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Technology Entrepreneurship, Enriching Entrepreneurship Education

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Introduction

Technology entrepreneurship focuses on the commercialization of emerging products and services based on novel technology inventions in either nascent or established markets. It is an inherently interdisciplinary field of study as it is closely related to entrepreneurship as a discipline in terms of methods and tools, while the context is that of science and engineering. Technology entrepreneurship has received increased attention in academia especially during the past two decades due to the rising expectations toward universities regarding socioeconomic engagement. Universities are not any longer merely responsible for research and education in purely academic contexts; instead they are expected to increasingly engage in activities that contribute directly to solving societal issues and promoting economic growth. The introduction of entrepreneurship education in the engineering context provides a promising avenue for effective socioeconomic engagement of universities. In turn, technology entrepreneurship enriches entrepreneurship education in multiple ways. The purpose of this entry is to provide a general introduction to technology entrepreneurship and to highlight the contribution of technology entrepreneurship to entrepreneurship education.

Development of Technology Entrepreneurship

In their efforts to contribute to socioeconomic growth, universities have been pursuing multiple options and activities. A typical example for such activities is a close collaboration with industrial and communal entities in close proximity to universities to advance regional growth and development. The interactions with actors external to the university context are typically organized by intermediaries within the academic context, such as knowledge or technology transfer offices (KTOs/TTOs). The KTOs utilize a wide set of tools and methods to establish collaboration models between academic staff and external stakeholders, such as companies and municipalities. In the engineering context, the objective of KTOs is to create spin-offs and new venture ideas based on technology that is either directly generated through applied research or is developed as a side product of related research efforts. A major incentive is the potential promise of high growth that is often presumed to be inherent to technology-based ventures.

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As the sources of novel technological inventions are typically researchers, a major focus lies on the development of an entrepreneurial mindset and activities of scientific staff. In the engineering context, this means that an objective is the active engagement of researchers from the technical and engineering faculties in entrepreneurial activities, such as identifying potential markets for a technology that was developed during engineering research. The in-depth technical knowledge of these researchers is an important prerequisite to commercialization of that particular technology. However, the respective researchers have oftentimes neither experience nor interest in entrepreneurial activities as it is not part of their profession and training. The distance between engineering research performed by scientist and market considerations of KTO staff resembles a barrier to effective technology commercialization.

Although the use of KTOs resembles a common approach to create structures that promote socioeconomic engagement of universities, the results have oftentimes been disappointing in terms of numbers of spin-offs and new ventures. This has led to an ongoing search for functioning models for technology commercialization and entrepreneurial engagement of academic staff.

The Emergence of Technology Entrepreneurship Education

The last decades have seen an introduction of entrepreneurship education content and practice within curricula of various disciplines outside of business and management studies. As this is adopted within the engineering domain, technology entrepreneurship education emerges. However, while engineering education had a clear focus on the development and application of technology without any relation to market contexts, entrepreneurship education pursued the objective to create new products, services, and ultimately ventures. Technology entrepreneurship education aims to bridge this gap between the disciplines with the objective to develop entrepreneurial knowledge and competences along in-depth understanding of technology. This is based on the assumption that the conscious use of the intersection between engineering and business studies will lead to an increased entrepreneurial engagement of (graduate) students that possess engineering competences. In turn, these students can better contribute to the development of technology-based new ventures in close proximity to the academic context.

In practice, technology entrepreneurship education occurs either through the introduction of entrepreneurship content in the curriculum of existing engineering programs or the creation of entirely new programs that focus on competences that utilize the intersection between engineering and business. Such programs do not only teach about the development and application of technology but also put the respective technologies into a market context, for instance, by investigating the impact of new technologies on established industries or identifying opportunities for the development of new ventures based on specific technologies.

The Objective of Technology Entrepreneurship Education

In addition to the objective to educate students for competences related to technology commercialization, technology entrepreneurship education focuses also on increasing the entrepreneurial engagement and mind-set of academic staff that had previously none or only limited experience with entrepreneurship. For instance, engineering researchers participating as lecturers in programs that educate for technology entrepreneurship get in contact with entrepreneurship research and practice. The increased awareness and understanding of entrepreneurial activities reduce the barriers for own entrepreneurial engagement, especially when this is part of educational efforts and thereby part of their profession. In such a context, researchers relate entrepreneurial activities directly with their research fields and their profession. In turn, this increases the motivation of engineering researchers to engage in subsequent entrepreneurial activities in relation to technology originating from their own research. This is in contrast to traditional technology transfer

practice, where the KTO adopts a dominant role in the process of technology commercialization and the barriers to entrepreneurial engagement of non-entrepreneurship researchers are significantly greater.

The traditionally clear separation between the educational disciplines of entrepreneurship and engineering resulted in difficulties for technology transfer due to a disconnection of technology research from potential market contexts. Technology entrepreneurship education bridges this disconnection and utilizes the potential benefits of the intersection between engineering and entrepreneurship for educational purposes. Additionally, it contributes to generating entrepreneurial activities of academic staff from the engineering faculties and is as such an option for alternative models for technology transfer and commercialization.

Contribution of Technology Entrepreneurship to Entrepreneurship Education

The adoption of entrepreneurship education in the engineering discipline receives significant attention in practice and research. While practice is primarily concerned with educational specifics, such as the adoption of engineering curricula to integrate entrepreneurship content and activities, research is investigating among others the suitability of pedagogical approaches for specific desired learning outcomes, e.g., the ability to identify technology-based new venture ideas. Both research and practice generate insights that enrich entrepreneurship education in various ways.

Context-Dependency of Pedagogical Approaches

It is undisputed that context has a major impact on learning outcomes in educational activities of any kind. This applies not only to context in terms of the general content along with learning objectives such as knowledge and skills but also to the context-dependent effectiveness of specific pedagogical approaches. The context-dependency of educational specifics (such as the pedagogical approach, teaching activities, desired learning outcomes, etc.) deserves special attention when educational activities that were developed in the context of a specific discipline get transferred to the context of a different discipline. As entrepreneurship education is adopted in the engineering domain, research and practice have been and still need to investigate the effectiveness of established pedagogical methods from general entrepreneurship education in the context of technology entrepreneurship. Recent inquiries indicate that this process has been accompanied by a frequent misalignment between pedagogical approaches stemming from entrepreneurship education and desired learning outcomes in relation to engineering education. Therefore, it is essential that the fit between pedagogical approaches and desired learning outcomes is carefully evaluated to account for context-dependency as technology entrepreneurship education emerges. Furthermore, pedagogical specifics of engineering education need to be considered in this alignment as the interdisciplinary nature of technology entrepreneurship and related education objectives call for interdisciplinary approaches in the design of suitable pedagogy.

Pedagogical Paradigms in Technology Entrepreneurship Education

Engineering education typically assumes a problem-based and application-oriented approach in the design of pedagogical methods. This is primarily due to the requirement of application-related understanding and hands-on experience of engineering graduates. Engineers need to understand, design, implement, and apply/use technical products and systems. This is strongly related to constructivist learning paradigms, such as experiential learning theory (ELT), which argues that conscious learning occurs through iterations of experience, observation, conceptualization, and experimentation. While ELT has received recurring attention in entrepreneurship research as an ideal and guidance in developing new education approaches, constructivist learning paradigms are inherent to engineering education in general. Therefore, technology

entrepreneurship education benefits greatly from the pedagogical paradigms of engineering education and their close connection to desired learning outcomes. The introduction of entrepreneurship content in engineering education generates new pedagogical models for achieving desired learning outcomes that can in turn greatly enrich entrepreneurship education. Additionally, entrepreneurship pedagogy research benefits from inquiries regarding the use and effect of concepts and theories in interdisciplinary settings, such as technology entrepreneurship.

Contextual Factors of Technology Entrepreneurship Education

An important contextual element of engineering education is the use of laboratories and workshops in the development and application of technical products and systems. This part of the problem-based focus of engineering education is essential in the development of engineering-related desired learning outcomes and well aligned with constructivist learning paradigms. The use of spaces, e.g., laboratories and workshops, creates a reference to real-world problems and contextualizes learning content and objectives in application-oriented scenarios. This happens, for instance, through the use of novel technical equipment, software development, and exercises in prototype development that mirror the activities and tasks of potential future engineering professions. Even more important than the impact of specific spaces is the contact and collaboration of communities of practice related to those spaces. For example, the feedback and support from professional engineers regarding the development of a technical prototype create an in-depth learning experience for students that exceeds classroom learning. Actual hands-on experience is especially important in the development and application of tangible products and services, which is often a shared focus of engineering education and technology entrepreneurship. Thus, the interaction with suitable spaces and related communities of practice is essential in the development of capabilities for technology entrepreneurship. This applies not only to the development of technical products and services but also to the process of identifying and evaluating market opportunities for the respective products and services. This specific characteristic of technology entrepreneurship carries implications for potential adoption in the practice of general entrepreneurship education.

"Spillover" Effect: Entrepreneurial Engagement of Academic Staff

Educating engineering students for technology entrepreneurship has a major impact on academic staff involved in related activities. The need for professional input from both the engineering and the entrepreneurship disciplines calls for a close interdisciplinary collaboration of academic staff such as researchers and lecturers. This does not only generate the expertise necessary to pursue effective educational activities; it can also positively impact the perception of entrepreneurship of involved academic staff. Researchers and lecturers with limited or no previous interest in entrepreneurship engage in entrepreneurial activities as part of their teaching obligations. In turn, this generates an understanding and awareness of entrepreneurship and can build the foundation for future entrepreneurial engagement even outside of curricular activities.

Special Focus: Parallel Development of Technology and Commercialization

Although entrepreneurship education has diverse objectives that can vary according to contextual circumstances, an overarching goal of such educational efforts is the development of knowledge, skills, and competences that promote the development of any elements related to new ventures. In technology entrepreneurship, this receives even more emphasis as the focus lies on the close connection between technology development and commercialization opportunities. This does not only alleviate past issues with a disconnection of technology research and commercialization efforts but also generates a very real contribution to technology transfer and commercialization.

Summary: The Contribution of Technology Entrepreneurship

Technology entrepreneurship does not only extend the application range of entrepreneurship

education; it also provides valuable insights and new implications that enrich research and practice of entrepreneurship education. In essence, the introduction of entrepreneurship content and methods in the engineering context leads to a change of education outcomes, such as knowledge, skills, and capabilities, but potentially also to entrepreneurial engagement of academic staff that has previously been unaware and/or uninterested in entrepreneurship. Thus, technology entrepreneurship plays a conducive role in universities' socioeconomic engagement, because it offers alternative models for transferring knowledge and technology from academia to society and economy. On the educational level, the adoption of entrepreneurship education in the engineering context enables the use of results from decades of entrepreneurship-related pedagogical research and practice in the design and structure of engineering courses that aim to educate for entrepreneurial knowledge, skills, and capabilities alongside engineering-specific learning outcomes. In turn, technology entrepreneurship enriches entrepreneurship education as it provides insights into the applicability of generic pedagogical models for entrepreneurship, the context-dependency of desired learning outcomes, and a connection to pedagogical methods from the engineering domain.

Cross-References

- ▶ Being, Becoming and Enabling the Entrepreneurial
- ▶ Blended Learning Pedagogy in Higher Education
- ▶ Entrepreneurial Actions in Entrepreneurship Education
- ▶ Student-Staff Partnerships in Teaching, Learning, Research, and Reform

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