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You say you can, but can you? The impact of entrepreneurship education on unwarranted and gendered entrepreneurial self-efficacy - a calibration study

Anne Rienke Van Ewijk
School of Economics, Utrecht University, Utrecht, Netherlands and College of Business, Abu Dhabi University, Abu Dhabi, United Arab Emirates

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Abstract

Purpose – Entrepreneurial self-efficacy (ESE) has a dark side largely ignored in the field of entrepreneurship education. Research in educational psychology indicates that self-efficacy is prone to misjudgment, with novice learners often displaying overconfidence. Furthermore, this misjudgment is gendered; studies suggest that men are more likely to display overconfidence and less likely to correct erroneous self-assessments. However, realistic self-assessments are essential for effective learning strategies, pivotal for performance in the ambiguous entrepreneurial context. Therefore, this study explores whether entrepreneurship education helps mitigate overconfidence, and if this impact varies by gender.

Design/methodology/approach – Common in educational psychology, but new in the field of entrepreneurship education, a calibration design captures discrepancies between perceived and actual performance. Data from before and after an introductory undergraduate entrepreneurship course ($N = 103$) inform descriptive analyses, statistical comparison tests and calibration plots.

Findings – As expected, nearly all novice students showed significant overconfidence. Curiously, gender difference was only significant at the end of the course, as overconfidence had decreased among female students and increased among male students.

Originality/value – The paper advocates a more nuanced stance toward ESE, and introduces ESE accuracy as a more fitting measure of entrepreneurial overconfidence. The findings flag the common use of self-perception as a proxy for actual competence, and evoke new research avenues on (gender differences in) learning motivations of aspiring entrepreneurs. Finally, the study shares guidance for entrepreneurship educators on fostering a "healthier" level of self-efficacy for better entrepreneurial learning.

Keywords Entrepreneurship, Education, Gender, Self-efficacy, Overconfidence, Competence, Calibration

Paper type Research paper

1. Introduction

Entrepreneurial self-efficacy (ESE), as domain-specific application of Bandura's concept of self-efficacy (Bandura, 1977, 1997), is rooted in agency theory (Newman *et al.*, 2019) and refers to an individual's belief in his/her capability to perform tasks and roles aimed at entrepreneurial outcomes (Chen *et al.*, 1998). ESE is highly relevant for key aspects of entrepreneurship, such as risk-taking, creativity, leadership, proactivity, persistence and passion (Newman *et al.*, 2019). According to Ajzen's theory of planned behavior and Shapero's entrepreneurial event model (Boyd and Vozikis, 1994; Krueger Jr *et al.*, 2000), ESE is a proven determinant of entrepreneurial intentions, fostering entrepreneurial behavior.

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Considering the contribution of successful entrepreneurship to economic development (Bosma *et al.*, 2021), ESE has emerged as a key psychological construct in entrepreneurship research (Batista-Canino *et al.*, 2024; Newman *et al.*, 2019). Accordingly, lower ESE among women has raised concerns (Birley, 1989; Dempsey and Jennings, 2014) and motivated studies on the effect of entrepreneurship education on gender differences in entrepreneurial motivation (e.g. van Ewijk and Belghiti-Mahut, 2019).

However, ESE has a dark side, which is until now largely ignored in entrepreneurship literature (Newman *et al.*, 2019). The few studies that illuminate this dark side, associate very high ESE with overconfidence and point to the risk of entrepreneurs stopping to seek feedback and engage in trial-and-error (Lindsley *et al.*, 1995; Uy *et al.*, 2024), while this behavior is crucial for reducing the ambiguity and uncertainty of the entrepreneurial context (Minniti, 2004; Shepherd and Gruber, 2021). This study aims to provide a more granular perspective by positing that, rather than high ESE, the issue of overconfidence is more accurately explored by measuring inaccurate or unwarranted ESE. Unwarranted self-efficacy in other domains is amply explored in educational psychology. Decades of research confirm that self-efficacy is rarely representative of actual competence, with the majority of students displaying a strong tendency to overestimate their abilities and a minority of high achievers underestimating their abilities (Magnus and Peresetsky, 2018; Schlösser *et al.*, 2013; Talsma *et al.*, 2019). Particularly excessive self-efficacy, i.e. overconfidence, has negative consequences. All competence development, for example, is severely hampered by overconfidence: when individuals are ignorant of their ignorance, they are less able to improve (Dunning, 2011; Jaeken *et al.*, 2017). Specifically, unwarranted ESE affects entrepreneurial performance – being overly optimistic and displaying high ESE negatively influences revenue and employment growth in dynamic environments (Hmieleski and Baron, 2008) – as well as the perpetuation of entrepreneurial careers – seeing that improved new venture performance after business failure experience was fully moderated by the entrepreneur's ability to learn from this experience (Boso *et al.*, 2019).

Therefore, it is imperative that entrepreneurship education not only boosts students' ESE, but also improves their ability to accurately assess their entrepreneurial competence by reducing their overconfidence. This leads to the following research questions: "Is the apparently common discrepancy between self-reported and actual competences, i.e. overconfidence, also prevalent among entrepreneurship students?" (RQ1) and "Does entrepreneurship education help to reduce this discrepancy, i.e. attenuate overconfidence?" (RQ2). Given the widespread gender disparity in ESE, it is essential that gender is an integral component of these analyses: "To what extent does the potential impact of EE on overconfidence differ between male and female students?" (RQ3).

Through this effort, the study makes a number of contributions to entrepreneurship and entrepreneurship education literature. First, it promotes a more nuanced valuation of ESE than commonly presented in theoretical perspectives on entrepreneurship, highlighting its dark side. Second, it introduces a more robust way to measure overconfidence than previously used in entrepreneurship studies. Third, it shares insights from educational psychology for mitigating excessive ESE. Fourth and last, it proposes various interesting research avenues for theoretical advancement on entrepreneurial learning and offers practical guidance to entrepreneurship educators.

2. Theoretical framework

2.1 The psychology of biased self-efficacy

Self-efficacy – perceptions of one's capability to organize and execute required courses of action to achieve particular outcomes (Bandura, 1977, 1997) – is widely believed to be the most important non-intellectual determinant of academic performance (Schneider and

Preckel, 2017). This is illustrated by the multitude of resources to help educators increase their students' self-efficacy (e.g. Haskell, 2016; Ritchie, 2015).

However, psychologists have emphasized for decades that this relation is typically shallow and weak (Dunning, 2011; Mabe and West, 1982), whether in the classroom (Hansford and Hattie, 1982; Talsma *et al.*, 2019) or in the workplace (Davis *et al.*, 2006; Stajkovic and Luthans, 1998). Moreover, this significant relation is often established at the group level, which is irrelevant in a learning context (Talsma *et al.*, 2019). The average self-efficacy of weak students might be lower than that of strong students, but it is found to be still much higher than their own performance, while strong students underestimate themselves (Bol *et al.*, 2005; Dunning, 2011; Talsma *et al.*, 2019). Simply put, many students who believe they are competent, are actually not quite competent, while students who are modest, are actually highly competent.

Research consistently demonstrates that individuals tend to overestimate their knowledge across various domains (Dunning, 2011). This cognitive bias is pervasive across many aspects of life; for example among children and adolescents solving mathematical problems (e.g. Chen and Zimmerman, 2007), music performers (Hewitt, 2015), university students in psychology (Schlösser *et al.*, 2013) and statistics (Magnus and Peresetsky, 2018) and novice drivers preparing for their driving test (Mynttinsen *et al.*, 2009). Overconfidence is particularly evident when measuring self-efficacy in competence domains that are broad, generalized, and/or distant in time (Dunning, 2011; Talsma *et al.*, 2019). Finally, dramatic overestimation is typically strongest among people in the bottom 25% of performers, across a wide range of tasks in the lab: from logical reasoning and grammar skills to social abilities such as assessing a sense of humor (Kruger and Dunning, 1999). The overconfidence effect holds after correcting for measurement error, for easy and hard tasks, and even when participants receive incentives for accuracy (Dunning, 2011).

What makes self-evaluations so inaccurate? Particularly for novice learners, self-efficacy judgments are made in the absence of mastery information, a key source of self-efficacy beliefs (Bandura, 1997). Hence, people rely on alternative sources to base self-efficacy judgments on, which all come with issues (Dunning, 2011). First, people derive confidence from indirect indicators, such as decision-making speed and apparent familiarity, which are highly subjective. Second, people derive confidence from being rational, following systematic rules, irrespective of whether these rules are right or wrong. Third, people derive confidence from their own pre-conceived notions about whether they are good or bad in certain skills in general, even when it is questionable that these are related or correct (Dunning, 2011).

The dominant explanation in previous literature is that novice learners and poor performers suffer from the "unskilled, unaware and unable" effect (Kruger and Dunning, 1999). This ignorance of ignorance, or meta-ignorance (Dunning, 2011), represents a dual burden: the lack of competence to perform well comes with a lack of insight into what is required to perform well, resulting in unjustified overconfidence. This also explains why the statistically significant correlation between perceived and actual performance is moderate in sports and athleticism, but radically smaller for competences, such as communication, interpersonal or managerial skills (Mabe and West, 1982), where having the competence is a prerequisite for being able to accurately evaluate this competence in oneself and others (Dunning, 2011).

Other explanations of the overconfidence bias in learning contexts include the self-enhancement motive (Ehrlinger *et al.*, 2016) and defensive self-deception (Stankov and Lee, 2014), both fueled by aspirations or desired outcomes (Serra and DeMarree, 2016) or by performance norms within an educational institution (Clayson, 2005). Defensive self-deception makes people diffuse information that is threatening to the self-and enhance positive information. The most common cognitive tools to achieve this are self-serving

reasoning, biased hypothesis testing and biased recall or memory (Karpen, 2018). First, success is attributed to one-self and failure to external factors (Shepperd *et al.*, 2008). Second, people require less solid evidence for information that confirms a positive self-view, than when the information disconfirms a positive self-view, to believe it (Lord *et al.*, 1979). Third, people are more likely to remember self-enhancing information than self-critical information, even re-writing their memories (Sanitioso *et al.*, 1990).

Self-enhancement bias implies that self-efficacy beliefs that exceed current capacity to perform are adaptive: overconfidence motivates students to mobilize resources to increase performance above previous levels and makes them more persistent (Bandura, 1997). Hence, attempts to make students more realistic about their performance capacity are dangerous, because perceived competence creates a self-fulfilling prophecy with respect to performance outcomes (Ballard and Johnson, 2005). Findings by Gramzow *et al.* (2003) suggest that these explanations might be complementary to each other and illustrate the Dunning–Kruger effect at the same time. Overconfident students with poor previous performance, seemingly motivated by defensive self-deception, subsequently demonstrated repeated poor performance. Overconfident students with average to high previous performance, seemingly motivated by self-enhancement, did improve their performance. Hence, the self-fulfilling prophecy effect of high self-efficacy only worked for strong students.

As in other domains, self-efficacy in entrepreneurship is generally considered to be a good indicator of actual entrepreneurial competence and predictor of subsequent entrepreneurial performance (Mitchelmore and Rowley, 2010; Newman *et al.*, 2019). Only a handful of studies challenge this assumption, by highlighting the negative effects of (very) high confidence. For example, Koellinger *et al.* (2007) found ESE correlated to increased business entry, but also to faster exit. Hmieleski and Baron (2008) observed that being overly optimistic in dynamic business environments had a negative impact on the revenue and employment growth of new ventures. Hayward *et al.* (2010) posited that greater socially constructed confidence increases chances of bias in entrepreneurial forecasts, such as underestimating the competitive response or overestimating the demand for products or services. Simon and Shrader (2012) demonstrated how high certainty boosts new product introductions, but reduces the likelihood of new product success. Finally, Uy *et al.* (2024) found that very high ESE reduces active feedback seeking, unless it is accompanied by high state error mastery orientation, i.e. the belief that mistakes are inevitable and provide opportunities for learning (Frese and Keith, 2015). However, none of these studies use comparisons between perceived and actual (objectively measured) performance, nor do their data provide insight into the prevalence of overconfidence among (aspiring or novice) entrepreneurs compared to the general population. It is thus merely the observation that self-efficacy accuracy is generally low, with self-efficacy often excessive, among learners across a wide variety of others domains (see above), that underlies the expectation of low ESE accuracy among inexperienced entrepreneurship students.

H1. Entrepreneurship students display excessive ESE, i.e. overconfidence

2.2 Reducing unwarranted self-efficacy: why and how

Ignorance is unavoidable and forgivable: it is natural that people are ignorant about their ignorance (Dunning, 2011). Completely unbiased self-knowledge is unattainable, as bias is deeply ingrained and the mechanisms that produce it operate below the level of awareness (Karpen, 2018). Completely unbiased self-efficacy is also undesirable. A moderate amount of overconfidence does help us take action and persist toward the achievement of goals in spite of adversity (Dunning, 2011). Some overconfidence also maintains our mental health, and facilitates contentment and altruism (Karpen, 2018). As outlined earlier, overconfidence in the context of education could become self-fulfilling for some students (already performing

well in other areas), as higher expectations might lead them to work harder and more intensely, increasing the probability of success (Ballard and Johnson, 2005; Magnus and Peresetsky, 2018).

However, overconfidence is detrimental in the early stages of planning and preparing for goal achievement (Dunning, 2011) and more pronounced overconfidence can lead to risky behavior and poor performance (Karpen, 2018; Robbins and Beer, 2001). This is in line with studies that found a negative correlation between new venture performance and entrepreneurs displaying high self-esteem or over-optimism (Baron *et al.*, 2016; Lindsley *et al.*, 1995; Uy *et al.*, 2024). In education, overconfidence is generally associated with a complacent attitude, with students being content to "breeze" through their studies without putting in much effort or adequately monitoring their performance (Dunlosky and Rawson, 2012). In this case, unjustified self-efficacy beliefs obscure discrepancies between the current and desired state of learning, leading to reduced effort and performance that is below potential (Talsma *et al.*, 2019). The tendency in education to boost domain-specific self-efficacy (Haskell, 2016; Ritchie, 2015) is not needed by under-efficacious high performers and increases risks for novice learners and low performers, such as stopping studying before they are properly prepared for an assessment, or refraining from seeking academic support which is sorely needed (Talsma *et al.*, 2019).

Taken together, it appears that self-efficacy beliefs which more accurately reflect actual performance capacity – as much as possible (Dunning, 2011) – are most beneficial to most students, in the sense that warranted beliefs enable students to adopt effective learning strategies to become more competent (Stankov and Lee, 2014). This is confirmed by one of the rare studies on self-efficacy calibration. Talsma *et al.* (2019) found that self-efficacy accuracy explains variance in performance over and above the variance explained by self-efficacy measured immediately prior to the performance of a task: implying that it is a more important predictor of performance. This warrants a more prominent role for self-efficacy accuracy in entrepreneurship education and research as well.

Despite educational interventions, overconfidence remains ubiquitous. Several studies found that students did not adjust their overconfident expectations during education, even when faced with multiple, lower, assessment outcomes over time (Foster *et al.*, 2017; Serra and DeMarree, 2016; Schlösser *et al.*, 2013). Moreover, reducing the overconfidence bias of students with a history of poor performance almost seems like a lost cause (Dunning, 2011). Data suggest that poor performers do not improve the accuracy of their self-assessments, even when provided with recordings and feedback regarding their deficits (Ferraro, 2010; Hacker *et al.*, 2000). Similarly, accuracy did not increase among participants who were offered monetary incentives for higher accuracy (Ehrlinger *et al.*, 2008, study 4), nor among those who were given an accountability incentive, in the sense that they knew they might have to justify their self-evaluations to an expert (Ehrlinger *et al.*, 2008, study 4).

However, there is hope, particularly for novice learners. Several studies have asserted that people naturally, over time, will learn their true skill level, resulting in less bias (Ryvkin *et al.*, 2012). Furthermore, counterbalancing negative findings, various studies did find that students' grade expectations became more accurate as they gained experience in the course (Grimes, 2002; Magnus and Peresetsky, 2018). Overconfidence bias, objectively established by comparing student self-evaluations with instructor assessment of an exam and client ratings of a role-play, was even mitigated in a more 12-h training on "soft" competences, such as interpersonal skills (Jaeken *et al.*, 2017): trained students went from either pretest overestimation to posttest equivalence, or from pretest equivalence to a posttest underestimation. Effective ingredients of such education include experience, repeated (formative) assessments, with (possibly incentivized) reflection and feedback containing subsequent instructions and guidance on how to proceed from there (Dunning, 2011; Miller and Geraci, 2011).

Although entrepreneurship education studies on ESE accuracy are so far non-existent, there is abundant evidence that entrepreneurial education and training can enhance students' ESE. In line with social cognitive theory (Bandura, 1997), researchers indicate that education provides opportunities for mastery experiences, vicarious learning, social persuasion and judgments of one's own physiological state, at postgraduate, undergraduate and high-school level (Newman *et al.*, 2019). For example, business plans and live cases promote students' enactive mastery, while entrepreneurial role models are a source of social persuasion and enable vicarious learning of, among other things, psychological strategies to cope with contextual ambiguity or impediments (Abaho *et al.*, 2015; Gielnik *et al.*, 2015). Although only indirectly linked to ESE accuracy, this transformative effect of entrepreneurship education on ESE inspires a tentative, yet hopeful, premise that it may also improve ESE accuracy.

H2. Taking an entrepreneurship course attenuates students' excessive ESE, i.e. reduces overconfidence

2.3 Gendered (entrepreneurial) self-efficacy

Previous studies find that, on average, women display significantly lower ESE than men (Birley, 1989; Dempsey and Jennings, 2014; Kalleberg and Leicht, 1991; Newman *et al.*, 2019; Wilson *et al.*, 2007). For example, Nowiński *et al.* (2019) found that men from four different countries scored themselves higher than women on searching, planning and marshalling. Notably, self-efficacy scores on exactly these three activities (not others) were also found to be key predictors of entrepreneurial intentions. In addition, women need a higher level of education to perceive themselves as sufficiently capable to perform entrepreneurship-related tasks (Thébaud, 2010), as illustrated by the finding that ESE increase after undergraduate entrepreneurship education was only significant for male students (Shinnar *et al.*, 2014). Komulainen *et al.* (2009) examined ninth graders' narratives of enterprising selves and found that the possible selves of boys matched the culturally valued representations of the autonomous, risk-taking entrepreneurial individual more closely than the self-representations of girls did. This culturally masculine representation was also found in entrepreneurship course descriptions at 81 universities in 21 countries (Jones and Warhuus, 2017). Positive findings, such as female students evaluating their entrepreneurial abilities higher than their male counterparts in Norway (Ljunggren and Kolvereid, 1996), remain the exception. Several causes of this gender difference have been proposed, such as women perceiving a conflict between traditional female gender roles and entrepreneurship (Díaz-García and Welter, 2011) or women considering the pay-offs of entrepreneurship to be less appealing (Shinnar *et al.*, 2014).

In the light of the discrepancy between perceived and actual performance, self-efficacy versus competence, though, the pertinent question is whether female students are more likely, or less likely, to display overconfidence in their ESE. With specific studies on ESE accuracy lacking, the remaining educational literature does not provide a clear-cut direction. For example, Sharma and Shakeel (2015) report less overconfidence among male students regarding their exam grades in India, while others report no statistical difference in prediction accuracy of academic performance between men and women in the USA (Grimes, 2002; Maxwell and Lopus, 1994) and in Finland (Kakkonen, 2011).

That said, a considerable amount of study results suggest that women are more accurate in their judgment. For example, women are more realistic about housing prices, unemployment and inflation (Guzman, 2012), men are more overconfident in stock investments (Barber and Odean, 2001) and male students are more likely to be overconfident in mathematics at high school (Jakobsson *et al.*, 2013), and at university in macroeconomics (Jakobsson, 2012), statistics (Magnus and Peresetsky, 2018), economics and

quantitative courses (Nowell and Alston, 2007), especially when they are wrong (Lundeberg *et al.*, 1994). In addition, as time progressed female students became more adept than male students at "tuning", e.g. calibrating score expectations to improve their accuracy (Grimes, 2002; Magnus and Peresetsky, 2018). This leads to the following expectations:

H3a. Before entrepreneurship education, female students display more accurate ESE, i.e. are less overconfident, than male students

H3b. After entrepreneurship education, excessive ESE, i.e. overconfidence, has diminished more among female students than among male students

3. Methods

Alignment or discrepancy between subjective beliefs and corresponding objective outcomes, particularly on metacognitive judgments, is often explored within a calibration paradigm (e.g. Talsma *et al.*, 2019). In line with previous calibration studies and studies on the Dunning–Kruger effect (e.g. Dunning, 2011; Nederhand *et al.*, 2020; Schlösser *et al.*, 2013), a quantitative approach was chosen that enabled capturing students' self-perceptions objectively without need for interpretation, minimizing the time between judgment and demonstration of competence and providing reviewers of those demonstrations with clear anchor points for revision.

3.1 Study design

The empirical data for this study are derived from an education project in higher education that was appropriate for testing the hypotheses presented: including high quality content, novice learners and collectively trained instructors. An introductory innovation and entrepreneurship course was designed by members of a university in the top 10 of the QS World University Rankings 2023, in collaboration with a selection of 15 entrepreneurship educators from various public and private universities in a rapidly developing country in the Middle East. In line with the recommendation to include specific national contextual barriers and opportunities (Giacomin *et al.*, 2011), these entrepreneurship instructors were consulted to help customize the course to the local context. In addition, they took part in a training program of several weeks spread out over a year to ensure alignment in active pedagogy. The new undergraduate course, with 30 contact hours of interactive lectures with exercises to be spread over one semester, consisted of three parts: basics of innovation with the design thinking framework, basics of entrepreneurship with the lean start-up methodology and an appreciative inquiry on the role of entrepreneurial behavior in local society and organizations. Students were assessed with two projects (on design thinking and on lean) in groups of three to five members as well as an individual exam. As was customary in this particular cultural context for the undergraduate level, student groups were single-gender only. The projects did not involve external stakeholders, but drew on students' own (campus) environment.

Six trained entrepreneurship educators distributed a survey to capture whether ESE was (un)warranted (see section 3.2) at five universities among their undergraduate students, new to entrepreneurship education, at the start and at the end of the introductory course, in the academic years 2016–2017 and 2017–2018. While the program aimed to make the course mandatory on the long run, it was offered as an elective in these initial years. Ethical clearance was obtained from the institutional research board of the principal investigator. To enhance the often low response rate of online student questionnaires (Van Mol, 2017), students received class time to fill out the survey, after being informed that participation was voluntary and anonymous, and that their instructors would not able to access the data until

after final grades were released. In total, 212 students were invited to participate in the start survey and 203 in the end survey, with response rates of 74% at the start (T1/N = 157) and 66% at the end (T2/N = 134). The end measurement took place during the last class, before the course grades were released to the students. The study included only students who completed both surveys (N = 103). Table 1 summarizes the sample characteristics.

3.2 Entrepreneurial self-efficacy accuracy: measure

Assessing bias in self-assessment is ideally measured through objective, specific and verifiable criteria (Gramzow *et al.*, 2003), which is easier to establish for knowledge and analytical skill components of competence (Silveyra *et al.*, 2021). Therefore, this study focused on self-assessed entrepreneurial knowledge and the ability to provide arguments supporting positive attitudes towards entrepreneurship.

Following Bandura's (1986) recommendation to design self-efficacy measures as close to performance outcomes as possible, two trained educators drafted a customized pre-post questionnaire to capture students' self-efficacy regarding items specifically related to the course learning outcomes. A Likert scale with few anchor points was preferable, as the questionnaire had to be quick (Preston and Colman, 2000), that is, students typically without long attention spans were responding during limited class time, and the questionnaire had to be quick to understand, i.e. not leading respondents to skip categories, when they are unable to differentiate between seemingly similar options (Chang, 1994). To avoid the use of a midpoint as a dumping ground or easy way out (Kulas and Stachowski, 2013), it is recommended to omit a midpoint, when respondents are unfamiliar with the survey topic or not expected to have formed their opinion about the topic (Weems and Onwuegbyzie, 2001) or when they are under strong social desirability pressures (Chyung *et al.*, 2017; Raaijmakers *et al.*, 2000). Hence, a 4-point Likert scale was employed. The questionnaire was reviewed by three peers and two public officials in education, involved in the project. The three themes of the questionnaire were: knowledge (e.g. knowing the difference between innovation and entrepreneurship, the steps of the design thinking process, or where to find funding), skills (e.g. data collection, idea generation, teamwork, presenting) and attitude (e.g. appreciating the value of entrepreneurship for society, within organizations or for their own careers). To capture the degree in which ESE is warranted, the questionnaire included both Likert items and open-ended control questions. The table under Appendix provides an overview of the items used. As expectations of performance need adjustment to the idiosyncrasies of the course at hand (Nabi *et al.*, 2017), these items do not capture entrepreneurial competence comprehensively, but they match the modest ambition level of an introductory course for inexperienced undergraduate students.

Characteristics	Categories	*N*	Percentage
Gender	Female	71	68.93%
	Male	32	31.07%
Residency status	Citizen	29	28.16%
	Resident	74	71.84%
College	Business	53	51.46%
	Engineering	22	21.36%
	Arts	9	8.74%
	Sciences	11	10.68%
	Medicine	8	7.77%
Total		103	100%

Table 1. Sample profile

Source(s): The author's own creation

Self-efficacy accuracy measures judgment precision, reflecting the magnitude of the deviation between self-efficacy and performance (Talsma *et al.*, 2019). There are two ways to measure self-efficacy accuracy: using a difference score – comparing correct and provided answers – or using a residual score – evaluating the difference between correct and provided answers that is left after compensating for previous scores (Gramzow *et al.*, 2003). As the student respondents in this study have no previous experience in entrepreneurship education and there are therefore no previous evaluations to compare to, using a difference score was applicable.

A score of 3 ("agree") or 4 ("strongly agree") on the selected items automatically triggered a follow-up open-answer question. For example, the statement "I can describe the design thinking process" was followed up by the question "Please list some of the steps in the design thinking process". After comparing the revisions by two entrepreneurship educators involved in the project, an instructor score of 1 ("strongly disagree"), 2 ("disagree"), 3 or 4 was attributed, which could either be the same as the student's score, or lower. Contrary to Talsma *et al.* (2019), who capture bias in both directions, this approach enabled measuring overconfidence, but not under-confidence. See the table in Appendix for a full list of items.

3.3 Analyses

After checking for normality of distribution in the preliminary analyses, the hypotheses will be tested by analyzing descriptive statistics and executing a series of dependent (T1 vs T2) and independent (male vs female) *t*-tests and the non-parametric alternatives thereof. Type I errors (rejecting the null hypothesis when it is actually true) were mitigated by setting a high confidence level of 95% when producing p values for all tests. Calibration plots serve as visual supplement of the analyses for the first hypothesis: with subjective judgment on one axis and objective outcome on the other, the line indicating overconfidence bias can be compared to the hypothetical straight line indicating perfect calibration. Unlike single calibration coefficients, these plots facilitate researchers to assess the prevalence of bias, while also providing an easily interpretable visual display of bias across performance levels (Pieschl, 2009).

4. Findings

By means of preliminary analyses, normality of distribution for ESE accuracy was assessed for six samples: all students ($N = 103$), female students ($N = 71$) and male students ($N = 32$) at both points in time (T1 and T2). The table in Appendix summarizes how only the samples with exclusively male students displayed a normal distribution, implying a dependent samples *t*-test to compare between male students over time and non-parametric alternatives, i.e. the dependent samples Wilcoxon signed rank test and independent samples Mann–Whitney U test, for all other comparisons.

4.1 Hypothesis 1: Findings

In line with previous studies on self-efficacy accuracy (e.g. Talsma *et al.*, 2019), a one-sample test was used to compare the mean accuracy score of all students to a hypothesized mean value of zero, which implies perfect calibration. The Wilcoxon signed rank test demonstrated that the prevalence of overconfidence bias at the group level is significant at both the start and the end of the course: in both instances, the actual mean of −0.80 deviates from the hypothesized mean of 0 at $p < 0.001$. Calibration plots (Figures 1 and 2) visualize this overconfidence.

However, mindful of possible data collection bias (see section 3.2), the mere presence of overconfidence is not sufficient to confirm H1. In addition, it is relevant to assess the degree of

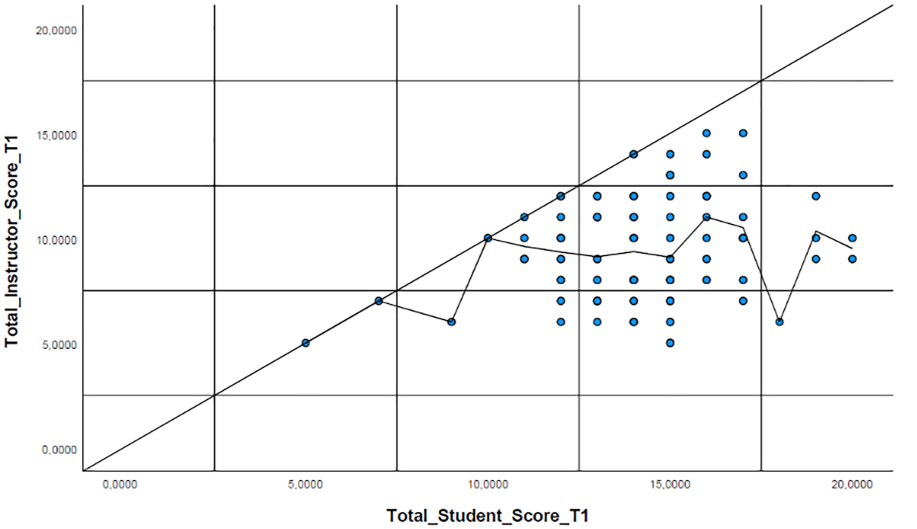


Figure 1.
Calibration plot: overconfidence bias at the start of the course (T1) – *max. score = 20*

Source(s): The author's own creation

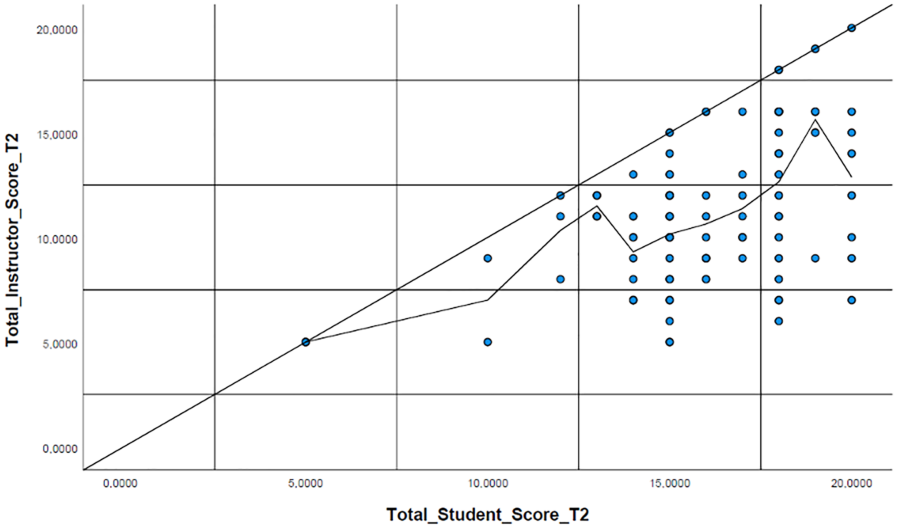


Figure 2.
Calibration plot: overconfidence bias at the end of the course (T2) – *max. score = 20*

Source(s): The author's own creation

overconfidence as well as its distribution over individual students. First, the data suggests that the level of overconfidence overall is not exorbitant. The maximum overconfidence score is −15, which would occur if students give themselves the highest score (4) on all five statements, while the revision of their answers amount to the lowest score (1). In the results, we see that the individual averages of overconfidence range from −0.2 to −2.6, a mere 1.3%–17.3% of the hypothetical maximum. In addition, a distribution wherein many students with

no or minor overconfidence outbalance a few students with relatively major overconfidence would also suggest rejecting the hypothesis. With a group mean for overconfidence of −0.94, students' relative overconfidence can be expressed in the following categories: minor (−0.1 to −0.9), moderate (−1.0 to −1.9) and major (−2.0 to −2.9). However, the descriptive statistics in Table 2 demonstrate that, at both points in time, practically half of the students (49.5%) displays moderate to major overconfidence. Combined with the statistical analyses, this distribution provides support for retaining hypothesis 1.

4.2 *Hypothesis 2: Findings*

Considering that the data distribution for the total sample is not sufficiently normal, and the samples are dependent, the Wilcoxon signed rank test was used to assess whether taking an entrepreneurship course helped reduce students' overconfidence bias. However, the mean difference for overconfidence was close to 0 (−0.940 vs −0.942) and insignificant ($p = 0.933$). As visible in Figure 3, there was an almost equal number of students who reduced (44) and increased (39) their overconfidence bias, with 20 students not demonstrating any change. A further check revealed an effect size ($r = -0.006$), which was negligibly small according the standards of Cohen (1992), indicating that a Type II error of a false negative is unlikely. Thus, hypothesis 2 is rejected.

4.3 *Hypothesis 3a: Findings*

Again, one-sample tests were used to compare the mean accuracy score of female and male students separately to a hypothesized mean value of zero (perfect calibration). The Wilcoxon signed rank test demonstrates no gender difference at the start of the course, in the sense that the aggregate prevalence of overconfidence bias is equally significant ($p < 0.001$) for female (mean = −0.80) and male (mean = −1.10) students.

In addition, the visualization of overconfidence in the calibration plots per gender group at the start of the course (Figure 4) does not display a clear difference in the size of overconfidence prevalence. This visual suggestion can be statistically tested with the Mann–Whitney U test. The results confirm that the gender difference is not statistically significant at the start of the course (mean ranks of 46.9 versus 54.3/$U = 973.5$, $p = 0.244$).

Finally, Table 2 presents the distribution of female and male students over the relative overconfidence levels. At the start of the course, there is hardly any difference, with 45% of female and 43.8% of male students displaying moderate or major overconfidence (relative to the group mean). In sum, all findings lead to a rejection of hypothesis 3a.

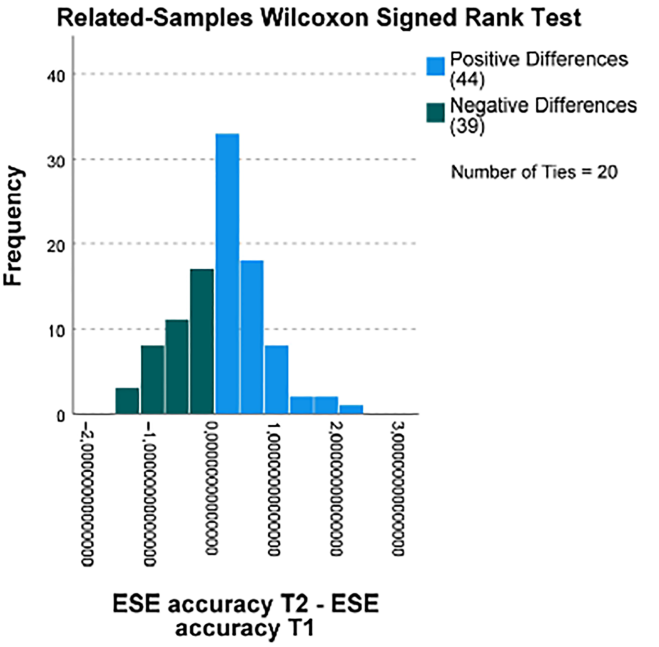
4.4 *Hypothesis 3b: Findings*

Both groups display a significant increase in ESE (i.e. average self-assessment score on the five items). For female students the mean goes from 14.3 to 15.9, and for male students from

Level of overconfidence in entrepreneurial competences	All students ($N = 103$)		Female students ($N = 71$)		Male students ($N = 32$)	
	T1	T2	T1	T2	T1	T2
None (0)	8 (7.8%)	13 (12.6%)	4 (5.6%)	12 (16.9%)	4 (12.5%)	1 (3.1%)
Minor (−0.1/−0.9)	44 (42.7%)	39 (37.9%)	35 (49.3%)	31 (43.7%)	9 (28.1%)	8 (25.0%)
Moderate (−1.0/−1.9)	44 (42.7%)	41 (39.8%)	27 (38.0%)	26 (36.6%)	12 (37.5%)	15 (46.9%)
Major (−2.0/−2.9)	7 (6.8%)	10 (9.7%)	5 (7.0%)	2 (2.8%)	2 (6.3%)	8 (25.0%)

Source(s): The author's own creation

Table 2. Number of students per (relative) overconfidence level



Source(s): The author's own creation

Figure 3.
Student differences in ESE accuracy before and after the entrepreneurship course

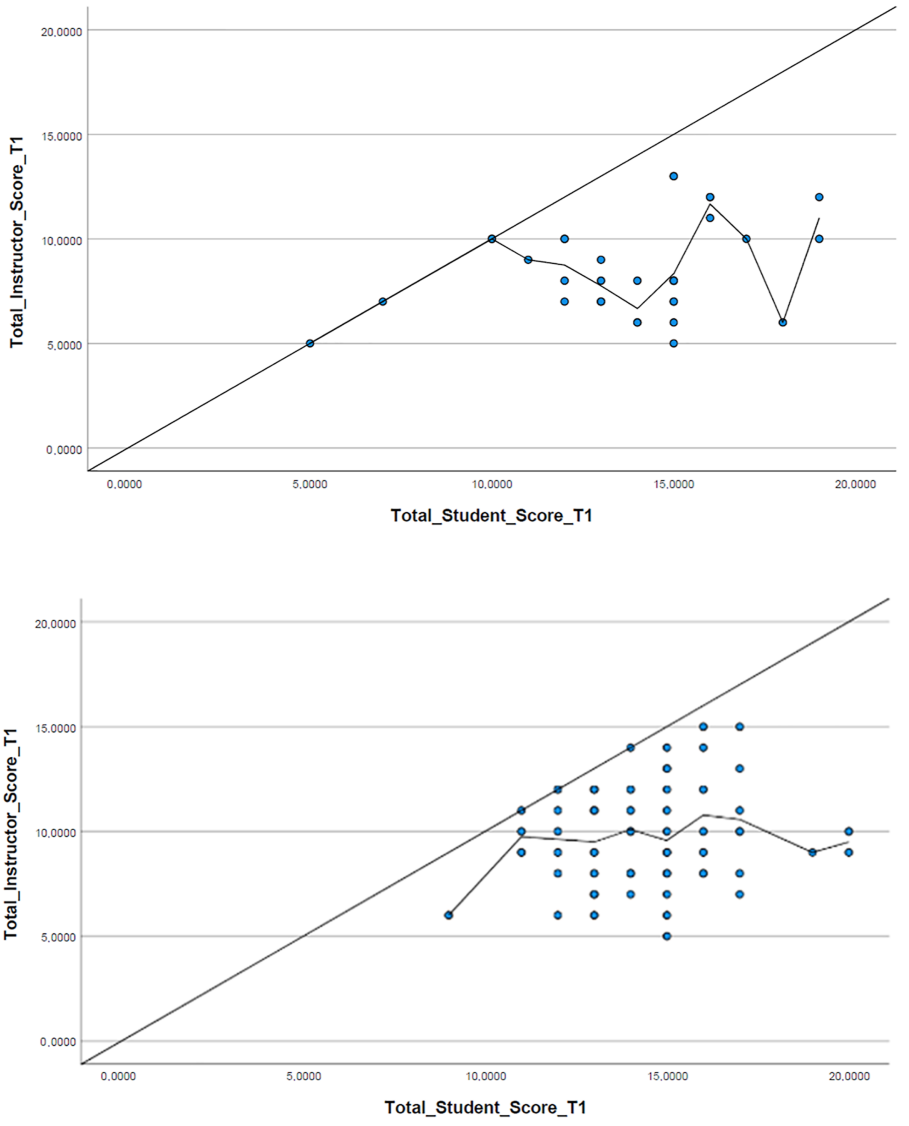
13.8 to 16.0, with $p < 0.001$ for both in the related-samples Wilcoxon signed rank test. The test also indicates four to five times more positive changes than negative changes. However, for female students this coincides with a considerable and significant increase in performance (aggregate instructor score on the five items increases from 9.8 to 12.0, with $p < 0.001$), while for male students' performance increases only slightly, and not significantly (from 8.6 to 9.3, with $p = 0.172$).

Change in ESE accuracy was computed by deducing the individual score on ESE accuracy at the end of the course from the score at the start of the course. A Mann–Whitney independent samples test reveals that female students displayed more change than male students, with mean ranks 57.2 and 40.4, respectively ($U = 765.5$, $p = 0.008$). The descriptive statistics demonstrate that this change is positive. In the calibration plots at T2 (Figure 5), the area size between the interpolation lines of hypothetical and actual scores is visibly smaller for the sample of female students. Table 2 presents the distribution of female and male students over the relative overconfidence levels: at the end of the course: 39.4% of the female students versus 71.9% of male students display moderate or major overconfidence (relative to the group mean). Finally, the Mann–Whitney U test indicates significant gender difference in ESE accuracy at the end of the course ($U = 592.5$, $p < 0.001$) in favor of female students (mean ranks of 35.0 versus 59.7). In sum, hypothesis 3b is supported, with the surprising additional observation that overconfidence among male students has not only endured, but even increased.

5. Discussion

5.1 Research implications

Following the order of the research questions and hypotheses, first, as expected, the results show a moderate (half of the students displaying between 6.6 and 17.3% of the maximum



Source(s): The author's own creation

Figure 4.
Calibration plots (T1): overconfidence bias male (left) vs female (right) – *max. score = 20*

overconfidence level), but significant ($p < 0.001$) discrepancy between self-reported and actual course-related entrepreneurial knowledge. This finding aligns with previous findings in the fields of psychology (e.g. Dunning, 2011; Mabe and West, 1982) and educational psychology (e.g. Magnus and Peresetsky, 2018; Schlösser *et al.*, 2013). However, it refutes the implicit assumption that self-efficacy is an appropriate proxy for competence, frequently made in studies where entrepreneurial competences are measured through subjective self-perceptions (e.g. Bolzani and Luppi, 2021; Mitchelmore and Rowley, 2010; Ferreras-Garcia

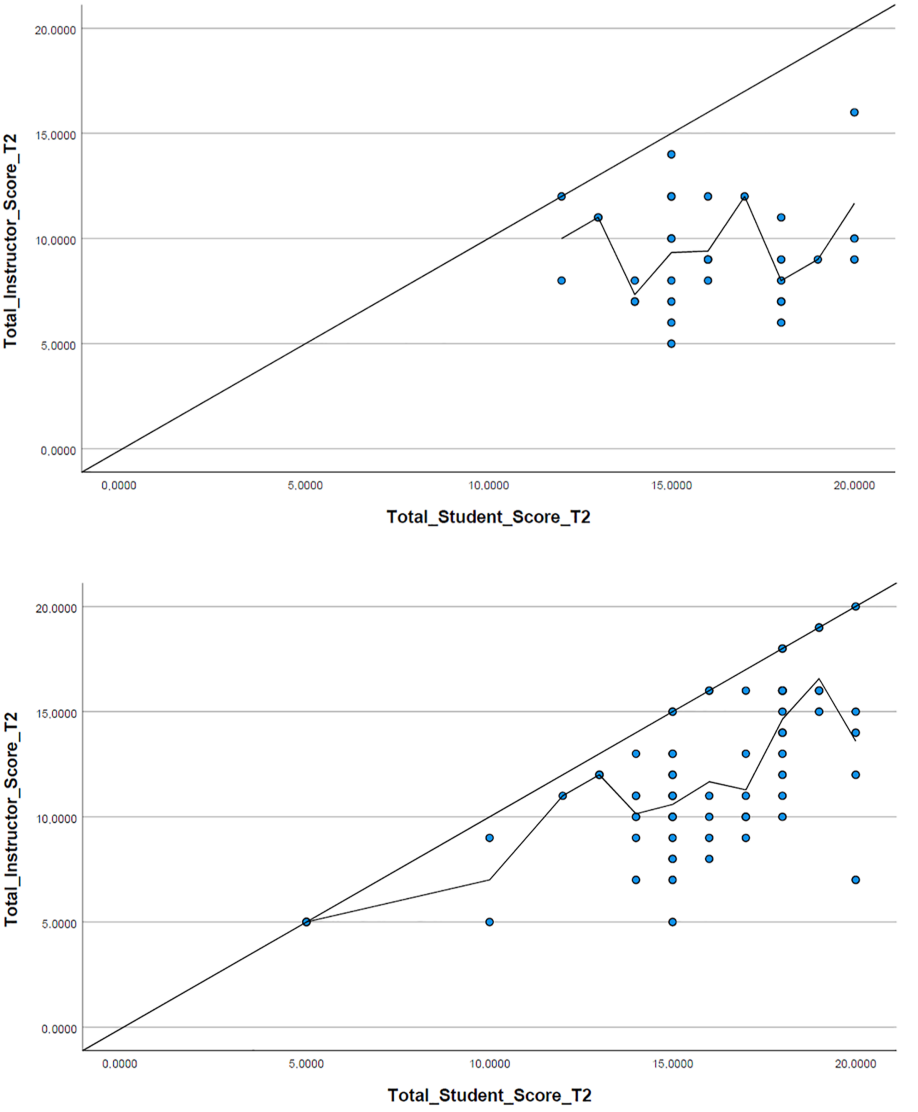


Figure 5.
Calibration plots (T2): overconfidence bias male (left) vs female (right) – *max. score = 20*

Source(s): The author's own creation

et al., 2021; Silveyra *et al.*, 2021). Students' confidence in their own knowledge, skills and attitudes was not justified; many of these novice learners thought they knew, but did not really.

Second, the results provided no evidence that entrepreneurship education reduced the gap between self-reported and actual entrepreneurial knowledge, skills and attitudes. In line with Talsma *et al.* (2019), but contrary to the results of Magnus and Peresetsky (2018), at the aggregate level there was no significant change in students' ESE accuracy (mean

change: 0.002/p = 0.933), with an almost equal amount of increases and decreases. Considering that students with more accurate self-beliefs are better able to adopt more effective learning strategies (Stankov and Lee, 2014), this observation is disappointing. There are several possible causes for this lack of improvement. As suggested by Bolzani and Luppi (2021), perhaps students were not actively engaged in meta-cognition, self-assessment and critical self-reflection on competence development, necessitating more explicit instruction and practice. Then again, exposure to relevant mastery information (Bandura, 1997) and practice over time does help people to learn their true skill level (Ryvkin *et al.*, 2012). From that perspective, it could be that this introductory entrepreneurship course was too short or not sufficiently intense. On the other hand, Jaeken *et al.* (2017) found that a training program on helping skills of merely 12 h did reduce students' overconfidence, in spite of the many processes that make the unskilled-unaware effect persist even in the face of explicit feedback, such as self-protection, central worldviews, or (incorrect) preexisting knowledge (Dunning, 2011). Alternatively, perhaps there were not sufficient strong performers among the samples, as strong performers are better able to correct their self-evaluations (Dunning, 2011). Due to the absence of data on students' performance levels, such as course grades or overall GPA, this hypothesis could not be tested. Nonetheless, the observed gender effect in ESE "tuning" points to a possible alternative explanation.

Third, female students did not display more accurate ESE than their male counterparts at the start of the course: at that point in time, a similar amount of overconfidence for male and female students (−1.1 and −0.8) was equally significant ($p < 0.001$). While aligned with other studies that found no significant gender difference in overconfidence (Grimes, 2002; Kakkonen, 2011; Maxwell and Lopus, 1994), this result contradicts the widespread observation that men are generally more overconfident than women (e.g. Guzman, 2012; Magnus and Peresetsky, 2018; Nowell and Alston, 2007). Notably, and concerningly, it is only after participating in their first entrepreneurship course, that a gender difference among students becomes salient. At the end of the course, the same amount of overconfidence is spread out more equally over female students (more moderate). Furthermore, the level of overconfidence is significantly lower among female students than among their male counterparts, where overconfidence has markedly increased: from an average of −1.1 to −1.4 ($p < 0.001$) and with now 71.9% instead of 43.8% of male students in the highest relative overconfidence level. This gendered impact coincides with the findings by Grimes (2002) and Magnus and Peresetsky (2018) that female students were better at tuning their self-efficacy, to better resemble actual performance, over time. It is not immediately clear why this occurs. Gender-effects in entrepreneurship education impact have often been linked to traditional gender roles and the masculine image of the entrepreneur (Díaz-García and Welter, 2011; van Ewijk and Belghiti-Mahut, 2019; Jones and Warhuus, 2017), but these do not directly explain a gender effect in ESE tuning. From the theoretical framework, another possible explanation emerges: gendered learning motives. Could it be that female students are more susceptible to the self-enhancement motive (Ehrlinger *et al.*, 2016), while male students are more susceptible to defensive self-deception (Stankov and Lee, 2014)? In other words, perhaps chances in ESE accuracy are driven by gendered outlooks on learning and what meaning the learning process carries for the learner's identity.

5.2 Practical implications

If future research confirms that unwarranted ESE is widespread, with entrepreneurship education reducing it for female students but increasing it for male students, then educational policy-makers and educational institutions need to reconsider what they ultimately wish to achieve. If entrepreneurship educators direct their (un)conscious

educational efforts toward mainstream aspirations for higher ESE (Newman *et al.*, 2019), they risk contributing to severely undesirable outcomes. There is ample evidence that our efforts will most likely increase the pool of potential entrepreneurs (Boyd and Vozikis, 1994; Krueger Jr *et al.*, 2000; Newman *et al.*, 2019). That pool, however, is filled with mostly male swimmers, and with many swimmers who are likely to drown when overconfidence prevents them from adopting appropriate learning strategies (Stankov and Lee, 2014; Uy *et al.*, 2024) and formulate unbiased entrepreneurial forecasts (Hayward *et al.*, 2010), leading to lower revenue and employment growth (Hmieleski and Baron, 2008), reduced likelihood of new product success (Simon and Shrader, 2012) and, ultimately, faster business exit (Koellinger *et al.*, 2007). In this dystopian scenario, we unintentionally perpetuate the skewed male–female ratio in entrepreneurship and flood entrepreneurial ecosystems (with limited resources) with a large group of aspiring entrepreneurs of which only a few are high-potential. In sum, we need to start mitigating this: our teaching and learning methods should aim to enhance our students' ESE accuracy, with consideration of probable gender differences.

From entrepreneurship literature, two potentially helpful concepts emerge. First, entrepreneurship educators may focus on increasing students' self-control to prevent over-ambitious goal-setting (Baron *et al.*, 2016). Second, students may benefit from explicit educational efforts on error mastery orientation (Uy *et al.*, 2024). Neither directly aims for increasing ESE accuracy or reducing ESE. This is not surprising as this research focused on practicing entrepreneurs, whose experience strongly influences ESE. Instead, the main goal is to provide tools to avoid cognitive entrenchment – a condition impeding a person from recognizing the value of other people's inputs, adopting other people's advice and accepting disconfirming feedback (Zhang *et al.*, 2022) – in spite of high ESE. Thus far unexplored in entrepreneurship education, concrete recommendations for effective interventions are yet to be developed.

For readily available suggestions for improving ESE accuracy, we can turn to educational psychology. According to this body of literature, entrepreneurship educators of novice learners would do well to emphasize that entrepreneurial competences, like any other competence, are adaptable. Educators should offer reassurance that entrepreneurial competences can be learned and improved, and point out that becoming aware of what still needs to be learned is a first step toward that (Jaeken *et al.*, 2017). By setting the first tests early on, and asking students to estimate their performance beforehand, educators provide opportunities for students to improve their self-assessments at an early stage by themselves. Asking for estimates is effective even without additional reflection support (Nederhand *et al.*, 2020). When taken, these opportunities help students to make better decisions with respect to the allocation of time and effort for the course (Magnus and Peresetsky, 2018).

Furthermore, entrepreneurship educators can take stock of their students' learning motivations themselves, ideally before starting the course. Although actual experience and performance are the main cause for not being able to accurately assessing one-self, students' level of self-esteem defense, narcissism and self-deception likely make the effect persevere longer (Dunning, 2011). Knowing this, educators can adjust their teaching content and strategies.

For example, educators should only stimulate ESE for students with the capacity for accurate self-analysis (Gramzow *et al.*, 2003): students with a self-enhancement motive – most likely top performers or, as suggested by the results, female students. On the other hand, educators need to convince learners with a self-deception motive – most likely underperformers and, possibly, male students – that critical self-reflection and healthy self-doubt is positively associated to performance. Contrary to common practice, research demonstrates how directly targeting self-efficacy biases – such as through reflection exercises or teaching about bias mechanisms – is largely ineffective (Dunning, 2011;

Karpen, 2018). After all, the same biases that operate during normal cognition also operate during introspection and processing of critical information (Karpen, 2018). Limited success has been achieved with accountability manipulations, such as requiring self-reflections where individuals provide real-life anecdotes to explain certain traits or informing participants that they would need to justify their self-assessments to an expert afterward (Sedikides *et al.*, 2002).

Alternatively, there are several interventions that help students become more accurate in their self-evaluations in spite of their biases. To start, positive bias is reduced when individuals assess themselves on more specific, externally created, measurable criteria as opposed to ambiguous soft skills (Dunning, 2011). For example, educators can inquire how often a student asked follow-up questions in the latest interview instead of requesting a self-evaluation on empathetic need-finding or communication skills in general. Providing specific standards has proven to be beneficial for all students' calibration accuracy, and particularly for low performers (Nederhand *et al.*, 2019) Emphasizing that the entrepreneurial competence at hand is modifiable, also reduces the threat to the self and thereby the likelihood that underlying biasing mechanisms will be activated. Finally, it is important to provide constructive feedback, supported by objective, preferably real-time documentation of student performance and accompanied by clear guidance on how to improve (Karpen, 2018). Instructors can choose to provide this feedback themselves, or ensure that it comes from other, sometimes more influential sources, such as students' peers or external stakeholders, such as local businesses (Lindh and Thorgren, 2016).

6. Study limitations and research opportunities

It is important to emphasize the constraints of the study, particularly in terms of sample characteristics and data limitations. First, the study builds on a modest sample of undergraduate students from a single country, albeit with multiple nationalities from the region. More research is required to assess the external validity of the results. This will help ascertain to what extent the results are replicable across different cultural and economic settings, and whether the findings apply to both novice and experienced entrepreneurs. Second, the dataset lacked information that would have enabled testing more comprehensive explanatory models. Specifically, the data did not provide insight into under-confidence – typically found among experienced or high-achieving learners. Course grades or generic performance metrics, such as GPA, would have helped in comparing ESE accuracy among students with different performance levels (Talsma *et al.*, 2019). Furthermore, common predictors of high ESE could not be controlled for; such as self-selection (Rideout and Gray, 2013) or prior entrepreneurial experience among students or their team members, which can enhance ESE through vicarious learning (Newman *et al.*, 2019). Although the research design might have reduced the impact of vicarious learning – students took the survey in class without discussing answers with team-members and with the possibility to adjust their ESE scores if the open-ended control questions proved too challenging – these potential mitigations could not be confirmed with the data available.

Alongside research aimed at overcoming these limitations, the findings open up several other promising avenues for further investigation. The demonstrated prevalence of unwarranted ESE reinforces previous calls (Nabi *et al.*, 2017; Pittaway and Cope, 2007) to move our research focus beyond well-studied motivational constructs, such as entrepreneurial intentions and self-efficacy and toward factors that incite entrepreneurial quality, enhancing chances and durability of entrepreneurial success. Considering the independent and direct positive effect of self-efficacy accuracy on actual performance in other academic contexts (e.g. Talsma *et al.*, 2019), ESE accuracy needs to be among those factors. However, research designs to explore ESE accuracy are likely time-consuming. The content (Bandura, 1986) and format

(Chyung *et al.*, 2017; Weems and Onwuegbyzie, 2001) of surveys to capture ESE need to be carefully customized to the target group. Additionally, performance measures need to be objective, specific and verifiable (Gramzow *et al.*, 2003), ideally triangulating for comparison scores (e.g. using external judges, instructors and/or peers).

Above all, the results suggest that all future researchers take on a more nuanced stance toward ESE as indicator of positive impact. At least in this study, entrepreneurship education did not only maintain, but even boost unrealistic beliefs about their own entrepreneurial competence for most male students, trapping them even deeper in the Dunning–Kruger effect of being unable and unaware (Dunning, 2011). The tendency among entrepreneurship educators to avoid providing negative feedback or even constructive criticism (Dinham, 2010) might prevent disengagement from entrepreneurship students with a self-enhancement motive (Vancouver and Kendall, 2006), but this is clearly not helpful to students with a defensive self-deception motive (Talsma *et al.*, 2019). Therefore, exploring what is a "healthy" level of overconfidence (Dunning, 2011; Karpen, 2018) and how entrepreneurship education can facilitate more warranted ESE, are meaningful research directions, necessitating deeper and richer qualitative and mixed-method studies. For example, explorations could shed more light on the influence of different peer and relational environments (Pocek *et al.*, 2021). Moving beyond the realm of higher education, entrepreneurship studies could focus on how (gendered) learning orientations relate to entrepreneurial learning in "real life", contributing to the practice theory of entrepreneurial learning (Thompson and Illes, 2020).

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Appendices

Construct*		Likert items + open-ended control questions**
ESE accuracy	1	I can describe the "design thinking" process *If "agree" or "strongly agree": Please list some steps in the design thinking process*
	2	If I need help (guidance and funds) with my start-up, I know where to get support *If "agree" or "strongly agree": Please name two accelerators/incubators for start-ups in our country. If "agree" or "strongly agree": Please name two sources of funding for a start-up*
	3	I am very good in developing new and creative ideas *If "agree" or "strongly agree": Please name two techniques to create new ideas*
	4	Innovation and entrepreneurship are very important for our society/economy *If "agree" or "strongly agree": Please give two examples of the value of innovation and/or entrepreneurship for our society/economy*
	5	Innovation and entrepreneurship will be very important for my future career *If "agree" or "strongly agree": Please give two examples of the value of innovation and/or entrepreneurship for your future career*

Note(s): *Difference score between self-scored Likert items and instructor-scored open answers, adapted from Talsma *et al.* (2019)

**Directly derived from course learning objectives and study materials, as prescribed by Bandura (1986), and Nabi *et al.* (2017) / with 4-point scale following recommendations by Chang (1994), Chyung *et al.* (2017), Kulas and Stachowski (2013), Preston and Colman (2000), Raaijmakers *et al.* (2000) and Weems and Onwuegbyzie (2001)

Source(s): The author's own creation

Table A1. Course-customized ESE accuracy - items

Criteria Samples	Mean/ median	Skewness	Kurtosis	Histogram	Q-Q plots	Shapiro–Wilk	Conclusion (normality)
All T1	Slightly unequal (−0.94/ −0.80)	−0.22	−0.082	Incomplete bell-shape	Straight line	0.96*	No
All T2	Slightly unequal (−0.94/ −0.80)	−0.32	−0.59	Incomplete bell-shape	Straight line	0.96*	No
Female T1	Slightly unequal (−0.90/ −0.80)	−0.35	−0.80	Incomplete bell-shape	Straight line	0.95*	No
Female T2	Slightly unequal (−0.77/ −0.80)	−0.50	0.06	Incomplete bell-shape	Straight line	0.94*	No
Male T1	Slightly unequal (−1.04/ −1.10)	0.07	−0.69	Incomplete bell-shape	Straight line	0.96	Yes
Male T2	Slightly unequal (−1.33/ −1.40)	0.24	−0.81	Incomplete bell-shape	Straight line	0.96	Yes

Table A2.
Normality of data distribution - tests

Note(s): *NB.* $^{*}=p < 0.05$, $^{**}=p < 0.01$, $^{***}=p < 0.001$
Source(s): The author's own creation

Corresponding author
Anne Rienke Van Ewijk can be contacted at: a.r.vanewijk@uu.nl