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Curriculum Innovation for Employability: Reflection on Computer Science MSci Integrated Master with Industrial Experience

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Abstract
An emerging curriculum innovation within UK Higher Education is MSci Integrated Masters with Industrial Experience. However, we know little about how such programmes may be designed based on feedback and insights from its three main stakeholders: employers, students, and academics. In this paper we reflect on our ongoing work for curriculum development and evaluation, focusing on the MSci Computer Science at Lancaster University. We report on 15 interviews with employers offering placements, MSci students, and academics supervising them. We focus on the critical issue of matching interests and competencies across the three stakeholders to construct industry placements, while allowing for the negotiation of their mutual benefits. Findings also highlight stakeholders' perceived placement's challenges and ways of addressing them. We conclude with several suggestions for the MSci curriculum development including mechanisms for managing stakeholders' expectations, recognising companies' contributions, strengthening academics' engagement during placements, and ensuring effective matching process among companies providing placements, students and academics.

1. Introduction

An emerging curriculum innovation within UK Higher Education is MSci Integrated Masters with Industrial Experience. There are strong educational perspectives supporting such innovation, around students' engagement with real life problems while accessing communities of practice beyond academia. However, we know little about how such programmes may be designed based on feedback and insights from its three main stakeholders: students, academics and employers. The importance of graduates' preparedness for the job market cannot be overemphasised. Previous work expressed concerns about the potential of Higher Education Institutions in the UK to meet the skill needs of the industrial sector, particularly in STEM disciplines (Wakeham, 2016), with the unemployment figure for Computer Science graduates features as high as 10% with large geographical variations (Shadbolt, 2016).

In this paper we reflect on our ongoing work for curriculum development and evaluation, focusing on the MSci Computer Science at Lancaster University. The School of Computing and Communications at Lancaster University has been ranked the first in the UK by the Times/Sunday Times Good University Guide on graduate prospects in 2015. We believe that this is partly due to the success of the MSci programmes. For the last 3 years, all our MSci graduates are either in graduate job or graduate education.

In this paper, we draw from our experience of running this programme over the last 4 years, and our work on curriculum innovation (Sas, 2006a, 2006b; Sas and Dix, 2007, 2009a, 2009b), knowledge transfer (Sas, 2009) and employability (Sas, 2016).

2. Context

2.1 Lancaster's MSci in Computer Science

Our MSci Computer Science programme provides a blend of academic content and industrial experience. It currently recruits about a dozen students, with a small, yet steady growth each year. The programme aims is to provide students with a broad, yet rigorous treatment of the fundamental principles of the Computer Science. In the first term, students take 4 taught modules, while in the second term they take part in a 10 weeks initial placement. This is followed in the summer term by a 7 weeks second placement, mostly with the same company, while the remaining 3 weeks being allocated to the project writing. We further discuss the placement modules.

2.2 Placement Modules

The programme features two placement modules, designed to challenge students and develop their existing knowledge, understanding and skills from their previous three years of study to produce a significant piece of academically rigorous project work. Here, students tackle a real-world problem by applying their knowledge in Computer Science. The first placement module allows student to familiarise with company's environment and to explore the feasibility of a specific project. The second placement module requires them to actually engage and complete the project proposal developed at the end of the first placement module. More specifically, the two placements modules build on each other and focus on a specification, design, implementation and/or evaluation project at the suitable level for MSci. Most of the completed projects involve systems or apps development, with a few focusing on evaluation studies. Here we have some examples of typical project outcomes:

- App development (used within company's product suite)
- Design and implementation of a customer portal (still in use)
- Design of a business information system (still in use)
- Security assessment and users' perception of security tasks

2.3 Placement Modules' Assessment

The assessment of the initial placement module consists of a report on the placement's work, with both technical and reflective components (50%), a project proposal (25%) and an oral presentation (25%). The assessment of the second placement module consists of a dissertation (100%) as well as a poster session where students showcase their work and receive feedback from both employers and academic staff.

2.4 Mentoring and Supervision during Placement Modules

During placements, each student is assisted by an industry mentor and an academic supervisor. The former works with the student on the day to day activities, while the latter provides academic input on a weekly basis to ensure the necessary level of academic content and rigour, and that the student progresses towards the completion of his/her assessment work. There are also Knowledge Business Centre mentors (see section 3.3.) providing students with additional insight into the day to day expectations and responsibilities of working with industry.

3. Study Findings

We report on 15 interviews with the three main stakeholders: 8 employers who offered MSci placements, 3 MSci students, and 4 academics supervising MSci projects. The study findings highlight students' feedback and attainment, as well as the challenges of placement and ways of addressing them. We conclude with a reflection on the value of the findings for MSci curriculum design in general and placement modules in particular.

3.1 Students' Attainment and Feedback

Students continuing to the fourth year of the MSci programme need to meet the progression criteria of achieving 2:1. Hence, it is probably less surprising that their attainment is strong, with half of them achieving 2:1 degree classification, and the other half achieving a 1st degree classification. In terms of feedback, all students greatly appreciated the opportunity to work in a company and to gain real world experience that can differentiate them on job market.

3.2 Companies' Feedback

Most of the companies expressed satisfaction with students' great level of engagement throughout the placements. Some micro SEMs which have three or four full time staff may take two students every year, and often the results of students' work such as the applications or systems that the students built and the code they wrote, continue to be used by the companies after the placement has ended: "*I was very happy with the online service app I have developed. It is going to be used by the company*". As a result, most of the MSci students received job offers from their placement companies. Findings also indicate that over the last three years, all MSci Computer Science graduates have been employed in graduate jobs, i.e. graduate scheme at BBC, BT, employment within the placement company, or in other in other SMEs or larger companies, while the rest have enrolled in postgraduate education, i.e. PhD studies. As a result of providing placements, companies also benefit from getting to be known both for the services/products they provide, but also among SCC students and graduates, which may support their future graduate recruitment: *"They also get to basically have students and see how they perform. Sometime, they recruit students immediately or later".*

3.3 The Placement Process

Organising these placement modules, would be very difficult without the help of Knowledge Business Centre (KBC), which plays a vital role in facilitating students' placements within a range of businesses from SMEs to large corporates. The KBC is an integral part of the School of Computing and Communications. On reflection, KBC colleagues play three key roles. They have developed in depth ongoing knowledge about potential companies interested in providing placements within the North West of the UK, by maintaining a network of existing "partner companies". They also monitor the placement and negotiate any tensions arising between students and the companies. The KBC also provides additional one to one mentorship to students during placements.

One of the most critical elements of the placement process is the *matching of each student with a company and an academic supervisor.* This matching process is ensured by the KBC together with the MSci tutor and focuses on three elements: time scale, number of companies involved in the process, and the need to offer equal opportunities to all students to access their choice of placement.

In terms of timing, the process usually starts in August, when the 3rd year students provide CVs and cover letters with their placement interests, including career aspiration, and availability to travel. By Sept-Oct, the companies are asked to send to KBC their project brief or expression of interest for hosting placement, including skill requirements, i.e., programming skills. Companies set tasks that are related to students' knowledge and experience, allowing them to apply it in a professional setting. The KBC targets potential companies by sending flyers with requests for placement and what it entails. We identified that something that works well is targeting 2 companies for each student. This offers students choice to choose from at least two companies and their briefs. At the same time, it limits the risk of disappointing the companies which prepared briefs but attracted no students for their offered placements.

In Nov-Dec we run an Introductory, half day workshop where all companies which provided briefs are invited to describe their projects to the MSci students, by focusing on the project idea, specifications and required skillsets. At the end of this workshop, each student completes a form with his/her top three placement choices. Subsequently, the MSci tutor and dedicated staff members from the KBC work together to match students' CVs, cover letters and their top three choices, with the companies' project briefs. The aim is to meet students' 1st or 2nd choice. The next step for the MSci tutor is to identify potential academic supervisors, whose input is required to further tune the brief in order to ensure sufficient academic content of the project.

3.4 Placements' Challenges

The main challenges associated with the placements can be broken down in those experienced by the students, companies and academics.

Students' challenges are mostly due to their lack of experience of working in industry settings. For example, students tend to overcommit, by finding it hard to say no when asked to do something by their industrial mentors. A common side effect is that students become overwhelmed and overworked, having to complete both the work for the company required by the placement, and its associated academic assessment. In some cases, the dissertation writing lacks behind. Students' overcommitment is underpinned by the often competing academic and placement's demands, as illustrated in the below quote:

> "*The companies are all eager to get all from the students. They're investing in them … They get our better students anyway [and] see the benefit that they're bringing and they think that's brilliant! I need more of that.*"

As a result, **companies' main** challenge is that they can develop unrealistic expectations regarding students' work. Another challenge is that a company which has prepared a brief for a placement may not get to host a student. In this case, they can become disappointed and fail to re-engage in the following year with the placement programme. Finally, a challenge, which so far has not materialised, is the perceived risk of disruptive students and their potential negative impact on a small SME and their working culture.

The main challenge experienced by the **academics** is their relative limited input into students' daily work; they also need to guide students towards successful completion of their assessments. There is at time, an unspoken tension between the pull of the academic supervisor and industry mentor, which requires negotiation.

4. Implications for MSci Curriculum Design: Good Placement Practices

We now reflect on the identified good practices as ways to address the above challenges. These include mechanisms for managing stakeholders' expectations, recognising companies' contributions, and strengthening academics' engagement during placements.

4.1 Expectation Management for both Students and Companies

Most of this work focuses on identifying opportunities to *manage the expectations* of each of the three stakeholders: students, companies, and academics.

For students, this means supporting them to set boundaries. Over the last years, we have learned the value of running a workshop with students before they join the company explaining what is expected from them (e.g. keeping regular working hours, dress code, etc.), how they should behave, when and how to interact with their supervisor, and about their assessments. We also talked to them about saying no when additional tasks endanger the completion of their academic assessments. We make them aware that there is a risk that some companies (especially small ones) may show a tendency to overburden students.

In time, we have also developed several mechanisms for **managing companies' expectations**. The more we have engaged with a specific group of companies, the easier it become to manage them, as the companies learn to work with us. But for any new company, the engagement process needs to be initiated. The four mechanisms for managing companies' expectations are further detailed. First, we have flyers prepared by the KBC with requests for placement and what it entails. These are sent out to all prospective companies. Second, we provide feedback on companies' project briefs, which we solicit in advance. Such briefs are reviewed and we provide feedback to the companies with respect to the scope of the proposed project: *"That's feasible or that's not feasible. I think we need to cut it down"*; "*They don't buy consultancy, they [just] get the students to work with*". Third, we have learned to run an introductory workshop with students and companies to ensure that the student fits in the company environment. This addresses the biggest worry from the companies such as: "*Is that student going to be disruptive?" Especially if they're a small team, they need to see they have a rapport with them and make sure that they're not going to disrupt the workspace completely".* Finally, we actively monitor any conflict and aim to address it as soon as possible. Conflicts are often due to some miscommunication between the student and the company, and a third party such as KBC is in the best positon to negotiate it.

4.2 Recognising Companies' Contribution

Another good practice that we developed was formalizing the companies' engagement with the School. Companies with which we collaborate on a yearly basis receive the status of SCC partner companies and are advertised as such on our website. Those who fail to recruit students despite providing project briefs are advertised as offering summer interns, so that they still have access to some students.

4.3 Strengthening Academics' Engagement

Currently there is limited support for academics supervising MSci projects, as they are predominantly company-driven. Findings indicate that in order to meet academic expectations, the supervisors attempt to inject as much academic rigour in the project as they can. For

example this consists of guiding the students to seek generalisable solutions beyond the specific scope of the brief: *"Making sure there was some kind of research component; guide towards a solution that was more generalized*".

In order to keep academics better informed about students' performance during the placement, we developed forms through which the industry mentors provide feedback on students' work. This feedback is further considered by academics during the marking of students' reports. There is also scope for the academic supervisors to engage in a direct dialogue with the industry mentor, and some of the academics have started to do so.

4.4 Ensuring Effective Matching Process

Findings indicate the importance of having dedicated staff to engage with the companies and support the effective matching of the three stakeholders: companies, students and academics. Crucial here is the role of the KBC in supporting communication mechanisms among these stakeholders, as a third party negotiating tensions between students and companies, and as provider of additional mentoring.

5. Conclusions

This paper presents findings on the benefits and challenges of industrial placements as part of Lancaster's MSci Computer Science programme. We advance the understanding of the beneficial impact of this programme on graduate employability. Our findings also led to the identification of several good practices around industrial placements related to managing stakeholders' expectations, recognising companies' contributions, strengthening academics' engagement during placements, and ensuring an effective matching process among the three stakeholders.

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Authors' Short Bio

Corina Sas received her PhD degree in 2004. She is Senior Lecturer in the School of Computing and Communications (SCC), and Associate Director of the Institute of Social Futures at Lancaster University. She was Chair of the British HCI'07 conference and associated chair for CHI and DIS 2014. Since 2013, Corina has been Director of Studies in SCC overseeing the undergraduate programmes delivered to over 500 students. She has been an investigator on grants totalling over £6m, and has over 80 peer-reviewed publications. Her expertise focuses on technologies for reflection and remembering, and the role of affect in reflection, memory and sense-making.

Dr Andreas Mauthe is Reader in the School of Computing and Communications with research interests in Networked Systems, focusing on two main areas, i.e. Network Management and Multimedia Systems. He has been published in more than 70 peer-reviewed publications and has been a senior member in more than 9 projects in recent years. He has been Director of Studies in SCC (2011-2013) and has led the curriculum design for the MSci schemes. Currently, Dr Mauthe is MSci tutor.

Sarah Mills graduated from De Montfort University with a BA (Hons) in Business Study. She has worked at Lancaster University for over 12 years in a senior administrative capacity.

Colin McLaughlin has been working at Lancaster University in InfoLab21 for nearly a decade. His role has always been focussed on the development of external relationships in order to support the School of Computing & Communications. The activity covers a portfolio of more the £10million worth of ERDF projects, enhancing the value of co-location, research collaborations including RCUK and H2020, working with public bodies such as BIS NW, Innovate UK and the Digital Catapult, and large industrial partnerships such as HP, BBC & IBM.

Dr Joe Finney is Senior Lecturer in SCC, with research interests in network and system support for mobile, embedded and ubiquitous computing. Through the prototyping of novel and emerging applications, he works to discover new requirements, architectures, protocols and techniques for future networks and systems. Dr Finney is Director of Recruitment.

Steve Fish obtained his Ph.D. in 1993 from Dundee University. He is currently Head of Business Partnerships and Enterprise in the School of Computing and Communication (SCC) at Lancaster University where his team support undergraduate and postgraduate student placements with industry as well as developing new research initiatives with commercial and academic partners. Previously Steve was the Director of Enterprise at Aberystwyth University's Institute of Biological Environmental and Rural Sciences (IBERS), playing an active role in developing projects valued in excess of £30m.