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ENGINEERS ENTREPRENEURS: ENHANCING SKILLS OF STEM STUDENTS

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Abstract

This paper supports the postulate that entrepreneurship education is crucial for sustainable development, seeking to highlight the criticality of entrepreneurial skills development and their role in boosting employability among STEM students from selected universities in the Balkan region. The study is based on a two-week STEM (self)employment bootcamp, developed and piloted with 53 students from five Western Balkans' universities, in the framework of the project Reconnecting universities and enterprises to unleash regional innovation and entrepreneurial activity – KnowHub, co-financed by the European Union Erasmus+ programme. The impact of the bootcamp concept on the entrepreneurial competences, ambitions and mindset was measured using a customised evaluation tool based on the HEInnovate's EPIC tool. The concept effectively promoted socially relevant competences, including sustainability values and assessment of the social and ecological impacts of ideas, as well as teamwork, communication, diversity and internationalisation. Participating students showed important progress, higher confidence and motivation for inventing new solutions based on their quality and unique ideas, which offers plenty of opportunities for concept adaptation with the aim of making and supporting generations of engineers entrepreneurs – engipreneurs.

Key words: *Engipreneur, Entrepreneurial education, STEM.*

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1. Introduction

It is unknown to what extent entrepreneurship influences engineering students' academic or career choices nowadays. Even though more engineering students are exposed to entrepreneurship education, little study has been done to assess how engineering students feel about it, how it affects their learning, or how it affects their professional competence. Many young people from the Balkans are losing hope and are contemplating leaving their country in search of greater personal and economic fulfilment (Isbendjian, Kinkade, Thorup, & Waddell, 2023). Moving forward, entrepreneurship education is gaining importance in both academia and practice, with increased investments from non-governmental organisations (NGOs), governments, academia, and business in the region's youth.

Entrepreneurship education for engineering graduates is vital as it places the foundation to utilise engineering technical expertise to spinout companies (Sababha, Basal, Al-Qaralleh, & Al-Daher, 2020) and to exploit entrepreneurial opportunities that result from technological innovation (Holzmann, Hartlieb, & Roth, 2018). The STEM Bootcamp which is the focus of this study is a tangible example of academia working collaboratively with local business and government leaders to address local needs practically and sustainably. It has been shown that engineering students have a high potential to become entrepreneurs, and a great number of engineering students actually do create their businesses after graduating.

In this work, the authors present their experience using the HEInnovate's EPIC tool to introduce entrepreneurial training into the existing curriculum for engineering students and the effects EntreComp competences had on shaping their entrepreneurial mindsets.

1.1 Efficient entrepreneurial education concepts

Education is fundamental for development and success, aiming to create well-educated individuals who will contribute to economic growth and a better society (Polenakovikj, et al., 2022). Training youth with entrepreneurial skills and more active mindset could empower them to excel in today's challenging world and develop our social and economic outlook (Banha, Coelho, & Flores, 2022). EntreEdu concepts are impact driven and enhance students' abilities to define business purposes, explain marketing plans, implement ideas and create business plans, which are taught or improved through entrepreneurship courses. Most of the initiatives in entrepreneurship education in Europe emerged from the business school sector (Gibb, 2002), but the entrepreneurial competences are broader, aiming to bridge the educational and working world, to be used and adapted to different contexts and to serve as an inspiration to introduce changes for a better future (Bacigalupo, Kampylis, Punie, & Van den Brande, 2016). When considering incorporating entrepreneurship education into engineering curricula, Sanchez et al. (2018) examined how entrepreneurial incentives affect future engineers' business intentions, showing that entrepreneurial training influences students' propensities

to start their own businesses. Motivation is driven by showcasing successful startups, idea-generation workshops, business plan creation and competitions (Barba-Sánchez & Atienza-Sahuquillo, 2018). Extracurricular initiatives such as competitions, fairs, community projects, can also boost student success rate (Penaluna, Penaluna, & Polenakovikj, 2020).

The first impact of introducing entrepreneurship education into existing curricula at university or designing and developing entrepreneurial skill programmes for students is the creation of new companies. Indeed, there is a positive relationship between ecosystems and the propensity to create companies in the regions into which they are located, by disseminating the economically exportable knowledge and improved competitiveness resulting from a higher competitiveness among ecosystem actors (Banha, Coelho, & Flores, 2022). Moreover, entrepreneurial activities help solve environmental problems by encouraging innovation for environmentally friendly products, services and responsible processes (Doh, Tashman, & Benischke, 2018).

2. The case of the KnowHub STEM (Self)employment Bootcamp. Measuring the impact of results.

This paper focuses on the results of a two-week STEM (Self)employment camp, developed and piloted in the framework of the project Reconnecting universities and enterprises to unleash regional innovation and entrepreneurial activity – KnowHub. The target group is STEM students from all three cycles of tertiary education. The first week includes forming diverse student teams, receiving theoretical input and mentoring based on the EntreComp competences. The second week focuses on intensive work on business concepts, supported by daily coaching, and concluding with a pitching event with positive competitive environment that serves as an additional motivator and dedication booster.

The impact of the bootcamp concept was measured using a customised evaluation tool based on the HEInnovate's EPIC tool, both before and after the bootcamp. A total of 35 questions were developed to evaluate the participants' self-perceived entrepreneurship competencies, clustered into four dimensions: Entrepreneurial Competences, Entrepreneurial Intentions and Attitudes, Entrepreneurial Mindset & Enterprising Behaviours, and Educational Effects, with responses rated on a Likert scale ranging from 1 (lowest) to 7 (highest). This section highlights key findings from the two EPIC-based evaluations of the pilot bootcamp, held in Girona, May 2022. The bootcamp involved 53 students from five Western Balkan universities, with 46 of them submitting valid evaluations.

2.1 Result at dimension level

Considering the level of the target core-competences in Table 1, a significant improvement is noticed in each of the four dimensions. The perceived benefit of the bootcamp ranges from +24% in Entrepreneurial Competences to +8% in

Entrepreneurial Intentions and Attitude. The underlying concept seems to be particularly successful in the entrepreneurial competences component. Additionally, a rise of +12% is seen in the Educational Effect dimension, which measures the bootcamp's learning impact.

Table 1. Scoring PRE/POST bootcamp and perceived relative effect per target dimension

Dimension	PRE Bootcamp	POST Bootcamp	Increase/ Decrease
Entrepreneurial Competences	4,6	5,7	24%
Entrepreneurial Intentions and Attitudes	5,3	5,7	8%
Entrepreneurial Mindset & Enterprising Behaviour	4,9	5,5	12%
Educational Effect	5,1	5,7	12%

2.2 Result at individual participant level

The results on individual participant level in Table 2 show that 34 of the 46 participants who provided a valid assessment (73,9%) had benefited from the bootcamp. However, the significant number of participants (12) who reported back the opposite, ranging from -4% to -34% could be contacted for more detailed feedback to revise the underlying concept or at least parts of it.

Table 2. Perceived impact on individual participant level

Participant ID	PRE Bootcamp	POST Bootcamp	Increase/ Decrease
1	4,9	5,2	6%
2	5,7	5,0	-12%
3	4,1	6,3	54%
4	4,7	6,9	47%
5	4,3	6,1	42%
6	6,0	7,0	17%
7	4,3	5,6	30%
8	5,4	6,2	15%
9	4,2	7,0	67%
10	4,4	4,9	11%
11	5,7	5,5	-4%
12	6,3	6,6	5%
13	5,0	5,8	16%
14	4,5	6,8	51%
15	4,9	6,5	33%
16	5,2	6,1	17%
17	6,1	5,9	-3%
18	4,9	4,0	-18%
19	4,5	6,2	38%
20	3,7	6,9	86%
21	3,3	4,5	36%

Participant ID	PRE Bootcamp	POST Bootcamp	Increase/ Decrease
22	5,3	4,1	-23%
23	5,7	5,9	4%
24	5,5	4,9	-11%
25	5,3	6,0	13%
26	4,4	6,5	48%
27	5,2	6,5	25%
28	5,0	3,3	-34%
29	5,3	4,3	-19%
30	5,3	5,1	-4%
31	3,9	5,9	51%
32	5,8	6,8	17%
33	5,5	5,3	-4%
34	6,1	5,1	-16%
35	4,7	7,0	49%
36	4,1	4,2	2%
37	4,3	6,1	42%
38	3,8	6,5	71%
39	5,5	5,7	4%
40	3,8	4,5	18%
41	3,5	6,1	74%
42	5,6	6,2	11%
43	3,7	5,1	38%
44	5,3	6,4	21%
45	3,2	6,2	94%
46	4,8	4,3	-10%

2.3 Result at individual question level

On the level of the individual question, each single question does show an increase PRE/POST bootcamp, Table 3. This allows the general conclusion that the developed training concept is successfully implemented into the bootcamp.

Table 3. Result per individual question

Dimension	Individual Question	PRE Boot-camp	POST Boot-camp	Increase/ Decrease
Entrepreneurial Competences	Identify opportunities for innovative value creation within your field of expertise	4,2	5,5	31%
	Achieve goals that you set for yourself	5,1	5,7	12%
	Be the one who takes the initiative	4,6	5,7	24%
	Anticipate which opportunities will be of high value	4,3	5,4	26%
	Create a project plan	4,7	5,9	26%
	Finish tasks that you have started, even if you are tired of them	5,1	5,7	12%
	Come up with innovative ideas	4,4	5,6	27%
	Actively network in order to increase your number and quality of contacts	4,8	5,8	21%
	Deal with uncertainty when implementing new activities	4,3	5,8	35%
	Come up with new and different solutions	4,5	5,6	24%
	Estimate a budget for a new project	4,3	5,5	28%
	Work with many different people	5,6	6,5	16%
	Assess the social and ecological impact of your ideas	4,2	5,7	36%
	Look for new opportunities to develop new knowledge and skills	5,8	6,4	10%
	Make people enthusiastic about your ideas	4,9	5,6	14%
	Apply sustainability values (social and ecological) to your own practice	4,3	5,6	30%
	Identify the novel value in new ideas within your field of expertise	4,2	5,5	31%
	Assess which needs and requirements are necessary to solve the most important challenges within your field	4,6	5,6	22%
	Assess various ways in which your ideas can develop successfully	4,5	5,6	24%
Entrepreneurial Intentions and Attitudes	My goal is to become an entrepreneur	5,0	5,4	8%
	Negative/positive	5,9	6,2	5%
	Start my own company	4,4	5,7	30%
	To be my own boss	5,8	5,9	2%
Entrepreneurial Mindset & Enterprising Behaviour	I often get unique ideas	4,6	5,5	20%
	Solve problems in new ways	5,6	5,7	2%
	Inventing new solutions to problems is an important part of who I am	4,6	5,7	24%

Dimension	Individual Question	PRE Boot-camp	POST Boot-camp	Increase/ Decrease
	It motivates me more to work on my own ideas rather than to work on ideas from others	5,2	5,5	6%
	I believe in the quality of my own ideas from the very start	4,9	5,7	16%
	It is easy for me to use my experience to find patterns in novel contexts	4,6	5,6	22%
Educational Effect	I asked questions in class because I wanted to learn new things	5,2	5,6	8%
	Listened to my ideas	5,3	5,8	9%
	Readings and textbook-based assignments	4,7	5,4	15%
	I felt good about myself when I was at my educational institution	5,6	5,9	5%
	Student-led and/or student-designed projects	5,0	6,0	20%

The holistic view on the data independent of the individual participants, dimension and individual questions shows a general increase from 4.8 to 5.7, which represents an overall increase of 18%. This increase suggests that the concept was well adapted and contributed to development and enhancement of entrepreneurial skills, as well as fostering a more proactive approach among STEM students.

3. Discussion and conclusions

Encouraging engineering students to launch technical businesses is crucial for countries with slow economic growth and positively influences their intentions and decisions to launch own firms. The concept of the STEM Bootcamp allows the participating students to address real-life challenges a specific industry is facing and try to bring an innovative solution. Thus, it is confirmed that entrepreneurship education is not to be dissociated from engineering education. Based on the positive assessment, such initiatives and training concepts offer opportunities for further adaptation and implementation in various contexts and various target groups.

This also brings about the idea of how we consider the relation formal education versus non-formal education. Non-formal education is centred on the learner, it inevitably has features that are flexible concerning the procedures, goals, and materials that were initially defined and implemented. As a result, it is easier to respond to changes that may impact the needs of the community and of students.

The piloted STEM bootcamp integrates research, technology transfer and teaching, with the aim to enhance collaboration between companies and higher education institution, ultimately fostering the employability of graduates.

Engineering could be strengthened and improved through innovation and entrepreneurship. The trainings concentrating on the competences from the

EntreComp Framework have addressed the absence of innovation and entrepreneurship activities at the universities in the Western Balkans. Synergies with other projects and initiatives were created to achieve cost effectiveness and conduct trainings with high quality materials. The materials were designed in a modular manner to accommodate various competency levels.

Conducting two assessments before and after the event allows quantitative evaluation of the perceived benefits of the participants. The results showed that most of the participants felt significantly better informed about entrepreneurship after the workshop. Thus, the benefit of the concept seems to be proven. The continuation of such entrepreneurship training seems sensible and justified.

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REFERENCES

[1] Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The Entrepreneurship Competence Framework.* Publication Office of the European Union.

[2] Banha, F., Coelho, L. S., & Flores, A. (2022). Entrepreneurship Education: A Systematic Literature Review and Identification of an Existing Gap in the Field. *Education Sciences, 12*(5). doi:10.3390/educsci12050336

[3] Barba-Sánchez, V., & Atienza-Sahuquillo, C. (2018). Entrepreneurial intention among engineering students: The role of entrepreneurship education. *European Research on Management and Business Economics, 24*(1), 53–61. doi:https://doi.org/10.1016/j.iedeen.2017.04.001

[4] Doh, J. P., Tashman, P., & Benischke, M. (2018). Adapting to Grand Environmental Challenges Through Collective Entrepreneurship. *Academy of Management Perspectives*, *33*(4).

[5] Gibb, A. (2002). In Pursuit of a New 'Enterprise' and 'Entrepreneurship' Paradigm for Learning: Creative Destruction, New Values, New Ways of Doing Things and New Combinations of Knowledge. *International Journal of Management Reviews, 4*(3), 233–269. doi:10.1111/1468-2370.00086

[6] Holzmann, P., Hartlieb, E., & Roth, M. (2018). From Engineer to Entrepreneur - Entrepreneurship Education for Engineering Students: The Case of the Entrepreneurial Campus Villach. *International Journal of Engineering Pedagogy (iJEP), 8*(3), 28–39. doi:https://doi.org/10.3991/ijep.v8i3.7942

[7] Isbendjian, J.-P., Kinkade, S., Thorup, C. L., & Waddell, S. (2023). *Photo Credits: International Youth Foundation*. www.iyfnet.org

[8] Penaluna, A., Penaluna, K., & Polenakovikj, R. (2020). Developing entrepreneurial education in national school curricula: lessons from North Macedonia and Wales. *Entrepreneurship Education, 3*, 245–263. https://doi.org/10.1007/s41959-020-00038-0

[9] Polenakovikj, R., Velkovski, T., Jovanovski, B., Polenakovikj, L., Velkovska, M., Kostikj, J., & Uzunovska, N. S. (2022). *Green Innovation in VET - Status quo and challenges.* National Centre for Development of Innovation and Entrepreneurial Learning. doi:10.13140/RG.2.2.36667.69922

[10] Sababha, B., Basal, A. M., Al-Qaralleh, E., & Al-Daher, N. (2020). Entrepreneurial mindset in engineering education. *Journal of Entrepreneurship Education, 23*(S1).