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ABSTRACT

The future engineer is labelled an entrepreneurial engineer, having networking, teamwork, opportunity recognition, creativity, risk management, and discipline-specific skills. Therefore, entrepreneurship education is being increasingly introduced in engineering education. The various educational designs used to introduce entrepreneurship education have been discussed extensively, but a clear scheme for the classification of such methods is not available. In this study, a classification scheme for entrepreneurship education is introduced by building on prior frameworks and authentic learning situations to differentiate educational approaches and learning contexts. We explore and combine different models of entrepreneurship education offered at 10 technical universities in the Nordic countries. Through this exploration, we identify three categories of learning contexts, which we label 'imitation', 'pretence', and 'real,' adding to the three classes of educational conceptions identified in the literature and verified through empirical data: 'teacher-directed', 'participatory', and 'self-directed'. This leads to a six-class taxonomy for entrepreneurship education approaches.

Introduction

Today's engineers are expected to create both social and economic value through their engineering efforts (Oswald Beiler 2015; Yi and Duval-Couetil 2018). They are expected to have the competences that enable them to solve complex technological problems; social skills such as teamwork, communication, and networking (Creed, Suuberg, and Crawford 2002; Täks et al. 2014); the ability to discover and act upon opportunities, be creative, and manage uncertain scenarios (Nichols and Armstrong 2003; Oswald Beiler 2015). Many of these competences are congruent with and expected to be developed from an education in entrepreneurship (Creed, Suuberg, and Crawford 2002; Nichols and Armstrong 2003; O'Leary 2012; Täks et al. 2014). Entrepreneurship education is considered one of the most important routes for honing innovative individuals in engineering departments (Huang-Saad and Celis 2017; Ling and Venesaar 2015). In line with this concept, Creed, Suuberg, and Crawford (2002) introduced the term *entrepreneurial engineer* to denote the future engineer, and entrepreneurship education has become increasingly present and important in engineering faculties (Da Silva, Costa, and de Barros 2015; Nichols and Armstrong 2003; Oswald Beiler 2015; Souitaris, Zerbinati, and Al-Laham 2007; Standish-Kuon and Rice 2002; Täks, Tynjälä, and Kukemelk 2016; Yemini and Haddad 2010; Zappe et al. 2013).

With the increasing popularity of entrepreneurship education in engineering, several discussions have emerged on the topic (Kazakeviciute, Urbone, and Petraite 2016), and several

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designs and methods of providing entrepreneurship education to engineers have evolved (Duval-Couetil, Shartrand, and Reed 2016), for example, the use of problem-based learning (Chau 2005) and real-life cases and projects (Creed, Suuberg, and Crawford 2002). The manner in which entrepreneurship education should be incorporated into engineering departments has been discussed and debated extensively. Some scholars have argued for more action-oriented approaches (Elia et al. 2011), while others have sought greater balance in the application of traditional teaching and hands-on activities (Ling and Venesaar 2015; Mäkimurto-Koivumaa and Belt 2016). Mäkimurto-Koivumaa and Belt (2016) argued that action-oriented activities should be included in students' initial years of study, while entrepreneurship knowledge should be provided later in their educational pathway. Others have argued for the inclusion of more real cases as opposed to only action-based learning activities (Creed, Suuberg, and Crawford 2002; Ollila and Middleton 2011).

Hence, based on this discussion and a lack of consensus about the design of entrepreneurship education in engineering education, calls have been made for the further development of entrepreneurship education in engineering (Oswald Beiler 2015). Especially, calls have been made for the further investigation of engineering students' views on entrepreneurship (Täks, Tynjälä, and Kukemelk 2016) and to improve our understanding and exploration of various pedagogical approaches (Costello 2017; Herman and Stefanescu 2017; Huang-Saad and Celis 2017). For instance, Duval-Couetil, Shartrand, and Reed (2016) advocated for more action-based learning, while Herman and Stefanescu (2017) emphasised that engineering education already includes many practical activities and that entrepreneurship education and engineering curricula should be better aligned than they are at present. In other words, although Mäkimurto-Koivumaa and Belt (2016) provided new theoretical and practical implications for entrepreneurship in engineering education, a discussion of the different educational activities associated with entrepreneurship education, ranging from the classroom to the real world, appears to be missing.

Therefore, there is a need to organise different types of entrepreneurship education in engineering. Although discussions on the classification of entrepreneurship education often focus on individual students' learning situations and objectives (Mäkimurto-Koivumaa and Belt 2016), they should consider practical activities as well (Duval-Couetil, Shartrand, and Reed 2016; Herman and Stefanescu 2017), especially because these types of education can expectedly help students in developing the entrepreneurial skills needed to become entrepreneurial engineers (Creed, Suuberg, and Crawford 2002; Duval-Couetil, Shartrand, and Reed 2016). The literature presents several examples of different types of entrepreneurship education, including examples of designs that offer more hands-on learning, real-life experiences, and real-world learning opportunities (Creed, Suuberg, and Crawford 2002; Ollila and Middleton 2011). However, an overview or systematisation of what entrepreneurship education could be is still lacking. Therefore, in this study, we attempt to answer the following research question: How are students engaged in real-world learning opportunities through entrepreneurship education in technical universities?

Specifically, we create a taxonomy of entrepreneurship education based on authenticity. To this end, we first investigate the literature on the classification of entrepreneurship education in the light of authentic learning scenarios. In doing so, we create a framework that is investigated using empirical data and elaborated up on based on the findings related to the learning contexts of various educational designs.

The remainder of the paper is organised as follows. In the following section, we expand on and systematise a few of the most common and well-cited classifications used in entrepreneurship education. Then, we analyse these classifications in the light of authentic learning and develop a model based on the analysis results. In the subsequent section, we present the methods used to collect and analyse our empirical data, which were gathered from entrepreneurship education programmes offered by 10 technical universities. Thereafter, we introduce the empirical results and present the proposed taxonomy. Finally, we provide the conclusions of this study and a few suggestions for future research.

Classification of entrepreneurship education

To develop a taxonomy, we first explore a few of the most common models and classifications applied in entrepreneurship education. Later, we summarise and organise these different classifications in Table 1. The last column in this table illustrates the distinctive characteristics of each classification, while the other columns highlight a few of the similarities.

Throughout this paper, we use the phrase 'educational approaches' to denote entrepreneurship rather than 'pedagogy' or 'teaching' alone. We base this terminology on Richardson's (2005) work on learning and teaching in higher education. He argued that teaching conceptions could be differentiated into teacher-centred and student-centred types. These teaching conceptions and specific learning contexts influence the approach. Hence, in this study, the phrase 'educational approach' encompasses educational conception and the learning context, thus widening the focus to include students and contexts, in addition to teachers and classrooms. In presenting the extant literature, we mainly use the term educational approach, although we separate this term into educational conception and learning context when developing our taxonomy based on our results.

About, for, in, or through model

One of the most well-known classifications of entrepreneurship education is the 'about, for, in, or through' model. This model has been evolved for more than three decades and has been applied and discussed frequently in the literature and at conferences in recent years (e.g. Blenker et al. 2011; Gibb 2002; Hannon 2005; Hoppe, Westerberg, and Leffler 2017). One stream of the relevant literature focuses on different subcategories as objectives under this model, as illustrated in Mwasalwiba's (2010) review of entrepreneurship education. According to this definition, the focus of education is on attaining the objective of teaching either *about* entrepreneurship or *for* entrepreneurship. Another objective is teaching *in* entrepreneurship, which is explained as honing individuals to be more innovative or entrepreneurial *in* their workplace or firm (Mwasalwiba 2010).

According to another stream of thought in the literature (e.g. Blenker et al. 2011; Hoppe, Westerberg, and Leffler 2017; Pittaway and Cope 2007), the model is thought of more as being constituted of approaches to entrepreneurship education, and thus, it has a broader meaning than the meaning of the individual words in the model name. This view of the 'about, for, in, or through' model is perhaps the most widely applied understanding of the model. However, diverging views have been put forth within this literature stream as well. Pittaway and Cope (2007, 215) defined *about* entrepreneurship as education in which 'courses tend to focus on explaining entrepreneurship using traditional techniques', a definition shared by other researchers. The same coherence applies to education *for* entrepreneurship, which is often thought of as preparing students for the future as entrepreneurs and equipping them with the necessary skills and competencies. However, the approaches to education *for* entrepreneurship might vary in how they are executed. For instance, while Pittaway and Cope (2007) referred to the skills or competencies acquired through learning by doing, Hoppe, Westerberg, and Leffler (2017) focused less on student action in this approach.

Many scholars have combined the idea of education *in* and *through* entrepreneurship. For example, Pittaway and Cope (2007, 215) stated that this is one approach in which students 'try to emulate the way entrepreneurs learn through their practice'. By contrast, Hoppe, Westerberg, and Leffler (2017) separated the two, where *in* is an 'approach [that] handles entrepreneurship as an acted practice' (753), and *through* is an approach in which 'entrepreneurship is chiefly a complementary didactic tool for attaining learning goals that can be hard to reach in other ways' (754).

Pittaway and Cope (2007) further focused on entrepreneurial learning and how simulating entrepreneurship through experiential learning and reflective practices could benefit students. However, their view appears to end in simulations of and reflections on the real world by setting 'a scene' for students. By contrast, Hoppe, Westerberg, and Leffler (2017) varied the definitions of *in* and *through* education such that they were not limited to the simulation. While education *in* entrepreneurship

Table 1. Overview of entrepreneurship education classifications.

	Article	Educational Classes				Other dimensions
About-for-in-through	Hannon (2005)	**About** *Studying entrepreneurship as an academic field*	**For** *Preparing individuals to enact an entrepreneurial life or act on an immediate opportunity through the creation of a new business or venture*	**Through** *Entrepreneurship learned through other subjects*		
	Pittaway and Cope (2007)	**About** *Explaining entrepreneurship by using traditional techniques*	**For** *Acquiring entrepreneurial skills through learning by doing*		**In/Through** *Trying to emulate how entrepreneurs learn through entrepreneurial practice; focusing on reflection, (re)conceptualisation, and action*	'No real entrepreneurship possible' *Needs to emulate entrepreneurship but involves several simulations close to the real world; discusses students' ownership of ideas*
	Mwasalwiba (2010)	**About** *Obtaining a general understanding of entrepreneurship as a phenomenon*	**For** *Educating entrepreneurially means creating an entrepreneur, i.e. an individual who is destined to start a new venture, and providing tools to start a business*	**Through** *Educators use new venture creation to help students acquire business understanding and a range of skills or competences*	**In** *Helping individuals to become more entrepreneurial (innovative) in their existing firms or places of work*	Objective vs. Approach *The article explains 'through' as a teaching method within the 'for' approach rather than an objective by itself, and thus, it cannot be compared as equal to the others; presents teaching methods as a separate classification (see below)*
	Hoppe, Westerberg, and Leffler (2017)	**About** *Education as an analytical approach, traditional*	**For** *Competence focus, but not as action-oriented as 'in'*	**Through** *Entrepreneurship as a didactic tool used to learn other subjects*	**In** *Entrepreneurship as an acted practice*	Narrow vs. Broad *Narrow business focus in education or broad focus on entrepreneurship, e.g. in established businesses and so on*
Traditional: Action-based	Rasmussen and Sørheim (2006)	Individual-centred *Focus on the individual student becoming entrepreneurial after education*			Action-based *Focus on involving students in idea development*	*Although the article focuses on traditional and action-based approaches, the illustration of their model includes students as project owners in an additional class. Moreover, they discuss the focus on business in education – whether it is on the students alone and no business ideas or whether a few low- or*

	Mwasalwiba (2010)	Traditional/passive *Methods in which students are passive in a learning scenario, e.g. lectures, case studies, and group discussions*			Action-based/innovative *Methods that require instructors to facilitate learning; these methods offer less control, but they facilitate self-discovery in students based on their activities*	*high-potential ideas are generated during education* Mwasalwiba favoured the more action-based methods because they are more aligned with the development of new ventures as outcomes of education; traditional methods train students to work for an entrepreneur, not to become one
The worlds of entrepreneurship education	Neck and Greene (2011)	Entrepreneur World *Focused on the individual in terms of traits and creating a hero of the activities of entrepreneurs; uses lectures, business basics, and exams*	Cognition World *Focused on the individual but with intention of creating an entrepreneurial mindset among students; uses case teaching and simulation*	Process World *Focused on the new venture creation process and on describing it as a linear and predictable process; uses cases, business plans, and business modelling*	Method World *Focused on lifelong learning and introduction of learning to learn; presentation of methods to be applied in entrepreneurial situations; uses action, practice, and reflection*	
The continuums of entrepreneurship education	Neck and Corbett (2018)	Old School *Traditional; students are largely passive and the teacher lectures; therefore, the focus is on the teacher, pedagogy is the primary approach, and awareness is the main outcome*		Likely Today *Students simulate entrepreneurship, and the teacher acts more as a coach than a lecturer; thus, the learning centre is divided between the teacher and the students; the desired outcome is a mindset among the students*	Ideal *The centre of learning is shifted to the students, and the teacher is more a facilitator than a coach; students in this approach are active and perform entrepreneurship; the desired outcome of education is start-ups*	Motivation and readiness to learn *The model's classes are divided based on the students' or educator's motivation and the students' readiness to learn, which is an important aspect of the model because students in their late teens or early twenties might not have the motivation to start their own ventures; the model is also defined as education that has a new venture as its primary objective/outcome*

considers entrepreneurship as an acted practice and the *through* definition could be considered entrepreneurship education, given that it is defined as a didactic tool, Hoppe, Westerberg, and Leffler (2017) developed a new model based on whether education focuses on businesses from a narrow view or on outcomes in a broader sense. In this model, the educational approach is divided into the traditional *about* plus a combination of *in* and *through* on one axis, while the other axis ranges from a business focus to a broad focus (intrapreneurship, business development, etc.). This excludes education *for* because it is thought to be present in both *about* and *in/through*.

Traditional action-oriented education

Rasmussen and Sørheim (2006) presented a model based on students' involvement, in which they differentiated whether education is individual-centred or action-oriented with an emphasis on learning by doing. They introduced the individual-centred model as the more traditional model for educating students in entrepreneurship that places students in a passive classroom setting. Thus, this model should not be compared with student-centred education, where the educational approach shifts from a teacher-led to a student-led design (Lea, Stephenson, and Troy 2003; Richardson 2005). The individual-centred design has been less frequently applied in the explored types of education (Rasmussen and Sørheim 2006), and the types of education that are available at present appear to have shifted from this design, although a few types of education continue to follow this approach (Mwasalwiba 2010).

Furthermore, Rasmussen and Sørheim (2006) discussed the extent of students' involvement in their education in terms of idea development and quality. In their model, 'University strategies for entrepreneurship education' (187), they grouped students into 'passive', 'active', and 'project owners', depending on the involvement levels of individual students. Moreover, they introduced an axis that described the focus on business ideas in terms of whether it has an 'individual focus', a 'low potential', or 'high-potential'. Mwasalwiba (2010) presented a similar but simpler definition.

Worlds of entrepreneurship education

Neck and Greene (2011) presented three known 'worlds' of entrepreneurship education. In addition, they proposed 'the method world' as the fourth world. This world builds on entrepreneurship action and practice, where the idea is to create lifelong learning among students and emphasise entrepreneurship as a method. The three other worlds focus more on 1) the individual, which is somewhat similar to the aforementioned individual-centred learning (Rasmussen and Sørheim 2006); 2) the process world, where entrepreneurship is presented as a linear activity, and prediction is a central assumption; and 3) cognition, which involves creating an entrepreneurial mindset.

Neck and Greene (2011) argued that a shift towards the method world is needed, and this approach to entrepreneurship education should be implemented in all types of education – not only in entrepreneurship education focused on the creation of new ventures.

Continuum of entrepreneurship education

More recently, Neck and Corbett (2018) developed the 'continuum of entrepreneurship education' model. Among the different classes within the continuum model, the most prominent differences lie in the instructional approach – pedagogy, andragogy or heutagogy – and student–teacher roles. The latter difference is explained in terms of whether students are self-directed, thus assuming responsibility for their learning, and whether the teacher is more of a facilitator or a lecturer. In this model, the responsibility is shifted towards the students, as in the 'ideal' type of entrepreneurship education. In the 'old school' approach, students are primarily passive, and teachers lecture rather than coaching or facilitating learning, while the education labelled 'likely today' is somewhere in the middle of the three educational forms.

Classifying entrepreneurship education through authenticity

As mentioned in the Introduction, a few scholars have argued for more real-life cases instead of student-centred learning or action-based learning alone (Creed, Suuberg, and Crawford 2002; Ollila and Middleton 2011). While engineering education already involves real-life interactions through internships or business-related project work, Creed, Suuberg, and Crawford (2002, 194) argued that to become entrepreneurial engineers, students need to explore more than 'narrow defined design or optimisation projects'. In their view, students need to acquire skills that can be utilised in the 'big picture', where collaboration, team playing, communication, and insights into non-technical and human factors are essential. By working as entrepreneurs in contexts that involve hands-on activities, engineering students might acquire the skills necessary for their future work life (Creed, Suuberg, and Crawford 2002; Duval-Couetil, Shartrand, and Reed 2016). Thus, authentic learning situations are necessary for educating entrepreneurial engineers.

Authenticity and situated learning focus on assigning to students coherent, meaningful, and purposeful activities conducted in the social context where they usually occur (Brown, Collins, and Duguid 1989). In this manner, students can understand how different professions and social contexts operate, how the people in these contexts obtain their knowledge, and how this knowledge can be used to solve contextual problems. Different definitions of authentic learning situation have evolved since the seminal work of Brown, Collins, and Duguid (1989) (e.g. Borthwick et al. 2007; Gulikers, Bostiaens, and Kirschner 2004; Herrington and Herrington 2006; Herrington and Oliver 2000; Herrington, Reeves, and Oliver 2014; Rule 2006; Stein, Isaacs, and Andrews 2004). Herrington and Herrington (2006) summarised the literature under nine characteristics of authentic learning: an authentic context, authentic activities, access to expert performances, encouragement of different perspectives, collaboration, reflection, articulation, coaching and scaffolding, and authentic assessment. However, they admitted the existence of diverse views on and various definitions of authentic learning. For instance, in a literature review, Rule (2006, 2) summarised the descriptions of authentic learning under four themes:

(1) the activity involves real-world problems that mimic the work of professionals in the discipline with presentation of findings to audiences beyond the classroom;
(2) open-ended inquiry, thinking skills, and metacognition are addressed;
(3) students engage in discourse and social learning in a community of learners; and
(4) students are empowered through choice to direct their own learning in relevant project works.

While these definitions differ to some extent, they overlap substantially. Nonetheless, in the remainder of this paper, we apply Rule's definition because it is based on a review of more than 40 definitions of authentic learning across disciplines. In Table 1, several points from Rule's definition have been identified in the different frameworks. For instance, the second point about open-ended inquiry (Mwasalwiba 2010), thinking skills (Hoppe, Westerberg, and Leffler 2017; Rasmussen and Sørheim 2006), and metacognition (Neck and Greene 2011) is mentioned in several frameworks. With the increasing focus on reflection (Hägg and Kurczewska 2016) in entrepreneurship education, it is expected that this point will be incorporated in many entrepreneurship education courses.

The fourth point of Rule's definition was identified in the summarised literature in Table 1 as well. Students' control over their own learning is a central topic in all frameworks in Table 1 and, increasingly, in the rightmost side of the column 'educational classes'. However, a few differences can be identified from the literature. First, all frameworks summarised in Table 1 present *one* class or type of education, which can be referred to as traditional, passive, or old school. Such education uses the most common academic approach to learning, wherein the students are in a classroom, and the teacher imparts her or his knowledge to the students through lectures. The activities in this approach might include lecturing, case studies, group discussions, and exams. The objective could

be learning about entrepreneurship, creating awareness, or gaining an understanding of entrepreneurship. We label such education the *teacher-directed* approach.

Second, the middle section of the table denotes a new group, which includes the educational approaches labelled 'for' and 'through', 'cognition world' and 'process world', and 'likely today'. According to Hannon (2005, 108), these approaches will 'prepare individuals for enacting an entrepreneurial life or immediate opportunity through the creation of a new business or venture'. Although students are more active under this approach, their activities continue to be influenced by the teacher, and the approach employs assignments with given inputs or outputs. Therefore, we label this approach *participatory*.

The last group in the table, which was identified based on the differences highlighted in the right-most column of 'Educational Classes', contains 'in' entrepreneurship, 'action-based' entrepreneurship, the 'method world', and 'ideal' entrepreneurship education. Action, reflection, and student-centred learning are central to this group. Mwasalwiba (2010) stated that in this approach, which he calls the action-based or innovative approach, the teacher has a lesser degree of control. However, he did note that this is a source of learning for the students. Neck and Greene (2011) mentioned lifelong learning and noted that students should learn methods that can be applied in the entrepreneurial world. We label this group *self-directed*. Thus, in terms of students' control over their learning situation, the classes in the different frameworks could be differentiated in terms of being less authentic in the more teacher-directed educational approach and more authentic in the self-directed educational approach.

Points one and three in Rule's definition are, to a lesser degree, discussed and included in these different frameworks. However, in the right-most column of Table 1, which highlights the distinctive characteristics of each classification, discussions of Rule's last two points can be found to some degree. For instance, in terms of Rule's first point, Pittaway and Cope (2007) 'strive' towards replicating the real world while stating that it cannot be reached, whereas Neck and Corbett (2018) focus only on the types of education that aim to create new ventures, thus aiming at real-world initiations. Rasmussen and Sørheim (2006) offer the clearest example of different connections to the real world. According to them, students can be distinguished as passive, active, or project owners of their new ventures based on their degree of involvement in activities. The question of whether their ideas have business potential is addressed as well. Thus, these classifications include clear descriptions of what seem to be real-world problems, mimicking the work of professionals in the discipline, and presentation and interaction with individuals outside the classroom.

In terms of the third point of Rule's definition, she described the community of learners as having several aspects. It could be a group of learners, a community setting in which a student's activities are set, or the wider community of professionals that is connected to the student's discipline. Rule (2006, 6) summarised this as '[t]he community of learners who scaffold learning for each other during discussions along with the audience beyond those learners who set the context for the problem both form important components of authentic learning experiences.' Hence, students might span their discussion to, for instance, the problem owners, customers, or other stakeholders outside the classroom.

This latter concept is not extensively discussed in the various frameworks summarised in Table 1. Nonetheless, it is implicitly a part of the definitions. In Neck and Corbett's (2018) discussion of students engaging in entrepreneurship, they expect the context of such entrepreneurship to include external actors. The same applies to the ideas of Rasmussen and Sørheim (2006), whose discussion of business ideas and student involvement involved a contextual implicated assumption that students interact with external actors. While the frameworks in Table 1 miss this point to some degree, other frameworks in the literature focus on the concept of context in entrepreneurship education, for example Nab et al. (2010) and, more recently, Kassean et al. (2015).

Nab et al. (2010) stressed that entrepreneurship education should strive to achieve a learning situation in which students can experience entrepreneurial behaviours in an uncertain and unpredictable environment. This view was supported by Kassean et al. (2015, 701), who argued for 'real-world experience, action, and reflective processes to engage students in authentic learning, which

should lead to greater entrepreneurial abilities and propensity'. However, Nab et al. (2010) remarked that the learning situation will never be perfectly real because risks, including financial risk, cannot be achieved, and students should be protected against 'too risky and unsafe environments'. Nevertheless, they provided a holistic view of authentic learning in entrepreneurship education, according to which context, students, and other parties (teachers, entrepreneurs, peers), as well as the task, are included in the learning situation.

In the case of authentic learning, especially in education focused on entrepreneurship and entrepreneurial activities, the idea of real-world problems, emulation of professionals, and presentation of results to external audiences often seem to coincide with discourse and social learning in a community of practitioners (Haneberg and Aadland 2019; Higgins and Elliott 2011). These activities occur in contexts in which students are active and involved in learning activities, together with external audiences. The above examples illustrate this. However, they do not clarify how the different contexts are designed and embedded in the education. Hence, the different frameworks, classifications, and studies in Table 1 discuss authentic learning situations in entrepreneurship education to some extent, but they do not focus on contextual interaction. The literature on entrepreneurship education does not clearly present the characteristics of different types of educational designs in terms of contextual interaction or embeddedness, as identified through an authenticity lens. As such, we must explore the differences among the various existing types of entrepreneurship education and understand how these types of education can be organised and included in our current understanding of educational approaches, as well as in our understanding of learning contexts in the light of authentic learning.

Methods

This paper describes a case study of entrepreneurship education in the Nordic countries by using an embedded single-case design (Yin 1994), where 10 embedded case studies of entrepreneurship education in technical universities are included. The insights expected from the cases (see Siggelkow 2007) are variations in how entrepreneurship education is conducted in technical universities. Therefore, the embedded case studies were selected to provide a broad view within the shared context.

Research context and data collection

The educational systems across the five countries are rather similar, although contextual differences do exist in terms of industry, economy, and policy (see e.g. Smeby and Stensaker 1999). These factors might influence the creation and design of entrepreneurship education (see e.g. Faherty 2015; Premand et al. 2016). The various types of entrepreneurship education considered herein were selected based on Gulieva's (2015) report on the types of entrepreneurship education in 27 technical universities in the Nordic countries. In both Norway and Iceland, only one university verified the information (presented in the report) regarding its educational offerings. For these two countries with missing information regarding their universities' entrepreneurship education offerings, additional information was gathered by searching the universities' official websites. The universities included in the study are listed in Table 2. To ensure interviewee anonymity, these universities are hereinafter randomly labelled using a phonetic alphabet code word ranging from Alpha to Juliet.

We explored the various universities' entrepreneurship education approaches, designs, and objectives through semi-structured interviews with teachers and course managers. At each site, we interviewed three to four teachers or course managers individually. In total, we conducted 32 interviews with teachers or course managers, resulting in approximately 31 h of recorded interviews and more than 330 pages of transcribed data. The topics in the interview guide included the role of entrepreneurship education in the university; how the teachers worked on various courses in terms of course design; details about lectures, with an emphasis on the tools and exercises used; and how the courses were evaluated, developed, and updated. Before the interviews, descriptions of the various courses

Table 2. Overview of entrepreneurship education at ten Nordic universities.

Country	University	Entrepreneurship courses included in the study	Entrepreneurship programmes included in the study	Organisation
Denmark	Aalborg University	Four-day interdisciplinary workshop; courses as part of the bachelor programme	Two-year master's programme	Several departments involved; collaboration; 'hub' organises activities
	Aarhus University	Summer course; courses as part of bachelor programmes		Mostly one department delivering courses to other departments
Finland	Aalto University	Two minors as part of other programmes; courses as part of other programmes		One department offers 50% of the courses; other departments offer related courses; student 'hub' organises activities
	Technical University of Tampere	Minor and courses as part of other programmes		Collaboration among three universities; 'hub' organises activities
Iceland	University of Iceland	Courses as part of other programmes	Three-semester master's programme	Collaboration primarily between two departments
	University of Reykjavik	Three-week interdisciplinary course; minor as part of master's programme		Courses organised primarily by one department
Norway	Norwegian University of Science and Technology	Courses as part of master's programmes	Two-year master's programme	Programme and courses from one department; student 'hub' organises activities
	Arctic University	Courses as part of master's programmes	Two-year master's programme with two tracks	Programme and courses offered by one department in collaboration with semi-internal lab
Sweden	Chalmers University of Technology	Courses as part of master's programme	Two-year master's programme with four tracks	Programme and courses offered by one department; 'hub' organises activities
	Lund University	Courses as part of master's programmes	One-year master's programme	Programme offered by one department; collaboration with science park

and programmes were gathered from web-based resources. These data included course descriptions, assessments, curricula, course credits, teacher information, learning outcomes, recommended prior knowledge, requirements, and schedules. Moreover, we gathered data regarding enrolment requirements, programme designs, faculty presentations, stories from prior students, and visions of the programmes. This information was later used to triangulate the information provided by the interviewees (Yin 1994). The interviews lasted approximately an hour each, and both authors participated in all but two interviews. Before the analysis, the interviewees were given the opportunity to validate the transcripts, which is consistent with Guba and Lincoln's (1989) evaluation criteria for research.

Coding and analytical approach

We investigated the educational approaches and the authenticity of the learning contexts with different foundations. For these tasks, we employed somewhat different approaches. Although data were collected using the same procedure, data analyses for the educational approaches and authenticity were conducted using deductive reasoning and inductive reasoning, respectively. Hence, the educational approaches of the different universities were coded according to the previous studies presented in Table 1, and the inherent themes of these educational approaches were searched and identified across the universities. Furthermore, when investigating authenticity, datasets obtained *within* the different codes of the educational approaches were investigated. Thus, this design followed a thematic analysis, as described by Braun and Clarke (2006), albeit with different approaches for the educational approaches and authenticity.

The interviews were coded using NVivo 11 software, and the coding was performed in steps, going back and forth from data to theory, but with two overarching steps that constituted the analysis. The data were first coded according to the subjects in the interview guide by using the following first-order categories: content, objectives, overarching design, and development. For example, a course on Lean Start-up (content) might include lecturing and business plan writing (approach) with the aim of offering insights into the entrepreneurial world to students (objectives). In this round of coding, these codes were applied to individual courses and to entire programmes to facilitate identification of differences. Then, we discussed the various codes and the themes identified in the first coding and refined the coding scheme.

In this round of coding, we determined that courses and programmes were often inseparable in the interviewees' answers and that the exploration of the learning designs was too coarse for the purpose of identifying clear differences between the cases. Therefore, we merged the course and programme coding and created subcategories to clarify the differences in the learning designs. The subcategories were based on overarching trends in the data as well as on inspiration from the literature and the three-class educational approach differentiation described in the theory section. Then, we used the coding scheme to split the learning design into four categories: theory learning, tool learning, mindset activities, and process learning. The fourth category contained the three former educational approaches as applied in a systematic learning situation, but it should not be compared with Neck and Greene's (2011) 'process world'. The themes generated using these codes were then reviewed across the different universities. After coding the educational approaches, the authenticity view of each type of education was explored *within* the datasets, which were separated based on educational approaches in the previous step. The different themes of authenticity were then reviewed not only across the different universities but also across the different educational approaches.

One of the authors and a research assistant performed the coding independently, and the coding was discussed before it was finalised. The coding performed by the two parties exhibited an overall average agreement of 97.5%. However, the inter-rater reliability of the coding was rather low, exhibiting slightly lower than moderate agreement strength (Landis and Koch 1977). Further exploration and comparison of the coded data indicated that the inter-rater reliability was often low owing to coding preferences. In certain situations, one coder included half-sentences, while the other included entire sentences. Thus, both coders often saw the same information but coded it differently, which led to a good level of agreement but reduced inter-rater reliability in a few cases. The various themes generated using the codes were further analysed across the data of the different universities. The resulting themes of educational approaches and authenticity are presented in the following section.

Findings and analysis towards a taxonomy

In Figure 1, the findings and the quotes obtained from the different universities illustrate the connections among the different educational conceptions, hierarchical connections, and the learning context authenticity of each type of education. The figure depicts the themes that emerged from the data, where the educational conceptions – *teacher-directed, participatory,* and *self-directed* – fall under the grey areas in the middle of the figure. On the left side of the figure, the second theme of learning context points to the appropriate texts. A third theme, the hierarchical layout of the educational approaches, is illustrated on the right side of the figure.

Empirical confirmation of the educational conception criteria

In the universities considered herein, some form of traditional lecturing was a part of most of the courses or programmes. The examples that we found included guest lectures, case presentations and discussions, academic writing, video presentations, readings, and lectures. While different topics were introduced in the courses or programmes for different reasons, most of the institutions
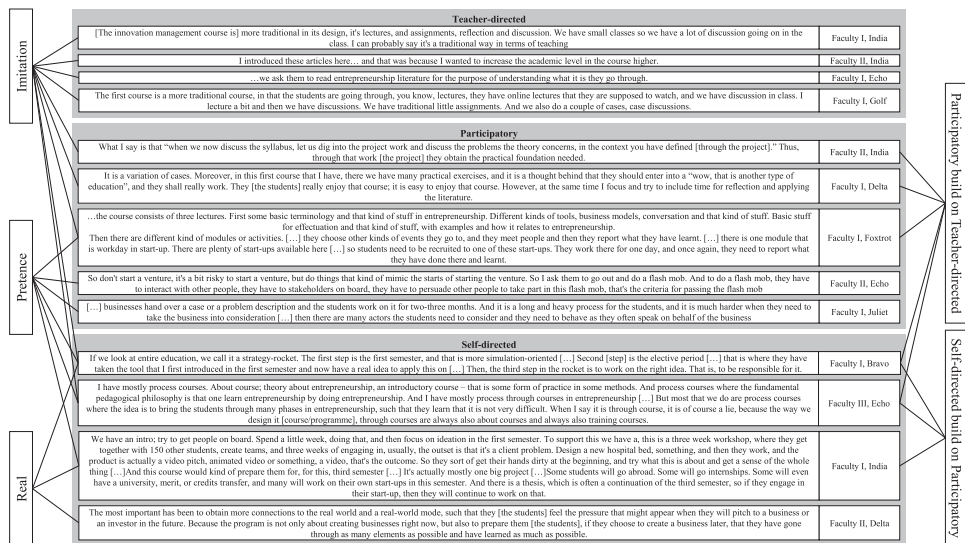
Figure 1. Illustration of quotes of the participants and findings from the universities organised after analysis.

used this approach to increase the academic level of their educational offerings or to legitimise subsequent activities, as described by Faculty I from Echo University and Faculty II from India University (Figure 1). Thus, most of the teachers used traditional 'old school' teaching to create a foundation for the students and enhance their knowledge.

Furthermore, in a few of the courses or the programmes, the students were active in their education to some degree, indicating a more action-based approach. The teachers often introduced tasks and activities that were intended to provide the students with some experience in entrepreneurial activities, tools, or methods, as described by Faculty I from Foxtrot University (Figure 1). The same was the case at Delta University, where the teachers guided the students in their work, thus functioning as coaches. Other examples of this educational approach included students working with canvases, patent exploitation simulations, audit exercises, and internship work tasks.

In some of the educational offerings in these universities, we identified an approach in which the students were required to act on their own, as described by Faculty II from Delta University. In this case, the students were required to choose how to approach different issues, which tools to apply, and which methods to use in their work. Faculty I from Bravo University underlined this, stating that students must ' … work on the right idea. That is, to be responsible for it'. Both these universities ran venture creation programmes, in which the students were more self-driven and approached their tasks with open-ended problems and solutions. However, other universities offered activities in which the students simulated their businesses and planning, which were subsequently evaluated by external stakeholders, but the students themselves had to plan all the 'actions' throughout the process.

The findings indicated that the different types of education used different methods for instruction, and none of the universities had identical views regarding which methods should be included. However, the various educational conceptions could be grouped into three classes, as introduced through the various models mentioned in the theory section (Hannon 2005; Hoppe, Westerberg, and Leffler 2017; Neck and Corbett 2018; Neck and Greene 2011; Pittaway and Cope 2007). Hence, the empirical data obtained in the present study validated the educational conception criteria identified in previous studies – teacher-directed, participatory, and self-directed.

Identifying learning context criteria

The connection to the real world in the different educational courses and programmes varied. For example, Faculty I from Delta University (Figure 1) used cases while introducing and applying various tools and methods. By contrast, the students at Juliet University worked with external entrepreneurs on the ideas and businesses of the external entrepreneurs. The students from this university used tools and methods to create reports about the innovations of these businesses, which is similar to the case of Delta University explained above. However, at Juliet University, collaboration between the students and external entrepreneurs (i.e. stakeholders outside the classroom) afforded the students opportunities to tackle real-world problems with external stakeholders outside of academic assignments, thus introducing the students to a wider professional context.

The two prior examples illustrate the differences in the educational approaches, where the tasks are somewhat given, and the tools and the methods to be applied might be obvious. In other courses or programmes, the students had to decide for themselves the methods and tools to use, but there were differences in terms of how they interacted with external stakeholders. At Bravo and Echo Universities, the students had to apply their skills and knowledge to solve problems but these problems appeared to exclude professional contexts. The same situation was prevalent at Charlie University, where the students started imaginary companies and decided which strategies to use in the different growth phases of these companies. Moreover, the students selected and used different tools and methods in the work and planning processes for these companies. The students were guided by experienced entrepreneurs, but there were no stakeholders outside the classroom, which means a wider professional context was missing.

In many examples, the students were self-directed in their education while having some stakeholders in their work outside their classrooms, as mentioned by Faculty I from India University (Figure 1). The work performed by the students was of significant value for an external start-up, and the students often needed to decide which problems to address and how to overcome various barriers. However, in some cases, the students started their own companies, and these companies had the potential to continue growing after the students graduated. These companies solved real problems and had stakeholders outside the students' classrooms, but they were organised as the students' own companies and probably would not have been founded without the students' initiative. While the faculties at these universities stressed that the programme/course objective was to educate entrepreneurial individuals rather than to generate new ventures, they stated that these new ventures were desirable by-products, and they encouraged the students to work on these ventures after graduation. Thus, these programmes/courses not only mimicked the real world but also embraced it, and the students *were* professionals in a wider professional context while still being in an educational situation. Through such initiatives and activities, the students experienced greater risk because some of these ventures required the students to use their personal funds as well as to raise financial capital from external stakeholders. As such, the pressure was real, and the students felt the risks, as explained by faculty II from Delta University. Examples of such types of education include those described by the faculties from Bravo, Delta, and India Universities (Figure 1). Based on the analysis results, from the viewpoint of authentic learning contexts, we suggest three classes of entrepreneurship education. We label the first class 'Imitation'. Imitation may comprise traditional teaching, games, cases, or similar situations with low authentic contexts, as illustrated above. An educational situation based on imitation does not involve contact with any real problems or projects, nor a wider professional context. Even though there is no contact with real problems, projects, or professional contexts, the teacher may still attempt to make the activities relevant for the students within the boundaries of the classroom. The teacher thus provides an imitation of a general understanding of real problems, projects, and professional contexts.

We label the second class 'Pretence'. In a class based on pretence, some interactions occur with persons outside the educational context, that is, stakeholder(s) other than the students themselves or their teachers, as explained by Faculty I from Foxtrot University (Figure 1). This fulfils Rule's

(2006) definition in terms of authentic learning, although the level of authenticity might differ, especially in terms of the educational approach. Additionally, this level includes only the 'participatory' and 'self-directed' classes, as illustrated in Figure 1. The teacher-directed approach can teach students about the real world, but it does not involve any external stakeholders, may miss open-ended inquiries, and may not have an active student learning community. Therefore, it cannot be termed an authentic learning situation.

We label the last class of learning contexts 'Real'. Similar to the previous level, this level has an authentic context, but in this context, students do not mimic professionals. The students apply their efforts to their own projects, which have external stakeholders, but the students *are* the professionals. Hence, this level goes beyond what Rule (2006) defines as mimicking of professionals. Moreover, the students in this situation experience risks and 'feel the pressure' from being in charge and being project owners. Thus, these situations go beyond the view of Nab et al. (2010) on authentic learning situations in entrepreneurship education, as in, the students experience the risks and the realities of being entrepreneurs. This level includes only the 'self-directed' educational approach. Although the students are guided and receive feedback on their work, they have strong ownership of the projects and operate them rather autonomously. Moreover, the projects seem to go beyond the ownership definitions of Gulikers, Bostiaens, and Kirschner (2004) and Nab et al. (2010) because they could be 'by-products of the education' and, potentially, the future graduates' jobs. In addition, given the high ownership level, the students have a greater say in which activities and strategies to apply and follow. Given that the 'self-directed' approach requires the students to decide how to solve various problems, which is not an element of the other educational approaches, the 'real' level is reached only in the 'self-directed' educational approach, as illustrated in Figure 1.

The three classes identified in the analysis from the viewpoint of authentic contexts are collectively labelled the education's *learning context*. This axis does not limit itself to situations in which students operate, but it includes interaction and involvement. Thus, while the first axis revolves around educational conception, the second point, and, to some extent, the fourth point in Rule's definition, the second axis revolves around the first and third points in Rule's definition, focusing on the realness of tasks, involvement and interaction as a professional, and the learning situation in which activities occur.

Hierarchical design of the proposed taxonomy

The last identified theme shows that the various educational approaches are hierarchical, in that they require a theoretical foundation connected to the students' application of their knowledge. This was especially highlighted by Faculty III from Echo University (Figure 1). Hence, to achieve a 'participatory' conception, the faculty must introduce the 'teacher-directed' conception. This does not mean that the faculty must shift from the 'teacher-directed' *to* the 'participatory' conception but that education based on the 'participatory' conception must include some elements of the 'teacher-directed' conception as well. The same holds for the 'self-directed' conception. To attain this level, the education must include the 'participatory' conception and, thus, the 'teacher-directed' conception as well. Again, the educational approaches and the overarching design need not have a sequential order.

The educational conceptions and the learning context categories are illustrated in Figure 2. This finalises the taxonomy of entrepreneurship education approaches, including six classes, with the hierarchical design of the educational conception on the horizontal axis and learning contexts on the vertical axis, both based on authenticity.

Discussions and conclusions

In this study, we created a taxonomy of entrepreneurship education that allows for differentiation in terms of authenticity spanning all educational approaches in entrepreneurship education. Using authenticity as the foundation, we identified the learning context categories of 'imitation', 'pretence',
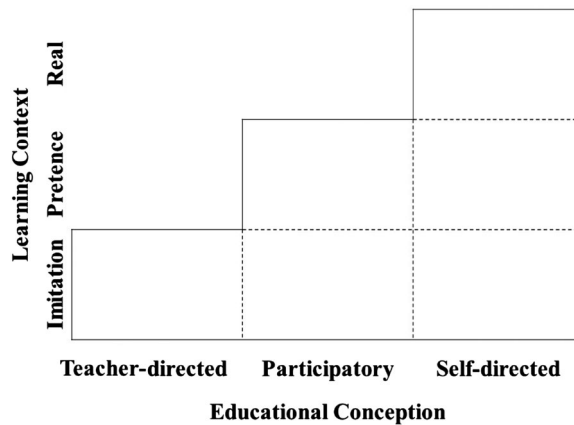
Figure 2. Taxonomy of entrepreneurship education approaches based on authenticity.

and 'real' from our empirical data. Moreover, our data confirmed the educational conceptions of 'teacher-directed', 'participatory', and 'self-directed', which we identified in previous classification studies, but the findings indicate that these educational approaches are hierarchically organised. In terms of connecting learning contexts and educational conceptions, the result is a two-dimensional taxonomy of entrepreneurship education approaches with six classes. This allows for better comparison among educational approaches and programmes in entrepreneurship education and in entrepreneurship within engineering education.

In previous classifications of entrepreneurship education, the more action-oriented learning designs (e.g. Hägg 2017; Neck and Corbett 2018; Neck and Greene 2011; Rasmussen and Sørheim 2006) have been denoted as 'through' education in the frequently used 'about, for, in, or through' model (Gibb 2002; Hannon 2005; Hoppe, Westerberg, and Leffler 2017; Pittaway and Cope 2007). To differentiate the 'through' types of education, Macht and Ball (2016) created a new framework based on authenticity (Gulikers, Bostiaens, and Kirschner 2004; Rule 2006; Stein, Isaacs, and Andrews 2004) and constructive alignment (Biggs 1996), dividing entrepreneurship education between academia and the real world. Our paper contributes to this literature stream by providing, from the viewpoint of authenticity, a more fine-grained separation of learning contexts and connecting learning contexts to the educational conceptions. The learning context dimension allows for evaluations of entrepreneurship education to capture the varying degrees of risk, complexity, and design with respect to authenticity. Moreover, the findings indicate that entrepreneurship education could include activities entailing risks that are beyond what has previously been introduced and defined as authentic in the literature. Hence, as a central part of entrepreneurship, it is possible to introduce into entrepreneurship education experience alongside risk, by designing the education to include a 'real' learning context. However, it should be mentioned that with such an educational design, uncertain situations might arise, leading to unplanned and inadvertent learning situations in the education, while an education based on an 'imitation' or a 'pretence' design might be characterised by more deliberate learning situations.

The taxonomy further enables one to conduct a more nuanced discussion about the identification of different mechanisms for facilitation and scaffolding depending on the differences in the types of learning contexts and educational approaches. As such, the use and requirements in terms of resources and contextual characters could be identified in the different types of education, given that a few of these types could be more demanding in this regard. This implication would be interesting and important for course managers seeking more self-directed types of education, for instance, such course managers should not ignore the other educational approaches, and yet, they should obtain insights into the investments necessary to initiate and run such types of

education. The introduction of types of education that are 'pretence' or 'real' are especially more demanding on both faculty and students.

For entrepreneurship education in the engineering discipline, the findings of this study support Mäkimurto-Koivumaa and Belt's (2016) view that action-based approaches should be introduced together with more traditional approaches. Moreover, our study contributes to engineering education by creating a taxonomy for identifying different types of entrepreneurship education that may be included in the education of entrepreneurial engineers. Through this classification, therefore, new entrepreneurship education can be adapted more easily into engineering curricula, as called for by Herman and Stefanescu (2017), helping less practical educations to apply more authentic and, thus, more self-directed entrepreneurship education. Moreover, the taxonomy contributes to engineering education research by introducing a classification that can be applied in the research on assessing entrepreneurship education in engineering education, which could meet the call for identification of the best methods for introducing entrepreneurship education in engineering departments (Costello 2017; Herman and Stefanescu 2017; Huang-Saad and Celis 2017). Thus, this study contributes to entrepreneurship education literature and engineering education literature, in addition to opening a pathway for further research in both disciplines.

One limitation of this paper is that the data were obtained from 10 technical universities in the Nordic countries. This means that the taxonomy likely consists of categories that are especially relevant for the literature stream focusing on entrepreneurship education as a part of engineering education (e.g. Da Silva, Costa, and de Barros 2015; Oswald Beiler 2015; Souitaris, Zerbinati, and Al-Laham 2007; Täks, Tynjälä, and Kukemelk 2016; Yemini and Haddad 2010; Zappe et al. 2013). However, the Nordic countries may constitute a special case in terms of having a large variety of learning situations, where industry and society participate in different ways. For instance, in Sweden, collaboration between industry and society has historically been considered a part of the 'third task' of universities, in addition to teaching and research, and such collaboration has been supported through policies and evaluations (Fogelberg and Lundqvist 2013).

Future research should use classifications in a more systematic way for describing the investigated types of entrepreneurship education to facilitate comparison and further development. Finally, as mentioned, we suggest that the proposed taxonomy be used as a possible starting point for developing suitable methods of assessing student learning under different combinations of learning contexts and educational approaches.

Disclosure statement

Notes on contributors

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