Ivona Huđek Kanižaj, PhD
Assistant Professor
University North, Croatia
Department of Logistics and Sustainable Mobility
E-mail: ihudek@unin.hr
Orcid: https://orcid.org/0000-0001-6400-9950

Dinko Primorac, PhD
Full Professor
University North, Croatia
Department of Economics
E-mail: dprimorac@unin.hr
Orcid: https://orcid.org/0000-0001-5150-5189

Ana Mulović Trgovac, PhD
Assistant Professor
University North, Croatia
Department of Communication, media and journalism
E-mail: ana.mulovic@unin.hr
Orcid: https://orcid.org/0000-0003-1341-6067

Željka Marčinko Trkulja, PhD
Assistant Professor
University North, Croatia
Department of Economics
E-mail: zmtrkulja@unin.hr
Orcid: https://orcid.org/0000-0001-5932-6986

ENTREPRENEURSHIP EDUCATION AND PERCEIVED BEHAVIOURAL CONTROL AMONG STEM STUDENTS: EVIDENCE FROM A PRE–POST STUDY

UDC / UDK: 37.091.3:005.342
JEL classification / JEL klasifikacija: A23, L26, I23, D91
https://doi.org/10.17818/EMIP/2026/43
Preliminary communication / Prethodno priopćenje
Received / Primljeno: July 14, 2026 / 14. srpnja 2026.
Accepted / Prihvaćeno: September 21, 2026 / 21. rujna 2026.

Abstract

This study examines changes in personal attitudes towards entrepreneurship, subjective norms, perceived behavioural control, and entrepreneurial intentions among STEM students after a single-semester entrepreneurship course. Grounded in the Theory of Planned Behaviour, the study uses the Entrepreneurial Intention Questionnaire to assess short-term differences between PRE and POST measurements. The sample comprised 99 PRE and 102 POST responses from

This work is licensed under a Creative Commons Attribution 4.0 International License.

undergraduate students enrolled in the Multimedia, Design and Application and Electrical Engineering programmes at University North. As responses were anonymous and could not be matched individually, PRE and POST measurements were analysed as an unmatched aggregate pre–post comparison using independent-samples t-tests. A statistically significant increase was found only in perceived behavioural control. The largest improvements related to students' knowledge of the steps needed to start a business and their ability to develop an entrepreneurial project from idea to implementation. The findings indicate that the course was associated primarily with stronger perceived entrepreneurial capabilities.

Keywords: entrepreneurship education, STEM students, perceived behavioural control, entrepreneurial intention, Theory of Planned Behaviour, pre–post study

1. INTRODUCTION

Entrepreneurship is widely recognised as an important driver of economic development, innovation, job creation, and social resilience. In contemporary knowledge-based economies, the ability to recognise, evaluate, and exploit business opportunities is relevant not only for individuals who wish to start their own ventures, but also for broader economic competitiveness and innovation capacity. According to the Global Entrepreneurship Monitor, entrepreneurial activity continues to play an important role in responding to uncertainty, technological change, climate challenges, and geopolitical disruptions (GEM, 2026). For this reason, entrepreneurship education has become an increasingly important component of higher education, as universities are expected not only to transfer disciplinary knowledge, but also to support the development of entrepreneurial competences, creativity, opportunity recognition, and innovation-oriented thinking among students (Fayolle and Liñán, 2014). At the same time, recent discussions in the field suggest that the practice of entrepreneurship education has often developed more rapidly than its theoretical and empirical foundations, leaving open questions about the effectiveness of different educational approaches and learning designs (Fayolle et al., 2026).

Particular attention has recently been given to the integration of entrepreneurship education into STEM fields, that is, science, technology, engineering, and mathematics. STEM students and graduates represent an important source of technological innovation, new product development, applied research, and knowledge commercialisation. However, technical knowledge alone is often not sufficient for transforming ideas, prototypes, or research results into viable products, services, projects, or ventures. For this reason, higher education institutions increasingly seek to combine STEM education with entrepreneurial learning, business model development, opportunity recognition, technology transfer, and innovation commercialisation (Maresch et al., 2016; Souitaris et al., 2007). Such integration is particularly relevant because students in STEM fields may possess strong technical competences, while having less exposure to

entrepreneurship, markets, customers, business planning, and venture creation processes.

Previous research generally suggests that entrepreneurship education can contribute to the development of entrepreneurial competences, self-efficacy, and entrepreneurial intentions (Martin et al., 2013; Bae et al., 2014; Sánchez, 2013). However, the findings are not uniform. Some studies report positive effects of entrepreneurship education on entrepreneurial intentions, while others point to limited, insignificant, or even negative effects, especially when short-term educational interventions are examined (Nabi et al., 2017; Oosterbeek et al., 2010; von Graevenitz et al., 2010). One explanation is that entrepreneurship education does not influence all dimensions of entrepreneurial orientation in the same way. While practical knowledge and perceived capability may be more responsive to educational intervention, deeper attitudes, social influences, and career intentions may require longer, more experiential, and more intensive exposure to entrepreneurial learning. This issue is especially important in STEM contexts, where students may benefit from entrepreneurial education, but may also develop a more realistic understanding of the challenges, risks, and demands of entrepreneurship.

The Theory of Planned Behaviour (TPB), developed by Ajzen (1991), offers a suitable theoretical framework for examining these issues. According to the TPB, intention is the immediate predictor of planned behaviour, while intention itself is shaped by three main antecedents: personal attitude towards the behaviour, subjective norms, and perceived behavioural control. In entrepreneurship research, personal attitude towards entrepreneurship refers to the extent to which an individual evaluates entrepreneurship as an attractive and desirable career option; subjective norms refer to perceived support from important people in the individual's social environment; and perceived behavioural control reflects the individual's belief that they possess the knowledge, skills, and ability to successfully engage in entrepreneurial activity. The TPB has been widely applied in studies of entrepreneurial intention and has shown strong explanatory value across different educational, cultural, and institutional contexts (Krueger et al., 2000; Liñán and Chen, 2009; Kautonen et al., 2015; Rauch and Hulsink, 2015).

At University North, the HEI2MARKET project ("Transforming Education into Innovation") is being implemented within the EIT Higher Education Initiative, with University North acting as the lead partner of an international consortium. The project aims to strengthen the innovation and entrepreneurial capacity of higher education institutions by embedding entrepreneurial curricula, fostering technology transfer, supporting start-up development, and strengthening collaboration between academia and the market. Its activities target students, academic staff, and non-academic staff and combine entrepreneurial education, mentoring, institutional capacity building, and support for transforming innovative ideas into market-oriented projects (EIT Higher Education Initiative, 2026). Within this broader institutional framework, the syllabus of the Fundamentals of Entrepreneurship course was modernised. In addition to basic entrepreneurial

concepts, the course includes content related to innovation, business models, opportunity recognition, technology transfer, commercialisation of research results, teamwork, and the practical application of entrepreneurial tools.

Therefore, the aim of this study is to examine changes in personal attitudes towards entrepreneurship, subjective norms, perceived behavioural control, and entrepreneurial intentions among STEM students after attending the Fundamentals of Entrepreneurship course at University North. The study is based on the Theory of Planned Behaviour and employs a pre–post research design using the Entrepreneurial Intention Questionnaire. In line with this aim, the following research question is proposed:

To what extent do STEM students' personal attitudes towards entrepreneurship, subjective norms, perceived behavioural control, and entrepreneurial intentions differ before and after attending the Fundamentals of Entrepreneurship course?

This study contributes to the existing literature in three ways. First, it provides empirical evidence on entrepreneurship education among STEM students in the Croatian higher education context, which remains less represented in comparison with research involving business and economics students. Second, it examines a single-semester entrepreneurship course modernised within the HEI2MARKET project, integrating innovation, opportunity recognition, business model development, technology transfer, and commercialisation-oriented content into STEM education. Third, rather than evaluating entrepreneurship education only through changes in entrepreneurial intention, the study distinguishes between changes across the four TPB constructs and complements the construct-level analysis with item-level evidence. This makes it possible to identify which specific dimensions of perceived behavioural control appear most responsive to a short-term educational intervention.

The paper is structured as follows. Section two reviews the relevant literature and develops the research hypotheses. Section three describes the research methodology, including the research design, course context and educational intervention, sample, measurement instrument, data collection process, and statistical analysis. Section four presents the empirical results, while section five discusses the findings, practical implications, research limitations, directions for future research, and the main conclusions.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The Theory of Planned Behaviour (TPB), developed by Ajzen (1991), is one of the most influential theoretical frameworks for explaining planned human behaviour and decision-making. Although the theory was not originally developed in the field of entrepreneurship, it has become one of the most widely used approaches for explaining entrepreneurial intentions (Krueger et al., 2000;

Kautonen et al., 2015). According to the TPB, intention is the immediate antecedent of planned behaviour, while intention itself is shaped by three key constructs: personal attitude towards the behaviour, subjective norms, and perceived behavioural control.

In the context of entrepreneurship, personal attitude towards entrepreneurship refers to the extent to which an individual perceives entrepreneurship as an attractive, desirable, and personally valuable career option. Subjective norms reflect perceived support or approval from important people in the individual's social environment, such as family, friends, and peers. Perceived behavioural control refers to the individual's belief that they possess the knowledge, skills, abilities, and control necessary to successfully engage in entrepreneurial activity (Krueger et al., 2000; Liñán and Chen, 2009). Previous studies have shown that all three constructs contribute to explaining entrepreneurial intention, although personal attitude towards entrepreneurship and perceived behavioural control usually have stronger explanatory power, while subjective norms often show a weaker and more context-dependent influence (Liñán and Chen, 2009; Kautonen et al., 2015; Bayona-Oré, 2023).

The TPB is particularly useful for research on entrepreneurship education because it allows educational effects to be examined through several different psychological and behavioural dimensions. Entrepreneurship education may influence students by making entrepreneurship appear more attractive, by increasing perceived social support for entrepreneurial activity, by strengthening perceived entrepreneurial capability, or by shaping entrepreneurial intentions. However, these dimensions are not necessarily equally responsive to educational interventions. Attitudes and entrepreneurial intentions may be relatively stable and shaped by previous experiences, personal values, family background, and broader career expectations. Subjective norms may be even more difficult to change through a single course, as they depend strongly on the wider social environment. In contrast, perceived behavioural control may be more directly influenced by educational activities because it is closely connected with students' knowledge, practical skills, understanding of entrepreneurial processes, and confidence in their ability to perform entrepreneurial tasks.

Entrepreneurship education includes a broad range of teaching and learning activities aimed at developing entrepreneurial knowledge, skills, competencies, attitudes, and intentions. The literature identifies different forms of entrepreneurship education, including formal courses focused on theoretical knowledge, experiential programmes based on simulations and practical assignments, mentoring and accelerator programmes, and project-based approaches in which students progress from idea generation to market-oriented application (Nabi et al., 2017; Fayolle and Liñán, 2014). Variations in the form, duration, intensity, and pedagogical design of entrepreneurship education are among the main reasons why previous empirical findings are not always consistent (Loi & Fayolle, 2021).

Meta-analytical evidence generally supports a positive relationship between entrepreneurship education and entrepreneurial outcomes. Martin et al. (2013), based on 42 studies, found that entrepreneurship education has positive effects on entrepreneurial knowledge, skills, perceived abilities, and intentions, with stronger effects in programmes focused on business creation. Bae et al. (2014), in a meta-analysis of 73 studies, also confirmed a positive association between entrepreneurship education and entrepreneurial intentions, but cautioned that the relationship becomes weaker once pre-existing entrepreneurial intentions are controlled for. This suggests that the observed effects of entrepreneurship education may partly reflect self-selection, especially when students who are already interested in entrepreneurship choose to enrol in such programmes. A similar concern is raised by Fretschner and Lampe (2019), who emphasise that hidden sorting and alignment effects may influence the observed outcomes of entrepreneurship education. These findings underline the need to examine educational effects carefully and to distinguish between different dimensions of entrepreneurial orientation. Evidence from Croatia also indicates that the effects of entrepreneurship education may differ across TPB constructs. In a study of students enrolled in an entrepreneurship-oriented programme, Vuković et al. (2015) found that personal attitude, perceived behavioural control, and subjective norms were positively associated with entrepreneurial intention, although subjective norms had the weakest predictive effect. At the same time, students across different years of study showed no significant differences in entrepreneurial intention or perceived behavioural control, suggesting entrepreneurship education does not uniformly affect all TPB constructs.

Entrepreneurship education may influence attitudes towards entrepreneurship by increasing students' awareness of entrepreneurship as a possible career path and by helping them understand the potential benefits, opportunities, and personal satisfaction associated with entrepreneurial activity (Martin et al., 2013; Nabi et al., 2017; Sánchez, 2013). However, attitudes may also become more realistic after students learn about the risks, complexity, and uncertainty associated with starting and managing a business. Therefore, a short educational intervention does not necessarily lead to a simple increase in positive entrepreneurial attitudes. Based on this reasoning, the following hypothesis is formulated for testing:

H1: There is a statistically significant difference in personal attitudes towards entrepreneurship before and after attending the Fundamentals of Entrepreneurship course.

The effects of entrepreneurship education on subjective norms are less consistent than its effects on other TPB constructs. Subjective norms depend on perceived approval and support from family members, friends, fellow students, and other relevant social actors. Since these perceptions are strongly embedded in the wider social and cultural environment, they may be difficult to change through a single-semester course. Nevertheless, educational activities can influence subjective norms indirectly by exposing students to entrepreneurial role models,

encouraging interaction with entrepreneurs, strengthening peer discussion about entrepreneurship, and creating a learning environment in which entrepreneurial activity becomes more visible and socially acceptable (Liñán and Chen, 2009). Research conducted in Croatia confirms that the role of subjective norms is not uniform. Although subjective norms have been positively associated with entrepreneurial intention, their contribution has generally been weaker than that of personal attitude and perceived behavioural control (Vuković et al., 2015; Širola, 2020). Morić Milovanović et al. (2015a) further found that social norms significantly predicted entrepreneurial intention among female students, but not among male students. These findings indicate that subjective norms are sensitive to social context and sample characteristics. Therefore, a course that increases students' exposure to entrepreneurs, entrepreneurial role models, and supportive peer interaction may be followed by a change in perceived social support for entrepreneurship. However, because previous findings do not provide a consistent basis for predicting the direction of this change, the following hypothesis is formulated:

H2: There is a statistically significant difference in subjective norms before and after attending the Fundamentals of Entrepreneurship course.

The most consistent findings in previous research relate to the positive effects of entrepreneurship education on perceived behavioural control and entrepreneurial self-efficacy. Perceived behavioural control is particularly relevant in educational contexts because it reflects students' assessment of their ability to perform entrepreneurial tasks. Unlike broader career attitudes or social norms, perceived behavioural control can be strengthened through the acquisition of specific knowledge, practical skills, and procedural understanding. Recent evidence from the Croatian higher education context similarly highlights the importance of students' confidence in their own abilities, showing that self-efficacy plays a key role in recognising entrepreneurial opportunities and suggesting that educational programmes should focus not only on knowledge acquisition but also on strengthening students' perceived capabilities (Bulog et al., 2026). Entrepreneurship courses can help students understand how to recognise opportunities, develop business models, evaluate ideas, plan entrepreneurial projects, and identify the practical steps required to start a venture (Souitaris et al., 2007; Lorz et al., 2013). Sánchez (2013), in a quasi-experimental study with a pretest–posttest design and a control group, found a statistically significant increase in self-efficacy among students who attended an entrepreneurship programme. Since the course examined in this study included practical content related to opportunity recognition, business models, technology transfer, and commercialisation, perceived behavioural control is expected to be especially responsive to the educational intervention. Therefore, the third hypothesis is formulated:

H3: There is a statistically significant increase in perceived behavioural control after attending the Fundamentals of Entrepreneurship course.

The relationship between entrepreneurship education and entrepreneurial intention is more complex. The Theory of Planned Behaviour assumes that changes in attitudes towards entrepreneurship, subjective norms, and perceived behavioural control should contribute to changes in entrepreneurial intention. Several studies have found positive effects of entrepreneurship education on entrepreneurial intentions (Martin et al., 2013; Bae et al., 2014; Sánchez, 2013). However, other studies have reported limited, statistically insignificant, or even negative effects. Oosterbeek et al. (2010) and von Graevenitz et al. (2010) suggest that entrepreneurship education may provide students with a more realistic understanding of the challenges of entrepreneurship, which can lead to stabilisation or even a decrease in entrepreneurial intention. Nabi et al. (2017), in a systematic review of 159 studies, also conclude that the effects of entrepreneurship education on entrepreneurial intention remain mixed and that more rigorous and longitudinal research designs are needed. These findings indicate that entrepreneurial intention may not change immediately after a short educational intervention, even when students' perceived entrepreneurial knowledge or capability improves. Accordingly, the following hypothesis is proposed:

H4: There is a statistically significant difference in entrepreneurial intentions before and after attending the Fundamentals of Entrepreneurship course.

STEM students represent a particularly relevant group in entrepreneurship education research. Their technical knowledge and problem-solving skills can provide a strong foundation for innovation, product development, technology-based ventures, and commercialisation of research results. However, research indicates that students in technical and natural science fields often have less exposure to entrepreneurial content than business and economics students and may demonstrate lower levels of entrepreneurial self-efficacy or entrepreneurial intention (Maresch et al., 2016). At the same time, STEM students may benefit substantially from entrepreneurship education because such education can help them connect technical expertise with market needs, customer value, business models, and venture creation processes. Souitaris et al. (2007) found that entrepreneurship programmes can influence science and engineering students, while Teixeira and Davey (2010) showed that entrepreneurship courses may improve students' perceptions of their entrepreneurial abilities. More recent research also suggests that integrating entrepreneurship into STEM education can support entrepreneurial mindset, creativity, opportunity recognition, and innovation-oriented learning (Deveci and Seikkula-Leino, 2023; Hou et al., 2022; Setiawan et al., 2025).

Despite growing interest in STEM entrepreneurship education, empirical evidence remains relatively limited, particularly when compared with studies focusing on business and economics students. This is especially true for studies using pretest–posttest designs to examine short-term changes in TPB constructs after a specific educational intervention (Loi & Fayolle, 2021). Given the mixed findings in previous research and the relatively short duration of the educational intervention examined in this study, the hypotheses are formulated in terms of

statistically significant differences between the PRE and POST measurements, rather than assuming that all TPB constructs will necessarily increase after course participation. This approach allows the study to examine which dimensions of entrepreneurial orientation among STEM students are more responsive to a single-semester entrepreneurship course.

3. METHODOLOGY

3.1. Research design

The research employed a single-group unmatched aggregate pre–post measurement design without a control group. This design enabled the comparison of aggregate PRE and POST measurements of students' entrepreneurial attitudes, subjective norms, perceived behavioural control, and entrepreneurial intentions before and after attending the Fundamentals of Entrepreneurship course. Although this design does not allow strong causal inference and does not capture individual-level change when responses cannot be matched, it is suitable for exploratory evaluation of short-term changes following an educational intervention in a real higher education setting.

Pre–post designs are frequently used in research on entrepreneurship education, particularly when the aim is to examine whether students' entrepreneurial perceptions, competences, or intentions differ before and after participation in a course or programme (Souitaris et al., 2007; Sánchez, 2013). In this study, the design was considered appropriate because the course was delivered as part of the regular curriculum and the formation of a separate control group was not feasible.

3.2. Course context and educational intervention

The educational intervention examined in this study was the Fundamentals of Entrepreneurship course delivered to undergraduate STEM students at University North during the summer semester of the academic year 2025/2026. The course was redesigned and modernised within the HEI2Market project, which aims to strengthen entrepreneurial and innovation capacities in higher education and improve the connection between academic knowledge, innovation, and market application.

Building on the previous course structure, which primarily focused on foundational entrepreneurial concepts, entrepreneurial risks, and business planning, the modernised course broadened its scope by integrating opportunity recognition, entrepreneurial ecosystems, business model development, technology transfer, innovation commercialisation, and project-based entrepreneurial learning. Greater emphasis was also placed on teamwork, interaction with entrepreneurial

support institutions and practitioners, and the development and presentation of entrepreneurial ideas through pitch deck preparation and short business pitches.

The course was delivered as a compulsory one-semester course (2 ECTS), comprising 15 hours of lectures and 15 hours of seminar-based work. It combined theoretical foundations with applied entrepreneurial activities aimed at helping students connect their technical and creative competencies with market needs and innovation processes.

In addition to lectures, the course included seminars, workshops, and continuous activities supported through the Learning Management System (LMS), enabling students to apply theoretical knowledge in practical contexts. As part of the course, students completed both individual and team-based assignments. Individually, students conducted interviews with entrepreneurs from their local environment and prepared reflective reports, gaining first-hand insight into entrepreneurial experiences, challenges, and venture development processes. In team-based seminar activities, students worked on identifying entrepreneurial opportunities, analysing problems, identifying target users, assessing market and competitive potential, and developing value propositions.

Based on the identified opportunity, student teams developed a Business Model Canvas, prepared a simple business plan, and delivered a three-minute entrepreneurial pitch. These activities were designed not only to strengthen entrepreneurial knowledge but also to develop teamwork, communication, opportunity-recognition, analytical, and problem-solving skills. The course also included practical exposure to the entrepreneurial ecosystem through a guest lecture delivered by representatives of Technology Park Varaždin (University North, 2026). As an entrepreneurial campus, Technology Park Varaždin supports innovative companies by providing modern infrastructure, access to funding opportunities, and support for entering international markets (TECH_PARK Varaždin, 2026). The guest lecture provided students with insights into entrepreneurial support mechanisms, start-up incubation, innovation development, and the local entrepreneurial ecosystem. In addition, lectures incorporated case studies, start-up examples, and examples of real Croatian companies to connect theoretical concepts with entrepreneurial practice.

This course context is particularly relevant for the present study because perceived behavioural control is closely related to students' understanding of entrepreneurial processes and their confidence in performing entrepreneurial tasks. The practical activities, especially opportunity recognition, business model design, market analysis, and the sequential development of entrepreneurial projects, directly align with the perceived behavioural control dimension, particularly students' understanding of the practical steps required to start a business and their ability to develop an entrepreneurial project from idea to implementation. Therefore, the intervention was expected to be especially relevant for strengthening students' perceived entrepreneurial capabilities.

3.3. Sample

The research was conducted among undergraduate students at University North who attended the Fundamentals of Entrepreneurship course in the academic year 2025/2026. The study included students from two STEM-oriented professional undergraduate study programmes: Multimedia, Design and Application and Electrical Engineering. These programmes were selected because their students combine technical, creative, and applied competencies that may be relevant for innovation, project development, and potential entrepreneurial activity.

The PRE measurement was conducted at the beginning of March 2026, while the POST measurement was conducted at the end of May 2026, after students had attended the course. The PRE measurement included 99 valid responses, while the POST measurement included 102 valid responses. The POST measurement was intended for the same course cohort that had participated in the PRE measurement. However, due to the anonymous data collection procedure, individual responses could not be matched across the two time points, and complete overlap between the PRE and POST respondents could not be verified. Therefore, the analysis should be understood as an unmatched aggregate pre–post comparison of two contextually related student samples.

Table 1 presents the demographic characteristics of the PRE and POST samples. The demographic structure of the two measurement groups was broadly comparable, particularly with regard to study programme and gender distribution. In both measurements, the majority of students were enrolled in the Multimedia, Design and Application programme, while a smaller proportion came from Electrical Engineering. Gender distribution was also highly similar across both measurement points, with a slight predominance of male students. Some differences were observed in employment status and entrepreneurial family background, which should be taken into account when interpreting the findings. The average age of students was similar across the two measurements (PRE: M = 20.4 years; POST: M = 20.7 years).

Table 1 Demographic characteristics of the PRE and POST samples

Characteristic	PRE (N = 99)	POST (N = 102)
Study Program		
Multimedia, Design and Application	78 (78.8%)	82 (80.4%)
Electrical Engineering	21 (21.2%)	20 (19.6%)
Gender		
Female	45 (45.5%)	46 (45.1%)
Male	54 (54.5%)	56 (54.9%)
Employment During Studies		
Not employed	43 (43.4%)	48 (47.1%)
Occasionally employed	44 (44.4%)	38 (37.3%)
Regularly employed	12 (12.1%)	16 (15.7%)
Entrepreneurial Family Background		
Yes	40 (40.4%)	52 (51.0%)
No	58 (58.6%)	46 (45.1%)
Not sure	1 (1.0%)	4 (3.9%)

Source: authors

The study employed a convenience sample consisting of students enrolled in the selected course and study programmes. Therefore, the findings should be interpreted within the specific institutional and educational context of University North and should not be generalised to all STEM students without caution. Nevertheless, the sample is appropriate for an exploratory evaluation of short-term aggregate changes in entrepreneurial attitudes, subjective norms, perceived behavioural control, and entrepreneurial intentions following participation in a single-semester entrepreneurship course.

3.4. Measuring instrument

Entrepreneurial attitudes, subjective norms, perceived behavioural control, and entrepreneurial intentions were measured using the Entrepreneurial Intention Questionnaire (EIQ) developed by Liñán and Chen (2009). The instrument is based on the Theory of Planned Behaviour (Ajzen, 1991) and represents a validated and widely used measure of entrepreneurial intentions and their antecedents. It enables the measurement of the main TPB constructs relevant to entrepreneurship: personal attitude towards entrepreneurship, subjective norms, perceived behavioural control, and entrepreneurial intention.

The questionnaire consisted of 20 items measured on seven-point scales. Agreement items ranged from 1 (strongly disagree) to 7 (strongly agree), while subjective-norm items ranged from 1 (strongly disapprove) to 7 (strongly approve). The personal attitude towards entrepreneurship scale included five items, subjective norms included three items, perceived behavioural control included six items, and entrepreneurial intention included six items. The values of each construct were calculated as the mean score of the corresponding items, with higher values indicating a higher level of the measured construct. For one POST respondent with a missing response to EI4, the entrepreneurial intention score was calculated as the mean of the five available EI items.

For the purpose of this study, an adapted Croatian version of the Entrepreneurial Intention Questionnaire was used. The items were translated and linguistically adapted to ensure clarity and comprehensibility for the respondents, while preserving the meaning of the original TPB constructs. Minor contextual adaptations were made to reflect the educational setting. Specifically, “firm” was replaced with “business or project” in selected items, “colleagues and mates” was replaced with “fellow students” in SN3, and PBC5 specified the development of an entrepreneurial project “from idea to implementation”. The same instrument and response scale were used in both the PRE and POST measurements. The complete wording of the items is reported in Table 3.

The internal consistency of each scale was assessed using Cronbach’s alpha coefficient (Cronbach, 1951). Table 2 presents the reliability coefficients for all four constructs in both measurements. The Cronbach’s alpha values ranged from 0.795 to 0.964, exceeding the commonly accepted threshold of 0.70 (Hair et al.,

2019). These results indicate satisfactory to very high internal consistency of the scales used in the study. The particularly high values for the entrepreneurial intention scale should be interpreted as evidence of strong internal consistency, while also suggesting that the items within this construct measure a highly coherent dimension of entrepreneurial intention.

Table 2 Reliability coefficients of the EIQ scales

Construct	Number of Items	Cronbach's α (PRE)	Cronbach's α (POST)
Personal Attitude (PA)	5	0.904	0.940
Subjective Norms (SN)	3	0.795	0.854
Perceived Behavioural Control (PBC)	6	0.904	0.912
Entrepreneurial Intention (EI)	6	0.958	0.964

Source: authors

3.5. Data collection process

Data were collected at two time points during the implementation of the Fundamentals of Entrepreneurship course. The PRE-measurement was conducted at the beginning of March 2026, during the first lecture of the course, before students were exposed to the modernised entrepreneurship content. The POST-measurement was conducted at the end of May 2026, during the final lecture of the course, after students had participated in the course activities. The PRE-measurement yielded 99 valid responses, while the POST-measurement yielded 102 valid responses.

Participation in the research was voluntary and anonymous. Before completing the questionnaire, students were informed about the purpose of the study and that the collected data would be used exclusively for scientific and research purposes. By choosing to complete the questionnaire, students provided their informed consent for the anonymous use of their responses in the study. No personal identifiers were collected, and individual PRE and POST responses could therefore not be linked. The POST measurement targeted the same course cohort as the PRE measurement. However, because responses were anonymous, participation at both time points could not be verified at the individual level.

The PRE-measurement was conducted in paper form, while the POST-measurement was conducted using an online Google Form. Although the use of different data collection formats may represent a potential methodological limitation, both measurements used the same questionnaire, the same response scale, and the same target group of students enrolled in the course. This procedure enabled a comparison of aggregate PRE and POST results while preserving respondent anonymity.

3.6. Statistical analysis

The data were analysed using IBM SPSS Statistics 27. The analysis included descriptive statistics, reliability analysis, correlation analysis, and comparison of PRE and POST measurements. Descriptive statistics were used to present means and standard deviations for the four TPB constructs and their corresponding items. Internal consistency of the scales was assessed using Cronbach's alpha coefficient, following the commonly accepted threshold of $\alpha \geq 0.70$ for satisfactory reliability (Hair et al., 2019).

Because individual PRE and POST responses could not be linked due to the anonymous data collection procedure, methods designed to assess within-person change, such as the paired-samples *t*-test, repeated-measures ANOVA, or longitudinal mixed-effects modelling, could not be applied (Field, 2018). A difference-in-differences design was also not feasible because the study did not include a control group. A non-parametric alternative, such as the Mann–Whitney U test, was considered, however, it would not resolve the absence of linked observations and would examine differences in score distributions rather than directly compare the construct means that constituted the primary outcomes of the study.

Consequently, the analysis was conducted as an unmatched aggregate pre–post comparison. Given the approximately continuous composite scores, the broadly comparable composition and size of the two measurement groups, and the absence of statistically significant differences in their variances, the independent-samples t-test was considered the most appropriate available method for comparing group-level mean scores (Field, 2018). This approach does not measure individual-level change and cannot provide a causal estimate of the course effect; it only assesses whether aggregate mean scores differed between the two measurement points. Pre–post designs have also been used in previous entrepreneurship education research to examine changes in students' entrepreneurial perceptions, competences, and intentions (Souitaris et al., 2007; Sánchez, 2013).

As an additional robustness check, multiple linear regression analysis was used to examine whether the observed PRE–POST difference in PBC remained statistically significant after controlling for differences in sample composition. PBC was entered as the dependent variable and measurement period, coded as PRE = 0 and POST = 1, as the main predictor. Study programme, gender, employment status, and entrepreneurial family background were included as covariates and entered using dummy coding. Two models were estimated: an unadjusted model containing only the measurement-period indicator and an adjusted model containing the measurement-period indicator and the demographic covariates. The purpose of this analysis was not to examine the individual effects of demographic characteristics, but to assess the robustness of the PRE–POST difference in PBC.

Before conducting the t-tests, the assumption of homogeneity of variance was examined using Levene's test. The results showed no statistically significant differences in variances between the PRE and POST groups for any of the observed constructs ($p > .05$), which justified the use of the equal variances assumed version

of the independent samples t-test (Field, 2018). Statistical significance was assessed at the $p < .05$ level.

Effect sizes were calculated using Cohen's d in order to assess the practical magnitude of the observed differences, not only their statistical significance. The interpretation of effect sizes followed Cohen's (1988) conventional guidelines. In addition, Pearson correlation coefficients were calculated separately for the PRE and POST measurements to examine the relationships among the TPB constructs. The correlation analysis was used as a supplementary descriptive and interpretative procedure and was not intended to establish causal relationships among the constructs.

4. RESULTS

This section presents the results of the empirical analysis. First, descriptive statistics are presented for the four TPB constructs and their individual items in the PRE and POST measurements. Second, Pearson correlation coefficients are reported to describe the relationships among the TPB constructs at both measurement points. Third, independent-samples t-tests are used to examine whether statistically significant differences occurred between the PRE and POST measurements. Finally, a multiple linear regression analysis is presented as a robustness check to determine whether the observed PRE–POST difference in PBC remained statistically significant after controlling for differences in sample composition.

Table 3 presents descriptive statistics for all TPB constructs and their corresponding items in the PRE and POST measurements.

As shown in Table 3, the highest average value in the PRE measurement was observed for subjective norms (SN; $M = 6.17$; $SD = 0.99$), while the lowest average value was observed for perceived behavioural control (PBC; $M = 3.51$; $SD = 1.35$). This indicates that, before the course, students perceived relatively strong social approval for entrepreneurship but assessed their own entrepreneurial capabilities and practical control over entrepreneurial tasks more modestly.

In the POST measurement, perceived behavioural control increased from $M = 3.51$ to $M = 4.26$, representing the largest observed change among all four TPB constructs. The strongest increases were observed for PBC4 ("I know the practical steps required to start a business") and PBC5 ("I know how to develop an entrepreneurial project from idea to implementation"), indicating a substantial improvement in students' perceived knowledge of practical entrepreneurial processes. In contrast, personal attitudes towards entrepreneurship decreased from $M = 5.15$ to $M = 4.92$, subjective norms from $M = 6.17$ to $M = 5.90$, and entrepreneurial intention from $M = 4.38$ to $M = 4.11$. However, none of these differences was statistically significant.

Table 3 Descriptive statistics for constructs and individual items in PRE and POST measurements

Code	Item	PRE M (SD)	POST M (SD)	Δ
PA	Personal Attitude	5.15 (1.30)	4.92 (1.46)	−0.23
PA1	Being an entrepreneur has more advantages than disadvantages for me.	5.34 (1.21)	5.19 (1.41)	−0.15
PA2	An entrepreneurial career is attractive to me.	5.02 (1.63)	4.86 (1.68)	−0.16
PA3	If I had the opportunity and resources, I would like to start my own business or project.	5.77 (1.53)	5.22 (1.71)	−0.55
PA4	Being an entrepreneur would bring me great personal satisfaction.	5.07 (1.61)	4.88 (1.67)	−0.19
PA5	Among different career options, I would prefer to be an entrepreneur.	4.55 (1.64)	4.46 (1.65)	−0.09
SN	Subjective Norms	6.17 (0.99)	5.90 (1.13)	−0.27
SN1	Immediate family – to what extent would they approve of me starting my own business?	6.27 (1.14)	5.92 (1.33)	−0.35
SN2	Friends – to what extent would they approve of me starting my own business?	6.35 (0.95)	5.99 (1.23)	−0.36
SN3	Fellow students – to what extent would they approve of me starting my own business?	5.89 (1.41)	5.78 (1.29)	−0.11
PBC	Perceived Behavioural Control	3.51 (1.35)	4.26 (1.24)	+0.75
PBC1	Starting and managing a business/project would be easy for me.	3.46 (1.43)	3.74 (1.38)	+0.28
PBC2	I am ready to launch a viable entrepreneurial project.	3.66 (1.72)	3.98 (1.63)	+0.32
PBC3	I can control the process of establishing a new business/project.	3.70 (1.56)	4.11 (1.49)	+0.41
PBC4	I know the practical steps required to start a business.	3.24 (1.78)	4.77 (1.37)	+1.53
PBC5	I know how to develop an entrepreneurial project from idea to implementation.	3.34 (1.72)	4.72 (1.52)	+1.38
PBC6	If I attempted to start a business, I would have a high likelihood of success.	3.65 (1.64)	4.25 (1.55)	+0.60
EI	Entrepreneurial Intention	4.38 (1.57)	4.11 (1.64)	−0.27
EI1	I am prepared to do anything to become an entrepreneur.	4.24 (1.62)	4.17 (1.66)	−0.07
EI2	My professional goal is to become an entrepreneur.	4.03 (1.69)	3.83 (1.77)	−0.20
EI3	I will make every effort to start and run my own business.	4.53 (1.75)	4.10 (1.79)	−0.43
EI4	I am determined to start a business in the future.	4.61 (1.63)	4.33 (1.72)*	−0.28
EI5	I have seriously considered starting a business.	4.31 (1.86)	4.02 (1.87)	−0.29
EI6	I have a strong intention to start a business one day.	4.55 (1.79)	4.23 (1.83)	−0.32

*Note: PRE N = 99; POST N = 102; measurement scale 1–7, n = 101 for EI4 due to one missing response.

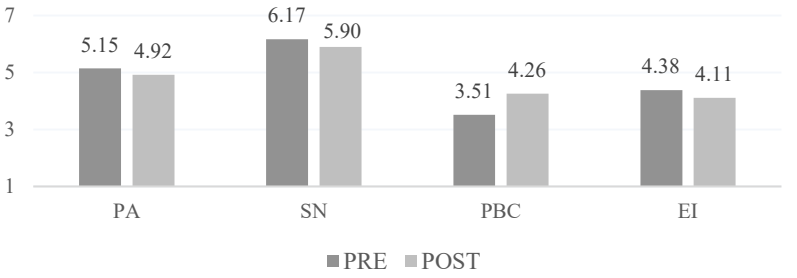
Source: authors

These results suggest that the most pronounced observed change was related to students' perceived entrepreneurial capability, particularly their understanding of venture creation processes and project development. At the same

time, the slight declines observed in personal attitudes, subjective norms, and entrepreneurial intentions may indicate a more realistic perception of entrepreneurial challenges after exposure to the course content and practical entrepreneurial tasks. However, these descriptive changes should be interpreted cautiously.

Figure 1 presents a visual comparison of the average values of the four TPB constructs across the PRE and POST measurements.

Figure 1 Comparison of the average values of the constructs in the PRE and POST measurements



Source: authors

As shown in Figure 1, the most pronounced increase was observed for perceived behavioural control, while personal attitudes towards entrepreneurship, subjective norms, and entrepreneurial intention showed slight declines between the two measurements. This descriptive pattern is consistent with the item-level results presented in Table 3. However, given the unmatched pre–post design and the absence of a control group, these descriptive differences should be interpreted as observed aggregate changes rather than as definitive evidence of causal effects.

To further examine the relationships among the TPB constructs, Pearson correlation coefficients were calculated separately for the PRE and POST measurements. The results are presented in Table 4.

Table 4 Pearson correlations between constructs — PRE and POST measurements

PRE measurement				
	PA	SN	PBC	EI
PA	—	.370**	.434**	.843**
SN	.370**	—	.415**	.275**
PBC	.434**	.415**	—	.454**
EI	.843**	.275**	.454**	—
POST measurement				
	PA	SN	PBC	EI
PA	—	.407**	.587**	.865**
SN	.407**	—	.376**	.370**
PBC	.587**	.376**	—	.666**
EI	.865**	.370**	.666**	—

Note: **Correlation is significant at the 0.01 level (2-tailed).

Source: authors

The correlation analysis revealed statistically significant positive relationships among all TPB constructs in both measurement periods. The strongest correlation was found between personal attitude (PA) and entrepreneurial intention (EI) in both the PRE measurement (r = .843, p < .001) and the POST measurement (r = .865, p < .001). This finding is consistent with the Theory of Planned Behaviour, according to which a more favourable personal attitude towards entrepreneurship is strongly associated with entrepreneurial intention.

The correlation between perceived behavioural control (PBC) and entrepreneurial intention (EI) increased from *r* = .454 in the PRE measurement to *r* = .666 in the POST measurement, indicating a stronger association between these constructs in the POST measurement. Nevertheless, the correlation results should be interpreted as descriptive evidence of associations between the examined constructs rather than as evidence of causal relationships.

To examine whether statistically significant differences occurred between the PRE and POST measurements, independent-samples *t*-tests were conducted, while Cohen's *d* was calculated to assess the standardized magnitude of the observed differences.

Table 5 Results of t-tests for independent samples

Construct	PRE M (SD)	POST M (SD)	Δ	t	df	p	Cohen's d
PA	5.15 (1.30)	4.92 (1.46)	−0.23	1.166	199	.245	0.165
SN	6.17 (0.99)	5.90 (1.13)	−0.27	1.817	199	.071	0.256
PBC	3.51 (1.35)	4.26 (1.24)	+0.75	−4.102	199	< .001***	0.579
EI	4.38 (1.57)	4.11 (1.64)	−0.27	1.192	199	.235	0.168

Note: Δ = POST − PRE. The t statistics are based on the PRE − POST comparison. Cohen's d values are reported as absolute values. Statistical significance: *** p < .001.

Source: authors

As shown in Table 5, a statistically significant difference between the PRE and POST measurements was found only for perceived behavioural control (PBC; $t = -4.102$; $df = 199$; $p < .001$; $d = 0.579$). According to Cohen's (1988) conventional guidelines, the effect size was moderate, indicating that the observed increase in PBC was statistically significant and moderate in magnitude. Therefore, hypothesis H3 was supported.

In contrast, the differences were not statistically significant for personal attitude (PA; $t = 1.166$; $p = .245$; $d = 0.165$), subjective norms (SN; $t = 1.817$; $p = .071$; $d = 0.256$), or entrepreneurial intention (EI; $t = 1.192$; $p = .235$; $d = 0.168$). The effect sizes for all three constructs were small. Therefore, hypotheses H1, H2, and H4 were not supported.

To examine whether the significant PRE–POST difference in PBC remained statistically significant after adjustment for differences in sample

composition, an additional robustness analysis was conducted. The unadjusted and adjusted regression results are presented in Table 6.

Table 6 Robustness analysis of the PRE–POST difference in perceived behavioural control

Model	B for POST	SE	t	p	R^2	Adjusted R^2
Model 1: Unadjusted	.751	.183	4.102	< .001	.078	.073
Model 2: Adjusted	.718	.171	4.195	< .001	.243	.216

Note: The dependent variable is PBC. Measurement period was coded as PRE = 0 and POST = 1. Model 1 includes only measurement period. Model 2 controls for study programme, gender, employment status, and entrepreneurial family background. B represents the estimated difference between the POST and PRE measurements.

Source: authors

As shown in Table 6, the unadjusted model reproduced the difference identified by the independent-samples *t*-test, with PBC being .751 points higher in the POST measurement ($B = .751$, $SE = .183$, $t = 4.102$, $p < .001$). After controlling for study programme, gender, employment status, and entrepreneurial family background, the estimated difference decreased only slightly to .718 points and remained statistically significant ($B = .718$, $SE = .171$, $t = 4.195$, $p < .001$). Thus, the observed PRE–POST difference in PBC remained robust after adjustment for the included differences in sample composition. Nevertheless, this analysis controls only for the observed characteristics included in the model and does not establish a causal effect of the course.

Although the change in subjective norms was not statistically significant at the conventional 5% level, it approached statistical significance and showed a somewhat larger decrease than the changes in personal attitude and entrepreneurial intention. Nevertheless, this result should be interpreted cautiously and should not be treated as evidence of a statistically confirmed change in perceived social support.

A more detailed item-level analysis shows that the largest changes occurred within the perceived behavioural control construct. The strongest increase was recorded for PBC4 (“I know the practical steps required to start a business”; $\Delta = +1.53$) and PBC5 (“I know how to develop an entrepreneurial project from idea to implementation”; $\Delta = +1.38$). These were also the largest item-level changes observed in the entire study.

This finding is important because these two items directly reflect practical entrepreneurial knowledge and procedural understanding. In other words, the largest improvements were found precisely in those aspects of perceived behavioural control that are most closely related to the practical orientation of the course, including business model development, opportunity recognition, development of entrepreneurial ideas, and understanding the steps required to transform an idea into an entrepreneurial project. By contrast, items reflecting

broader perceptions of entrepreneurial ease or general likelihood of success showed more modest increases. For example, PBC1 ("Starting and managing a business/project would be easy for me") increased by +0.28, while PBC6 ("If I attempted to start a business, I would have a high likelihood of success") increased by +0.60.

Taken together, the results indicate that the course was followed by a statistically significant increase of moderate magnitude in students' perceived behavioural control, especially in relation to practical entrepreneurial knowledge and project development. However, the course was not followed by statistically significant changes in personal attitudes towards entrepreneurship, subjective norms, or entrepreneurial intentions. Therefore, the findings suggest that a single-semester entrepreneurship course may be more effective in strengthening perceived entrepreneurial capability than in immediately changing broader attitudes, perceived social support, or entrepreneurial intentions.

5. DISCUSSION AND CONCLUSION

The findings of this study indicate that entrepreneurship education is not necessarily followed by equal changes across all dimensions of the Theory of Planned Behaviour. After participation in the Fundamentals of Entrepreneurship course, a statistically significant increase was observed only in perceived behavioural control, while changes in personal attitudes towards entrepreneurship, subjective norms, and entrepreneurial intentions were not statistically significant. This pattern suggests that a single-semester entrepreneurship course may be more effective in strengthening students' perceived entrepreneurial capability than in immediately changing broader career attitudes, perceived social support, or entrepreneurial intentions.

The most important finding of the study is the increase in perceived behavioural control (PBC; $t = -4.102$; $p < .001$; $d = 0.579$). This result is theoretically consistent with the TPB framework and with previous research suggesting that perceived behavioural control and entrepreneurial self-efficacy are among the dimensions most directly influenced by entrepreneurship education (Souitaris et al., 2007; Lorz et al., 2013; Nabi et al., 2017). Unlike attitudes, subjective norms, and entrepreneurial intentions, which may be shaped by longer-term personal, family, social, and career-related factors, perceived behavioural control is more closely related to students' knowledge, practical skills, and understanding of entrepreneurial processes. Therefore, it is reasonable that this construct showed the strongest change after course participation.

The item-level results provide additional support for this interpretation. The largest improvements were observed for the items related to students' knowledge of the practical steps required to start a business and their knowledge of how to develop an entrepreneurial project from idea to implementation. These are precisely the aspects of perceived behavioural control most closely connected

with the practical orientation of the course, which included opportunity recognition, entrepreneurial idea development, business model development, innovation, technology transfer, commercialisation, teamwork, and the practical application of entrepreneurial tools. This suggests that the course may have contributed particularly to strengthening students' procedural understanding of entrepreneurship, rather than simply increasing their general interest in becoming entrepreneurs.

The absence of statistically significant changes in personal attitudes towards entrepreneurship, subjective norms, and entrepreneurial intentions should not be interpreted as a failure of the educational intervention. Rather, it confirms the importance of distinguishing between different outcomes of entrepreneurship education. Attitudes towards entrepreneurship and entrepreneurial intentions may be relatively stable and influenced by students' previous experiences, family background, perceived career alternatives, risk perception, and personal values. Similarly, subjective norms are strongly embedded in the wider social environment and may therefore be difficult to change through a single course. This interpretation is consistent with Morić Milovanović et al. (2015b), who found that social norms significantly predicted entrepreneurial intention among female students but not among male students at the University of Zagreb, indicating that their role may depend on the social context and sample characteristics. More broadly, the absence of a significant change in entrepreneurial intention is consistent with previous studies showing mixed effects of entrepreneurship education and suggesting that short-term educational interventions do not necessarily lead to immediate increases in intention (Oosterbeek et al., 2010; von Graevenitz et al., 2010; Nabi et al., 2017).

The small but consistent, statistically non-significant decreases observed in personal attitudes towards entrepreneurship and entrepreneurial intention may be cautiously interpreted as a possible reality check effect, which is consistent with previous studies suggesting that entrepreneurship education can sometimes lead students to develop a more realistic understanding of entrepreneurial challenges and risks (Oosterbeek et al., 2010; von Graevenitz et al., 2010). As students become more familiar with the complexity, uncertainty, and practical requirements of entrepreneurship, they may develop a more realistic understanding of entrepreneurial careers and their own readiness to pursue them. However, because these decreases were not statistically significant, this interpretation should be treated only as a possible explanation, not as a confirmed empirical finding. From an educational perspective, this is still important because entrepreneurship education should not be evaluated only by whether it increases entrepreneurial intentions. It can also help students make more informed and realistic career decisions.

The correlation results further support the relevance of the TPB framework in explaining entrepreneurial intentions in this study. Personal attitude towards entrepreneurship was strongly positively associated with entrepreneurial intention in both the PRE and POST measurements. The observed correlation between perceived behavioural control and entrepreneurial intention was higher in

the POST measurement than in the PRE measurement. However, these correlations represent descriptive evidence of association and should not be interpreted as evidence of causal relationships.

5.1. Practical implications

The findings have several practical implications for entrepreneurship education in STEM higher education. First, the significant increase in perceived behavioural control indicates that practical and process-oriented entrepreneurial content can be particularly useful for STEM students. Course elements related to opportunity recognition, business model development, development of entrepreneurial ideas, technology transfer, commercialisation, and practical steps of venture or project development appear especially relevant for strengthening students' perceived entrepreneurial capability. Therefore, entrepreneurship courses for STEM students should include concrete, applied, and project-oriented learning activities rather than relying only on theoretical explanations of entrepreneurship.

Second, the results suggest that a single-semester entrepreneurship course may be sufficient to improve students' perceived understanding of entrepreneurial processes, but may not be sufficient to substantially change personal attitudes, subjective norms, or entrepreneurial intentions. Although the course already included practical and experiential activities such as teamwork, interviews with entrepreneurs, business model development, pitch presentations, case studies, and guest lectures, the findings suggest that stronger changes in these broader dimensions may require greater intensity, repetition, and continuity of such activities. This implies that extending the course duration, increasing the number of practical sessions, or integrating entrepreneurship-related content into later stages of the study programme could contribute to stronger development of personal attitudes, social support perceptions, and entrepreneurial intentions. In this sense, entrepreneurship education may be more effective when designed as a longitudinal learning process rather than as a single isolated course (Loi & Fayolle, 2021).

Third, the findings are especially relevant for STEM programmes because students in these fields often possess technical, creative, or applied knowledge that can become a basis for innovation and commercialisation. However, such potential can remain underdeveloped if students do not understand how ideas are transformed into market-oriented projects, business models, or ventures. Entrepreneurship education can therefore play an important role in helping STEM students connect their disciplinary knowledge with opportunity recognition, customer value, innovation processes, and practical entrepreneurial action (Maresch et al., 2016).

Finally, the results suggest that entrepreneurship education should not be evaluated only through changes in entrepreneurial intention. While intention is an important outcome, it may not fully capture the educational value of entrepreneurship courses, especially in short-term interventions. Strengthening

perceived behavioural control, practical knowledge, and students' confidence in understanding entrepreneurial processes may represent an important and realistic educational outcome, even when students do not immediately express stronger intentions to start a business.

5.2. Limitations and future research

This study has several limitations that should be considered when interpreting the findings. First, the anonymity of the data prevented the matching of PRE and POST responses from the same respondents. This limitation, together with the slightly different number of valid responses in the PRE and POST measurements, may have reduced the precision of the observed changes and limited the ability to detect within-person variation over time.

Second, the study did not include a control group. Although the pre–post design provides useful insight into changes observed before and after course participation, it does not allow strong causal conclusions. While the additional regression analysis showed that the PRE–POST difference in perceived behavioural control remained statistically significant after controlling for observed differences in sample composition, including study programme, gender, employment status, and entrepreneurial family background, unobserved differences between the samples cannot be entirely ruled out. Therefore, although the robustness analysis strengthens confidence in the stability of the main finding, the absence of a control group prevents a definitive causal interpretation. Other factors occurring during the observed period may also have influenced students' responses.

Third, the sample was a convenience sample of students from two STEM-oriented study programmes at a single higher education institution. Therefore, the findings should be interpreted within the specific institutional, disciplinary, and educational context of University North and should not be generalised to all STEM students without caution.

Fourth, the PRE and POST data were collected using different formats. The PRE-measurement was conducted in paper form, while the POST-measurement was conducted using an online Google Form. Although both measurements used the same questionnaire, the same response scale, and the same target group, differences in data collection format may have influenced how students responded.

Fifth, the study measured self-reported attitudes, subjective norms, perceived behavioural control, and entrepreneurial intentions, but did not measure actual entrepreneurial behaviour. Therefore, the results should be interpreted as changes in students' perceptions and intentions, not as evidence of entrepreneurial action or venture creation.

Finally, the study focused on short-term changes measured immediately after course participation. It remains unclear whether the observed increase in perceived behavioural control would persist over time and whether such changes could later translate into stronger entrepreneurial intentions, entrepreneurial behaviour, or innovation-oriented career choices.

Future research should address these limitations by using anonymous identification codes that allow individual PRE and POST responses to be linked while preserving respondent anonymity. This would enable paired-samples analysis and a more precise assessment of individual-level change. Future studies should also include control or comparison groups where feasible, as this would strengthen internal validity and allow more cautious assessment of educational effects.

In addition, future research should include students from a broader range of STEM disciplines and higher education institutions in order to improve the generalisability of findings. Longitudinal designs with multiple post-course measurements would be particularly useful for examining whether increases in perceived behavioural control persist over time and whether such increases later contribute to changes in entrepreneurial intention or behaviour. Future studies could also examine the role of moderating variables such as gender, employment status, entrepreneurial family background, previous entrepreneurial experience, and study programme, as well as educational variables such as course duration, intensity of practical activities, and repeated exposure to entrepreneurship-related content across the curriculum. Finally, qualitative research could provide deeper insight into how students experience entrepreneurship education and how they interpret its relevance for their studies, careers, and potential entrepreneurial activities.

5.3. Conclusion

This study examined changes in personal attitudes towards entrepreneurship, subjective norms, perceived behavioural control, and entrepreneurial intentions among STEM students following participation in a single-semester entrepreneurship course. The results show that perceived behavioural control increased significantly after course participation, while personal attitudes towards entrepreneurship, subjective norms, and entrepreneurial intentions did not change significantly. The strongest improvements were found in students' perceived knowledge of the practical steps required to start a business and their ability to develop an entrepreneurial project from idea to implementation.

These findings suggest that entrepreneurship education in STEM contexts may first and most clearly strengthen students' perceived entrepreneurial capability, particularly their practical and procedural understanding of entrepreneurship. Such competence development may represent an important first step, which could later contribute to stronger entrepreneurial intentions and entrepreneurial behaviour as students gain more experience and repeated exposure to entrepreneurial learning. However, changes in broader entrepreneurial attitudes

and intentions may require longer, more intensive, and more continuous forms of entrepreneurial education.

The study contributes to entrepreneurship education research by demonstrating the importance of distinguishing between the development of perceived entrepreneurial capability and immediate changes in entrepreneurial intention. By providing evidence from an underrepresented STEM student population in the Croatian higher education context, the study shows that participation in a single-semester entrepreneurship course was followed by a significant increase in perceived behavioural control, particularly in students' practical and procedural understanding of entrepreneurship. For STEM higher education, these findings support the value of integrating entrepreneurship into curricula, especially when the aim is to help students connect technical and creative knowledge with opportunity recognition, innovation, commercialisation, and practical project development.

Author Contributions: Conceptualization, I.H.K.; Methodology, I.H.K.; Software, I.H.K.; Validation, D.P.; Formal Analysis, I.H.K. and D.P.; Investigation, I.H.K.; Resources, I.H.K.; Data Curation, I.H.K. and D.P.; Writing – Original Draft Preparation, I.H.K. and D.P.; Writing – Review & Editing, A.M.T. and Ž.M.T.; Visualization, Ž.M.T.; Supervision, D.P. and A.M.T.; Project Administration, I.H.K.; Funding Acquisition, I.H.K., D.P., A.M.T. and Ž. M. T.

Funding: This research was supported by the University North Scientific Research Project (Project No. UNIN-DRUŠ-26-1-5; CroRIS ID: 17607).

Conflict of interest: None.

Acknowledgement of AI or AI-assisted tools use: During the preparation of this paper, the authors used ChatGPT (OpenAI) for language editing, improving clarity and readability, and refining the academic style of the manuscript. After using the tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Bae, T. J., Qian, S., Miao, C., & Fiet, J. O. (2014). The relationship between entrepreneurship education and entrepreneurial intentions: A meta-analytic review. *Entrepreneurship Theory and Practice, 38*(2), 217–254. https://doi.org/10.1111/etap.12095

Bayona-Oré, S. (2023). The theory of planned behaviour and the entrepreneurial intention of university students. *Journal of Turkish Science Education, 20*(1), 136–149. https://doi.org/10.36681/used.2023.008

Bulog, I., Rimac Smiljanić, A., & Klepić, I. (2026). Što potiče poduzetničku budnost u visokom obrazovanju: Međuodnos samoučinkovitosti i financijske pismenosti. *Ekonomska misao i praksa*, 0-0. https://doi.org/10.17818/EMIP/2025/50

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297–334. https://doi.org/10.1007/BF02310555

Deveci, İ., & Seikkula-Leino, J. (2023). The link between entrepreneurship and STEM education. In S. Kaya-Capocci & E. Peters-Burton (Eds.), Enhancing Entrepreneurial Mindsets Through STEM Education (pp. 3–23). Springer International Publishing. https://doi.org/10.1007/978-3-031-17816-0_1

EIT Higher Education Initiative. (2026). *HEI2MARKET*. https://eit-hei.eu/funded-projects/explorer/hei2market/

Fayolle, A., & Liñán, F. (2014). The future of research on entrepreneurial intentions. *Journal of Business Research, 67*(5), 663–666. https://doi.org/10.1016/j.jbusres.2013.11.024

Fayolle, A., Loi, M., Suomi, K., Heljakka, K., & Liñán, F. (2026). Rethinking and renewing educational paradigms, theories, and pedagogies in entrepreneurship education. *Entrepreneurship Education and Pedagogy, 9*(3), 347–362. https://doi.org/10.1177/25151274261443087

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE Publications.

Fretschner, M., & Lampe, H. W. (2019). Detecting hidden sorting and alignment effects of entrepreneurship education. *Journal of Small Business Management, 57*(4), 1712–1737. https://doi.org/10.1111/jsbm.12448

GEM (Global Entrepreneurship Monitor). (2026). *Global Entrepreneurship Monitor 2025/2026 Global Report: From Uncertainty To Opportunity*. London: GEM.

Hair, J. F., Jr., Gabriel, M. L. D. S., da Silva, D., & Braga Junior, S. (2019). Development and validation of attitudes measurement scales: fundamental and practical aspects. RAUSP Management Journal, *54*(4), 490–507. https://doi.org/10.1108/RAUSP-05-2019-0098

Hou, F., Su, Y., Qi, M., Chen, J., & Tang, J. (2022). A multilevel model of entrepreneurship education and entrepreneurial intention: Opportunity recognition as a mediator and entrepreneurial learning as a moderator. *Frontiers in Psychology*, *13*, 837388. https://doi.org/10.3389/fpsyg.2022.837388

Kautonen, T., Van Gelderen, M., & Fink, M. (2015). Robustness of the theory of planned behavior in predicting entrepreneurial intentions and actions. *Entrepreneurship Theory and Practice, 39*(3), 655–674. https://doi.org/10.1111/etap.12056

Krueger, N. F., Reilly, M. D., & Carsrud, A. L. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing, 15*(5–6), 411–432. https://doi.org/10.1016/S0883-9026(98)00033-0

Liñán, F., & Chen, Y. W. (2009). Development and cross-cultural application of a specific instrument to measure entrepreneurial intentions. *Entrepreneurship Theory and Practice, 33*(3), 593–617. https://doi.org/10.1111/j.1540-6520.2009.00318.x

Loi, M., & Fayolle, A. (2021). Impact of entrepreneurship education: A review of the past, overview of the present, and a glimpse of future trends. In C. H. Matthews & E. W. Liguori (Eds.), Annals of Entrepreneurship Education and Pedagogy – 2021 (pp. 170–193). Edward Elgar Publishing. https://doi.org/10.4337/9781789904468.00018

Lorz, M., Mueller, S., & Volery, T. (2013). Entrepreneurship education: A systematic review of the methods in impact studies. *Journal of Enterprising Culture, 21*(2), 123–151. https://doi.org/10.1142/S0218495813500064

Maresch, D., Harms, R., Kailer, N., & Wimmer-Wurm, B. (2016). The impact of entrepreneurship education on the entrepreneurial intention of students in science and engineering versus business studies university programs. *Technological Forecasting and Social Change, 104*, 172–179. https://doi.org/10.1016/j.techfore.2015.11.006

Martin, B. C., McNally, J. J., & Kay, M. J. (2013). Examining the formation of human capital in entrepreneurship: A meta-analysis of entrepreneurship education outcomes. *Journal of Business Venturing, 28*(2), 211–224. https://doi.org/10.1016/j.jbusvent.2012.03.002

Morić Milovanović, B., Srhoj, S., & Krišto, T. (2015a). Modeliranje poduzetničkih namjera studenata i studentica Sveučilišta u Zagrebu. *Zbornik Ekonomskog fakulteta u Zagrebu*, *13*(2), 17-47.

Morić Milovanović, B., Krišto, T., & Srhoj, S. (2015b). What Distinguishes Students With Entrepreneurial Intentions? Analysis Of The Empirical Model Of Entrepreneurial Intention Determinants Among Students At The University Of Zagreb. *Ekonomska misao i praksa*, *24*(1), 151-170.

Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. *Academy of Management Learning and Education, 16*(2), 277–299. https://doi.org/10.5465/amle.2015.0026

Oosterbeek, H., Van Praag, M., & Ijsselstein, A. (2010). The impact of entrepreneurship education on entrepreneurship skills and motivation. *European Economic Review, 54*(3), 442–454. https://doi.org/10.1016/j.euroecorev.2009.08.002

Rauch, A., & Hulsink, W. (2015). Putting entrepreneurship education where the intention to act lies: An investigation into the impact of entrepreneurship education on entrepreneurial behavior. *Academy of Management Learning and Education, 14*(2), 187–204. https://doi.org/10.5465/amle.2012.0293

Sánchez, J. C. (2013). The impact of an entrepreneurship education program on entrepreneurial competencies and intention. *Journal of Small Business Management, 51*(3), 447–465. https://doi.org/10.1111/jsbm.12025

Setiawan, M. E., Suwono, H., Nur, H., Sulisetijono, S., & Husamah, H. (2025). Fueling entrepreneurship in STEM: Unveiling trends, educational programs, and their impact. *Social Sciences & Humanities Open*, *12*, 101798. https://doi.org/10.1016/j.ssaho.2025.101798

Širola, D. (2020). Determinants of entrepreneurial intentions: empirical evidence from Croatian perspective. *Zbornik Veleučilišta u Rijeci*, *8*(1), 169-187. https://doi.org/10.31784/zvr.8.1.17

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

TECH_PARK Varaždin. (2026). *TECH_PARK Varaždin*. https://techpark.hr/en/

Teixeira, A. A. C., & Davey, T. (2010). Attitudes of higher education students to new venture creation: A preliminary approach to the Portuguese case. *Industry and Higher Education, 24*(5), 323–341. https://doi.org/10.5367/ihe.2010.0005

University North. (2026). *Representatives of Technology Park Varaždin visit University North.* https://www.unin.hr/2026/03/predstavnici-tehnoloskog-parka-varazdin-gostovali-na-sveucilistu-sjever/?l=en

Von Graevenitz, G., Harhoff, D., & Weber, R. (2010). The effects of entrepreneurship education. *Journal of Economic Behavior and Organization, 76*(1), 90–112. https://doi.org/10.1016/j.jebo.2010.02.015

Vuković, K., Kedmenec, I., & Korent, D. (2015). The Impact of exposure to entrepreneurship education on student entrepreneurial intentions. *Croatian Journal of Education: Hrvatski časopis za odgoj i obrazovanje*, *17*(4), 1009-1036. https://doi.org/10.15516/cje.v17i4.1268

Dr. sc. Ivona Huđek Kanižaj
Docentica
Sveučilište Sjever, Odjel za logistiku i održivu mobilnost, Hrvatska
E-mail: ihudek@unin.hr
Orcid: https://orcid.org/0000-0001-6400-9950

Dr. sc. Dinko Primorac
Redoviti profesor
Sveučilište Sjever, Odjel za ekonomiju, Hrvatska
E-mail: dprimorac@unin.hr
Orcid: https://orcid.org/0000-0001-5150-5189

Dr. sc. Ana Mulović Trgovac
Docentica
Sveučilište Sjever, Odjel za komunikologiju, medije i novinarstvo, Hrvatska
E-mail: ana.mulovic@unin.hr
Orcid: https://orcid.org/0000-0003-1341-6067

Dr. sc. Željka Marčinko Trkulja
Docentica
Sveučilište Sjever, Odjel za ekonomiju, Hrvatska
E-mail: zmtrkulja@unin.hr
Orcid: https://orcid.org/0000-0001-5932-6986

PODUZETNIČKO OBRAZOVANJE I PERCIPIRANA KONTROLA PONAŠANJA KOD STEM STUDENATA: REZULTATI PRE–POST ISTRAŽIVANJA

Sažetak

Ovo istraživanje ispituje promjene u stavovima prema poduzetništvu, subjektivnim normama, percipiranoj kontroli ponašanja i poduzetničkim namjerama STEM studenata nakon pohađanja jednosemestralnog kolegija iz poduzetništva. Istraživanje se temelji na Teoriji planiranog ponašanja, a za procjenu kratkoročnih razlika između mjerenja prije i nakon završetka kolegija korišten je Upitnik poduzetničkih namjera. Sudjelovalo je 99 studenata u PRE i 102 studenta u POST mjerenju, upisanih na prijediplomske studije Multimedije, oblikovanja i primjene te Elektrotehnike na Sveučilištu Sjever. Budući da su odgovori prikupljeni anonimno i nije ih bilo moguće povezati na razini pojedinaca, PRE i POST rezultati analizirani su kao dva nezavisna uzorka primjenom t-testa za nezavisne uzorke. Statistički značajan porast utvrđen je samo u percipiranoj kontroli ponašanja, osobito u procjeni znanja o praktičnim koracima za pokretanje poslovnog pothvata i sposobnosti razvoja poduzetničkog projekta. Rezultati upućuju na jačanje percepcije vlastitih poduzetničkih sposobnosti, bez statistički značajnih promjena u poduzetničkim namjerama.

Ključne riječi: poduzetničko obrazovanje, STEM studenti, percipirana kontrola ponašanja, poduzetničke namjere, Teorija planiranog ponašanja, pre–post istraživanje.

JEL klasifikacija: A23, L26, I23, D91.