individual student is agreed in tripartite discussions between the student, the university tutor and their work-place manager. This allows learning tasks and assessments to be based around the work that the degree apprentice is engaged in.

When a specific degree is accredited it will state the modes of assessment that apply, and this is another aspect discussed between university and industrial partner(s). There may be some formal examination and coursework which is quite structured and fixed in nature. But there may also be tasks which are defined by learning objectives that can be met in different ways by individual students depending on the opportunities afforded by their working role. The nature of the exact task for each student would again be decided in the required tripartite meetings.

Degree Apprenticeships are as yet relatively new, having gained approval for delivery in 2015. Many universities are now embarking on their first one, either with curricula currently under development or with a first cohort now underway. Whether the intended outcomes of the scheme will be met is yet to be evaluated, however, initial indications are that they are increasing in popularity amongst universities (with more providers registering), in industry (with many companies now looking for suitable academic partners) and with students.

4.2.1 Involvement of university, industry and government

The government is key in this initiative, providing the necessary structure and financial incentives that make the scheme attractive to employers and degree apprentices. In addition to the intended benefits to industry of providing more graduates with

better-focused skills the Degree Apprenticeship scheme offers companies direct financial incentive. This is because they would in any case have to pay an "Apprenticeship Levy" but can off-set that cost against the funding for the degree apprenticeships.

Industry have been involved as trailblazers in creating the standards and are also central in the development of every degree proposal against the standard. Companies therefore have a considerable degree of ownership of the curriculum. However, it is a partnership with the academic provider so universities discuss with the industrial collaborators to create a strong syllabus which will ensure that students obtain a robust theoretical grounding and full range of transferable skills as opposed to just being trained for a particular role.

4.2.2 Involvement of learners

Degree apprentices are involved as an equal contributor in tripartite meetings. They are encouraged to take responsibility for their own learning and to negotiate learning and assessment activities with their manager and tutor. There has not been time for any evaluation to take place on this so it will be interesting to see how far in practice students feel they are able to shape their learning. Despite the flexibility in negotiating work-based learning activities, students must work within the structure of the degree. The general content and timetable is set for the cohort as a whole. A single degree is likely to bring together apprentices from a number of different areas (either from within a single company or from many different companies). Thus a class could represent a diverse range of knowledge and skills. In theory, that could support student-led learning drawing on shared experiences of the group. However, in practice this would depend entirely on the how the curriculum is conceived and delivered.

4.3 Industry-driven development in Slovakia

In Slovakia, the digital skills shortage has been noted as a key problem in all industries for many years. Employers have been expressing dissatisfaction, firstly at the number of qualified applicants and secondly at the skills of graduate applicants who lack hands-on experience with problem solving in IT projects.

Over the years, the Faculty of Management Science and Informatics at the University of Zilina has been repeatedly commended as one of the best ICT faculties in Slovakia and recognized for producing graduates who are immediately employable. Despite this fact, traditional ICT degree courses were found not to be following the ICT trends as the curricula offered were too traditional and therefore failing to meet the changing needs of industry. At the same time, universities are able to produce a limited number of graduates. In the Zilina Faculty of Management Science and Informatics, only around 100 ICT professionals graduate with a Masters level de-

gree every year. Unfortunately, the annual demand of local companies is several times bigger. The university is not able to multiply the number of graduates as well as change curricula significantly (as it would require a new accreditation process), therefore, ICT companies have decided to cope with this problem individually.

One solution widely used by local ICT companies is an internal ICT course tailored to their own needs. This model was already tested by two local companies in Zilina. The ICT course composition and duration were very similar in both companies. Participants of this course were recruited as potential workforce. They were assessed according to essential criteria such as: level of knowledge in programming, potential fit with the company culture, internal drive and motivation to pursue an ICT job. The course was completely free for participants and they even got two substantial benefits: hardware and salary during the whole program.

There was extensive coursework and constant examination. Those who failed were excluded from the program. The approach centred on work-based learning with minimum lectures and maximum self-study and practical learning during actual software development.

The intended outcomes of this course were met. However, companies faced several challenges: course composition, course material (subcontracted to university), number of applications, quality of applicants, budget, value of the participant to the company compared to time and money invested. Therefore, they decided to search for a new model in cooperation with the university. Individual companies were not willing to invest the amount of time and money needed to train skilled workers. They agreed to cooperate within an ICT cluster and develop meaningful courses in cooperation with the university. They are now working on a new ICT course under the supervision of the Zilina ICT cluster and using co-creation methods for the course development.

4.3.1 Involvement of university, industry and government

In this case study, government were not involved as part of the proposed solution. The course was created in close cooperation between university and industrial partners. It was a regional initiative, allowing specific needs of individual companies to be addressed. As a result, the university involved was able to see itself as a meaningful contributor to the creation of the syllabus of the course. On the other hand, strong company involvement in the curriculum development met their specific needs. The on-going collaboration within the ICT cluster ensures that development of new course under the changing requirements can be developed through a process of continuing dialogue between industry and university.

4.3.2 Involvement of learners

Participants were not involved in the initial development of the course, however, they were encouraged to take responsibility for their own learning. Participants eval-

uated this type of course as extremely helpful and the best students from the course (mostly all who passed) are working in the companies that trained them. A single course has brought together participants from a number of different areas. Thus, participants represented a diverse range of knowledge and skills. In practice, the curriculum was conceived and delivered by practitioners who were extremely motivated to get the best out of participants.

5 Discussion

The skills gap is acknowledged as major problem worldwide. Projected figures indicate that in many areas the gap is huge. The European Commission calculates the demand for workers with ICT skills to be growing by about 4 percent annually, which may lead to a shortfall of 900,000 qualified workers vacancies in 2020 [12]. This is a significant problem which creates a substantial challenges for policymakers at all levels [5].

Given the scale of the problem and diversity of needs, it is likely that a variety of different solutions will be needed to tackle the problem in different ways and at many levels. The three case studies reported here give an indication of the diversity of approaches currently being adopted. They also give an indication of some of the aspects which are important considerations for the success or failure of such a scheme. Each of the schemes involves stakeholders in different ways. The UK Degree Apprenticeships are top down in conception (that is, initiated at government level) but are implemented at a local level by collaboration between academia and industry. There is flexibility but only to a certain degree because the basic specifications are fixed. The ICT training approach in Seinajoki is a regional initiative instigated by the university. Again, it sees industry involvement as central and the co-creation principle works well in ensuring industry's needs are met and in engendering shared ownership and responsibility. In Slovakia, industry were the initial movers, taking the training situation into their own hands to meet their skills shortages. However, the investment for companies to do this in time and money proved a major disincentive and the model now adopted is a collaboration between a group of businesses and academia.

Although different in nature, the schemes have all found (although not in all cases the original approach) that co-creation with industry is a key factor. While tailored individual solutions are attractive, the resources required make it infeasible. All three approaches involve the delivery of central, core material while allowing scope for individual student and company directions through large components of workplace learning. Universities are well-placed to develop a curriculum which provides students with a broad range of knowledge and skills needed not just to serve a company in the short time but to become innovators in the field. While industry has sometimes complained about the "abstract" and theoretical nature of university teaching there appears to be a growing awareness that a balance of that is needed in order for their own growth and development.

Another feature to come of the case studies is the need for courses to be flexible and adaptable to meet changing needs in industry and new research from universities. It remains to be seen whether the fixed syllabus of Degree Apprenticeships will allow sufficient flexibility for this to work successfully.

Although the three studies all involve students to some degree it is clear that they are not being involved in the inception and development of the initiatives as much as they might be. We suggest that this is an area that should be considered for the future. With shortages of recruits for many STEM degrees, the student voice on contents and modes of study would be a valuable input. There is some degree of student perspective incorporated currently at an individual module level (with work-based learning and technology-supported distance learning). However, the design of such schemes often does not involve student voice to any significant degree. This may lead to problems further on. For example, there are anecdotal indications that the workload on Degree Apprentices is in some cases stressful and unsustainable.

One of the main motivations for each of these schemes is to bridge the skills gap. Indications are that they are proving attractive but that these are just initial steps [19]. However, there are also other possible benefits that can be gained by a move from more traditional methods of course provision. Schemes which are more accessible (such as the Seinajoki ICT training) are likely to attract students from a more diverse background. Similarly, a Degree Apprenticeship model (with it's emphasis on practice and employment and with funding to the students) is likely to increase access to Higher Education for students from low-participation groups. Initial studies are starting to indicate that this is indeed happening [19].

6 Conclusion

Although it is early days, the schemes presented in our case studies are all informally reporting success in terms of attractiveness to industry, recruitment of students and placement of graduates in industry. However, there are still many challenges to be faced. These include limited places due to funding, a lack of flexibility in curricula, lack of student voice, student workload and successful management of workplace learning to meet learning objectives, both as a challenge in the workplace and in universities. This together with the fact that demand continues to increase means that more work and more initiatives with high capacity are needed. As the current schemes begin to mature, further research is needed to evaluate their strengths and weaknesses in order to inform future work. It is likely that a range of different schemes will be needed to cover different situations and needs, but co-creation as a basic principle may well be beneficial in all cases.

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