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Abstract

The Scottish government launched a nationwide drive to increase entrepreneurial skills, looking to become a "world-leading entrepreneurial and innovative nation". One of the key ambitions of this is to build an education system with entrepreneurship and innovation at its core. Within computing degrees, however, there is traditionally a focus on preparing students for employment within industry, rather than preparing them with an entrepreneurial skillset. This chapter discusses lessons learnt from the design and implementation of an entrepreneurship module taught to Honours-year computing students during the 2016 to 2017 academic year and defines a proposed series of workshops showcasing its future implementation.

Keywords

entrepreneurship; computing; computer science education; higher education

The Scottish government launched a nationwide drive to increase entrepreneurial skills, looking to become a world-leading entrepreneurial and innovative nation. Within this context, entrepreneurship is considered a mind-set of seeking new opportunities which can be turned into sustained business growth. One of the key ambitions of this drive is to build an education system with entrepreneurship and innovation at its core, which

would promote creativity and ambition within the curriculum. The Quality Assurance Agency (QAA) for Higher Education defines entrepreneurship education as a way of equipping students with "the additional knowledge, attributes and capabilities required to apply [the ability of generating ideas and the skills to make them happen] in the context of setting up a new venture or business" (QAA, 2012).

Within computing degrees, there is traditionally a focus on preparing students for employment within industry rather than preparing them with an entrepreneurial skillset, despite content taught within entrepreneurship education being directly applicable to computing (e.g. project management, prototyping). This chapter discusses lessons learnt from the design and implementation of an entrepreneurship module taught to final-year computing students during the 2016 to 2017 academic year and defines a proposed framework showcasing its future implementation.

The main question targeted by this research was as follows: How do we best support the development of entrepreneurial skills to Computing students? To answer this question, a literature search was undertaken and combined with a qualitative analysis of 18 student responses from a prior run of an existing module. The results of this informed the creation of a series of workshops which could be used to support the development of entrepreneurial skills within a computing-related degree.

The study was undertaken to address the lack of entrepreneurial skills being embedded into computing-related degrees. Historically, within the School of Computing Science and Digital Media at the Robert Gordon University (RGU), the subject of entrepreneurship has been typically restricted to a single module that takes place in the final semester of the final year within the larger context of the undergraduate curriculum. The proposed framework considered how to best support the development of these skills and whether it would be possible to successfully embed them throughout the curriculum.

The main objective of the study was to consolidate literature on entrepreneurship education curriculum development and run a qualitative analysis on responses gathered from a 2016 to 2017 module on entrepreneurship, run with final-year undergraduate students at the School of Computing Science and Digital Media. A framework would be generated from the consideration of these two data points to inform how to best

embed entrepreneurial skills in a computing context. Future work would include informal interviews with experts, such as tutors at organisations such as the Scottish Institute for Enterprise (SIE) or Elevator UK, and a plan for evaluating its success once it has been rolled out in a wider context.

Literature review

What is entrepreneurship?

The topic of entrepreneurship is one that spans across many disciplines and consists of a number of definitions. Research conducted by Davidsson (2004) shows that "entrepreneurship" could be used to describe a number of topics, including new enterprise, new organisations, innovation, taking advantage of opportunity and production methods. This view is shared by Shane and Venkataraman (2007), who call it "a broad label under which a hodgepodge of research is housed". The umbrella term "entrepreneurship" usually consists of skills that promote idea development, communication, creativity and business flair, typically taught in a constructivist manner, with many educators acting as guides and mentors, rather than instructors (Powell, 2013). The QAA (2012) succinctly sums up enterprise skills as "having an idea and making it happen", with entrepreneurship building upon these skills in the context of setting up new ventures or developing existing organisations.

Entrepreneurship education

Whilst it is difficult to define exactly what is meant by the term entrepreneurship, over the past three decades, entrepreneurship has become an academic discipline that is taught across a variety of courses in higher education. Research by Piperopoulos and Dimov (2015) has shown that entrepreneurship education "can contribute to the development of students' entrepreneurial attitudes, abilities, and skills [as graduate outcomes] and hence enhance their intentions to launch new ventures". These graduate outcomes can be expanded into terms such as opportunity recognition, problem solving, personal awareness and creativity (QAA, 2012).

A systematic literature review by Blenker et al. (2014) showed that entrepreneurship education is a growing field encompassing papers based on both qualitative and quantitative data analysis techniques. Studies in this field often focus on student intention and perception of the subject, typically showcasing that students initially have

a negative attitude or perception towards entrepreneurship (Fayolle & Gailly, 2015; Zhang, Duysters, & Cloodt, 2014) – this is posited to be for a number of reasons, including the student's perception of a mismatch, or a gulf, between their current self and their image of a "successful" entrepreneur, often portrayed (both using in-class examples and in the media) as well-spoken/rich/successful.

The research between entrepreneurship education and pedagogy is poorly defined. Some researchers question the legitimacy of the field as a whole due to a lack of actual entrepreneurs teaching the field as academics (Blenker & Christensen, 2010). This is a challenging aspect to address given the fact that some also view entrepreneurship as an innate skill, rather than a subject that can (or, in some instances, should) be taught (Haase & Lautenschläger, 2011; Lans, Blok, & Wesselink, 2014).

Across multiple fields, educators are "challenged with designing effective learning opportunities for entrepreneurship students" (Kuratko, 2005). A number of papers were found that discuss entrepreneurship pedagogies, with certain journals devoted to researching and analysing the topic (e.g. the *Journal of Entrepreneurship Education*). The QAA (2012) contrasts two types of entrepreneurial teaching – study of the theoretical topic (underpinned by traditional pedagogies) or learning how to do (focusing on developing the entrepreneurial skills and mind-set within students in a more constructivist manner) – concluding that as an academic discipline, an ideal curriculum would combine both theory and practice. Within the wider literature, there is little that discusses entrepreneurship pedagogy, and no literature was found specific to the intersection between entrepreneurship education and computing.

An attempt at refining a subject-specific search using keywords such as "enterprise", "education", "teaching model", "framework" and "pedagogy" resulted in a number of papers. After a review of abstracts, the ones considered irrelevant were discarded, leaving only two papers for discussion, as detailed below.

The first paper (Hannon, 2005) indicates that supporting the development of entrepreneurship outside its usual business context (e.g. within a computing course) could have "potential utility in a post-university environment". There is no mention of pedagogy and no course structure in this paper.

The second paper (Doboli, Kamberova, Impagliazzo, Fu, & Currie, 2010) presents three computing/entrepreneurship modules that were ran in the same university, developed by "experienced local entrepreneurs". There is little indication of module content, no mention of pedagogical awareness, and a post-module survey shows mixed results. The paper concludes with an indication of further study which, as yet, does not seem to have been published.

The gaps identified in this literature led to the following research question being identified: How do we best support the development of entrepreneurial skills to computing students?

A review of the literature indicated that whilst entrepreneurship education is a growing field, there is general consensus that this is normally learnt by doing, with instructors acting as advisers and supporting its development in a constructivist manner. There is no evidence-based, subject-specific literature on suggested frameworks which place entrepreneurship education within the specific subject context, suggesting that this area is ripe for future research.

Methodology

Institutional context

This research was primarily conducted in the United Kingdom, within the School of Computing Science and Digital Media at RGU in Aberdeen, Scotland. The university has a strong focus on professional education, directly leading to very high employment rates for graduates.

As part of School policy, students are asked to anonymously fill in mid-semester feedback sheets on every module. The results of such a survey conducted during an existing entrepreneurship module (now discontinued) in the 2016 to 2017 teaching session was used in an approach inspired by grounded theory (Myers, 2008) to understand issues found with the module. Findings from the literature review were used to provide context to the qualitative analysis, and from this, a number of workshops were proposed.

The module

An existing module (Entrepreneurship and Enterprise Development) was used as the basis for this study. The module was delivered as a core component during the final semester of the final year of most BSc degrees taught within the School of Computing Science and Digital Media at the time, all of which fall under the broader umbrella term of "computing". It had an existing module descriptor with learning outcomes and indicative module content; however, there was no historical developed content, and the module guide contained little detail aside from a proposed overall structure.

Due to the lack of suitable frameworks resulting from the literature review, an approach inspired by Doboli et al. (2010) was taken to populate the module guide. Whilst the original study had "experienced local entrepreneurs" develop the modules, this module was developed in close collaboration over a series of focus groups with key instructors from organisations that deliver unstructured workshops on entrepreneurship education, such as the SIE and Elevator UK, with local business owners invited to give guest lectures where appropriate. This ensured that whilst the module contained topics deemed important by industry experts, it was still structured, delivered and assessed in a constructivist manner. This was achieved by designing the module as an avenue for students to sandbox a business idea: it allows for practical freedom as they are learning by doing, but also gives a safe space to fail and iterate on existing products based on feedback gained by the teaching staff. A full discussion on the development of the module lies outside the remit of this paper; however, a copy of the redeveloped module guide is given in Table 11.1 for reference.

Table 11.1

The module guide for Entrepreneurship and Enterprise Development

Week	Topic
1	Introduction to Entrepreneurship
2	Idea Generation – Disrupting Technologies
3	Elevator Pitches
4	Finance and Costing

5	Prototyping and Wireframing
6	Business Strategies
7	Business Model Canvas
8	Delivering Pitches
9	Building a Business Plan
10	Assessment
11	Assessment
12	Assessment

Participants

The module was delivered as a core component of the final year within a variety of courses delivered at the School of Computing Science and Digital Media, including BSc Business Information Technology, BSc Computer Science and BSc Computing (Graphics & Animation). All students were invited to complete an optional mid-semester survey on their experience of the module. As per School policy, the invite was verbally issued once during Week 6 of the semester and followed up by a notice on the virtual learning environment. Of the 86 students within the module, 18 responded to the survey (20.9%), with this being inside standard limits found by Baruch and Holtom (2008) for preliminary studies. Analysis, therefore, continues based on the acceptability of this response rate.

The survey, known internally within the School as the Module Evaluation Questionnaire, is an optional tool used within all modules delivered within the School of Computing Science and Digital Media. It is deployed at Week 6 of each semester so that module leaders can react appropriately to student feedback. To retain complete anonymity, the survey does not collect identifying data such as name, student number or course studied, and these items are therefore not available for further analysis (e.g. whether the feedback differed depending on the degree path that a certain student was

undertaking, for example, whether a Computer Science student was more likely to enjoy or appreciate the module over a Computing (Graphics and Animation) student). This qualitative analysis used responses to Questions 24 ("Please identify three things you think are good about this module") and 25 ("What changes to the module would improve your experience of it?") of the survey, which were the only two questions allowing students to give free-text feedback.

Ethical considerations

There was limited contact with participants in this study, and as such, there was little ethical consideration. Whilst student feedback was used as part of the analysis of the study, this feedback was collected anonymously, with no identifiers on the virtual learning environment, and was therefore acceptable to be used in this research.

Data analysis

Thematic analysis is a qualitative methodology that has become one of the most widely used frameworks for analysing qualitative data (Bryman, 2012). It involves an analysis of data through materials gathered by researchers, splitting that data into core themes (e.g. how to identify categories and how to establish relationships between them). A key process in thematic analysis is analytic coding, where segments of the collected data are assigned to categories with descriptive labels or keywords ("codes"), which in turn leads to an emerging understanding in the form of themes. The researcher's interpretations of the data shape his or her emergent codes (Bryman, 2012).

Instances of the feedback reflecting teaching style were removed (e.g. "[the lecturer] made sure we had plenty of feedback"), and an analytic coding process was applied to the remaining feedback gathered from the open-text responses of Questions 24 and 25 of the survey, resulting in the following coding scheme:

- Variation of topics

- Industry professionals

- Creativity

- Real-life application

- Not suited to final year.

A disadvantage of thematic analysis is that it is susceptible to a single researcher's abilities and understanding, and that the derived core themes might be biased based on the researcher's perception of the results. To counteract this possibility, an inter-rater reliability was performed with an academic colleague who was provided with a list of the analytic codes shown on page xxx and asked to ascribe these codes to the set of completed student feedback.

The reliability between the two raters was Kappa = 0.615 (p < 0.001), 95% CI (0.343, 0887). This indicated a substantial agreement across raters, allowing for the coding scheme to be used to infer conclusions based on the overall student feedback.

Analysis and findings

The agreed coding scheme helped to identify core topics and trends in the received feedback from students. In order to understand these topics and trends, each analytic code was analysed in further detail with respect to the student feedback.

Variation of topics

The proposed module was built in conjunction with key institutions that promote entrepreneurship in Scotland, with the goal of providing an overview of entrepreneurship to a non-traditional demographic of students. As it was not possible to assume any prior knowledge of entrepreneurship, enterprise or business, a variety of topics needed to be covered within the module. Through instances of the analysed feedback, it can be seen that students appreciated the variation of topics taught under the entrepreneurship umbrella (e.g. "There is plenty of variation in lectures"). The designed module led students from idea generation to the creation of a prototype and a business model canvas, effectively allowing students to develop a business idea in a "safe" environment, with constant feedback and guidance. This was considered successful and was reflected in the student feedback (e.g. "It was a good preparation for my own entrepreneurship – this module allowed me to sandbox a business idea").

Industry professionals

As the module was being developed, it became clear that some of the topics should be delivered by experts in the field. This follows the approach proposed by Doboli et al. (2010). Whilst industry professionals used as guest lecturers were appreciated by the students (e.g. "Guest speakers are friendly and eager to help"), feedback indicated that these sessions did not always work as lectures. This is attributed to the fact that industry

experts do not necessarily have the pedagogic knowledge to deliver a lecture: "E.g. [the guest lectures] don't really work in the lecture hall […] – there's not enough room to work interactively". Following the constructivist approach discussed in the literature review, these sessions would work best as smaller groups, where guest members from industry could act as mentors, rather than lecturers, and run interactive workshops based on their knowledge base and skillset. This could be supported by an academic member of staff to ensure suitability to the curriculum.

Creativity

Based on the definition proposed by the guidance document written by the QAA (2012), it is important for any module teaching entrepreneurial skills to promote creativity and creative thinking within its content. Creativity is an ongoing theme in the subject area in which this module is contained (Computer Science), and opportunities for personal projects and creativity were provided to students. For example, students had three opportunities to present business ideas: first as an elevator pitch, then as a prototype and finally as a business case. For each of these, students were encouraged to think of their own idea and retroactively build on this initial idea based on formative feedback. Furthermore, through deliverables such as stand-up presentations and video-based prototypes, students were encouraged to use technology in ways that empowered creativity. The analysed feedback indicated that the module was an "opportunity to be creative" and that it "specified a vital detail: trying and failing is not a bad thing".

Real-life application

Students indicated that the module content was relevant to the real world; for example, "It motivates me to start up my own business in the future" and "It is nice to learn another side of computing that we could put into practice outside of university". This was achieved through the presence of industry members throughout the module and through the fact that students were asked to produce their own ideas and reflect upon them throughout the various assessment points. The relevance of the taught content to potential real-world application was made clear at several points throughout the module.

Not suited to final year

Whilst the module was delivered as a core component in the final semester of the final year in an undergraduate degree, respondents indicated that they were not convinced at

the module's suitability in the curriculum, suggesting that it may work best as a non-core topic delivered outside of the final year.

Summary

It is clear through an analysis of the gathered feedback that students found the module content useful, and that there was a clear link between the module content and real-world application. It is also clear, however, that students were not convinced that the module was delivered at a suitable point within their curriculum. Whilst this work is based on a small sample of respondents of one cohort and is not generalisable, this work may be used as a basis to plan and prototype further developments to support entrepreneurship education within higher education environments. For example, within the existing context, this could take the form of a set of optional workshops offered to students across all taught years, allowing them the chance to pilot and sandbox a business idea.

Conclusions and future work

The research question posed at the start of this research project will be discussed as preliminary conclusions below in order to evaluate the success of this research project. The results from this study are encouraging but limited to the context within which this study was run. The small participant numbers mean that the results cannot be widely generalised. The implications of these findings are used to inform the direction of current and future work, which will help in the further validation of these results.

Research implications

How do we best support the development of entrepreneurial skills to computing students?

Whilst an established, peer-reviewed framework could not be found in the existing literature, it is clear that an attempt at supporting the development of entrepreneurial skills should be done in a constructivist manner, allowing students time to learn by doing. This approach was used to develop the module content and to structure the module around the idea of sandboxing a business idea. Post-semester feedback from the students suggested that the module supported the development of entrepreneurial skills, particularly when focusing on creativity, interaction with industry and real-world application. It was clear that some students did not feel comfortable having entrepreneurial skills embedded within the curriculum as a core component. Further

work with a wider sample needs to be carried out before concrete conclusions can be put forward for recommendation.

Current work: SEED

The work reported in this paper is preliminary, and further work needs to be carried out in order to establish how to best support the development of entrepreneurial skills – not just within computing, but also across other non-traditional subjects.

Following on from this work, discussions were undertaken with colleagues in Medical Education at the University of Dundee to develop a solution that would allow for entrepreneurial skills to be delivered across institutions and disciplines. These discussions resulted in the creation of SEED (**S**kills in **E**ntrepreneurship **Ed**ucation), a series of workshops which can be delivered as optional components across year groups within courses to interested students.

Following on from the seminal work discussed in this chapter, a SICSA (Scottish Informatics & Computer Science Alliance) education grant was awarded to the authors to run a workshop in September 2017. The purpose of this workshop was to introduce SEED to invited academics, key organisations such as Elevator UK and the SIE, and other stakeholders. The workshop initiated discussion on the need of such a process and consisted of small-group sessions where it was critically evaluated and refined to its current iteration. At this stage, SEED was initially proposed to consist of the following six workshops, which drew upon the sandbox structure of the original module and could be made subject-specific depending on the context in which they were being presented:

- 1: Introduction to Non-Traditional Skills & Idea Generation
- 2: Elevator Pitches
- 3: Managerial Skills
- 4: Prototyping – From Concept to Creation
- 5: The Business Model Canvas
- 6: Student Presentations

Future work

A number of aspects of the research described here could be further researched. First of all, the SEED needs to be formally verified and refined – the authors are currently in discussion with colleagues across a network of Scottish institutions. A proposed pilot

aims to run the proposed set of workshops with a number of student cohorts across the different institutions. Data gained from this pilot will be used to further develop SEED.

A theme that emerged from the workshop was the use of language when running events that attempts to support the development of entrepreneurial skills to students and recruiting students to attend such events. Initial observations by the authors, discussions with colleagues at the workshop and existing research discussed in the literature review (Fayolle & Gailly, 2015; Zhang et al., 2014) indicate that the use of certain terms considered to be business-related, for example, "entrepreneurship", "enterprise", "business plan" and so on elicit certain concerns in prospective students that cause them to disengage from the subject before they attempt it. A longer term comparative study could closely explore this area and establish what effect language has on student engagement and long-term satisfaction.

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