**Educating Engineers to Develop New Business Models: Exploiting Entrepreneurial Opportunities in Technology-Based Firms**

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Forthcoming Technological Forecasting and Social Change

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**Abstract**

This study examines educational frameworks and practices useful in teaching engineers to develop new business models (BM) that exploit entrepreneurial opportunities in technology-based firms. We compare three existing frameworks (Blue Ocean, the Business Model Canvas, and the Business Model Innovation Framework) used to teach how to develop new business models. We then report findings from two studies: (1) five years of teaching engineers at a business school; and (2) a two-year intervention carried out at an aerospace engineering firm engaged in new business model development. In both studies, the challenges of business-model-related education involve the limits to creativity imposed by existing frameworks and the difficulty in prototyping new business models. The opportunities of business-model-related education include the transformation of the educator into a coach by effectively combining explanation- and experience-based learning approaches into a virtuous learning cycle. Systematic thinking about business model design, enabled by the business model frameworks, is of crucial importance to generate viable business models for new technologies.

***Keywords***: education of engineers; business model frameworks; technology entrepreneurship education

1. **Introduction**

Interest in technology entrepreneurship education has increased in recent years (Mosey, 2016; Phan et al., 2009), with repeated calls for educators to integrate the different worldviews of managers and technologists (Linton, 2002, 2015). Scholars argue that technology education needs to focus more on “innovation and entrepreneurship” components, with anticipated outcomes of education programs geared toward “organizational renewal and new-venture creation” (Clarysse et al., 2009: 428) to better equip students to find or create jobs in today’s knowledge-based economy. Recent developments in entrepreneurship education have questioned the traditional approach of writing business plans (Leschke, 2013) to focus more on recursive interaction involved in the unique process of crafting business models (BMs) in more hands-on, trial-and-error learning contexts (Demil et al., 2015). This is particularly relevant to the education of engineers, whose technical training does not always facilitate taking up business initiatives (Maresch et al., 2016).

BMs have been conceptualized as the architecture a firm uses to create and deliver value to customers and the mechanisms employed to capture a share of that value (Teece, 2018), connecting technology to economic outcomes (Chesbrough, 2010; Papagiannidis and Berry, 2007). BMs have been studied both by scholars interested in technology-based firms (TBFs) (Berends et al., 2016; Bohnsack et al. 2014) and by entrepreneurship scholars (George and Bock, 2011; Zott and Amit, 2007). Research on BMs has come to fruition over the last two decades, since the development of information and communication technologies spurred a plethora of new BMs (Foss and Saebi, 2017). Scholars have proposed different frameworks to facilitate the crafting of new BMs, such as the BM canvas (Osterwalder and Pigneur, 2010) and the BM Innovation Framework (Amit and Zott, 2012). These frameworks have become popular components of courses aiming to educate students about how to exploit entrepreneurial opportunities (e.g., Brandenburg et al., 2016; Toro-Jarrin, et al., 2016).

Academics have generated an insightful body of knowledge about BMs, yet research has so far focused on the development of the frameworks themselves. Scholars have not reflected on the use of the frameworks in the classroom or other settings, the different types of audiences that can use them, or the role of the educator during this process. To better understand the implications of BM framework use for technology entrepreneurship education, we need to take a step back from framework development efforts and study the boundary conditions of when, how, and for what purposes such frameworks can be effective. Scholars highlight the importance of entrepreneurial activities that must be context-specific to technology-based firms (Clarysse et al., 2009), yet ways to use newly developed BM frameworks in different contexts remain unexplored. To fill this gap, and with the aim to explore and understand the use of existing BM frameworks for technology entrepreneurship education, we ask: *How can engineers be educated to develop new business models exploiting entrepreneurial opportunities in and for technology-based firms?*

We first compare three existing frameworks: Blue Ocean (Kim and Mauborgne, 2005), BM Canvas (Osterwalder and Pigneur, 2010), and the BM Innovation Framework (Amit and Zott, 2012). We then report on findings from two studies conducted in different contexts with different audiences using the same frameworks with the same educator: (1) five years of teaching entry/middle-level engineers in the classroom; and (2) a two-year intervention with top-level managers at an aerospace engineering firm involved in new BM development. Based on the results, we highlight two challenges of BM-related education: the limits to creativity imposed by existing frameworks and the difficulty in prototyping new BMs in real time. At the same time, BM-related education enables the transformation of the educator into a coach who helps students and managers to apply available tools to their problems, effectively combining explanation- and experience-based learning in a virtuous learning cycle.

These findings contribute specific insights to the technology entrepreneurship education and BM literatures about the boundary conditions, affordances, and constraints related to using BM frameworks to educate engineers in different contexts (entry/middle- and top-level managers). On the theoretical level, our analyses suggest that educating engineers in technology entrepreneurship needs to integrate business concepts such as BMs and the related frameworks, combined with creativity-related and prototyping practices. This will help engineers escape the restraints of their prior knowledge and broaden their horizons regarding what is possible in BM design. Systematic thinking about BM design, enabled by the BM frameworks, is crucial for engineers that develop advanced technologies for which they need to find viable BMs.

1. **Literature Review**
   1. *Overview of research on educating engineers about technology entrepreneurship*

The question about how to educate engineers about business-related concepts remains high on the research agenda (Linton, 2002, 2015; Phan et al., 2009). This is because engineers’ training does not always facilitate taking up business initiatives (Loras and Vizcaino, 2013; Maresch et al., 2016). Scholars of entrepreneurship education have identified audience types as a key issue in developing courses (Fayolle and Gailly, 2008). The objectives strongly depend on audience types and each type of audience has its own specificities in terms of background, learning style needs, and psychological profile (Alberti et al., 2005). Hence, McGowan and colleagues (2015) argue that a one-size-fits-all approach is inappropriate for entrepreneurial learning within science and engineering disciplines.

Technology entrepreneurship, defined as “recognizing, creating, and exploiting opportunities, and assembling resources around a technological solution” (Ratinho, Harms, and Walsh, 2015: 169), includes a diversity of situations and contexts. It takes the form of academic spin-offs, technology commercialization, and technology transfer (Link et al., 2015). To foster the creation of TBFs, a great diversity of actors within the regional ecosystem are involved, including researchers, scientists, students, managers, policy-makers, and entrepreneurs (Wright et al., 2017). Entrepreneurship education contributes to technology entrepreneurship by providing tools, knowledge, skills, and competences for students to meet the challenges of the global knowledge society (Groen et al., 2006).

However, and in spite of the face validity of teaching technology entrepreneurship, traditionally there has been only a weak link between the fields of research, technology transfer and commercialization, and entrepreneurship education (Phan et al., 2009). The extant research usually focuses on distinct thematic areas that are generally disconnected. For instance, articles examining how technology entrepreneurs exploit opportunities rarely discuss the implications for technology entrepreneurship education, and vice versa. Entrepreneurship education is often driven by institutionally legitimized practices rather than current developments (Karlsson and Honig, 2009).

Until relatively recently, there has been less emphasis on entrepreneurial activities and more focus on technology development. For example, in the traditional curriculum, the role of teamwork, especially linking interdisciplinary teams and institutions (firms, universities, government, incubators) has not been stressed (Lamine et al., 2017). Consequently, entrepreneurship education relating to TBFs is a relatively unexplored topic that offers a variety of opportunities for scholarly inquiry (Nelson and Monsen, 2014).

For some authors, the focus should be on venturing projects that are “real,” intensive, interdisciplinary, iterative, group-based, and “hands-on” (Barr et al., 2009; Harms, 2015). Felder and Silverman (1988) suggest that paying attention to learning styles is particularly appropriate for engineering students. Byrne et al. (2009: 358) argue that “engineering students are typically active learners [...] Their reasoning proceeds from particulars such as observations, measurements, and data. They feel more comfortable with active experimentation and respond best to pictures, diagrams, flow charts, timelines, films, or demonstrations.”

Thus, engineering students, especially those with several years of on-the-job experience, are likely to differ from other students, such as undergraduates or business students without an engineering degree. This is because engineers self-select (and are selected) into their education, and then professional career, based on the motivation to design and build things, and they perceive themselves as “science-driven and not necessarily entrepreneurial” (Maresch et al., 2016: 177). Engineers perceive creativity and innovation as inherent qualities associated with their profession; yet, they have also been found to “rarely consider starting up a business as one of their career options upon completing their studies.” Loras and Vizcaino (2013: 999) conclude that “technical training appears to be an enabler of creativity and an obstacle to business initiatives” for engineers. Maresch and colleagues found that “students who have previously received a business education are more likely to acquire and process knowledge related to entrepreneurship” as compared to science and engineering students (Maresch et al., 2016: 177).

One particularly important challenge engineers face is developing viable BMs for new technologies. For example, Howell and colleagues (2018: 237) explain the importance of designing a viable BM for a low-cost sensor technology used to increase the number of weather stations in sub-Saharan Africa. Without a viable BM, the authors argue, the diffusion of this frugal innovation that improved weather forecasting and mitigated crop losses due to weather for local farmers might not have been possible. Surprisingly, the business modeling methods developed by management scholars are frequently ignored (Massa et al., 2017), and as a result technology management education curricula have been mainly confined to how organizations respond to technological, rather than business-related, challenges. The challenge of educating engineers about developing new BMs stems from engineers being educated to “reason about knowledge associated with mathematics and sciences,” that is, hard sciences offering often unique answers to specific problems (Dym et al., 2005). Developing new BMs, however, is emphatically not a problem with a unique answer—quite the opposite, a great diversity of BMs has been documented (Dentchev et al., 2018; Muñoz and Cohen, 2017). Additionally, the process of BM design and innovation is recognized as complex due to the number of BM components and interactions between them (Snihur and Tarzijan, 2018), often only revealed during implementation (Howell et al., 2018).

Some TBFs have been using boot camps to provide engineers with hands-on entrepreneurial skills (Clarysse et al., 2009: 434). Such corporate practices signal a move from teaching based on exemplary cases to project coaching and hands-on BM development in real time, which might be more useful to engineers. Another advantage of practicing business modeling techniques in real time is the generation of a concrete result (i.e., a functioning BM) beyond knowledge accumulation and the personal development of participants. This is particularly useful for engineers that are employed in TBFs that frequently search for new BMs to exploit market opportunities.

In sum, although the education literature recognizes that engineers are a different audience from usual business students, and that they need education about entrepreneurship to connect new technologies with viable BMs and exploit opportunities in their market, little is known about the specific practices that can help them to do so. We therefore examine how to educate engineers to develop new BMs to exploit entrepreneurial opportunities both within existing TBFs and for TBFs in university courses. We start by reviewing the existing BM frameworks developed by researchers to assist managers and entrepreneurs with the process of developing effective new BMs.

* 1. *Overview of research on business models and the related frameworks*

A BM is “an architecture for how a firm creates and delivers value to customers and the mechanisms employed to capture a share of that value” (Teece, 2018: 1). The use of BM vocabulary enables thinking about how to design BMs because a model can always be changed or improved through better design and experimentation (Andries et al.,2013). Designing new BMs involves introducing activity systems new to the focal firm industry (Snihur, 2016), and has been conceptualized as a way to link technological advances to economic outcomes (Chesbrough, 2010). This is a particularly important business concept for engineers, who might need to develop a new product based on technological advances and couch that product in a (new) BM to reach the intended customers (Howell et al., 2018).

Several frameworks have been developed to assist managers and entrepreneurs in developing new BMs. Frameworks provide simplified representations of the complex underlying context for decision makers and “suggest the dimensions that a mental representation should include” (Csaszar and Levinthal, 2016: 2032), often through some visual representation useful to structure thinking and analysis. Some examples of frameworks for strategy development include the Boston Consulting Group growth-share matrix, Porter’s five forces, or generic strategies (Jarzabkowski and Kaplan, 2015). BM frameworks are the latest addition (Vuorinen et al., 2017).

Although framework development is a long-standing activity of management scholars, reflection about the use of frameworks in practice is much more recent (Vuorinen et al., 2017). To contribute to this reflection about framework use, we reviewed the BM literature based on an in-depth search of the *Business Source Complete* database and recent literature reviews (Foss and Saebi, 2017; Massa et al., 2017). We limited our review to articles and books that present generally applicable business modeling tools and offer a specific framework. We next identified the most cited frameworks used for teaching and research about developing new BMs based on citations. For cross-validation, we reviewed 20 syllabi of BM-related courses delivered in Asian, North-American, and European universities. Through our network, we identified university professors involved in BM-related courses and asked them to share their syllabi. We then broadened our search to the syllabi of courses with “business model” in their title or content online. This resulted in 20 syllabi from 13 countries, including Canada, China, Denmark, France, Netherlands, UK, and USA, of which 20% used the Blue Ocean, 70% used the BM Canvas, and 65% used the BM Innovation framework (several syllabi used more than one framework). The frameworks identified are summarized in Table 1.

[Insert Table 1 about here]

We review the three most popular frameworks, based on the number of received citations and syllabus mentions, in chronological order of publication, below.

* 1. *Background on business model frameworks*

First, the Blue Ocean framework focuses on developing a value curve for the attributes of the company’s product or service that customers care about, compares different competitors along the defined attributes, and helps find new attributes (Kim and Mauborgne, 2005). Value curve analysis relates closely to the value proposition (Moingeon and Lehmann-Ortega, 2010) that the BM is expected to create for a particular actor involved in the new BM (Chesbrough, 2010). Although the Blue Ocean does not always refer directly to the new BMs, the approach taken is very similar to the definitions of new BMs in the literature, and has been successfully used for teaching how to develop new BMs with both students and practitioners (Deshler and Smith, 2011).

Second, the BM Canvas provides nine elements for developing, describing, and visualizing BMs: key partners, activities, and resources, value proposition, customer relations and segments, channels, cost structure, and revenue streams (Osterwalder and Pigneur, 2010). The BM Canvas has become a popular tool during the last decade, especially in classes on entrepreneurship (Cosenz and Noto, 2017; Hoveskog et al., 2015). It is also used to connect R&D results to economic outcomes during technology commercialization (Toro-Jarrin et al., 2016).

Third, the BM Innovation Framework developed by Amit and Zott (2012) is slightly different from the other two as it encourages BM designers to ask six questions, about customer needs, types of activities, structure and governance of activities, value created for stakeholders, and revenue models, to reflect systematically on the BM elements that can be innovated.

* 1. *Comparison of business model frameworks*

Comparing the three frameworks, value creation is at the center. This is in line with what academics regard as the strength of BM research, bringing the locus of attention to how value is created by organizations (Priem et al., 2013). Blue Ocean analysis focuses on value curve, value proposition is at the center of the BM Canvas, and one of the six BM Innovation questions is about value creation for stakeholders. Blue Ocean framework is very much customer-centric and provides the easiest visual comparison of the value curve for the firm and its competitors, while the BM Canvas and BM Innovation Framework are firm-centric and usually used to analyze the firm rather than for competitor comparison.

The BM Canvas offers a holistic, one-page representation of the BM, which can be easily used for communication with various parties, such as potential investors or employees. The BM Canvas has the most user-friendly design for teaching as the Canvas can be projected on the wall to enable students with Post-its to work on BM design. At the same time, it has the most elements (i.e., nine closely-interlinked blocks), which might sometimes be difficult to clearly differentiate and goes somewhat against Jarzabkowski and Kaplan’s (2015) recommendation that “simpler tools are easier to remember and use.” This leads to a rather static description of the nine blocks, which often ignores key connections between, for instance, key activities, revenue streams, and company cost structure.

Value creation for all stakeholders, including potential partners as well as customers, is considered in the BM Innovation Framework. It requires deeper understanding about activity systems from students due to the more Socratic focus on questions rather than blocks. It is also more parsimonious with the six questions than the BM Canvas with its nine blocks. Issues common to all three frameworks include the lack of evaluation of fit with the company’s existing BM when used in established firms, and the lack of evaluation of inherent risk or questioning of the underlying assumptions that might be flawed (e.g., about customers, partners, etc.). Table 2 details the main features of the three frameworks relevant for teaching.

[Insert Table 2 about here]

In sum, several recently developed BM frameworks are useful to educate engineers about technology entrepreneurship. However, little cumulative research exists about how, when, and with which audiences to apply BM frameworks. We address this gap.

1. **Method and data**

*3.1. Research design*

To elaborate theory about how to teach engineers to develop new BMs in and for technology-based firms, it is first important to distinguish teaching contexts based on specific audiences. Students with an engineering degree, often equipped with several years of professional experience, habitually go back to university for a business degree. When they do, they are exposed to entrepreneurship education, and, in recent years, various popular BM frameworks. Second, engineers often evolve to management roles where they have to implement organizational renewal initiatives, often focused on the search for new BMs (Berends et al., 2016; Khanagha et al., 2014).

To study our research question, it is relevant to examine these two audiences, comparing education in business schools to what happens in organizations. This is more productive than focusing on a sample that would not be representative of either audience, as they differ in terms of age, professional experience, hierarchical position, and context within organizations. We therefore conducted two studies with student and professionally employed engineers, with similar engineering backgrounds but different formal positions, roles, and authority level. The purpose of this theoretical sampling was to develop theory useful to educational needs of engineers in different professional positions, not to test it.

The first study relies on the first author’s delivery of a yearly 12-hour “Innovation and new BMs” course in a highly-ranked French business school. This course was offered as part of the “Innovation and Entrepreneurship Major” in an executive education program and was aimed at engineers who study part-time to acquire a Master’s degree in business. These students are usually recruited from the local ecosystem of TBFs, many of them active in the knowledge-intensive aerospace sector. Student background includes an engineering degree and several years (six, on average) of professional experience, related to engineering as well as entry-level and middle-management positions. The course was taught repeatedly over the period of five years to six consecutive cohorts of students.

The second study relies on the first author’s collaboration with an established engineering company in the aerospace sector, given the pseudonym AERO, to facilitate the development of new BMs by the top management (with engineering background) over a period of two years. This company was serendipitously chosen as AERO is locally well-known for its engineering culture and its Strategy Vice-President (VP) contacted the first author, asking for academic assistance with the development of new BMs.

The first author was the main instructor in both studies and introduced various practices to counter challenges met during teaching, for instance in terms of creativity emergence or prototyping issues. Engagement in action research (Bradbury-Huang, 2010; Chevalier and Buckles, 2013) has several advantages, such as high practical relevance to other instructors using similar frameworks, in-depth knowledge about practical tools used, and repeated observation of and direct interaction with cohorts of students resulting in better real-time understanding and continuously improved teaching practices, which are reflected upon and shared below.

The combination of insights from the two studies is a strength: we draw conclusions from educating both entry-/middle-level managers and highly experienced senior practitioners with an engineering background to the use of BM frameworks. The two types of engineers in our setting face the same issue (i.e., lack of knowledge about developing new BMs). The two teaching contexts provide complementary insights and facilitate the examination of the BM frameworks use in two highly applied educational contexts (a business school and an existing organization).

*3.2 Data collection*

Our analysis relies on multiple sources of data. For the first study of engineers in entry-/middle-level management positions seeking an additional business degree (part-time), we rely on more than 60 teaching hours delivered in 2013-17 to over 150 students, written and oral material based on student projects and presentations during the course, as well as students’ written evaluations of the course and oral feedback transcribed by the instructor. Course participants in the first study were selected by the business school’s program administration, independent of the research goals. The number of participants was similar to the usual number of students in MBA classrooms.

For the second study of engineers in top management positions we conducted more than 30 hours of participant observation at AERO, including a presentation by the participating researcher concerning existing BM frameworks, several subsequent ideation meetings with more than 10 of the company’s top managers applying the frameworks to develop new BMs for AERO, and five semi-structured interviews. The number of participants in the ideation meetings was chosen by AERO top management, not by the researcher. The researcher then used her access to attend the meetings concerning the development of new BMs and interviewed some of the willing meeting participants as well as a past CEO to better understand AERO culture and innovation dynamics. The researcher’s role varied from active participation and training during the first two meetings to less active observation later. Table 3 summarizes the data sources used.

[Insert Table 3 about here]

*3.3. Data analysis*

We followed the principles of grounded theory (Glaser and Strauss, 1967) to generate a plausible and useful theory about BM education experiences of top-, middle-, and entry-level engineers. We applied this methodology because our literature review did not reveal existing theory on the use of BM frameworks for education of engineers (Cho and Lee, 2014). Specifically, we examined “what is actually going on” and the interpretations of these realities by the participating actors (Suddaby, 2006). This methodology is appropriate as we aim to uncover how actors make sense of their education experiences to explore and understand the use of existing BM frameworks in and for technology entrepreneurship education. We progressed from a very detailed reading and analysis to greater generality in three analytical steps.

First, we performed thematic analysis based on the instructor’s course notes, student feedback, and course evaluations from the executive education program, using a large set of data-based “open codes” (Strauss and Corbin, 1990). We then searched for underlying meanings and relationships between codes and different levels of themes, or “something important about the data in relation to the research question” (Braun and Clarke, 2006: 88) that characterized the process of applying BM frameworks. For example, we interpreted comments about difficulty of idea generation, such as “Where should the new ideas come from?” to indicate a challenge of surfacing novelty when using BM frameworks. Constant comparison between the insights from the data and participant meanings was enabled by the action research approach: the researcher’s learnings from one cohort of students were implemented and tested with another cohort, for instance enabling insights about useful creativity-enhancing tools (see Findings for details).

Second, we wrote a detailed case narrative about AERO and its BM development project, documented the interactions between the researcher and company executives, summarized the dynamics during the ideation meetings, and compiled a list of all the material referring to the company’s current BM and the development of potential new BMs. Company history was reconstructed through public documents (e.g., annual reports, press releases), four interviews with top managers, and a two-hour interview with the past CEO (Table 3). Results were presented and discussed with AERO managers for validation and to enhance trustworthiness.

Third, following the grounded theory precept of constant comparison (Suddaby, 2006), we compared themes emerging from the thematic analysis in the two studies. We then compared findings to the existing literature on teaching engineers (Dym et al., 2005; Wheadon and Duval-Couetil, 2014) to refine our understanding, with authors iterating our interpretation, until a close match between theory and data. We grouped the six first-order codes into three more abstract second-order themes based on common features and emerging theoretical insights. Subsequent iterations resulted in two third-order aggregate dimensions. Figure 1 depicts the coding structure. Table 4 presents supporting evidence.

[Insert Figure 1 and Table 4 about here]

1. **Findings**
   1. *Process approach to teaching how to develop new business models*

The teaching was organized in two phases in both studies: (1) presenting and analyzing the existing frameworks for new BM development; and (2) coaching students to apply frameworks to a particular problem. The first phase focused on *explanation-based,* deductive learning through a lecture supplemented by reading materials from academic journals and books. The second phase focused on *experience-based,* inductivelearning through directed group work followed by group presentations and discussion of results.

In the first phase, following a lecture-style presentation by the educator, participants were asked to think about and discuss the advantages and disadvantages of different frameworks in groups, and then participated in a general discussion about these. In the second phase, the participants were asked to apply the BM frameworks to specific situations to gain concrete experience, observe, and reflect about framework use through practice. The first phase was similar in both contexts. During the second phase, in the executive education program the problem was formulated by the educator, involving the development of a new BM for a specific industry. At AERO, the objective was the development of new BMs for the company.

The teaching experience varied between the two studies while using the same deductive material. The depth and breadth of framework application and the ensuing discussion reflected contextual differences. The more specific and pressing problem (developing new BMs for AERO) increased the depth of the discussion and brought up political issues within the company (e.g., differences between marketing and R&D managers in identifying the company’s main customers). During the executive education program, the discussion was broader and related to more general management issues. The focus was on understanding better different practices and tools, and how those could be useful in students’ careers. For executive education audiences, the abstraction level was higher and the instructor frequently had to reformulate situational learnings to obtain generally applicable insights. This contrasted with the company set-up, where the focus was on much more specific and practical solutions useful to AERO. This shows how students actively influence the education process, engaging with the frameworks that interest them the most, and raising issues that are most relevant for their personal context, knowledge, and experience with learning.

At the same time, we discovered similarities between the two contexts. Our data analysis revealed two challenges and one opportunity of BM-related education: the challenge of surfacing novelty, the challenge of prototyping new BMs, and the opportunity to generate a virtuous learning cycle (Figure 1). We explain each in turn below.

* 1. *Challenge of surfacing* *novelty*

The frameworks used to teach how to develop new BMs are often more complex than the usual 2x2 matrices used in management capstone courses. The three frameworks used focus on the (more numerous) dimensions to consider when developing new BMs (Table 2), which creates their biggest limitation when it comes to stimulating creativity. For instance, when asking students to develop a new BM for a specific industry based on Blue Ocean and using the value curve, the results of the group projects, repeated throughout the five years with different student groups, were very similar across groups and cohorts. Instead of generating novelty with respect to existing industry BMs, students drew the value curve based on their prior experience of industry functioning, and had a very difficult time adding new dimensions that would generate new-to-the-industry BMs. For example, in an exercise with the consulting industry, the only novel BM that one group out of two cohorts of students (around 12 groups in total) came up with was leveraging big data to provide consulting advice to clients. All other BMs were similar repeats of the already well-established BMs within the industry.

While the value curve is open-ended, the blocks in the BM Canvas, and questions in the BM Innovation Framework limited creativity and out-of-the-box thinking by imposing such pre-determined structures. As one student commented during class:

*“I try to think about customer segments, but it’s only the existing industry segmentation examples that come to mind—people with money or the low-income customers. How should I think to find new customer segments?”*

The inherent complexity of the frameworks made creativity emergence difficult as students spent considerable time trying to understand how exactly the frameworks work (more than 50% of allotted group discussion time on average) rather than coming up with novel ideas. Overall, the BM Canvas and the Blue Ocean value curve were generally more user-friendly than the BM Innovation Framework, for which more training and a deeper understanding of activity systems seemed required. For instance, another student commented:

“*I think it is harder for me to use the BM Innovation Framework than the others, I do not think I completely grasp what is meant by activities or governance structure*.”

Interestingly, this problem was alleviated in the context of AERO, where the BM innovation project was prolonged over several months, which provided ample time for participants to get acquainted with the BM frameworks, understand their use, and apply them repeatedly. The presentation of the BM frameworks took place in January, and the ideation meetings followed in February, April, and October. This sustained rhythm enabled a more in-depth analysis of the potential BMs compared to the executive education course, structured over a couple of consecutive days, which offered less time for knowledge absorption and personal reflection.

Yet, similar to the engineering students, novelty generation was difficult for AERO, especially at the beginning, as one participant commented in frustration:

“*How can we come up with a novel BM? Everything has already been tried here either by us or by our competitors!*”

To remedy the issue of limited creativity, the instructor incorporated process-based teaching techniques, discussing additional tools to stimulate creativity, such as use of analogies, brainstorming, design thinking, and alternative framing of problems. For instance, one effective tool was watching a video documenting the process of a new product development at IDEO, a successful product development consulting firm. Learning about the creativity and ideation process from this video subsequently facilitated students’ work on developing BMs with the frameworks introduced by the instructor, improving the quality of the results due to process insights about “how creativity works.” This was reflected in numerous course evaluation comments. For example, one comment read: “I learnt how to use design thinking, which really facilitated the task of developing a new BM for me,” and another said: “Getting acquainted with the process of design thinking was an important learning from this class.”

Another useful tool to stimulate creativity was the use of analogies—at AERO, the executives went through the 50 different BM patterns in various industries described by Gassmann, Frankenberger, and Csik (2015) and mindfully chose the patterns that could be applied to their business. This generated a surprising boost in creativity, resulting in over 120 ideas for new developments. One of the participants commented:

“*This wellspring of creativity was rather unexpected for me personally*. *It was great to see all team members participate and come up with so many ideas, whereas before we seemed to be stuck and had very few ideas in my group.”*

Analogical reasoning was applied by team members to transfer some features of BM patterns from other industries, such as “pay-per-view” in the TV industry, to their own aerospace industry, with the development of new concepts such as “pay-per-landing” for revenue generation. Analogies also helped the executive education students develop new BMs, although the volume of ideas was smaller, reaching a maximum of 60 ideas. This might have been related to the more limited time spent on brainstorming compared to AERO. All in all, analogies were useful to trigger creativity in both studies.

Additionally, design thinking was relatively easy to teach to students with an engineering background, who often had experience with the design of devices, systems, or processes, and could more easily transfer their knowledge about design in science and technology to designing BMs. One executive education participant commented:

“*We are used to having a process to design product prototypes or various simulators at our company, but it was new to me to use design tools for more abstract, business concepts such as a BM. I found this part of the approach very enlightening. It is also something I could use back at work.*”

The encouragement to use visual representations like the BM Canvas, drawing different BMs on whiteboards, and working with sketches helped create the connection between the existing knowledge engineers had about device or product design and the design of new BMs.

* 1. *Challenge of prototyping novelty*

Our data revealed that another challenge of using existing BM frameworks is the inherent need for experimentation and trial-and-error learning during the BM innovation process. “How can we test if this will work?” was a recurrent question during our two studies. The difficulty stems from the challenge of having to test a new BM off-line, or relying heavily on cognition and imagination rather than real-time implementation. For instance, reasoning by analogy enabled AERO to come up with various ideas for new BMs such as “pay-per-landing.” However, it remained unclear whether such analogical transfers could work with their customers or partners. The Sales Manager commented:

“*It is difficult to know if our customers would use this en masse, they might need to be educated about the benefits, I can imagine some of them trying, but the uncertainty is high.*”

In contrast to cognition-based “off-line” evaluations, experiential processes inherently require at least partial implementation to evaluate efficacy, making them “on-line” evaluation mechanisms: actions are tried, their outcomes experienced, and subsequent revisions made. Students remarked on this problem repeatedly, in both classroom exercises and during the AERO ideation meetings. For instance, one executive education evaluation read:

*“It would have been even better to test if our new BM could actually work. This is, however, difficult to do as there are many assumptions underlying all the Canvas choices, and how to test them is not obvious.”*

The problem of how to effectively prototype new BMs is compounded by the high number of elements and interactions between them, which hinders testing. Although engineers are often used to testing new products, it is less straightforward to test new BMs, which are abstract concepts rather than physical artifacts that are easier to show and touch.

The problems with on-line evaluation for AERO were exacerbated by the question of whether, when, and how to reveal the new BM to various stakeholders, such as customers or partners, in order to test them. The Sales and Marketing Director remarked:

*“So, to test this new BM we have to discuss it with our suppliers and customers, but if we do that, others may learn too early about this initiative. We work in a very tightly connected ecosystem, our customers can easily start discussing this new model with our competitors, and we do not want that, do we?”*

These concerns led AERO to prioritize internal development, at the expense of quick feedback from external stakeholders to reduce uncertainty about their interest.

On-line BM testing was particularly difficult to implement in the executive education course spanning a few days, where most of the testing had to be performed off-line due to time and space constraints. The educator designed specific guidelines, using the lean startup method, to help students test BMs through prototyping. However, as time for comprehensive testing was not available, a lot of confusion and uncertainty remained: this was evident in the classroom as well as at AERO as groups engaged in long discussions about which BM design options to choose, difficult to resolve without on-line testing.

The on-line testing of new BMs appeared closer to reality and allowed AERO to come up with more operationalizable ideas than executive education students. At AERO, many top managers’ discussions evolved around the trade-off between on-line testing of new BM ideas with customers and partners and the risk of competitors learning about these BMs and imitating them too early. For instance, the Strategy VP commented:

*“Our customers often have a tight relationship with our competitors. Sometimes our customers are also our competitors in some markets. It is not easy for us to test some new ideas about BMs with them.”*

* 1. *Opportunity to generate a virtuous learning cycle*

An important element of the approach concerns designing a virtuous learning cycle within the course program to sustain learning. The two phases of explanation- and experience-based learning were repeated over time to cumulate knowledge and understanding and learn to apply the frameworks and find their limitations. This blending of explanation and experiential phases engendered abundant positive feedback from students, who repeatedly commented about “excellent distribution between theory and practice” and “useful theoretical understanding that helped with practical applications in the second part of the course” (Table 4).

Our data also revealed that the use of BM frameworks when teaching engineers goes beyond teaching methods based on exemplary case studies by leveraging the coaching educational style during the experiential phase. This educational style minimizes “lecture” time and transforms the educator into a coach who imparts tools and techniques to students and asks for evidence of their conclusions based on the use of tools. It helped engineers realize the relevance of entrepreneurial skills and techniques while appropriating the generic tools developed by researchers (i.e., BM frameworks). One student commented:

*“I realized during this course that business skills are actually very useful, and not obvious to acquire from just looking at a framework or reading an article or a textbook. How to argue with a tool in hand is my most useful learning here that I can transfer back to my professional engagements.”*

When adapting the explanation-experience virtuous learning cycle using BM frameworks, the educator shifted roles from a teacher providing lecture-style material in the first phase, to the coach role during the second phase. This involved helping participants find a common language and a good understanding of frameworks when working with a particular tool, especially useful in the corporate setting when engineers from different units and functions had to collaborate. While it was useful to explain the frameworks to students in the more directive explanation-based phase, it was also necessary to let students experience first-hand the benefits and shortcomings of the BM frameworks during the experience-based phase. This was highly appreciated by students, as evidenced by course evaluations (Table 4).

1. **Discussion**

*5.1. Summary of findings and contributions*

We began with the research question concerning the education of engineers to develop new BMs in and for technology-based firms. Our findings revealed the challenges of applying current BM frameworks, such as the difficulty of surfacing novelty, and the problems with prototyping BMs in real time. These challenges were countered by the employment of creativity-enhancing tools, such as use of analogies, brainstorming, design thinking, and alternative framing of problems, and prototyping tools, such as the lean startup method. Our findings confirm and augment prior studies pointing out the role of analogical reasoning for BM design (Martins et al., 2015) and the usefulness of the lean startup method (Harms, 2015). Adding to these studies, we examine an empirical context of technology-intensive and innovation-focused engineer-led organizations and focus on problems they face in terms of commercialization of their technological advances.

We also uncover the opportunities provided by BM-based teaching approaches, including the educator’s transformation from a lecturer into a coach and the formation of a virtuous learning cycle. The two sequential phases, the first *explanatory*, using existing BM frameworks, and the second *experience*-based, encouraging their application, foster the engagement of students in “learning by doing and reflection” (Pittaway and Thorpe, 2012: 852). The two phases are linked into a mutually reinforcing relationship that enables student learning of new competences to design innovative BMs applicable to the technological innovations of their firms. This is in line with existing evidence that mixing different types of learning exercises increases student engagement (Austin et al., 2009) and parallels the competence-based teaching model, where “teaching is conceived as a strategic intervention to allow for—and influence—how students organize the resources at their disposal into competences” (Béchard and Grégoire, 2005: 115). In our case, BM frameworks are resources that students learn to use to develop individual-level competences in innovative BM design. Systematic thinking about BM design, enabled by the BM frameworks referred to here, is of crucial importance to generate viable BMs for new technologies.

*5.2. Implications for technology entrepreneurship education*

Our study is one of the first empirical papers to bridge and contribute to two contingent research and practice fields: entrepreneurship education and technology entrepreneurship. Our insights are particularly timely and useful in the emerging context of digital technology entrepreneurship (Giones and Brem, 2017). We provide a first-hand account of education delivered to different groups of engineers, a particularly under-studied context for technology entrepreneurship education (Nelson and Monsen, 2014). While other studies have examined entrepreneurship education approaches such as effectuation (Nabi et al., 2018; Sarasvathy, 2001) or lean startup (Harms, 2015; Huang-Saad et al., 2016), we complement this literature by studying entrepreneurship education in technology-intensive setting (Gilbert, 2012) and use action research to report findings about both students’ and the educator’s perspectives useful for innovation contexts. Although there is significant research on BMs in entrepreneurial settings (George and Bock, 2011), we show how BM frameworks can be used for education beyond start-ups, in particular in our study of corporate entrepreneurship at AERO.

We contribute to understanding of the importance of context by suggesting different boundary conditions for different educational approaches such as BM frameworks or effectuation. Effectuation and lean startup approaches seem most appropriate for general entrepreneurship courses relating to the phase leading to startup (Nabi et al., 2018) or more specialized courses on social entrepreneurship (Harmeling and Sarasvathy, 2013). Specifically, researchers have commented that the concept of effectuation (Harmeling and Sarasvathy, 2013) “was developed in general entrepreneurship and is now often applied to the technology entrepreneurship field. Its roots are found in entrepreneurial cognition. Yet it was born devoid of input from the technology entrepreneurship literature. The concept therefore downplays the role that the differing nature of technologies plays, which severely limits the concept’s transference between technology product paradigms.” (Ratinho et al., 2015: 170). Thus, while the effectuation approach seems most appropriate for pre-startup early venturing efforts, BM frameworks can be used in courses centered on innovation and generation of novelty in settings *beyond* new ventures, in particular including established firms in technology-focused industries. In such contexts, development of new BMs can enable value creation from technological advances, helping engineers to think about how to commercialize newly developed technologies, the problem often confronted by TBFs like AERO.

At the same time, different educational approaches are compatible: for instance, the lean startup approach of experimentation, “build-measure-learn” loop, and iterative product development with notions such as minimal viable product or pivoting helped our students to prototype ideas for new BMs. Similarly, both causal and effectual reasoning can be used for BM development. This suggests that these different approaches with distinct units of analysis (individual-level entrepreneurial cognitive processes for effectuation, organizational-level product and its improvement for lean startup, and organizational-level business model for BM frameworks) can also be profitably combined.

In sum, our study contributes to technology entrepreneurship education with a thorough portrayal of various tools at the educator’s disposal to bridge the divide between engineers’ technological competences and their lack of business knowledge (Phan et al., 2009). BM frameworks are effective and actionable pedagogical tools that can help to link the disconnected fields of entrepreneurship education and technology entrepreneurship (Linton, 2015) and to support the development of relevant courses and programs in this context. We extend studies concerned with inculcating entrepreneurship skills in technology management education (Clarysse et al., 2009) by highlighting the need to drill down to a more fine-grained level to explore approaches that may be more effective in applying different BM frameworks or other entrepreneurship education approaches.

*5.3. Practical implications*

The practical implications of our research are to help engineers work on solutions to societal challenges such as climate change or inequality not only through developing useful technologies, but also by skillfully embedding them in viable and scalable BMs. This is relevant to various contexts, such as developing countries and frugal innovation (Howell et al., 2018) or the sharing economy, where new BMs can help find long-term solutions to problems we are facing today through for instance more efficient resource utilization (Muñoz and Cohen, 2017). Existing research suggests that a variety of BMs rather than a one-size-fits-all solution exist (Dentchev et al., 2018). Unlocking future value creation and capture potential might lie in the education of today’s and tomorrow’s leaders about the design options when it comes to new BM development.

We specifically reveal the need in technology entrepreneurship education to integrate BM and creativity approaches to help engineers realize novelty when exploiting opportunities in the knowledge-based economy. Our findings about the difficulty of realizing novelty suggest that experienced engineers might tend to enter a “knowledge corridor,” which primes them with particular knowledge but limits their effectiveness in other fields (Gruber, et al., 2013), where their experience with technology might hinder such tasks as BM design. This suggests that to escape the “knowledge corridor” created by prior experience and to broaden horizons in terms of what is possible with BM design, engineers need education not only about BM tools, but also about creativity-enhancing approaches. Our study provides preliminary insights into how educators can help engineers enrich their skill-set and expand mental models by adding business competences to technology-related skills. BM frameworks can help engineers from different functional or organizational units develop systematic thinking, a common language, and shared understanding for strategic conversation across organizational boundaries using BM-related vocabulary.

Our analysis also suggests that universities developing entrepreneurship education programs for a range of participants with a (technological) engineering background need to develop differentiated offerings that meet the needs of undergraduates, graduates, and executives. Programs adopting startup frameworks (e.g., effectuation approach) may be especially important for undergraduates and some graduates. Other graduate, post-experience, and executive programs may benefit more from a different curricular content more suited to company renewal through corporate entrepreneurship. In line with theoretical work about different teaching models for specific audiences (Fayolle and Gailly, 2008), our results also suggest a need for distinct approaches to teaching graduate engineering students as compared to interventions in customized corporate education programs (Groen et al., 2006). For instance, we found that testing new BMs, although challenging, was more feasible in a classroom context with engineering students, where the stakes were relatively low, than in an existing corporation. This is because of issues around revealing the new BM too early to potential customers, suppliers, or competitors (Casadesus-Masanell and Zhu, 2013) that firms face when involved in BM innovation. This problem with revealing innovation has been noted in innovation research (Alexy et al., 2013); however, less is known about how to deal with it when developing new BMs. Corporate executives have to carefully weigh the benefits of on-line testing with customers or partners to generate experiments and trial-and-error learning (Andries et al., 2013; Demil and Lecocq, 2015) and help timely pivoting, compared to the risks of revealing new opportunities to competitors too early. Technology entrepreneurship educators should be acutely aware of this trade-off as well. Our findings suggest that there is a need for more tools, precise guidelines from the educator, and allotted time slots to help students prototype BMs, both on-line and off-line. Our analysis indicates that educators should adapt their role depending on students’ backgrounds and levels of experience to foster the virtuous BM learning cycle and contribute to novelty generation.

To conclude, we uncovered several opportunities and challenges associated with the application of the existing BM frameworks. BM frameworks are useful pedagogical tools to systematize and organize thinking for the purposes of designing a variety of new BMs to solve societal challenges and create and capture value from innovative technological advances. Using BM frameworks in technology entrepreneurship education enables the blending of explanation- and experience-based learning and contributes to the transformation of the educator into a coach and the development of students’ competences to design innovative BMs. Yet, we also need additional research as well as further framework development to enhance the quality of education and the resulting innovations for our increasingly knowledge-based economies, in particular in terms of creativity-enhancing and prototyping tools.

*5.4. Limitations*

Our study’s limitations include a small sample of engineering students from one geographic area and cultural context, the selective use of three BM frameworks in teaching, and context-specific conclusions based on action research in technology-intensive industries. The focused scope of our study centered on the development of new BMs rather than *any* entrepreneurship endeavors, unfortunately did not permit the comprehensive evaluation of other entrepreneurship education approaches. Our approach is most useful for technology entrepreneurship and for corporate entrepreneurship contexts as our study is based on engineering students and an existing company from the aerospace industry. Other educational approaches, such as effectuation, might be more useful for less technology-intensive industries. Further research is needed to explore context-specificity of different pedagogical tools. These limitations constrain the generalizability of our conclusions; however, the diverse industry background and a variety of positions occupied by the executive education students somewhat alleviate concerns about transferability to other contexts. Further, engagement in action research limited the possibilities to use quantitative methods given our cyclic process (Susman and Evered, 1978) based on evaluation and continuous improvement of the teaching methods with each subsequent student cohort.

*5.5. Future research directions*

Our study offers a number of opportunities for research. First, future research could compare the effectiveness of various BM frameworks in the classroom (and beyond) to generate diverse and high-quality new BMs. Research on idea generation suggests that drivers facilitating a variety of ideas might be distinct from drivers that enable high-quality ideas (Girotra et al.,, 2010). This distinction might be applicable to the generation of new BMs, where different tools might be more effective for the generation of a variety of BMs, and other tools (e.g., prototyping, lean startup methods) might help with the generation of high-quality BMs. An alternative view suggests that the choice of a particular tool might be dissociated from its effectiveness; in other words, different tools might provide similar results (Jarzabkowski and Kaplan, 2015). It could be interesting to explore the results and effectiveness of using different didactic tools such as illustrative examples, case studies, and BM frameworks sequentially or simultaneously, with bigger or smaller groups of students. For example, Harms (2015) differentiates individual and team learning effects by examining individual and team assessments during a lean startup course. Similar methods could be applied to examine the effectiveness of various BM frameworks. Other aspects, such as how to teach the design of new BMs for greater social impact, are important to research further.

Second, closer attention needs to be paid to how companies engage in the BM innovation process and what can be learnt from this for the education of engineers and managers. More specifically, research could address how to deal with the different weaknesses of the current BM frameworks revealed, such as providing more tools for the stimulation of creativity and helping students to design experiments to test new BMs. There could be opportunities for knowledge transfer between what practicing managers do and what tools are used in the classroom.

Lastly, our focus here has been on engineers, based on an analysis of two studies in one institutional environment. Further research might extend this analysis to different approaches to the teaching of engineers in other schools and institutional contexts to establish the generalizability and boundary conditions of our findings. Additional research is also warranted to analyze the education of science, social science, and arts and humanities students looking to apply BM approaches to analyze opportunities for venture creation. This would help address comparative questions relating to similarities and differences with approaches to educating engineers.

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**Table 1.**

Business model frameworks.

|  |  |  |
| --- | --- | --- |
| **Framework** | **Published source(s)** | **Citations[[1]](#footnote-1)** |
| BM Innovation Framework | Amit and Zott, 2001, 2012; Zott and Amit, 2007, 2008, 2010 | 10310 |
| BM Canvas | Osterwalder, 2004; Osterwalder and Pigneur, 2010 | 8710 |
| Blue Ocean | Kim and Mauborgne, 2005 | 1024 |
| e3-value ontology | Gordijn and Akkermans, 2003 | 946 |
| 4i Framework | Frankenberger et al., 2013 | 123 |
| BM Roadmapping | Reuver, Bouwman, and Haaker, 2013 | 85 |
| BM Navigator | Gassmann et al., 2014 | 76 |
| BM Components | Moingeon and Lehmann-Ortega, 2010 | 43 |
| BM Map | Leschke, 2013 | 15 |
|  |  |  |

Note: Various pedagogical tools, such as illustrative examples or case studies, are used to teach BM development approaches. However, frameworks such as the BM Canvas have been recognized as the most used tools in BM-related education (e.g., Hoveskog, Halila, and Danilovic, 2015). Other approaches, such as effectuation or lean startup, constitute additional tools for entrepreneurship education.

**Table 2.**

Comparison of BM frameworks.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Feature*** | **Blue Ocean Framework** | **BM Canvas Framework** | **BM Innovation Framework** |
| *Seminal papers and books* | Kim and Mauborgne, 2005 | Osterwalder, 2004; Osterwalder and Pigneur, 2010 | Amit and Zott, 2001, 2012; Zott and Amit, 2007, 2008, 2010 |
| *Main building blocks* | Value curve analysis | Nine blocks: key partners, key activities, key resources, value proposition, revenue streams, customer relations, channels, customer segments, cost structure | Six questions about customers, activities, structure, governance, stakeholders, and revenue model |
| *Strong points when used for teaching* | * Focus on value creation; * Evaluation of value creation for customers; * Easy comparison to competitors/other industries. | * Holistic visual representation forcing systematic evaluation of different aspects and operational challenges; * User-friendly format, ready for brainstorming/use of Post-it notes in small groups, easy to present the result afterwards to others. | * Focus on value creation for all stakeholders (customers, other partners); * Focus on structural (how activities are linked with each other) and governance issues (why would partners join?). |
| *Issues when used for teaching* | * Value creation usually only evaluated for one (average) customer segment; other partners or operational issues (resources, cost structure) not considered. | * Too many inter-linked concepts; * Difficult to differentiate between blocks (e.g., key activities vs. key resources; customer relations vs. channels); * Static description, flows/connections between blocks not represented; * Lack of comparison to competitors. | * Questions alone do not provide a holistic graphical representation like the Blue Ocean value curve or the BM Canvas; * Lower user-friendliness/more practice required to master; * Static; * Lack of comparison to competitors. |
| *Common issues* | * Lack of evaluation of fit with existing company’s BM in established firms; * Lack of evaluation of inherent risk or underlying assumptions that might be flawed (about customers, partners, etc.). | | |

**Table 3.**

Data sources.

|  |  |  |  |
| --- | --- | --- | --- |
| **Study 1. “Innovation and new BMs” course taught in an executive education program (November 2013–March 2017)** | | | |
| ***Course title*** | ***Period of delivery*** | ***Teaching hours*** | ***Participants*** |
| Innovation and new BMs | Nov–Dec 2013 | 12 hours | 25 |
| Innovation and new BMs | Sept 2014 | 12 hours | 35 |
| Innovation and new BMs | Oct-Nov 2014 | 12 hours | 31 |
| Innovation and new BMs | Nov-Dec 2015 | 12 hours | 19 |
| Innovation and new BMs | June 2016 | 12 hours | 22 |
| Innovation and new BMs | March 2017 | 12 hours | 19 |
| **Study 2. Participant observation at AERO (April 2016–October 2017)** | | | |
| ***Topic*** | ***Period covered*** | ***Participants*** | ***Duration*** |
| Management meeting | April 2016 | 2 + researcher | 3 hours |
| Project kick-off meeting | January 2017 | 7 + researcher | 3 hours |
| Ideation meeting 1 | February 2017 | 8 + researcher | 8 hours |
| Ideation meeting 2 | April 2017 | 9 + researcher | 8 hours |
| Ideation meeting 3 | October 2017 | 12 + researcher | 8,5 hours |
| **Study 2. Interviews at AERO (April 2016–December 2017)**  **2. INTERVIEWS** (Sept 2010 – Dec 2011) | | | |
| ***Interviewee*** | ***Duration*** | ***Month/Year*** |  |
| R&D VP | 1 hour | 04/2016 |  |
| Strategy VP | 1 hour | 04/2016 |  |
| Past CEO | 2 hours | 09/2017 |  |
| Strategy VP | 2 hours | 10/2017 |  |
| R&D department head | 1 hour 30 | 12/2017 |  |

**Table 4.**

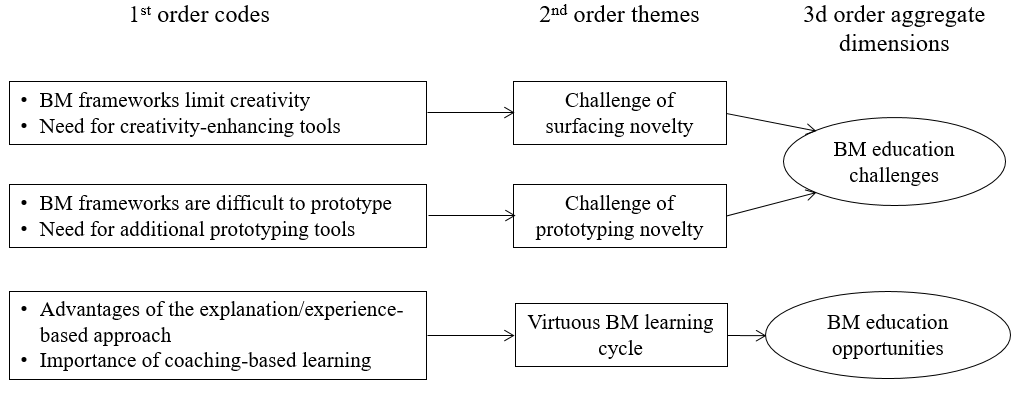
Data illustration for BM education process (from primary material).

|  |  |  |
| --- | --- | --- |
| **Higher-order themes** | **Illustrative quotations or episodes for selected first-order codes** | **Source** |
| BM education challenges:  Challenge of surfacing novelty | Engineers present posters with value curves (Blue Ocean framework) that are very similar across different groups and cohorts when asked to develop new BMs for different industries (e.g., aerospace, healthcare)  “Frameworks are great, but how should we go about figuring out what are the new elements to add? This is the same problem for Blue Ocean or the BM Canvas in my opinion, where should the new ideas come from?” (Student comment)  “I found the Ideo video very insightful, it helped our group to structure our brainstorming session afterwards to focus on idea generation first, not selection.” (Student feedback)  During the first two meetings only a few ideas came up without specific results in terms of novelty generation. The use of 50 BM patterns (Gassmann et al., 2015) fostered the generation of 120 ideas. The VP of Strategy commented: “I was surprised we were able to come up with so many ideas using these patterns and working by analogy to see what could be applied to our own industry, it was very useful.” | Student projects in EEP, various years  Class discussion, EEP  EEP course feedback  AERO observation and interview |
| Challenge of prototyping novelty | “So how should we test this? Should we invite customers to the drawing board immediately? Only then we will know if they like the idea, but then again, maybe this is still too early in the process?” (Strategy VP)  “We can ask several what-if questions, but we still need a reality check for all these relationships we have drawn here.” (Sales VP)  “We saw the Lean Method in our entrepreneurship class, shouldn’t we implement and test this new business model as the next step? This seems complicated to do though.” | AERO ideation meeting  AERO ideation meeting  Class discussion, EEP |
| BM education opportunity:  Virtuous BM learning cycle | “I enjoyed most the balance between theory and practice in this course: We first learnt about the different frameworks, and then could apply them ourselves. It made a lot of sense for me in the context of the changing electricity industry where I work, it made me think about all the new emerging options for innovation, taking a business model perspective to this helped. I think I can use this method in my job too.”  “We understand there are different BM frameworks, but we need a facilitator, someone who could help moderate our discussions, tell us which direction to follow as this is a difficult process for us. We know how to design new products or technologies, but we know much less about developing new business models.” (Strategy VP)  “We did not integrate the BM thinking into our various innovation initiatives previously, this has been a useful learning exercise for different managers in the company. Getting acquainted with tools to develop new BMs and applying them in real time has been very useful to help us see the opportunities in this space.” (R&D VP) | EEP course evaluation comment  AERO interviews |

EEP = executive education program

**Figure 1.**

Coding structure for BM education experiences.



1. Collected from Google Scholar on 08/12/17. [↑](#footnote-ref-1)