The design entrepreneur: How adaptive cognition and formal design training create entrepreneurial self-efficacy and entrepreneurial intention

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Why are design students more likely than other students to become entrepreneurs? The cognitive mechanisms underpinning design- and entrepreneurial thinking have been argued to be similar, suggesting relevance to business venturing. On the other hand, differential formal training in design vs business education suggests distinct types of "entrepreneurial self-efficacy". We report a survey (N = 296) of design versus business students that assessed how adaptive cognition and formal training drive distinct types of entrepreneurial self-efficacy and entrepreneurial intention. The study finds that design versus business students possess different types of entrepreneurial self-efficacy that are positively predicted by adaptive cognition, but differentially affected by type of education. Both types of entrepreneurial self-efficacy positively predict entrepreneurial intention to start up a business.
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Over the past few decades the meaning of the term "design" has slowly shifted from pertaining mainly to the practice of a certain *type of profession,* which is primarily the preserve of formally trained architects, engineers and designers, to now denoting a special *kind of thinking*, which people from any profession can engage in. Research into the former has sometimes been labelled "designerly thinking" (Cross, 1982), and relates centrally to the study of how trained, expert designers reason, while the latter is often termed "design thinking" (Johansson-Sköldberg et al., 2013), and relates especially to the study of how a prescriptive set of user-centered tools

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and process steps can be applied by any profession to improve on designed outcomes.

With their shared focus on cognitive processes, the designerly thinking and design thinking approaches have become somewhat entangled, leading to a degree of conceptual confusion as well as attempts to demarcate clearer distinctions regarding how to define design. As a case in point, consider the profession of business entrepreneurship, which has sometimes been compared to design and is claimed to require thinking much like that of designers. Past research, which we will review below, does indeed appear to show that designers and entrepreneurs generate ideas in similar ways by deploying similar types of problem-solving strategies and metacognitive monitoring and control mechanisms. But to what extent are entrepreneurship and design truly underpinned by equivalent cognitive and metacognitive processes and to what extent do important distinctions prevail that speak to the unique aspects of the causal determinants of outcomes in these two domains? The present paper sets out to disentangle some of these issues, in close alignment with the theme of DTRS13, which likewise seeks to explore such conceptual confusion and to debate the demarcation between domains.

We recognize that the entanglement between the notions of designerly thinking and design thinking may well worry many trained designers. With the conceptual expansion of design into other professions, are we not losing sight of core aspects of what it means to design as a designer? Should designers not be aiming to keep other professions off their design turf? On the other hand, the conceptual expansion also potentially brings new opportunities for trained designers. If design thinking is now something that can be meaningfully applied in management, marketing, innovation, human resources and the like, then might this capture new turf for designers and new professional roles for them to appropriate? In these respects, we are clearly dealing with contested issues that potentially have both negative and positive ramifications for design practitioners.

In the present paper, we aim to contribute to the exploration of the existing conceptual confusion relating to designerly thinking and design thinking by presenting an empirical study contrasting design students with business students, both in terms of how they are trained to think as well as in terms of how their different formal, professional training leads to distinct skills and competencies. Crucially, too, we are also interested in how such skills and competencies have downstream effects on what such students believe they are capable of, that is, their perceived *self-efficacy*. A particularly interesting outcome measure of what design versus business students believe they are capable of pertains to their *intention to start a new business venture*. Design graduates choose to start their own businesses much more frequently than

most other professional graduates. In Denmark, for example, approximately 30% of design school graduates become entrepreneurs within their first 10 years after graduation, exceeding most other cultural and artistic educational programs as well as business school graduates (~11%), with the average level in higher education being ~7% (Uddannelseszoom; Statistics Denmark).

There are several possible explanations for this observation. First, the structure of the labor market for professional designers is dominated by, and invites for, small-scale venturing. Second, graduate unemployment rates force trained designers to start their own ventures to maintain a living. Third, design graduates are trained with skills and ways of thinking that they believe are useful in business venturing, hence lowering the barriers to enter into business start-ups. In the present article, we investigate the latter explanation, whereby it is perhaps the case that design training positively affects graduate start-up activity through the acquisition of skills and ways of thinking believed to be relevant for starting a business. By exploring how the differential training of design versus business students leads to competencies and ways of thinking that in turn affect what the students believe they can do, and intend to do, in their subsequent careers, we aim to inform the debate about how design overlaps with other domains (such as business and entrepreneurship), and with what consequences.

1 Linking design to entrepreneurship

More than 50 years ago, Herbert Simon (1969) advocated the teaching of applied disciplines through design-based curricula, asserting that professional schools, including schools of business, engineering, law, medicine and architecture, are all concerned primarily with the process of design. Simon (1969, p. 130) famously defined design as "devising courses of action aimed at changing existing situations into preferred ones". Simon's definition of design could well pass as a definition of the entrepreneurial process, and it is clear that both design and entrepreneurship aim to change living conditions to produce better situations or new value. Thus entrepreneurship, when viewed through a design lens, might help students identify and act on unique venture opportunities (Neck & Greene, 2011).

Business models are now theorized as basic organizational frameworks to be "artfully" generated through design processes (Teece, 2010), utilizing visualization methods such as the Business Model Canvas (Osterwalder et al., 2010). There has also been a recent surge in training entrepreneurship by means of pedagogical approaches such as studio-based learning, which are well known to design education (Barry & Meisiek, 2015; Christensen, Arendt, & Hjorth, 2023). Lackéus (2015) has described experiential entrepreneurship education as pedagogically similar to traditional design education: it is problem- and opportunity-oriented; features long-term projects; delivers

value to external stakeholders; involves iterative experimentation; and demands team-based, real-world interactions with stakeholders and users.

It is not just entrepreneurial and design education that share similarities, but also entrepreneurial cognition and design cognition. Entrepreneurial cognition is defined as the knowledge structures that people use to make assessments, judgments and decisions involving opportunity evaluation, venture creation and growth (Mittchel et al., 2002). As noted by Ward (2004), novel and useful ideas are the lifeblood of entrepreneurs. To become successful, entrepreneurs need to generate valuable ideas for new products or services that will appeal to a market, identify new business opportunities and ensure that ventures are brought to fruition. Entrepreneurial cognitive processes play a key role in understanding how new ideas for ventures are recognized, generated or discovered, and how cognitive processes aid in transforming ideas to fully-fledged business models. In entrepreneurship research several generative cognitive processes seem to underpin the pursuit of new business opportunities, including intuition (Baldacchino, 2015), ideation (Gemmell et al., 2012), improvisation (Hmieleski, 2013), counterfactual thinking (Baron, 1998, 2000) and conceptual combination and analogy (Ward, 2004).

A particularly influential stream of entrepreneurial research stems from Sarasvathy (2001), who developed the concept of "effectuation" when working under the guidance of Herbert Simon. Effectuation has emerged as one of the key cognitive concepts argued to separate entrepreneurial thinking from cognitive processes arising in the domain of general economics. Sarasvathy (2001) suggests that entrepreneurs engage with distinct "logics", or cognitive processes, when pursuing entrepreneurial opportunities. She distinguishes between a "causation" logic, typically used in entrepreneurial situations associated with lower degrees of uncertainty, and an "effectuation" logic, which pertains to the early stages of venture creation in contexts involving greater levels of uncertainty. A causation logic entails beginning the process with a given goal, focusing on expected returns, emphasizing competitive analyses, exploiting existing knowledge and trying to predict an uncertain future. An effectuation logic, on the other hand, begins with a given set of means, focuses on affordable losses, emphasizes strategic alliances, exploits contingencies and seeks to control an unpredictable future (Perry et al., 2012). Entrepreneurs (much like designers) operate in environments that may be characterized as radically dynamic and uncertain, and in such contexts expert entrepreneurs have been argued to operate less in accordance with goal-directed, pre-planning behaviors, instead focusing on exploring how to mobilize available resources for some possible (but not pre-specified) value creation. This effectuation logic turns business creation into a design problem as opposed to an optimization problem. A recent study by Klenner et al. (2022) provides empirical insights from interviews with designer-founders on how design thinking and effectuation inform each other in practice, illustrating how design

thinking can function as an approach for entrepreneurial innovation and new venture creation.

2 *Entrepreneurial self-efficacy and entrepreneurial intention*

Why do design students frequently start their own businesses? To explore the possibility that design education (like business or entrepreneurship education) helps develop students' self-efficacy in starting and running a business, we set out to test empirically for the existence of a link between entrepreneurial self-efficacy (ESE) and entrepreneurial intention (EI). ESE refers to an individual's belief in their capability to perform tasks and roles related to entrepreneurial outcomes and is crucial in determining whether individuals choose to pursue entrepreneurial careers (Newman et al., 2019). Self-efficacy denotes a mechanism of agency, motivation and behavior, with theorists agreeing that it is domain specific (e.g., Bandura, 1997, 2006). According to the social-cognitive theory of career and academic interest, occupation-specific self-efficacy, as opposed to generalized self-efficacy, is linked to effects on career development and performance (Lent, Brown, & Hackett, 1994). In entrepreneurship research, ESE has emerged as a central psychological construct, with growing evidence indicating that entrepreneurial education enhances ESE in both undergraduate and graduate students (Newman et al., 2019). In addition, ESE is affected by individual differences (e.g., gender, personality, need for achievement) and exposure to mentors and role models (e.g., having entrepreneurs in the family).

EI may be defined as a state of mind directing a person's attention and actions towards self-employment (Souitaris et al., 2007). EI may concern either the initiation of a new business venture (generating a start-up) or the acquisition and scaling of an existing company. We focus here mainly on the former type of EI (i.e., initiating a start-up) (Zhao et al., 2005).

In relation to the outcomes of ESE, past research has frequently drawn upon the Theory of Planned Behavior (Ajzen, 1991) to explain the emergence of entrepreneurial intention (EI) and actual business venturing activities. According to the theory of planned behavior (Ajzen, 1991), planned behaviors are intentional and thus predicted by attitudes and perceived behavioral control. Here, ESE is believed to capture an individual's perceived behavioral control, which is a key element in their intention to engage in entrepreneurial behavior (Chen et al., 1998; Miao et al., 2017). Significant positive effects of ESE on EI have been found for both undergraduate and graduate students, as well as in the population at large (Newman et al., 2019). In past literature, EI has proved to be the best predictor of planned behavior towards self-employment, especially when behavior is rare, or involve unpredictable timelags (Bird, 1988). Research on EI has shown that university entrepreneurship programs raise

EI (Souitaris et al., 2007; Chen et al., 1998; Liñán & Fayolle, 2015), with some of the important educational factors being educational and structural support systems (Turker & Selcuk, 2009).

ESE is a multi-dimensional construct (Newman et al., 2019), consisting of a number of sub-factors (e.g., Barakat et al., 2014; Barbosa et al., 2007; Chen et al., 1998; Denoble et al., 1999; McGee et al., 2009). Although several studies treat ESE as a global, higher-order construct, research on the effects of education on ESE has identified differential educational effects on the sub-factors that underpin it (Chen et al., 1998). In the present study, we focus on the two entrepreneurial self-efficacy sub-factors of *new product development* and *opportunity identification and commercialization*. Our first hypothesis replicates past research on ESE and EI, extending it to formal design education contexts:

Hypothesis 1 The ESE sub-factors of new product *development*, and opportunity identification and commercialization both positively predict EI.

2.1 The effects of adaptive cognition on entrepreneurship

Both the design and business domains emphasize the need for practitioners to be attuned to environmental changes and to have the metacognitive ability to identify and apply strategies in flexible and "adaptive" ways that are appropriate to the prevailing situation or task (see Feltovich et al., 1997, and Klein, 2011, 2017, for important views on adaptive expertise). Sixty years of design cognition research has shown that expert designers employ adaptive strategies such as framing (Dorst, 2015), analogical reasoning (Christensen & Schunn, 2007), abductive reasoning (Dong et al., 2016), mental simulation (Ball & Christensen, 2009; Christensen & Schunn, 2009) and problem–solution co-evolution (Crilly, 2021; Dorst, 2019; Dorst & Cross, 2001; Wiltschnig et al., 2013). The strategies allow designers to learn from experimentation, to create hypotheses and to manage the epistemic uncertainty associated with ambiguous situations (Ball et al., 2010). Through metacognitive awareness of ongoing progress and challenges, expert designers selectively and adaptively engage in cognitive operations (Ball & Christensen, 2019; Christensen & Ball, 2018) and switch away from unproductive cognitive patterns through reflection with peers and more experienced designers (Schön, 1983).

Although research into entrepreneurship education focuses primarily on action, scholars have also debated the roles of reflection, metacognition and adaptive thinking in entrepreneurial knowledge production (Kassean et al., 2015; Lindh & Thorgren, 2016; Pittaway & Cope, 2007). Indeed, evidence suggests that adaptive strategies similar to those deployed in design are likewise associated with entrepreneurship (Garbuio et al., 2018; McMullen & Shepherd, 2006). For example, it has been found that metacognitive awareness

can engender the application of adaptive cognitive strategies in entrepreneurial contexts, underpinning an "entrepreneurial mindset", which consists of the ability to be flexible and to self-regulate cognition in complex, dynamic and uncertain task environments (Haynie et al., 2010). Such metacognitive awareness and the resulting entrepreneurial strategies also appear to be enhanced through training (Mevarech, 1999; Schmidt & Ford, 2003). Furthermore, the importance of being able to detect those possessing an entrepreneurial mindset led Haynie et al. (2009) to construct a measure of adaptive cognition in entrepreneurship, with this measure being defined as an individual's ability to be dynamic, flexible and self-regulating in their cognitions given dynamic and uncertain task environments. We used this measure in the present study to assess adaptative cognitive abilities in both design and business students.

Following the entrepreneurship literature, we hypothesize that entrepreneurship education should help to train adaptive cognition, which should subsequently lead to elevated levels of ESE. Given the arguments for the importance of adaptive cognition in both the design and entrepreneurship literatures, we do not predict a difference in the level of adaptive cognition between design versus business students. It does follow, however, that elevated levels of adaptive cognition in design students should lead to increased ESE, much like for entrepreneurship students. This leads to the second hypothesis:

Hypothesis 2 For both business and design students, adaptive cognition positively predicts the ESE sub-factors of *new product development* and *opportunity identification and commercialization*.

3 *The effects of design versus business education on entrepreneurship*

In arguing that designers and entrepreneurs may be thinking alike in many ways (e.g., by having similar mindsets and applying similar adaptive cognitive strategies), it is easy to lose sight of the fact that trained designers and business managers have, in fact, passed through very different educational systems, affecting their competencies, their identities and their ways of thinking. Thus, although design education may be linked to particular kinds of thinking, it is nevertheless the case that educational outcomes of formal design training are not simply reducible to these kinds of thinking. What trained designers can do – what roles they may fill in organizations, what type of value they may produce and what skills they have – extend beyond what may be described as "ways of thinking".

Higher education aims to train a range of program-specific competencies and skills, with student progression guided by domain-specific pedagogic approaches. Students on a university's business tracks are trained in core subjects and methods that are markedly different to those of students on design tracks.

The labor-market (i.e., the receivers of the outcomes of university education) expect that specific program content will feed through to graduates' competencies, allowing them to take up specialized organizational positions related to their education. As such, education is specialization; the trained business graduate is expected to be able to fill a very different role in an organization to the trained design graduate. Although none of this is surprising, it does highlight the need to maintain a keen eye on how business versus design students are educated, if the aim is to understand what roles they will be able to take up within or outside their chosen professions. What occupies us here is the extent to which a specific type of education (design vs. business) instills a degree of belief and self-efficacy in students that they have skills and competencies to stretch beyond narrow, specialized roles in business or design, allowing them to become successful *business* or *design entrepreneurs*.

ESE encompasses several sub-factors such as marketing, management, financial control, planning, opportunity identification, product development and creativity (Newman et al., 2019). Given the specialization of higher education, design versus business students should differ in terms of these ESE sub-factors. For example, previous research has documented program-specific differences on ESE sub-factors between students on different programs, with Chen et al. (1998) finding that entrepreneurship students had higher self-efficacy in marketing, management and financial control than either management or psychology students. Across the three types of students, ESE was positively related to the intention to set up one's own business.

Here we focus on how business versus designs students differ on the two ESE sub-factors of *new product development*, and *opportunity identification and commercialization*. We note that business education is a social science, with an emphasis on the social aspects of organizing, financing and marketing new business ideas, whereas design education is a material or technical science, with an emphasis on product development and reflective training in the materials of the situation (Schön, 1983). Given that design programs train for the iterative, hands-on development of newly designed outcomes within certain areas of design specialization, it may be expected that design education should increase a student's self-efficacy within new product development. Conversely, business programs usually do not train skills within new product development, and students usually receive no training in hands-on material interaction. Business programs do, however, focus on managerial aspects of innovation, including strategy and process steps, often through case-based learning, which should not translate to the same degree into new product development self-efficacy as would be the case with designers.

Business programs typically focus on management aspects of organizational life, including specialized organizational functions within strategy, marketing, operations, finance, innovation and human resources. This organizational

overview is often taught using lectures and casework. As such, business programs maintain an encompassing focus on the entire value-chain and the full spectrum of organizational life, maintaining a broader management overview compared to design education. While design programs often focus on aspects of user and market needs (i.e., one aspect of business-opportunity recognition) as a starting point for product development, business programs maintain a broader view of what constitutes an attractive business opportunity, extending into finance, pricing and cost structures, organizational scaling and management, marketing and business operations.

Baron and Ensley (2006) contrasted the knowledge structures driving pattern recognition for novice and experienced entrepreneurs, finding that the latter had richer and more clearly defined mental conceptions of what characterized a good business opportunity. Experienced entrepreneurs (in contrast to novice entrepreneurs) who were seeking to recognize business opportunities were found to focus on whether a business idea solves the customer's problems (which both design and business education typically focus on). However, they also focused on other concerns, including: the ability to generate positive cash flow and quickly generate revenue; the capacity to have a manageable risk; and the nature of the business organization pertaining to teaming and networking (which usually only business education focuses on). Consequently, business education should translate into a broader set of student competencies, and higher student self-efficacy, within business *opportunity recognition and commercialization*, compared to design education. This leads to the third hypothesis:

Hypothesis 3 Business students (vs. design students) will have more entrepreneurial self-efficacy pertaining to business *opportunity identification* and *commercialization*, whereas design students (vs. business students) will have more entrepreneurial self-efficacy in relation to *new product development*.

According to the preceding line of argumentation, EI concerns the starting up and running of a *new* business (e.g., based on the commercialization of a newly designed product line). However, EI can also come in the form of a distinct set of venturing activities pertaining to the acquisition and scaling of an *existing* company. Given the education-specific training in design versus business programs reviewed above, we hypothesize that venturing intentions may differ for design versus business students. Although design students may seek to start their own business with the purpose of producing and selling designed artifacts that they developed themselves, business students are more likely to have the intention of acquiring and scaling a company started by someone else (and where the main product sold was developed by someone else). Such an acquisition-oriented EI may be partially mediated by self-efficacy within *business opportunity identification and commercialization*, rather than self-efficacy within new product development. This led to the fourth hypothesis:

Hypothesis 4 Business students (vs. design students) will have a higher entrepreneurial intention to *acquire and scale* an established company, mediated by the students' entrepreneurial self-efficacy within business *opportunity identification and commercialization*.

4 Methods

We conducted structural equation modeling (SEM) to assess how design cognition and education-specific skills create entrepreneurial self-efficacy and, in turn, entrepreneurial intentions. SEM is used to investigate the significance level and direction of correlations in the hypothesized model. Standardization of correlation estimates allows for interpreting the output of SEM as path coefficients like in traditional OLS regression. Furthermore, SEM allows for the estimation of direct and indirect effects which are preferable when testing mediation hypotheses (Acock, 2013).

4.1 Sample

Data for this study came from a survey of second and fourth semester students at a large design and business university college in Denmark offering a two-year Academy Professions degree program on design, technology and business with two different sets of educational specializations (design vs. business). Testing students from the same program at the same institution allowed us to home in on specialization-specific effects of design versus business education, while holding institutional and cultural factors constant. The Academy Professions degree program starts with a joint semester of courses for all students, including an introduction to general aspects of entrepreneurship such as the Business Model Canvas. Students then separate into their design or business programs for three semesters of specialist courses, internships, electives and a final exam project. Links for the survey were distributed in-class during the start of the semester and were followed up in-person at a campus-wide meeting where students were specifically allocated time to answer the survey. The vast majority of surveys (78.7%) were filled out within the last month of the semester, with the remaining surveys filled out across the remaining parts of the semester. Of 554 students surveyed, 296 provided full answers to the survey (a response rate of 53.34%), with 75.68% of responses coming from second semester students and 24.32% coming from fourth semester students. Given the small sample of fourth semester students responding, we do not report results split by semester. The proportion of students responding in their second vs fourth semester did not differ between programs ($\chi^2(1) = 0.96$, $p = .33$).

4.2 Measures

4.2.1 Entrepreneurial intention (EI)

We adopted the global four-item measure of EI used by Zhao et al. (2005), but we split it into two separate 2-item measures. The first measure (EI-Start) covers aspects of starting a new business, while the second measure (EI-Acquire) covers the acquisition of an existing business. More specifically, for the first measure, respondents were asked to assess how interested they were in starting a business and in starting and building a high-growth business in the next 5–10 years. For the second measure, respondents were asked how interested they were in acquiring a small business and in acquiring and building a company into a high-growth business in the next 5–10 years. Responses were given on a 5-point Likert scale ranging from "very little" (1) to "a great deal" (5).

The measure of intention to start a new business had a high internal consistency, *Cronbach's* $\alpha = .81$, while the measure of intention to acquire a business had a slightly lower but nevertheless very good internal consistency, *Cronbach's* $\alpha = .73$. Confirmatory factor analysis with oblique rotation confirmed the decision to split the global measure into two separate ones. In the analyses, each measure was recoded into a dummy variable for respondents in the two top categories (4 + 5) of the scale. Respondents with a high intention to start a new business account for 39.86% of the sample ($n = 118$), while respondents with a high intention to acquire an existing business account for 22.97% of the sample ($n = 68$).

4.2.2 Education (design vs. business)

The university college offers four design specializations, covering fashion design, furniture design, pattern design and visual fashion. The three business specializations offered cover branding and marketing management, purchasing management and retail design and management. Distinguishing between enrolments into business or design specializations allows for an assessment to be made into education-specific effects on entrepreneurial intentions.

For the design students, the product (e.g., an item of fashion or furniture) is the focus of the specialty programs and the final exam. Emphasis is placed upon documenting the design process, idea generation tools, materials and hands-on "making", with competencies being developed through the production of a product. Knowledge is gained on the design process and methods, materials, aesthetics and sustainability, with key competencies developing within the implementation of design from an idea to a finished product, as well as describing and analyzing user needs, and taking part in product development processes. For business students, the focus of teaching sessions is on identifying and solving a business problem, often based on a case study. For

the final exam, the output is a written report that proposes a strategic solution to solve a business problem that the student has identified. Knowledge is gained on marketing, organizing, management and communication, with key competencies developing in relation to the introduction of new products to the market, project management, planning and implementation, and optimizing operations.

The two types of specialty programs also differ in their pedagogy. For business students, the pedagogy is comprised of lectures, casework and discussions where students work in groups and receive group-based guidance. Business projects are formulated as a report, and tend to progress through a set of steps, from selecting an approach, through problem formulation, to literature review, research design and on to analysis and conclusions. For design students, studio-based learning is the predominant form of instruction, with visualization and prototyping encouraged and with lectures mainly used to support studio work. Design projects materialize as a product (in support of a concept) considered as a design solution, which progress through a series of iterations from concept development through refinement to the building of a prototype. We note that 45.27% of students in the sample were enrolled in a design specialization, while the remaining 54.73% were enrolled in a business specialization. In the SEM analysis, education was coded as Business = 0 and Design = 1.

As a validation check that formal training had an impact on student competences across time in our sample, we tested whether the fourth semester cohort of students differed from second semester students in Entrepreneurial Self-Efficacy. For both ESE-NPD (Cohen's $d = 0.17$) and ESE-OIC (Cohen's $d = 0.27$) we found small positive effect sizes, indicating increased self-efficacy across time. Given the small sample size of fourth semester students, this was only significant for ESE-OIC, but does illustrate effects of formal training in our sample.

4.2.3 Entrepreneurial self-efficacy (ESE)

We included a four-item measure of ESE developed by Zhao et al. (2005). This measure was devised to measure self-efficacy regarding a general set of entrepreneurial tasks, covering how confident students feel they are in successfully identifying new business opportunities, creating new products, thinking creatively and commercializing an idea or development. The measure has been reported to have a strong correlation to other dominant measures of ESE, such as that developed by Chen et al. (1998). The Zhao et al. (2005) measure was developed as a global measure of ESE, aggregating across entrepreneurial task domains (Zhao et al., 2005, p. 1268).

To test for differential educational effects on ESE sub-factors, we separated the Zhao et al. (2005) ESE measure into two 2-item sub-factors pertaining to *new product development* (sample item: 'How confident are you that you can successfully create new products') and *opportunity identification and commercialization* (sample item: 'How confident are you that you can successfully identify new business opportunities'), respectively. Items in *new product development* did not cover prototyping abilities specifically. Similar ESE sub-factors have been applied in past research, with creativity and new product development being used in several measures (e.g., Barakat et al., 2014; Chen et al., 1998; DeNoble et al., 1999). Similarly, opportunity identification (Barbosa et al., 2007) and aspects of commercialization have been applied in several measures (Barakat et al., 2014; Chen et al., 1998; McGee et al., 2009).

The global ESE measure had an acceptable internal consistency, $M = 0.70$, $SD = 0.17$, *Cronbach's* $\alpha = .67$, as did the sub-factors relating to *new product development* (NPD), $M = 0.74$, $SD = 0.19$, *Cronbach's* $\alpha = .62$, and *opportunity identification and commercialization* (OIC), $M = 0.67$, $SD = 0.20$, *Cronbach's* $\alpha = .59$. While internal consistencies are acceptable (albeit at the lower end), confirmatory factor analysis using oblique rotation revealed that items load onto two factors, validating the decision to divide ESE into sub-factors.

4.2.4 Measure of adaptive cognition

To measure respondents' *entrepreneurial mindset* we used the measure of adaptive cognition (MAC; Haynie & Shepherd, 2009). MAC is a generalized measure of metacognitive awareness in an entrepreneurial context and includes 54 items divided across five dimensions of metacognitive awareness. Responses are given on an 11-point semantic differential scale, which is anchored on the left with the statement "not very much like me" and on the right with the statement "very much like me". A sample item is 'I find myself pausing regularly to check my comprehension of the problem or situation at hand'. The MAC showed a very high level of internal validity, $M = 0.72$, $SD = 0.10$, *Cronbach's* $\alpha = .92$.

4.2.5 Control variables

The analyses included control variables for socio-demographic characteristics such as gender, age and number of children as well as if any family member was an entrepreneur (Table 1). These control variables were included: (1) to account for any potential self-selection into design or business programs; and (2) because these indicators have previously been found to be influential in predicting entrepreneurship (Walter & Heinrichs, 2015) and entrepreneurial self-efficacy (Newman et al., 2019).

Table 1 Socio-demographic characteristics of the design and business students in the sample

	Design	*Business*
Entrepreneur in the family	0.50	0.58
Age (in years)*	24.87	22.54
Has children (1+)	0.16	0.09
Gender (female = 1)	0.88	0.91
Number of observations	134	162

Note: *Difference is statistically significant using a t-test, $p < .05$.

5 *Results*

Means, standard deviations and correlations for all measures that were included in the analyses are shown in Table 2. Both of the self-efficacy measures (ESE-NPD and ESE-OIC), the MAC, and the indicator of an entrepreneur in the family have a direct and significant relationship with the entrepreneurial intention to start a new business (EI-Start). Both of the self-efficacy measures (ESE-NPD and ESE-OIC) also have a direct and significant relationship with enrolment in design/business specializations (the education variable). Furthermore, MAC also correlates significantly with the entrepreneurial intention to acquire a business (EI-Acquire).

The results of the structural equation modelling analysis are presented below (Table 3), with two models being tested for their goodness of fit to the data: one involving EI-Start as the outcome measure and one involving EI-Acquire as the outcome measure. Both models fit the data well: Model 1 (outcome EI-Start), $\chi^2(4, N = 284) = 2.92, p = .57$; and Model 2 (outcome EI-Acquire), $\chi^2(4, N = 284) = 2.45, p = .65$. The remaining goodness-of-fit statistics shown in Table 3 indicate a reasonably good fit, meeting the criteria suggested by Hu and Bentler (1999) and Acock (2013). Standardized path estimates are presented in Figure 1.

The results shown in Figure 1 provide support of Hypotheses 1, 2 and 3. More specifically, the results from Model 1 indicate that self-efficacy sub-factor measures of ESE-NPD, $\gamma = 0.17$, $p < .01$, and ESE-OIC, $\gamma = 0.15$, $p < .05$, both positively predict the entrepreneurial intention to start a new business (EI-Start), thereby supporting Hypotheses 1. In other words, students with higher levels of each of the two ESE sub-factors also demonstrate higher levels of EI-Start. Hypothesis 2, which relates to the effects of adaptive cognition on ESE while controlling for design versus business education, is also supported, with standardized coefficients of 0.25 ($p < .01$) for ESE-NPD and 0.35 ($p < .01$) for ESE-OIC. This means that students with higher levels of adaptive cognition have correspondingly higher levels of each of the two ESE sub-factors, regardless of their education specialization. In relation to Hypothesis 3, the model confirms that business students have higher ESE-OIC levels compared to design students, $\gamma = -0.11$, $p < .05$, whereas design students have higher levels

Table 2 Means, standard deviations and correlations for all included variables and measures

	Mean	*SD*	*EI-Start*	*EI-Acquire*	*Education*	*ESE-NPD*	*ESE-OIC*
EI-Start	0.40	0.49					
EI-Acquire	0.23	0.42	0.49**				
Education	0.45	0.50	−0.05	−0.14			
ESE-NPD	0.75	0.20	0.23**	0.14	0.30**		
ESE-OIC	0.68	0.20	0.27**	0.20**	−0.12	0.41**	
MAC	0.72	0.10	0.19**	0.23**	−0.02	0.26**	0.36**

Note: EI-Start = Entrepreneurial Intention to start a business; EI-Acquire = Entrepreneurial Intention to acquire and grow; ESE = Entrepreneurial Self-Efficacy; ESE-NPD = New Product Development; ESE-OIC = Opportunity Identification and Commercialization; MAC = Measure of Adaptive Cognition. Control variables not included. $*p < .5$; $**p < .01$.

of ESE-NPD compared to business students, $\gamma = 0.33$, $p < .01$. We note, however, that the results from Model 2, with EI-Acquire as the outcome measure, lead to a partial rejection of Hypothesis 4. While business students have, as predicted, a higher level of EI-Acquire, $\gamma = -0.18$, $p < .01$, there is no evidence to support mediation by the level of ESE-OIC ($p = .47$). Instead, the level of ESE-NPD is found to mediate the effects (following the mediation approach advanced by Baron & Kenny, 1986), accounting for 34.63% of the effect of the education factor.

The part of Model 1 that links the education factor to EI-Start can be described as a double-opposing mediation model, with ESE-NPD and ESE-OIC serving as opposing mediators. Although not hypothesized, we tested for the direct and indirect effects of the education factor on EI-Start. Mediation analysis reveals that the inclusion of both of the self-efficacy sub-factors (ESE-NPD and ESE-OIC) fully mediates the effect of design versus business education on EI-Start. Furthermore, the effect of the adaptive cognition measure on EI-Start is partially mediated by the ESE sub-factors (ESE-NPD and ESE-OIC), with these sub-factors accounting, respectively, for 23.95% and 54.26% of the effect of the adaptive cognition measure.

6 *Discussion*

We tested four hypotheses pertaining to whether adaptive cognition and formal design training predict entrepreneurial self-efficacy and entrepreneurial

Table 3 Goodness-of-fit statistics for structural equation models

	M1: EI-Start	*M2: EI-Acquire*
$\chi^2(df)$	2.92(4)	2.45(4)
CFI	1.00	1.00
SRMR	0.01	0.01
RMSEA	0.00	0.00

Note: EI-Start = Entrepreneurial Intention to start a business; EI-Acquire = Entrepreneurial Intention to acquire and grow; CFI = Comparative fit index; SRMR = Standardized root-mean-square residual; RMSEA = root-mean-square error of approximation.

The design entrepreneur

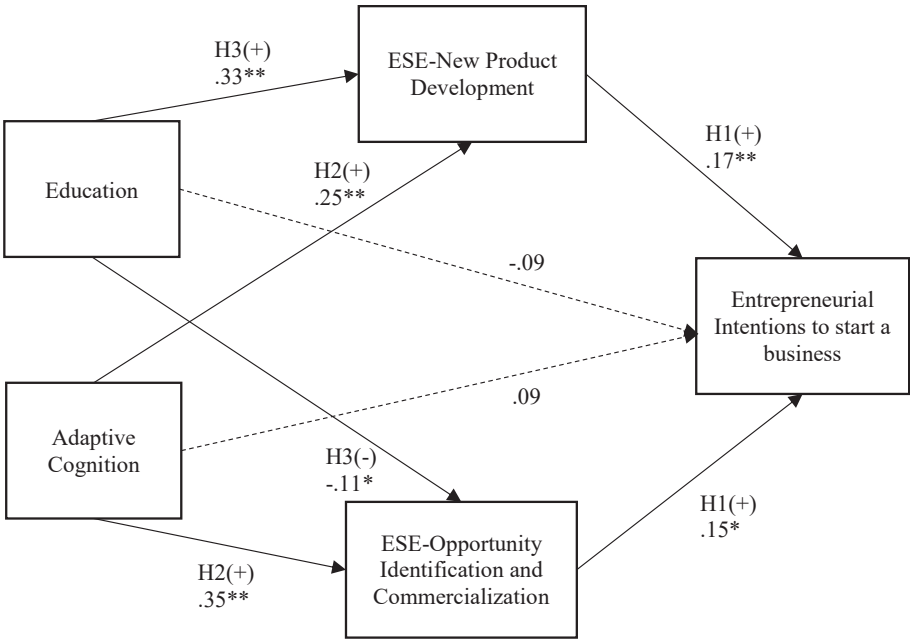


Figure 1 Structural Equation Model with the outcome Entrepreneurial Intentions to start a business. Parameter estimates are fully standardized. Solid arrows represent hypothesized paths; a dotted arrow represents a path that was not hypothesized. H = Hypothesis; ESE = Entrepreneurial Self-Efficacy. The model visualization does not display control variables. $*p < .05$; $**p < .01$

intention in design and business students. In support of the hypotheses, we found that: (1) entrepreneurial self-efficacy predicts entrepreneurial intention to start a new business in both business and design student samples; (2) the level of students' adaptive cognition predicts entrepreneurial self-efficacy in both business and design student samples; (3) formal, specialized training in design versus business leads to differential effects on the two entrepreneurial self-efficacy sub-factors, that is, trained designers believe they are more capable at achieving *new product development*, whereas business students believe they are more capable at achieving *business opportunity identification and commercialization*; and (4) formal business training (vs. design training) leads to entrepreneurial intentions to acquire and scale an existing company.

The results inform the design literature in several ways. First, in comparing design students and business students, the findings indicate that adaptive cognition may be considered a domain-general skill that both kinds of students display to an equal degree, and with the same types and levels of positive effects on students' self-efficacy beliefs in their abilities to perform entrepreneurial tasks. At the same time, formal educational specializations relating to design versus business were found to have differential effects on the entrepreneurial tasks that students believed they could perform, illustrating that formal education led to domain-specific skills. The data thus illustrate that

both domain-general (adaptive cognition; e.g., Klein, 2011, 2017) and domain-specific (formal education) conceptions of design co-exist in the same dataset, and that the two conceptions cannot be reduced to each other since they exert differential effects on entrepreneurial outcomes. Moreover, either focusing on design primarily as a kind of thinking (e.g., Johansson-Sköldberg et al., 2013) or as a kind of domain-specific formal training that leads to practitioners engaging in designerly thinking (e.g., Cross, 1982), will miss part of the story in relation to a designer's self-efficacy and behavioral intentions.

Second, the results support arguments that adaptive cognition (implicating designerly cognition) positively predicts designers' self-efficacy beliefs and their behavioral intentions in areas that go beyond design tasks. Here we found that the level of adaptive cognition positively predicted entrepreneurial self-efficacy and entrepreneurial intention for both designers and business students.

Third, formal design training (vs. business training) was positively linked to a student's belief in their ability to engage in new product development, but negatively linked to business opportunity identification and commercialization. This indicates that the specialization of formal design education exerts an education-specific effect on a student's self-efficacy beliefs within entrepreneurship tasks. These results underscore the point that to explain designers' self-efficacy beliefs and behavioral intentions in entrepreneurship there are at least two different pieces to the puzzle, whereby both domain-general cognitive abilities and domain-specific formal training of skills and competencies independently explain why so many designers start their own business.

Finally, the results help to inform the entrepreneurship literature, by highlighting that while formal design and business training may aid in producing higher levels of entrepreneurial self-efficacy, it remains the case that specific educational contents can lead to distinct types of self-efficacy. Thus, while the design-trained students believed in their abilities to produce new products and to start their own ventures on the basis thereof, the business-trained students believed in their abilities to identify business opportunities and engage in commercialization, and in their abilities to either start their own business, or to acquire and grow a business started by someone else. The two groups, however, showed no difference in their overall level of entrepreneurial intention to start a new business. In sum, the designer entrepreneur is likely to possess a different kind of entrepreneurial self-efficacy to the business entrepreneur, even though they may both think adaptively in similar ways.

Returning to the general issue of the shifting meaning of the term "design" from a *type of profession* to a *kind of thinking*, our results strongly suggest that to predict designers' self-efficacies and behavioral outcomes we need *both* domain-general theories of cognition *and* domain-specific theories of

skills and competencies acquired through formal design education. Only by understanding how trained designers have both skills and abilities that *stand out from other professions*, as well as having skills and abilities that *are found in other professions*, will we be able to understand fully the roles that designers believe they can play — and intend to play — in design and elsewhere. The implications for design education of our findings underscore the need to consider more than one downstream pathway towards student self-efficacy beliefs and business venturing career choices. Our results clearly highlight the dual need to educate for the development of adaptive cognition (which is also implicated in educational programs beyond design), while simultaneously consider carefully how education specific elements and features lead to distinct forms of entrepreneurial self-efficacy. The specific kind and level of student self-efficacy and entrepreneurial intention is likely to result from the combined effects of domain general cognitive training efforts, and domain specific educational capability training efforts.

The present study found similar levels of adaptive cognition amongst business and design students but hypothesized that both groups should have higher levels of adaptive cognition than other student groups not working within dynamic and uncertain task environments. Our sample, however, did not include a control group, and thus more research is needed to test this hypothesis directly. We also note that most business venturing takes place in teams. The present study did not explore the type of team composition sought or preferred by design versus the business entrepreneurs. It may be hypothesized that a heterogeneous skillset in a start-up team might lead to higher overall levels of team self-efficacy, and therefore team tendencies to start-up. Indeed, anecdotal evidence from our sample institutions suggests that graduate start-ups often employ a mix of design and business graduates. It is possible that the lack of formal training in management and organizational aspects may mean that the design entrepreneur may be less attentive to the importance of a heterogeneous skillset when building a start-up venture. Further research is again needed to unpack this issue. Finally, given that the students in the present sample were in their first or second year of their study, they may be considered either novices or early beginners in their educational domains of choice. With this limited time for formal professional training, it is possible that student self-selection into their educational programs may have partially influenced their levels of entrepreneurial self-efficacy. Future research should aim to deploy pre-post experimental designs in order to more firmly control for student self-selection effects. Further, research (e.g., using registry data) is needed to establish long-term effects on student career choices and business venturing, as opposed to the short-term effects we document here using surveys.

With this study we hope to have opened up new theoretical venturing possibilities for design researchers to explore, which relate especially to the roles that

designers believe they can play in entrepreneurship and other fields outside of traditional design, and the factors driving their beliefs.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

Acock, A. C. (2013). *Discovering structural equation modeling using Stata*. College Station, Texas: StataCorp LP.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Baldacchino, L., Ucbasaran, D., Cabantous, L., & Lockett, A. (2015). Entrepreneurship research on intuition: A critical analysis and research agenda. *International Journal of Management Reviews, 17*(2), 212–231. https://doi.org/10.1111/ijmr.12056.

Ball, L. J., & Christensen, B. T. (2009). Analogical reasoning and mental simulation in design: Two strategies linked to uncertainty resolution. *Design Studies, 30*(2), 169–186. https://doi.org/10.1016/j.destud.2008.12.005.

Ball, L. J., & Christensen, B. T. (2019). Advancing an understanding of design cognition and design metacognition: Progress and prospects. *Design Studies, 65*, 35–59. https://doi.org/10.1016/j.destud.2019.10.003.

Ball, L. J., Onarheim, B., & Christensen, B. T. (2010). Design requirements, epistemic uncertainty and solution development strategies in software design. *Design Studies, 31*(6), 567–589. https://doi.org/10.1016/j.destud.2010.09.003.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Bandura, A. (2006). Toward a psychology of human agency. *Perspectives on Psychological Science, 1*(2), 164–180. https://doi.org/10.1111/j.1745-6916.2006.00011.x.

Barakat, S., Boddington, M., & Vyakarnam, S. (2014). Measuring entrepreneurial self-efficacy to understand the impact of creative activities for learning innovation. *International Journal of Management in Education, 12*(3), 456–468. https://doi.org/10.1016/j.ijme.2014.05.007.

Barbosa, S., Gerhardt, M., & Kickul, J. (2007). The role of cognitive style and risk preference on entrepreneurial self-efficacy and entrepreneurial intentions. *Journal of Leadership & Organizational Studies, 13*(4), 86–104. https://doi.org/10.1177/10717919070130041001.

Baron, R. A. (1998). Cognitive mechanisms in entrepreneurship: Why and when entrepreneurs think differently than other people. *Journal of Business Venturing, 13*(4), 275–294. https://doi.org/10.1016/S0883-9026(97)00031-1.

Baron, R. A. (2000). Counterfactual thinking and venture formation: The potential effects of thinking about "what might have been". *Journal of Business Venturing, 15*(1), 79–91. https://doi.org/10.1016/S0883-9026(98)00024-X.

Baron, R. A., & Ensley, M. D. (2006). Opportunity recognition as the detection of meaningful patterns: Evidence from comparisons of novice and experienced entrepreneurs. *Management Science, 52*(9), 1331–1344. https://doi.org/10.1287/mnsc.1060.0538.

Baron, R., & Kenny, D. A. (1986). The moderator-mediation variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173.

Barry, D., & Meisiek, S. (2015). Discovering the business studio. *Journal of Management Education, 39*(1), 153–175. https://doi.org/10.1177/1052562914532801.

Bird, B. (1988). Implementing entrepreneurial ideas: The case of intentions. *Academy of Management Review, 13*(3), 442–454. https://doi.org/10.2307/258091.

Chen, C., Greene, P., & Crick, A. (1998). Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? *Journal of Business Venturing, 13*(4), 295–316. https://doi.org/10.1016/S0883-9026(97)00029-3.

Christensen, B. T., & Ball, L. J. (2018). Fluctuating epistemic uncertainty in a design team as a metacognitive driver for creative cognitive processes. *CoDesign, 14*(2), 133–152. https://doi.org/10.1080/15710882.2017.1402060.

Christensen, B. T., & Schunn, C. D. (2007). The relationship of analogical distance to analogical function and preinventive structure: The case of engineering design. *Memory & Cognition, 35*(1), 29–38. https://doi.org/10.3758/BF03195939.

Christensen, B. T., Arendt, K. M., & Hjorth, D. (2023). How learning spaces matter in entrepreneurship education: Introducingthe concept of topopraxis. *Entrepreneurship & Regional Development, 35*(3–4), 317–336. https://doi.org/10.1080/08985626.2023.2176549.

Christensen, B. T., & Schunn, C. D. (2009). The role and impact of mental simulation in design. *Applied Cognitive Psychology, 23*(3), 327–344. https://doi.org/10.1002/acp.1464.

Crilly, N. (2021). The evolution of "co-evolution"(Part 1): Problem solving, problem finding, and their interaction in design and other creative practices. *She Ji: The Journal of Design, Economics, & Innovation, 7*(3), 309–332. https://doi.org/10.1016/j.sheji.2021.07.003.

Cross, N. (1982). Designerly ways of knowing. *Design Studies, 3*(4), 221–227. https://doi.org/10.1016/0142-694X(82)90040-0.

DeNoble, A., Jung, D., & Ehrlich, S. (1999). Entrepreneurial self-efficacy: The development of a measure and its relationship to entrepreneurial action. In P. D. Reynolds (Ed.), *Frontiers of entrepreneurship research* (pp. 73–87). Stanford, CA: Center for Entrepreneurial Studies.

Dong, A., Garbuio, M., & Lovallo, D. (2016). Generative sensing: A design perspective on the microfoundations of sensing capabilities. *California Management Review, 58*(4), 97–117. https://doi.org/10.1525/cmr.2016.58.4.97.

Dorst, K. (2015). Frame creation and design in the expanded field. *She Ji: The Journal of Design, Economics, & Innovation, 1*(1), 22–33. https://doi.org/10.1016/j.sheji.2015.07.003.

Dorst, K. (2019). Co-evolution and emergence in design. *Design Studies, 65*, 60–77. https://doi.org/10.1016/j.destud.2019.10.005.
Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-Evolution of problem–solution. *Design Studies, 22*(5), 425–437. https://doi.org/10.1016/S0142-694X(01)00009-6.
Feltovich, P. J., Spiro, R. J., & Coulson, R. L. (1997). Issues of expert flexibility in contexts characterized by complexity and change. *Expertise in context: Human and machine*125–146, (Cambridge, MA; MIT Press).
Garbuio, M., Dong, A., Lin, N., Tschang, T., & Lovallo, D. (2018). Demystifying the genius of entrepreneurship: How design cognition can help create the next generation of entrepreneurs. *The Academy of Management Learning and Education, 17*(1), 41–61. https://doi.org/10.5465/amle.2016.0040.
Gemmell, R. M., Boland, R. J., & Kolb, D. A. (2012). The socio–cognitive dynamics of entrepreneurial ideation. *Entrepreneurship: Theory and Practice, 36*(5), 1053–1073. https://doi.org/10.1111/j.1540-6520.2011.00486.x.
Haynie, M., & Shepherd, D. A. (2009). A measure of adaptive cognition for entrepreneurship research. *Entrepreneurship: Theory and Practice, 33*(3), 695–714. https://doi.org/10.1111/j.1540-6520.2009.00322.x.
Haynie, J. M., Shepherd, D., Mosakowski, E., & Earley, P. C. (2010). A situated metacognitive model of the entrepreneurial mindset. *Journal of Business Venturing, 25*(2), 217–229. https://doi.org/10.1016/j.jbusvent.2008.10.001.
Hmieleski, K. M., Corbett, A. C., & Baron, R. A. (2013). Entrepreneurs' improvisational behavior and firm performance: A study of dispositional and environmental moderators. *Strategic Entrepreneurship Journal, 7*(2), 138–150. https://doi.org/10.1002/sej.1143.
Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118.
Johansson-Sköldberg, U., Woodilla, J., & Çetinkaya, M. (2013). Design thinking: Past, present and possible futures. *Creativity and Innovation Management, 22*(2), 121–146. https://doi.org/10.1111/caim.12023.
Kassean, H., Vanevenhoven, J., Liguori, E., & Winkel, D. E. (2015). Entrepreneurship education: A need for reflection, real-world experience and action. *International Journal of Entrepreneurial Behaviour & Research, 21*(5), 690–708. https://doi.org/10.1108/IJEBR-07-2014-0123.
Klein, G. A. (2011). *Streetlights and shadows: Searching for the keys to adaptive decision making*. Cambrideg, MA: MIT Press.
Klein, G. A. (2017). *Sources of power: How people make decisions*. Cambrideg, MA: MIT Press.
Klenner, N. F., Gemser, G., & Karpen, I. O. (2022). Entrepreneurial ways of designing and designerly ways of entrepreneuring: Exploring the relationship between design thinking and effectuation theory. *Journal of Product Innovation Management, 39*(1), 66–94.
Lackéus, M. (2015). *Entrepreneurship in education: What, why, when, how*. Paris: Entrepreneurship360 Background Paper.
Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of vocational behavior, 45*(1), 79–122.
Liñán, F., & Fayolle, A. (2015). A systematic literature review on entrepreneurial intentions: Citation, thematic analyses, and research agenda. *The International Entrepreneurship and Management Journal, 11*(4), 907–933. https://doi.org/10.1007/s11365-015-0356-5.

Lindh, I., & Thorgren, S. (2016). Entrepreneurship education: The role of local business. *Entrepreneurship & Regional Development, 28*(6), 313–336. https://doi.org/10.1080/08985626.2015.1134678.

McGee, J., Peterson, M., Mueller, S., & Sequeira, J. (2009). Entrepreneurial self-efficacy: Refining the measure. *Entrepreneurship: Theory and Practice, 33*(4), 965–988. https://doi.org/10.1111/j.1540-6520.2009.00304.x.

McMullen, J. S., & Shepherd, D. A. (2006). Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. *Academy of Management Review, 31*(1), 132–152. https://doi.org/10.5465/amr.2006.19379628.

Mevarech, Z. R. (1999). Effects of metacognitive training embedded in cooperative settings on mathematical problem solving. *The Journal of Educational Research, 92*(4), 195–205. https://doi.org/10.1080/00220679909597597.

Miao, C., Qian, S., & Ma, D. (2017). The relationship between entrepreneurial self-efficacy and firm performance: A meta-analysis of main and moderator effects. *Journal of Small Business Management, 55*(1), 87–107. https://doi.org/10.1111/jsbm.12240.

Mitchell, R. K., Busenitz, L., Lant, T., McDougall, P. P., Morse, E. A., & Smith, J. B. (2002). Toward a theory of entrepreneurial cognition: Rethinking the people side of entrepreneurship research. *Entrepreneurship: Theory and Practice, 27*(2), 93–104. https://doi.org/10.1111/1540-8520.00001.

Neck, H. M., & Greene, P. G. (2011). Entrepreneurship education: Known worlds and new frontiers. *Journal of Small Business Management, 49*(1), 55–70. https://doi.org/10.1111/j.1540-627X.2010.00314.x.

Newman, A., Obschonka, M., Schwarz, S., Cohen, M., & Nielsen, I. (2019). Entrepreneurial self-efficacy: A systematic review of the literature on its theoretical foundations, measurement, antecedents, and outcomes, and an agenda for future research. *Journal of Vocational Behavior, 110*, 403–419. https://doi.org/10.1016/j.jvb.2018.05.012.

Osterwalder, A., Pigneur, Y., & Clark, T. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers*. London: John Wiley & Sons, Ltd.

Perry, J. T., Chandler, G. N., & Markova, G. (2012). Entrepreneurial effectuation: A review and suggestions for future research. *Entrepreneurship: Theory and Practice, 36*(4), 837–861. https://doi.org/10.1111/j.1540-6520.2010.00435.x.

Pittaway, L., & Cope, J. (2007). Entrepreneurship education: A systematic review of the evidence. *International Small Business Journal, 25*(5), 479–510. https://doi.org/10.1177/0266242607080656.

Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Academy of Management Review, 26*(2), 243–263. https://doi.org/10.5465/amr.2001.4378020.

Schmidt, A. M., & Ford, J. K. (2003). Learning within a learner control training environment: The interactive effects of goal orientation and metacognitive instruction on learning outcomes. *Personnel Psychology, 56*(2), 405–429. https://doi.org/10.1111/j.1744-6570.2003.tb00156.x.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. London Basic Books, Inc.

Simon, H. (1969). *The sciences of the artificial*. Cambridge, MA: MIT Press.

Souitaris, V., Zerbinati, S., & Al-Laham, A. (2007). Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources. *Journal of Business Venturing, 22*(4), 566–591. https://doi.org/10.1016/j.jbusvent.2006.05.002.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning, 43*(2−3), 172−194. https://doi.org/10.1016/j.lrp.2009.07.003.
Turker, D., & Selcuk, S. S. (2009). Which factors affect entrepreneurial intention of university students? *Journal of European Industrial Training, 33*(2), 142−159. https://doi.org/10.1108/03090590910939049.
Walter, S. G., & Heinrichs, S. (2015). Who becomes an entrepreneur? A 30-years-review of individual-level research. *Journal of Small Business and Enterprise Development, 22*(2), 225−248. https://doi.org/10.1108/JSBED-09-2012-0106.
Ward, T. B. (2004). Cognition, creativity, and entrepreneurship. *Journal of Business Venturing, 19*(2), 173−188. https://doi.org/10.1016/S0883-9026(03)00005-3.
Wiltschnig, S., Christensen, B. T., & Ball, L. J. (2013). Collaborative problem−solution co-evolution in creative design. *Design Studies, 34*(5), 515−542. https://doi.org/10.1016/j.destud.2013.01.002.
Zhao, H., Seibert, S., & Hills, G. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. *Journal of Applied Psychology, 90*(6), 1265−1272. https://doi.org/10.1037/0021-9010.90.6.1265.