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Social science in action through graduate student internships on industrial innovation projects – A literature review

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Konstantina Stamati
Nikoletta Athanassopoulou
Diana Khripko
Clare Farrukh

* Please contact the corresponding author for feedback:

cjp22@cam.ac.uk

Abstract

The Cambridge Grand Challenges (CGC) initiative was set up in 2018 to foster collaboration between industry, government, and academia, and designed to help put the UK at the forefront of the industries of the future. As part of this, a program was set up to facilitate the process of Social Sciences doctoral students working with industry in short internships, to increase innovation and improve skills.

In this literature review paper we aim to review the basis of this approach and the academic and industrial context. A contribution is made towards uniting three distinct areas of literature, starting with the underpinnings of academic-industrial collaboration, followed by the social science perspective on academic-industrial knowledge exchange, then considering the links between internships and learning. The review concludes with proposed implications for knowledge transfer within this specific context. The paper highlights the research questions needed to further investigate the benefits, barriers and enablers, and the processes which facilitate the value delivering mechanisms of engagement, to demonstrate how such programs make a contribution towards improving UK industrial productivity.

Keywords

Innovation; grand challenges; social science; student internships; technology; knowledge transfer; industry; prospective sense-making; productivity; academic-industrial collaboration.

Introduction

The UK Government's Industrial Strategy (2017), since followed by the Innovation Strategy (2021), focused on improving productivity by strengthening five pillars – ideas, people, infrastructure, places and the business environment. It set out four Grand Challenges where Britain can take an international lead – artificial intelligence (AI) and big data; clean growth; the future of mobility; and meeting the needs of an ageing society. Broadly based and meaningful knowledge transfer between academia and industry is needed to underpin the two key aspects of ideas and people. However what is observed and measured in knowledge transfer, while being well intentioned and worthwhile within its own remit, involves technically trained people and long-term collaborations on well-established research projects. In addition, the ethical and social dilemmas embodied in new and emerging areas of science, technology and engineering require personnel with broader skill sets, such as those available from social scientists whose input will help ensure a balanced development perspective and include a wider range of societal insights.

Around a third of graduate level university students are in the Arts, Humanities and Social Sciences (UK HESA 2010; OECD 2017), who tend to gravitate towards work in the 3rd sector, government or policy employers (Diamond et al 2014). Social sciences students are less likely to apply to industry for jobs (Figure 1), and UK industry is largely unaware of the skillset and potential they offer, although multi-national companies are already recruiting strongly from this group. We cannot afford to lose the experience, skills and potential embodied in the people learning, researching and teaching in the social sciences as we design and implement the technological, industrial and social world of tomorrow (British Academy 2019). Further, social science graduate students deserve the chance to explore and consider the opportunities and fulfilment that industrial careers can provide before making their next career choice (British Academy 2020).

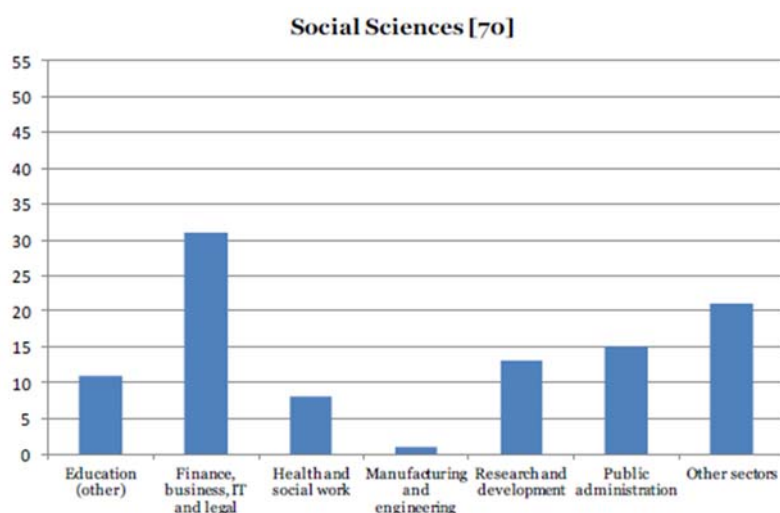


Figure 1: Destinations of 70 UK doctoral Social Science Students 7-9 years after graduation (Diamond et al 2014)

The Cambridge Grand Challenges (CGC) was founded in 2018 (Stamati 2018). Recognising that there is scope for establishing a new archetype, a dynamic and long-term partnership between business, government and academia, this project set out to explore such scheme and its benefits for multiple levels and stakeholders (Figure 2). The CGC established the Cambridge Social Science Partnership (CSSP) program as a pilot within the micro-level engagement activities. This enabled doctoral students to work with industry in short internships funded by ESRC (Stamati and Willmott, forthcoming). CSSP provided an opportunity to do a focused piece of work creating the conditions in which the University, government and industry can work successfully in pursuit of that vision.

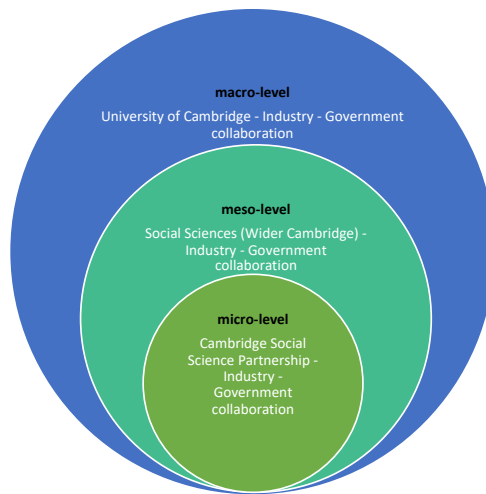


Figure 2: Cambridge Grand Challenges – Context and levels of collaboration to foster 3-way engagement

Social Sciences student internships from the University of Cambridge have traditionally taken place in government departments, public sector organisations and NGOs. Similarly, engineering and technology companies have tended to offer student internships within their technical teams to students from science, technology, engineering and mathematics (STEM) faculties. To tackle this discrepancy in the longer term, the Innovation Projects for Social Sciences Students program was set up as a pilot, to demonstrate the benefits of knowledge transfer between two atypical partners – University social sciences faculties and engineering/technology companies.

This paper reviews the literature underpinning the pilot application of this novel approach as one way to support the implementation of the Industrial Strategy. This literature is seen as key in understanding the value of the program to all parties, including companies, graduate students/early career academics and academic supervisors, of placing social sciences students within the technical teams of technology companies. The program’s aim was to increase the skills, employability and opportunity horizons of the individual students, and to provide industry partners with an appreciation of the wider innovative research capability that is available, through access to new ideas and greater interdisciplinarity. The long-term goal is for these newly gained perspectives to lead to potential ways of increasing future innovation and productivity across industry.

The Industrial Projects for Social Sciences Students internship program (2019/2020) had several stages. Firstly, it worked to identify specific industrial challenges, by carrying out exploratory roadmapping sessions with industry to map gaps and create groups of stakeholders to address specific industry needs. Secondly, it placed Social Science students into engineering and technology companies, including energy, pharmaceutical, airport operations, software, instrumentation and health insurance to address these needs. Thirdly, it collected feedback data from all involved. This was to build on existing literature and to highlight and emphasise potential impact, including direct benefits to graduate students/early career academics and companies, and indirect benefits to Universities, industrial sectors and the UK economy. The results from this pilot are reported elsewhere.

Literature review, gap and research questions

Generic studies on industrial-academic collaboration, knowledge transfer and open innovation (e.g. Perkmann and Walsh 2007) provide a strong base for proposing and analysing the outcomes of a pilot program of graduate social science students working in technology intensive industrial companies. However, there is also an increasing body of literature that seeks to review the methods and outcomes specifically between the Social Sciences and industry (OECD 2019; Pederson 2016; Bastow et al 2014). Additionally, the fields of learning more generally (Kolb 1984) and student internships more specifically (Galloway et al 2014; Shoenfelt et al 2013) inform this work. Although many internships studies consider vocational work, there is a growing interest in experiential learning for college and university students (Rompelman & Vries, 2002; Lucas et al 2009; Narayanan et al 2010) and an increasing focus in the research sector on the development of transferrable skills (Vitae 2008).

These streams of literature (Figure 3) are explored here at a high level, starting with the underpinning academic-industrial collaboration, followed by the social science perspective on academic-industrial knowledge exchange, then considering the links between internships and learning, and concluding with the implications for knowledge transfer within this specific context.

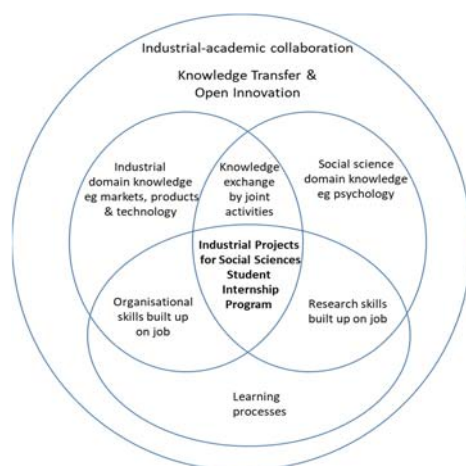


Figure 3: The literature context of the social science graduate student internships in industry

Underpinnings of Industrial-Academic collaboration

Academic-industrial initiatives

The advantages of collaboration between industry and universities are widely recognised (Lee 2000; Fabrizio 2007; Dowling 2015). Long term science and engineering research programs are well documented, and are shown as facilitating the efficient exchange of tacit scientific knowledge (Cockburn & Henderson 1998) as well as uncoded knowledge from current research findings (Fabrizio 2009). Work examining universities working with different industrial sectors and across a wide variety of communication channels and time frames has found some similarities in approach and success (Schartinger et al 2002; Bekkers and Bodas Freitas 2008). While no one-size approach fits all, it is agreed that university-business internships should be encouraged (Andersen et al 2013). In the last 15 years, work in open innovation has further demonstrated the benefits of collaboration within a wider and sometimes more informal innovation eco-system (Chesborough 2003). The challenge is now in making university research fully available (Striukova and Rayna, 2015), especially to support the wider and perhaps less technical needs of business innovation as demonstrated by recent European political interest (Horizon 2020). Being open to inputs and interactions with universities can help companies improve their innovation related practices (Farrukh et al, 2018).

Academic-industrial relationships and open innovation are reviewed by Perkmann & Walsh (2007), who recognise that the nature of university-industry links is already diverse. However, focusing on research-based collaborations and human resource transfers, they suggest that two aspects need attention: the search and match process between companies and universities, and the organisation and management of the collaborative relationships.

Technology and knowledge transfer factors

Researchers and practitioners interested in the dynamic process of technology transfer in industry have over the years identified a number of factors for success. These include the nature of the technology, the characteristics of the giver and receiver, the nature of the communication or relationship between them and the organizational context (Souder 1987; Souder and Padmanabhan 1989). Between organisations the transfer scope, transfer method, the knowledge architectures of individuals and groups involved, and the organizational adaptive ability are also seen as important (Rebentisch & Ferretti 1995). Knowledge management developments have broadened the view from technology to knowledge transfer and Shin et al. (2001) suggest that knowledge flow in and between organisations is most likely to be influenced by four specific factors: the knowledge transferred, the source, the recipient and the context. These knowledge-based factors can be used to understand industrial-academic collaborations in more detail (Grimpe and Hussinger, 2013).

Social Science perspective

Interdisciplinarity and impact - achieving integration for knowledge exchange

Tackling Global Grand Challenges requires interdisciplinarity and integration of knowledge across sectors. However, the rate of change in the academic funding mechanisms required for the integration of social sciences and humanities into scientific research collaborations is very slow according to Pederson (2016). He suggests that interdisciplinary collaboration requires structures to promote integration, engagement strategies, connecting between academic and non-academic stakeholders and the development of new scientific models across disciplines. Meanwhile, the UK government's ongoing impact agenda is set to shape the way in which social scientists prioritise the work they choose to pursue, the research methods they use and how they publish their findings (Bastow et al 2014). Social science research already delivers public policy impact, contributes to economic prosperity, and informs public understanding of policy issues as well as economic and social changes. This has been achieved, is partly through the role of 'hidden connections' in knowledge exchange i.e., bypassing formal barriers to get things done (Hughes et al 2011). This demonstrates that innovation and impact is much wider than patents, licencing and spin-outs, and encompasses people-based, problem solving and community orientated activities. The report suggests that this is a highly connected process that supports scholarship and a complementary two-way interaction with outside organisations, where individuals from external organisations more often make new connections with academics for help, on innovation and other operational topics, but academics are shown to be proactive too. Boundary spanning activities (Tushman 1977) are important to help academics connect externally in order to strengthen their research which also has an effect on teaching and students in terms of projects and job prospects (Hughes et al 2011). Calvert and Martin (2009) propose that Social Scientists can adopt many different roles and responsibilities when they take part in scientific research: they can be advocates, intermediaries, translators, connoisseurs, critics, activists or reformers. They can reflect on the implications of a finished piece of research, or become involved at a much earlier stage, becoming a required component of research programs and even being involved in the creation of new fields. This is reinforced by Cernea (1994), who proposes the creation of 'entrance points' for sociological and anthropological knowledge at all phases of projects, and by a series of initiatives in which ethical, legal, social and institutional (ELSI) activities have become purposely incorporated into synthetic biology discussion and research (BBSRC, 2008).

Mechanisms and skill sets – creativity, communication and problem solving in innovation

Recent studies on academic-industrial collaboration provide evidence of the contribution of social science graduates in facilitating knowledge exchange between academia and different areas of industry (Bastow et al 2014). New methods of data collection (i.e., labour force surveys and job adverts) show beyond doubt the flow of human capital into industry (OECD, 2017, 2019).

The studies (Bastow et al 2014; BA 2019, 2020) suggest, however, that it is still difficult to assess the actual mechanisms by which this contribution by social science graduates is made, due to the diversity of their inputs to innovation and the implicit nature of ‘softer’ skills. Specifically, social science graduates are thought to contribute critically to the diffusion and adaptation of innovation, as well as the implementation of process and organisational innovations, however these aspects are challenging to quantify. In addition, social science graduates often provide skills that are key for innovation but are difficult to fully capture, including creative and critical thinking, and communication skills.

So linking social scientists to the innovation process is difficult because their contribution is often rather indirect and difficult to capture. Three main challenges are highlighted (OECD 2019), (a) social scientists working more on improving processes and developing innovative practices rather than working on operational roles, (b) consultancies working as intermediaries so the underpinning academic content or connection is not seen and (c) social scientists not been involved directly in commercialisation of products and services or research co-operations but perhaps more background activities of problem solving through consultancy etc.

Current trends in Knowledge Transfer policies include facilitating co-creation, adapting to digitalisation, and supporting international knowledge collaboration (OECD 2019).

“Disciplines are but one dimension of relevance to contributions of science to innovation. Apart from the need for technical knowledge linked to specific scientific disciplines, certain ‘soft’ skills matter significantly in highly innovative jobs” (OECD 2017 p.6).

The authors point to research surveys by Avvisati et al (2013), showing that skillsets held by innovative and non-innovative workers differ most in terms of creativity (i.e. coming up with new ideas and solutions), critical thinking (i.e. a willingness to question ideas) and communication skills (i.e. the ability to present ideas to an audience). They also list alertness to opportunities, analytical thinking, the ability to co-ordinate activities, and the ability to acquire new knowledge rapidly as key capabilities for innovators.

So innovation is an area where social scientists should be able to play a key role. There is evidence that new innovation policy initiatives are in financial, regulatory and softer areas such as facilitating relationships, mobilising action, networking, integrating and building trust (OECD 2019). It is recognised that barriers to recognition still exist at firm level, in universities and research institutes, and between individuals (Bastow et al 2014).

Student internships – benefits and learning

Established view of student internships

Student internships can take a wide variety of forms and are well established in vocational education and training as well as higher educational settings (Sides and Mrvica 2016; Tovey 2001). They are seen as a form of active learning with elements of supervision and self-study that allows students to ‘learn by doing’, reflect upon that learning and gain feedback for improvement, usually in a 10-12 week period or for a specific number of hours on a weekly basis. Examples include the IT and

business fields (Ismail 2018), the hospitality industry (Leslie 2006), clinical internships for trainee doctors, nurses and other medical professionals (Yiend et al 2016), and professional engineering skills development within degree courses (Cooper et al 2004; Moore & Plugge 2008; Shawcroft 2018). However, recent studies have concluded that all forms of university-industry placements should be encouraged as they are mutually beneficial (BIC 2013; Velez & Giner 2015) and more recently internship programs in STEM disciplines have expanded (Galloway et al 2014).

Benefits of internships

A review of the benefits of internships for students and host organisations was carried out for the Department for International Development (Ismail, 2018) focusing on programs run by academic institutions in collaboration with industry, mostly in the developed world and mainly in business, hospitality and health fields. Most literature relies on self-reported evidence of benefits of the internship for interns and host organisations (Shoenfelt et al 2013).

The link between innovation and skills development at all levels is clear, from apprentice to doctorate (HVMC 2019). However, when focusing on employability, the literature often discusses soft and hard skills gained in different educational experience situations. A review of business education across Europe resulted in a useful three component view of graduate skills (Andrews and Higson, 2008), which are business specific issues (hard business-related knowledge and skills), interpersonal competencies (soft business-related skills) and work experience and work-based learning.

Benefits to students

Undergraduate student internships are generally seen as supplying valuable work experience, supporting education for students in industry and providing wider benefits such as self-efficacy, professional and entrepreneurship skills. Recent research (Shawcross 2018) focused on professional skills development, during a manufacturing engineering programme highlighted that 'doing the project' is only one of five sets of skills required for an internship, the others being managing self, managing the project, managing information and working with others. In another a study of engineering students, there is an interesting emphasis on receiving an authentic internship experience. Authenticity includes fit with the subject of undergraduate study, feedback on performance and how well student felt they had performed, leading to high self-efficacy (Lucas et al 2009). A positive outcome was also observed in a study of psychology students where students were actively encouraged to engage in career exploration courses with embedded service-learning internships (Peterson et al, 2014). This process aimed to help them reflect, recognise and develop knowledge, skills, and abilities by applying their subject specific learning in challenging community situations to develop leadership, flexibility, team working, conflict resolution and communication skills. Another study looking at benefits and challenges in post-graduate clinical placements concluded that, while added value was seen to be delivered in several ways, the actual implications for student employability and achievement remained to be established after the placement ended (Yiend et al 2016).

Several studies focus on the use of internships to foster employability, enterprise and entrepreneurship in the IT sector (Galloway et al 2014). The DFID report (Ismail 2018) comments on perceived improvements in skills and employment prospects specifically in the IT and business sectors. It considered that students develop interpersonal skills, team-working skills, professionalism and customer management experience that cannot be learned in the classroom environment and also have a chance to apply those skills in practice. Students also improve their communication, confidence and self-efficacy as well as being more likely to find jobs and earn more. In the IT sector internships provide valuable on the job training that helps with entrepreneurial skills and prepares them for self-employment. There is not sufficient evidence provided that it helps foster professional

networks that facilitate knowledge transfer although the potential is acknowledged. It is concluded that the organisational host or academic supervisor can provide valuable feedback to students.

Benefits to employers

Internships can provide extra resource at low cost to employers and can reduce recruitment and training costs. For example, in the healthcare field, good interpersonal skills are seen as a predictor of job performance in medical students, and knowledge sharing is more likely to occur if interns who join professional communities are assisted by well-connected mentors who can help them integrate into the community (Ismail, 2018). Another specific example is from the hospitality industry (Leslie 2006), where the potential benefits to the employer are in the areas of recruitment, training and labour turnover. Here recommendations are made in terms of the personnel policies and practices which can lead to the realisation of these benefits that in the long term enhance the functioning of the organisation. Narayanan et al (2010) also show that many universities highlight how internees can bring tangible benefits to the firm by providing new ideas and perspectives, increased productivity, completed project tasks, links to academic institutions and specialist skills. An example of company feedback is:

“We see it as our responsibility to contribute to the students’ training, and we have good experience with project-based internships being a good learning process. We also benefit greatly from the students, because they help push us and make sure we don’t stagnate. They bring new perspectives and are up-to-date with the new literature”.

Karen Riisgaard, Project Manager, Danish Board of Technology (Universities Denmark 2017)

Benefits to academics and institutions

Although much of the literature sees internships as part of the learning and career development process for undergraduates and providing benefits to host companies, academic benefits are seen too. For universities, research shows that internships enhance the reputation and visibility of academic institutions and so enhance their potential for recruiting students (Velez and Giner 2015), as well as fostering partnerships between academia and industry (Hurst & Good 2010). There is also evidence that student internships in some institutions have inspired students to open new businesses, helped business schools to feel a stronger connection to the community as well as improving institutional reputation (Weible 2009). However, some also question whether the full benefits to universities are being realised. One interesting insight was that academics saw undergraduate internships as part of their teaching responsibility without considering any possible research benefits, although the increased knowledge potential of post-graduate student internships might change this perception (Narayanan et al 2010). Another point raised, is the crucial role of the internship program coordinators in creating value for both students and employers. It is suggested this is through understanding individual student cohorts and companies in detail, and tirelessly seeking out new opportunities to match them effectively (Moore and Plugge 2008).

Benefits for all stakeholders - links to learning and sensemaking activities

It is accepted that internships can include project specific learning, organisational learning and interdisciplinary learning as outlined by frameworks such as the experiential learning cycle (Kolb, 1984; Little 1993) and the learning spiral (Nonaka and Takuchi, 1995). Taking a wider perspective, we can also see growing recognition of in-work training and learning (Senge 1990; HMVC 2019). Additionally, it could be argued that internships also promote a wide range of sensemaking activities for all parties involved in a program (Peterson et al 2014) for example for students making their way in the world and their choice of future careers (Campbell 2016), for academics regarding how their research involves others and delivers impact (Stigliani and Ravasi, 2012) and for prospective employers (Rohrbeck and Gemünden, 2011) by improving their understanding of the future world

and ways of working by having interns who bring wider set of skills and perspectives. Table 1 below provides a summary of the possible interactions.

Table 1: Summary of themes in literature in terms of skills and knowledge

Social Science (SS)	<->	Knowledge Transfer (KT) for Innovation		<->	Internship Program	
Skills of SS: research and wider		Current trends in KT	Current barriers in KT		Internship success factors	Sensemaking through internship
Skills related:						
Improve/develop innovation processes		Facilitating co-creation	Facilitating relationships		Student: Autonomy, self-reflection, positive attitude	Student: future career, industry insights, world view
Apply innovation processes		Adapting to digitalisation	Mobilising action		Company: Support from top management	Employers: future and innovation - wider view
Problem solving and community building		Supporting knowledge collaboration	Networking/ integrating and building trust		Supervisor: time and ability	Supervisor: Understanding of SS research, skills and university
Knowledge related:		Openings for SS?	Openings for SS?		Shared	Shared
-Research area -Ethical, Legal, Social and Infrastructural insights (ELSI)		Need people with deep understanding of ELSI implications of new technologies?	Need people with research and interpersonal skills?		Student/Company: Realistic expectations, Alignment of interest	Academia/Industry: understanding of impact of research/job perspectives

Gap and Research questions

Social Scientists’ analytical research skills, collaborative interpersonal skills, as well as their intuitive understanding of ethical, legal, social and institutional (ELSI) factors, are important elements for technological decision making and are increasingly vital in facing up to current global challenges, including the current pandemic.

Although there is literature on knowledge transfer from universities to industry and there are studies on student internships, the two have not been brought together, particularly for graduate students in the Social Sciences and technology intensive companies. So, this is the literature and practice gap that we seek to fill in the application of the Industrial Projects for Social Sciences Students program. The resultant research questions (RQ) are:

RQ1: What benefits have social sciences graduate students and technology-based industry found from short (3-6 month) internship projects?

RQ2: How (mechanisms) have the internship projects delivered value to company and student? i.e. by what *mechanisms* have these *benefits* been achieved

RQ3: How best to facilitate the programme/scheme? – i.e. *barriers and enablers* and looking at these to see what are the *success factors and learning points* of this pilot internship program

RQ4: To what extent do the findings combined with past literature enable us to propose a new view of the internship field for graduate students with respect to soft and hard skills and wider employability?

Conclusion

The collaborative CGC framework through the CSSP program was a very successful engagement mechanism succeeding in bringing together two atypical partners social science students and industry, especially in technology intensive sectors. The impetus from successive governments in focusing on the industrial challenges ahead to increase innovation and the global Grand Challenges justified the need, but the CGC framework (Figure 2) was necessary to increase the opportunity space for both social science academics and industry and align, co-ordinate and utilise resources better. The multiple stakeholders maximised the interdisciplinary nature of the innovation internship program in order to address the real industrial challenges more effectively. It is proposed that other Universities could do the same, and that this would snowball, delivering wider impact from the bottom up, ensuring that the Social Sciences supports current efforts to address key industrial challenges, that would help encapsulate and measure the value of Social Sciences more effectively, for example in the REF assessments.

The innovation internship program was extended after the first initial pilot, with largely the same format but additional administrative support and taking on board learning from the previous implementation.

Further work can use the literature review and research questions as a basis to examine student projects as cases as well as an assessment method for an intervention to 'foster the engagement' necessary to implement Industrial Strategy like challenges at student level. This type of approach allows what has been achieved and learned to be taken forward and used more widely at grassroots level, but still needs further development and testing more widely.

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