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Analysis of Development of Entrepreneurship Competences of Engineering Students Based on EntreComp Framework

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ABSTRACT

Engineering graduates play an important role in sustainable development, digital and green transition, and thus entrepreneurship competences. The focus of this research was to assess and compare perceptions of engineering students and professors of students' entrepreneurship competences development through formal learning by attending non-entrepreneurship study programs, as well as to assess the response of the students when they were exposed to informal entrepreneurship learning. Research data were collected using online questionnaires based on the EntreComp framework. Regarding formal learning results of the research showed that students thought that the non-entrepreneurship courses they attended helped them to develop certain entrepreneurship competences. Entrepreneurship competences didn't improve during the first year of the master's study program, and there was an improvement in some competences during the third year of the bachelor study program. This research showed that it was important to pay attention to informal entrepreneurship learning in the future, for the purpose of entrepreneurship competences development since students expressed a high level of satisfaction with such kind of learning.

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1. Introduction

Entrepreneurship competences can be developed through different types of learning. It is very important for the economy and society but at the same time very challenging task, to develop entrepreneurship competences of engineering students since formal engineering curricula and syllabuses of courses at the Faculty of Mechanical Engineering of the University of Sarajevo were not created with the intention to develop such competences of engineering students. Mechanical engineers play an important

role in sustainable development, digital and green transition through the development of industrial processes, machines, plants, and products for everyday life. Yet, when creating syllabuses of engineering courses and curricula focus of professors is on the engineering profession and not on the development of entrepreneurship competences. The vast majority of the scientific papers deal with the impact of entrepreneurship education on the development of certain entrepreneurship competences and entrepreneurship intentions which can be considered as the development of entrepreneurship competences with intention.

1.1 Literature review

United Nations' Sustainable Development Goals 4.4 and 8.3 emphasize the importance of entrepreneurship competence development and a substantial increase of young people and adults with these competences as well as the development of policies that would support entrepreneurship competences development and growth of micro-, small-, and medium-sized enterprises thus supporting aspirations of young people to start their own businesses [1].

European Commission promotes the development of entrepreneurship and transversal skills increasingly needed by the labor market as well as an increase of STEM (Science, Technology, Engineering, and Mathematics) graduates and fostering entrepreneurial and transversal skills defined as Action 7 in European Commission document [2].

Results of research on how European policies can help entrepreneurship competence development by analyzing the European Framework for Entrepreneurship Competences (EntreComp) [3] and its integration into education and training development show that EntreComp is recognized as critical for entrepreneurship competence development, but lack of vision and practice of implementation of EntreComp show that it can prevent its effective implementation [4]. EntreComp can increase motivation and understanding of entrepreneurship education and training and explore new ways and generate new knowledge on how sustainable development can be promoted. The initial phases of the self-assessment tool based on the EntreComp framework are presented in [5].

Syllabuses of non-entrepreneurship courses provided an opportunity to develop certain entrepreneurship competences defined within the EntreComp framework such as creativity, learning from experience, and financial literacy, while opportunity recognition, perseverance, and mobilizing resources were not emphasized. It was stated that professors unintentionally exposed students to the development of certain entrepreneurship competences and that the development of certain entrepreneurship competences didn't exclusively belong to entrepreneurship education only but could be embedded in courses that didn't belong to entrepreneurship education. It was concluded that even in the case when entrepreneurship was not the intended learning outcome students' entrepreneurship competences could be developed and enhanced [6].

Start-ups or new businesses might lead to improved competitiveness and sustainable economic growth. Entrepreneurs, defined as self-employed

persons, and entrepreneurship firms defined as small and young firms or market entries were compared with their counterparts defined as wage employees, and bigger and older or incumbent firms with respect to economic benefits defined as employment generation and dynamics, innovation, productivity and growth, and the creation of utility [7].

Exposure to compulsory entrepreneurship courses lowers entrepreneurship intention in both men and women, with a negative impact more noticeable in the case of women who may have experienced that having their own business is difficult to combine with other duties [8]. The effect on entrepreneurship attitudes and intentions of science and engineering students when exposed to entrepreneurship programs was investigated and the results of the research showed that entrepreneurship programs increase some attitudes and overall entrepreneurship intention [9].

Sustainable entrepreneurship competence is a significant factor explaining the entrepreneurial intentions of both higher education students and secondary-level students. If an individual develops the required competence for successful sustainable entrepreneurship, entrepreneurial intentions will follow [10]. Findings presented in GUESSS Global Report showed that 17.9 % of engineering students intended to be an entrepreneur directly after studies (based on a survey done in 58 countries across the globe and more than 267000 students included in the survey) and that intention to become an entrepreneur was smaller among female students comparing to male students [11].

Answers to two research questions: (1) to what extent the EntreComp framework can be used to evaluate entrepreneurship courses, and (2) to what extent problem-based learning Korda Method is suitable for entrepreneurship education as a student-centered pedagogy were the focus of research as well and it was concluded that EntreComp framework and Korda Method were suitable for entrepreneurship education [12]. Two conflicting claims by Schumpeter and Drucker were examined. Schumpeter claimed that entrepreneurship was not a profession, while Drucker claimed that it could be learned. The authors studied Babson College alumni entrepreneurs with an emphasis on education and experience. It was concluded that there was limited support for Drucker's claim since at the startup phase, the raising of money for the startup was in correlation with both prior entrepreneurship experience and entrepreneurship education. Also, it was concluded that prior startup experience was in correlation with startup performance [13].

Since entrepreneurship attitude can be improved through education, certain factors for both males and females that can help to define teaching activities guidelines to enhance entrepreneurship and intra-entrepreneurship capacity of students and thus better positioning at the labor market are identified in a study of entrepreneurship skills level of students enrolled in different disciplines at the University of Girona using Tricuspid skills model [14]. Conditions when entrepreneurship education could have the best impact on entrepreneurship intention were analyzed and it was found that there was a positive effect of entrepreneurship education on entrepreneurship intention in general. Since, subjective norms for engineering and science students have a negative effect on entrepreneurship intention, and since extend of time for entrepreneurship education was not usually possible, it was suggested to investigate entrepreneurship education didactics for engineering students that these students would accept [15].

The effect of sustainable entrepreneurship competence on entrepreneurial intentions in higher and secondary education contexts was examined and it was found that sustainable entrepreneurship competence was a significant factor that explained entrepreneurial intentions in both higher and secondary education contexts. This study proved that sustainable entrepreneurship competence was a significant variable in the regression model with a positive coefficient and that was positively correlated with entrepreneurship intentions [16].

Research on service-related competences in South East Europe showed that Vocational Education and Training (VET) offered a superior capacity for service-related competence development within formal learning. With regard to informal learning, workplace settings showed increased effectiveness in service-related competence development. Obstacles such as institutionalization and sustainability of service-related competences were observed in all South East Europe countries. In general competence development and validation process were given attention not only in academia but when there was involvement of public/civil and private sectors [17].

A self-assessment questionnaire was used to assess the entrepreneurial process competence of 355 students before and after entrepreneurship education intervention and the effect of an entrepreneurship education intervention on the entrepreneurial process competence of students in major Estonian universities was investigated. It was concluded that entrepreneurial process competences increased significantly, while the intention to create own business

didn't change [18]. The influence of entrepreneurship education, government support, global competence, entrepreneurship self-efficacy, and entrepreneurship intention on the entrepreneurship behavior of international students in the Republic of Korea was investigated and it was concluded that entrepreneurship education, government support, and global competence positively affected entrepreneurship behavior and that self-efficacy was important for entrepreneurship intention that would create entrepreneurship behavior. Entrepreneurship education and government support should be improved for global competence development [19].

Assessment of learning outcomes of the courses in higher education is based on Bologna Declaration and the tripartite European Qualification Framework (EQF) knowledge, skills, and attitudes model jointly referred to as competences [20]. The European Qualifications Framework is a learning outcomes-based framework consisting of 8 levels and helps to better understand and compare different national qualifications frameworks. Each level has descriptors for knowledge, skills and responsibility, and autonomy. Descriptors for the first, second, and third university cycles correspond to the 6th, 7th, and 8th levels respectively [21].

The link between individual creativity and the entrepreneurial intention of young people as well as the role of creativity supported in the family and creativity supported in the university education in this relationship was investigated and the proposed model underlined the potential moderating influence of entrepreneurship course attendance. Self-reporting was used for the measurement of variables, as in the vast majority of other studies [22]. Entrepreneurial process competence was recommended to be put as one of the main learning outcomes into the focus of the development and assessment of entrepreneurship education and entrepreneurship competences [23].

Structural equation modeling (SEM) was used to measure the learning outcomes of entrepreneurship education. Willingness to become an entrepreneur (affective learning outcome) can be generated by having entrepreneurs as guest lectures with their success stories, job shadowing, and company visits. Real-life projects with companies, business model competitions, business games, etc. can be used to help develop the knowledge and skills of students. It is important that students are participating in diverse educational activities and thus able to develop all three types of learning outcomes. The authors concluded that the tested framework can serve as an instrument for measuring the learning outcomes of entrepreneurship education [24].

Entrepreneurial teaching, business plan competition, and entrepreneurial practice positively support entrepreneurship competence which plays an intermediary role in the relationship between entrepreneurial teaching, business plan competition, entrepreneurship practice support, and entrepreneurial intention. Entrepreneurship education continuously affects entrepreneurial intention and improves the ability to establish a business [25]. In a comprehensive bibliometric analysis, it was shown that the role of entrepreneurship was one of four essential topics of innovative behavior of small and medium enterprises (SME) together with innovation capability, individual capabilities, and environmental issues of SMEs [26].

Besides EntreComp, there are several frameworks for assessing entrepreneurship competences like the Global Entrepreneurship Monitor (GEM), Global University Entrepreneurial Spirit Student's Survey (GUESS), and Entrepreneurial Personality, Attitudes, and Cognitions (EPIC) that are used as tools to evaluate entrepreneurship competences of students. GEM provides data on entrepreneurship activity, attitudes, and aspirations. GUESS is designed to measure the entrepreneurship spirit and intention of university students. EPIC is an assessment tool that measures an individual's entrepreneurship competences, entrepreneurship intention and attitudes, enterprising behaviors, entrepreneurship strategies, and educational effects and can provide a more in-depth evaluation of an individual's competences. Each tool has its own strengths and limitations. GEM provides comprehensive data on entrepreneurship trends and patterns but is not specifically designed to evaluate individual competencies. While GUESS is useful for assessing students' entrepreneurial intentions and attitudes, it covers multiple research topics which makes it complex and difficult to administer. EPIC uses entrepreneurship scenarios that may be interpreted in different ways and may produce uneven results [27, 28, 29].

On the other hand, EntreComp stands out as a comprehensive outline of the essential knowledge, skills, and attitudes necessary for fostering an entrepreneurship mindset. EntreComp has been developed by the European Commission in order to create a common understanding of what entrepreneurship competences are [30]. In [31] scale to measure entrepreneurship competence based on EntreComp was introduced and it was investigated whether entrepreneurship competences were related to start-up behavior. The findings in this research showed that entrepreneurship competences were related to start-up behavior. The authors [32] investigated to which

extent curricula were supported by entrepreneurship competences. The practical implication of the findings suggested that the EntreComp framework can be used to develop a comprehensive program approach to incorporate entrepreneurship competences into curricula. According to a bibliometric review [33] it was found that over the seven-year period from 2016-2022, EntreComp was addressed in 37 published scientific articles based on the Web of Science Core Collection database. Based on the literature review it can be seen that EntreComp has been widely used in scientific research and recognized as an adequate tool to assess entrepreneurship competences, thus it was used as a tool in this research.

However, there is a lack of research on the unintentional development of entrepreneurship competences in higher education and this issue hasn't been widely addressed [6]. Thus, in this research analysis whether non-entrepreneurship professors, whose syllabuses of the courses were not created with the intention to develop entrepreneurship competences, unintentionally create a learning environment and expose engineering students to develop certain entrepreneurship competences at the Faculty of Mechanical Engineering of the University of Sarajevo is done. Also, a new entrepreneurship learning environment outside of formal curricula and professors' formal lectures, by having entrepreneurs as guest lecturers to share their start-up and business stories was designed and its impact on students was analyzed. The additional contribution of our research is that it shows that entrepreneurship competences development is not exclusively within the intentional scope of entrepreneurship education but can be embedded and developed in other disciplines in higher education as well.

1.2 EntreComp framework

The Entrepreneurship Competence Framework (EntreComp) was used as a basis in this research, which is Science for Policy report by the Joint Research Centre, the European Commission's in-house science service [3]. EntreComp framework emphasizes that it could be used as a basis for the development of curricula and learning activities fostering entrepreneurship as a competence and also that it could be used for the definition of parameters to assess learners' and citizens' entrepreneurship competences. EntreComp recognizes three competence areas: 1. Ideas and opportunities, 2. Resources and 3. Into action, each competence area consists of five competences with total of 15 entrepreneurship competences (EC) as shown in Figure 1.



Figure 1. EntreComp Framework (source: Bacigalupo, M. et al. 2016, [3])

Three competence areas and 15 entrepreneurship competences are as follows:

1. Ideas and opportunities

- EC1 Spotting opportunities (identify and seize opportunities to create value)
- EC2 Creativity (develop creative and purposeful ideas)
- EC3 Vision (develop a vision to turn ideas into action)
- EC4 Valuing ideas (recognize the potential an idea has for creating value and identify suitable ways of making the most out of it)
- EC5 Ethical and sustainable thinking (assess the consequences of ideas that bring value and the effect of entrepreneurial action on the target community, the market, society and the environment – act responsibly)

2. Resources

- EC6 Self-awareness and self-efficacy (believe in ability to influence the course of events, despite uncertainty, setbacks and temporary failures)
- EC7 Motivation and perseverance (stay focused and don't give up - be determined to turn ideas into action and satisfy your need to achieve)
- EC8 Mobilizing resources (get and manage the material, non-material and digital resources needed to turn ideas into action and make the most of limited re-sources)

- EC9 Financial and economic literacy (estimate the cost of turning an idea into a value-creating activity)

- EC10 Mobilizing others (Inspire, enthuse and get others on board)

3. Into action

- EC11 Taking the initiative (initiate processes that create value, take up challenges and act and work independently to achieve goals)
- EC12 Planning and management (set long-, medium-, and short-term goals, define priorities and action plans, adapt to unforeseen changes)
- EC13 Coping with uncertainty, ambiguity and risk (make decisions dealing with uncertainty, ambiguity and risk)
- EC14 Working with others (work together and co-operate with others to develop ideas and turn them into action and network)
- EC15 Learning through experience (learn by doing)

1.3 Hypothesis and Research Aims

At the Faculty of Mechanical Engineering of the University of Sarajevo, learning outcomes of engineering courses were created with no intention to develop entrepreneurship competences at all, but to develop engineering competences specific to certain engineering courses only according to EQF. Despite this fact, the aims of this research are to investigate

students' perception of their entrepreneurship competences development at the Faculty of Mechanical Engineering of the University of Sarajevo through their formal learning by attending different non-entrepreneurship engineering study programs, as well as to investigate whether there was a difference in perceptions of students and professors regarding development entrepreneurship competences of students and whether engineering students perceived improvement of their entrepreneurship competences as they progressed through their study. Furthermore, the response of students to informal entrepreneurship learning, such as attending lectures delivered by entrepreneurs was analyzed.

Thus, the research hypotheses are:

Hypothesis 1: Students' perception with regard to their entrepreneurship competences development based on courses they attended differs from professors' perception based on the courses they teach.

Hypothesis 2: Students' perception of entrepreneurship competences development improves during the third year of a bachelor study program.

Hypothesis 3: Students' perception of entrepreneurship competences development improves during the first year of a master study program.

2. Methodology

The methodology is discussed in terms of sampling and data collection, questionnaires development, analysis of response rates of students and professors, and data analysis.

Analysis of the perception of entrepreneurship competences development was based on the Entre-Comp framework. For the analysis of the perception of entrepreneurship competences development of students within formal learning, two questionnaires were developed, one for students and one for professors.

With regard to informal learning by organizing several lectures out of formal curricula and learning, the level of satisfaction of students was assessed whether such an approach improved students' previous knowledge of entrepreneurship skills, whether lecturers clearly explained their entrepreneurship story and gave a certain level of self-confidence to students to start thinking entrepreneurially as well as whether students would recommend that more such lectures delivered by entrepreneurs out of formal curricula should be organized with real sector practice examples.

2.1 Sampling and data collection

There are seven study programs at the Faculty of Mechanical Engineering of the University of Sarajevo as follows:

- (1) Energetics, process technics, and environmental engineering (EPTEE)
- (2) Industrial engineering and management (IEM)
- (3) Machine production engineering (MPE)
- (4) Machine construction (MC)
- (5) Engines and vehicles (EV)
- (6) Defense technologies (DT)
- (7) Wood technologies (WT)

There are two study cycles at the Faculty of Mechanical Engineering of the University of Sarajevo: 1st study cycle with three study years (bachelor study program) and 2nd study cycle with two study years (master study program).

First two preparatory years of the 1st study cycle are identical for all seven study programs. All first two study year courses are fundamental engineering courses in their nature and as such are excluded from the analysis of formal curricula. So, students attending the first two study years are excluded from this research as well.

Each study year consists of 30 ECTS credits per semester. Accordingly, the 1st study cycle consists of 180 ECTS credits, while the 2nd study cycle consists of 120 ECTS credits. This applies to all listed study programs.

Analysis of the perception of students regarding entrepreneurship competences development was performed with students attending the 3rd study year of the 1st study cycle, as well as of the 1st and of the 2nd study year of the 2nd study cycle. Students of the 3rd study year of the 1st study cycle gave their reflection regarding the first two study years, while students of the 1st study year of the 2nd study cycle provided their reflection for the first three study years (1st study cycle), and students of the 2nd study year of the 2nd study cycle provided their reflection for the four study years. Also, the latest cohort of alumni was invited to provide their perception of entrepreneurship competences development.

To analyze the perception of students and professors of the contribution of courses and study programs to the entrepreneurship competences development of students two questionnaires were developed: one for students and one for professors.

2.2 Questionnaire for students

In order to get the perception of students regarding their entrepreneurship competences development online questionnaire for students was developed in this paper based on the EntreComp framework. Considerations, that this questionnaire was based on, were to get the perception of students from different study programs on how much the courses they attended at the Faculty of Mechanical Engineering helped them to develop their basic entrepreneurship competences as well as to get the perception of improvement of students' entrepreneurship competences as they progressed through their study.

The questionnaire consists of three questions: (1) to select the study cycle and year of study, (2) to select the study program and (3) to select entrepreneurship competences from EC1 to EC15 students thought they developed based on courses they attended at the Faculty of Mechanical Engineering of the University of Sarajevo.

The link for the online questionnaire was sent during the winter semester of the 2021/22 academic year to students of the 1st study cycle/3rd year, 2nd study cycle/1st year, and 2nd study cycle/2nd year. The questionnaire was also sent to 70 former students from the latest alumni cohort. Completing the questionnaire was completely anonymous and on a voluntary basis. A total of 313 students answered. The number of students to whom the link for the online questionnaire was sent by email, the number of answered questionnaires, and response rates per study year or alumni are depicted in Table 1. From Table 1 it can be seen that the average response rate of students was 64.4%.

2.3 Questionnaire for professors

In order to get the perception of professors regarding the entrepreneurship competences development of students through the courses they teach, an

online questionnaire for professors was developed in this paper, based on the EntreComp framework. Considerations, that this questionnaire was based on, were to analyze how much the syllabuses of courses taught at the Faculty of Mechanical Engineering of the University of Sarajevo helped to develop students' entrepreneurship competences from professors' point of view.

Each professor was asked to fill in the questionnaire only for syllabuses of the courses that they taught in the third year of the 1st study cycle and in the 1st and the 2nd year of the 2nd study cycle as well as to fill in one questionnaire separately for each course that they taught.

The questionnaire consists of four questions: (1) write the name of the course, (2) select the study cycle and year of study when the course is taught, (3) select the study program where the course is taught and (4) to select entrepreneurship competences from EC1 to EC15 professors thought their courses contribute to the development of students' entrepreneurship competences. It was emphasized that completing the questionnaire was anonymous.

Professors were instructed that it was not necessary that the entrepreneurship competences were explicitly and formally stated in the learning outcomes of the syllabus of that course. The total number of syllabuses analyzed by professors was 133 as depicted in Table 2.

The number of courses per study program in curricula and response rates per study program are depicted in Table 2. Out of the total number of courses 188, analysis by professors was done for 70.7% of courses.

2.4. Informal entrepreneurship learning

At the Faculty of Mechanical Engineering of the University of Sarajevo, 4 events were organized, where entrepreneurs delivered their entrepreneurial stories to students of the third year of the 1st study cycle and

Table 1. Number of answered questionnaires for students per study year or alumni

| Study cycle/ year of study or alumni | Number of students to whom the questionnaire was sent by email | Number of answered questionnaires | Response rate |
|---------------------------------------|--|-----------------------------------|---------------|
| 1st study cycle/ 3 rd year | 164 | 94 | 57.3% |
| 2nd study cycle/ 1 st year | 125 | 73 | 58.4% |
| 2nd study cycle/ 2 nd year | 127 | 86 | 67.7% |
| Alumni | 70 | 60 | 85.7% |
| Total | 486 | 313 | 64.4% |

Table 2. Number of answered questionnaires for students per study year or alumni

| Study program | Number of courses | Number of analyzed syllabuses | Response rate |
|---|-------------------|-------------------------------|---------------|
| Energetics, process technics, and environmental engineering | 41 | 41 | 100% |
| Industrial engineering and management | 24 | 24 | 100% |
| Machine production engineering | 26 | 20 | 76.9% |
| Machine constructions | 18 | 18 | 100% |
| Engines and vehicles | 29 | 10 | 34.5% |
| Defense technologies | 21 | 8 | 38.1% |
| Wood technologies | 29 | 12 | 41.4% |
| Total | 188 | 133 | 70.7% |

the 1st and the 2nd years of the 2nd study cycle. The aim was to explore the level of satisfaction of students through informal learning by organizing a series of lectures delivered by local entrepreneurs about their own business cases and by sharing their knowledge and experience with students. The level of satisfaction of students was measured by whether lectures clearly explained their entrepreneurship story and gave a certain level of self-confidence to students to start thinking entrepreneurially and whether students would recommend more such lectures delivered by entrepreneurs out of formal curricula to be organized with examples from the real sector practice.

2.5 Data analysis

Data were analyzed using descriptive statistics and statistical hypothesis testing of difference of two proportions with the level of significance $\alpha=0.05$. Also, for difference of proportions for each entrepreneurship competence 95% confidence interval was constructed.

3. Results and discussion

This section focuses on analysis of how students perceived whether they developed entrepreneurship competences during their study and on analysis of how professors perceived the contribution of syllabuses of courses they taught on developments of students' entrepreneurship competences. Formal statistical hypotheses tests of difference of two proportions were applied to conclude whether there were differences of proportions of students who perceived that they developed certain entrepreneurship competence and proportions of professors who perceived courses they taught helped in developing

certain entrepreneurship competences of students as well as tests regarding perception of improvement of students' entrepreneurship competences as they progressed through their study. Furthermore, in this section, informal entrepreneurship learning was analyzed as well.

3.1 Analysis of the perception of students

Figure 1. depicts the perception of students regarding the competences they acquired during their study at the Faculty of Mechanical Engineering. Out of the total number of 313 students who answered the questionnaire 54.3% expressed working with others (work together and co-operate with others to develop ideas and turn them into action and network), 53.7% expressed motivation and perseverance (stay focused and don't give up - be determined to turn ideas into action and satisfy your need to achieve), 49.8% expressed creativity (develop creative and purposeful ideas), 43.8% expressed vision (develop a vision to turn ideas into action), 44.1% expressed learning through experience (learn by doing) and 42.2% expressed planning and management (set long-, medium-, and short-term goals, define priorities and action plans, adapt to unforeseen changes).

Each of remaining 9 competences out of 15 total was rated by less than 40% of students as the competences they acquired during their study, while 6% of students stated that they acquired none competences (see Figure 2).

Development of certain competences of students depends on study program, what is shown in Figure 3. Almost half (48.8%) of students coming from Energetics, process technics and environmental engineering (EPTEE) study program think that they acquired Working with others (EC14) competence, while 64%

of students coming from Industrial engineering and management (IEM) stated that they acquired Planning and management (EC12) competence followed by 60.7% who stated that they acquired Working with others (EC14) competence.

Out of total number of students coming from Machine production engineering (MPE) study program 63.4% expressed that they acquired Creativity (EC2) competence, 60% of students coming from

Machine constructions (MC) study program think they acquired Creativity (EC2), 50% of students coming from Engines and vehicles (EV) study program stated they acquired Motivation and perseverance (EC7), while Working with others (EC14) competence was stated by 55.6% of students coming from Defense technologies (DT) and 62.5% of students coming Wood technologies (WT) study program as the competence they acquired.

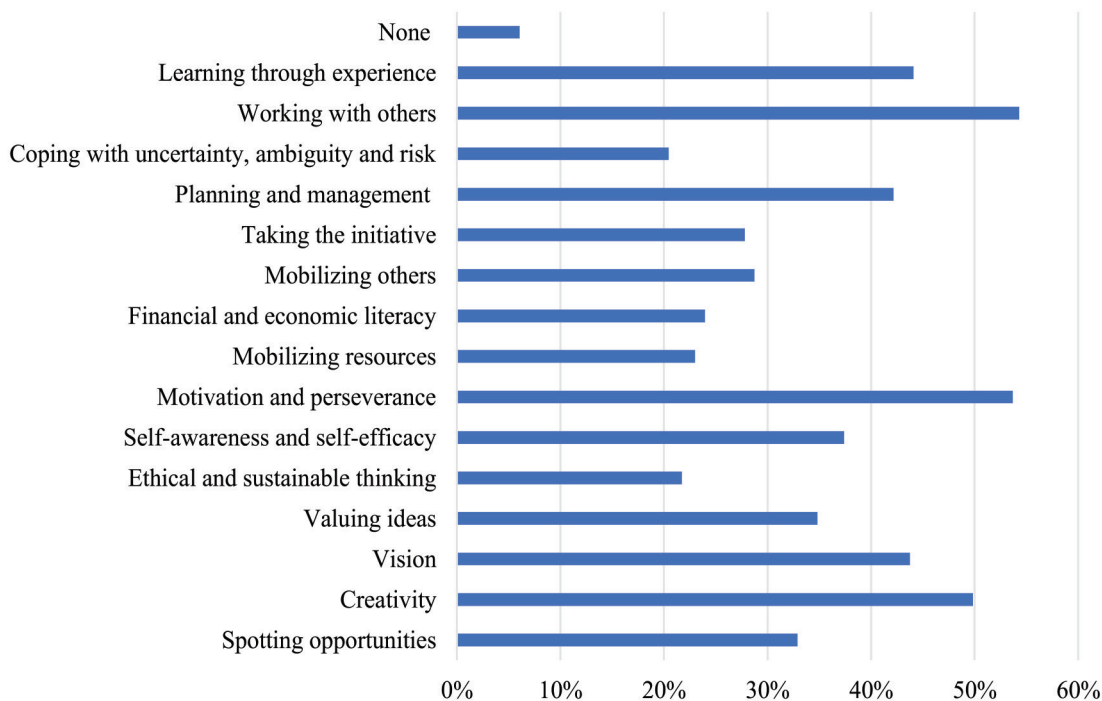


Figure 2. Entrepreneurship competences – responses by students

| | EPTEE | IEM | MPE | MC | EV | DT | WT |
|------|-------|-------|-------|-------|-------|-------|-------|
| EC1 | 20.7% | 48.3% | 31.7% | 37.8% | 0.0% | 22.2% | 37.5% |
| EC2 | 41.5% | 52.8% | 63.4% | 60.0% | 21.4% | 44.4% | 45.8% |
| EC3 | 37.8% | 49.4% | 58.5% | 37.8% | 35.7% | 44.4% | 33.3% |
| EC4 | 28.0% | 44.9% | 36.6% | 33.3% | 21.4% | 22.2% | 37.5% |
| EC5 | 18.3% | 25.8% | 12.2% | 28.9% | 28.6% | 11.1% | 25.0% |
| EC6 | 41.5% | 43.8% | 41.5% | 37.8% | 21.4% | 16.7% | 16.7% |
| EC7 | 47.6% | 64.0% | 51.2% | 46.7% | 50.0% | 50.0% | 58.3% |
| EC8 | 18.3% | 30.3% | 17.1% | 20.0% | 7.1% | 33.3% | 29.2% |
| EC9 | 18.3% | 37.1% | 22.0% | 17.8% | 14.3% | 22.2% | 16.7% |
| EC10 | 23.2% | 43.8% | 22.0% | 35.6% | 7.1% | 27.8% | 4.2% |
| EC11 | 29.3% | 36.0% | 22.0% | 24.4% | 14.3% | 27.8% | 16.7% |
| EC12 | 32.9% | 64.0% | 26.8% | 35.6% | 28.6% | 33.3% | 45.8% |
| EC13 | 20.7% | 24.7% | 22.0% | 20.0% | 21.4% | 16.7% | 4.2% |
| EC14 | 48.8% | 60.7% | 58.5% | 51.1% | 28.6% | 55.6% | 62.5% |
| EC15 | 40.2% | 41.6% | 43.9% | 48.9% | 50.0% | 55.6% | 45.8% |
| None | 4.9% | 6.7% | 2.4% | 6.7% | 14.3% | 5.6% | 8.3% |

Figure 3. Entrepreneurship competences per study program – responses by students

There were students who thought that they did not acquire any competence and the percentages per study program are as follows:

- (1) Energetics, process technics and environmental engineering (EPTEE): 4.9%;
- (2) Industrial engineering and management (IEM): 6.7%;
- (3) Machine production engineering (MPE): 2.4%;
- (4) Machine constructions (MC): 6.7%;
- (5) Engines and vehicles (EV): 14.3%;
- (6) Defense technologies (DT): 5.6%;
- (7) Wood technologies (WT): 8.3%.

Finally, analysis was done regarding acquisition of competences per study year including alumni and this analysis is shown in Figure 4. The best 5 rated competences among students of all study years including alumni were:

- (1) Creativity (EC2);
- (2) Vision (EC3);
- (3) Motivation and perseverance (EC7);
- (4) Working with others (EC14);
- (5) Learning through experience (EC15).

Nobody coming from alumni expressed that they acquired no competences, while 13.8% of students in the third year of the 1st study cycle, 5.5% of students in the first year of the 2nd study cycle, and 2.3% of students in the second year of the 2nd study cycle pointed they did not acquire any competence during their studying.

3.2 Analysis of perception of professors

Figure 5. shows how professors see the contribution of syllabuses of courses they teach on the development of student's entrepreneurship competences. All 15 entrepreneurship competences defined in EntreComp are considered. It can be seen that in over 70% of courses, professors see creativity, working with others, and learning through experience as learning outcomes of courses. On the other hand, only 21% of courses developed student's entrepreneurship competence related to coping with uncertainty, ambiguity, and risk. Financial and economic literacy is another entrepreneurship competence that was seen as a learning outcome in less than 36% of courses. Contribution to the development of other entrepreneurship competences was present in about 40% to 50% of courses.

Further clarification of these results is needed. According to the EntreComp approach 15 entrepreneurship competences are broken down further into threads, clearly defined through learning outcomes which are mapped across 8 different levels of progression from beginner to expert. For example, creativity is broken down into five threads, be curious and open, develop ideas, define problems, design value and be innovative. Each thread is defined with 8 learning outcomes mapped across 8 levels of progression, i.e., creativity is mapped with 50 learning outcomes. In the presented survey professor's perception is that over 70% of courses contribute to

| | 1st study cycle 3rd year | 2nd study cycle 1st year | 2nd study cycle 2nd year | Alumni |
|------|-----------------------------|-----------------------------|-----------------------------|--------|
| EC1 | 21.3% | 32.9% | 38.4% | 43.3% |
| EC2 | 40.4% | 56.2% | 55.8% | 48.3% |
| EC3 | 41.5% | 52.1% | 43.0% | 38.3% |
| EC4 | 24.5% | 41.1% | 34.9% | 43.3% |
| EC5 | 18.1% | 23.3% | 17.4% | 31.7% |
| EC6 | 26.6% | 39.7% | 47.7% | 36.7% |
| EC7 | 44.7% | 54.8% | 60.5% | 56.7% |
| EC8 | 8.5% | 28.8% | 25.6% | 35.0% |
| EC9 | 13.8% | 28.8% | 24.4% | 33.3% |
| EC10 | 18.1% | 34.2% | 31.4% | 35.0% |
| EC11 | 14.9% | 26.0% | 32.6% | 43.3% |
| EC12 | 35.1% | 39.7% | 40.7% | 58.3% |
| EC13 | 16.0% | 15.1% | 24.4% | 28.3% |
| EC14 | 42.6% | 60.3% | 57.0% | 61.7% |
| EC15 | 38.3% | 47.9% | 45.3% | 46.7% |
| None | 13.8% | 5.5% | 2.3% | 0.0% |

Figure 4. Entrepreneurship competences per study year – responses by students

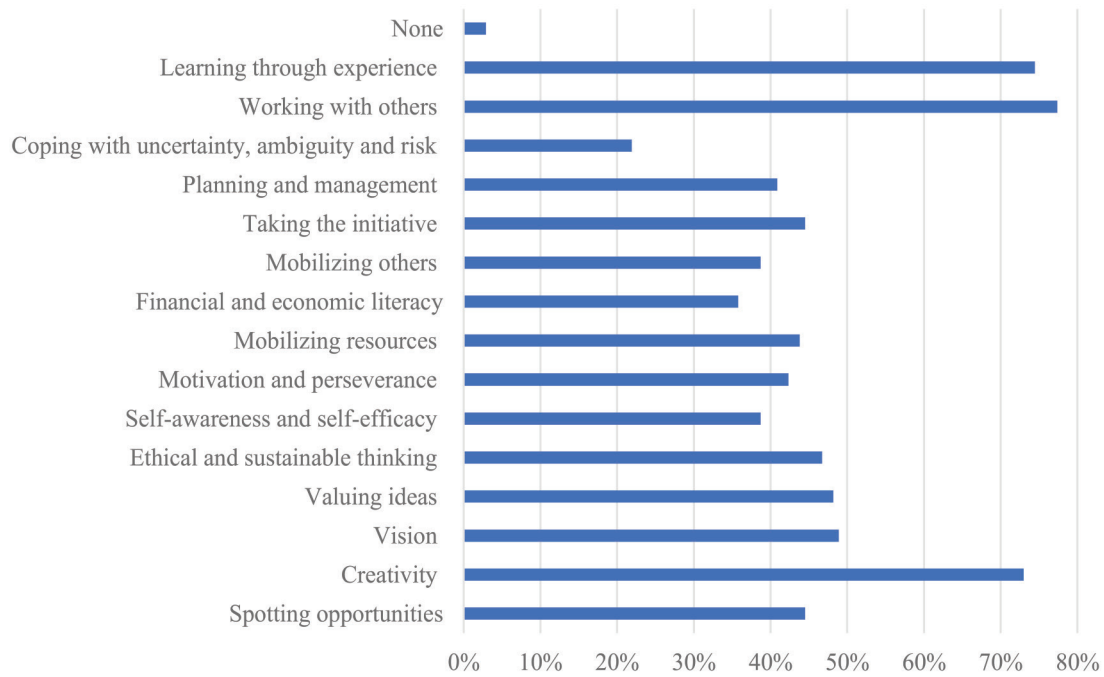


Figure 5. Entrepreneurship competences - analysis of syllabuses of courses

developing one or more out of 50 learning outcomes related to creativity.

Also, two courses with a contribution to creativity as a transversal competence with the same thread and its level of progression have no double contribution. But it could be concluded that the more course develop creativity the higher level of progression could be expected. However, it should have been in mind that only one course in the study program could contribute to each level of progression. In other words, if

a student in one course develops creativity as a transversal competence with a thread and with its a level of progression, all successive courses which offer development of creativity with the same learning outcomes (the same thread and the same level of progression) do not contribute to new development of creativity. Figure 6. depicts perception of professors of contribution on development of each of seven study programs to development of 15 entrepreneurship competences. It can be seen that large differences

| | EPTEE | IEM | MPE | MC | EV | DT | WT |
|------|--------|--------|--------|--------|-------|--------|--------|
| EC1 | 46.34% | 50.00% | 40.91% | 85.00% | 0.00% | 12.50% | 25.00% |
| EC2 | 78.0% | 79.2% | 54.5% | 95.0% | 20.0% | 87.5% | 75.0% |
| EC3 | 56.1% | 20.8% | 36.4% | 95.0% | 10.0% | 75.0% | 41.7% |
| EC4 | 53.7% | 50.0% | 50.0% | 70.0% | 10.0% | 0.0% | 50.0% |
| EC5 | 43.9% | 45.8% | 63.6% | 65.0% | 40.0% | 12.5% | 25.0% |
| EC6 | 36.6% | 50.0% | 50.0% | 65.0% | 10.0% | 12.5% | 0.0% |
| EC7 | 56.1% | 50.0% | 40.9% | 55.0% | 10.0% | 0.0% | 16.7% |
| EC8 | 43.9% | 45.8% | 54.5% | 70.0% | 10.0% | 0.0% | 33.3% |
| EC9 | 68.3% | 41.7% | 4.5% | 45.0% | 10.0% | 0.0% | 0.0% |
| EC10 | 46.3% | 54.2% | 59.1% | 30.0% | 20.0% | 0.0% | 0.0% |
| EC11 | 48.8% | 41.7% | 63.6% | 75.0% | 0.0% | 12.5% | 8.3% |
| EC12 | 56.1% | 62.5% | 22.7% | 30.0% | 40.0% | 12.5% | 16.7% |
| EC13 | 19.5% | 54.2% | 27.3% | 15.0% | 0.0% | 0.0% | 0.0% |
| EC14 | 87.8% | 70.8% | 81.8% | 95.0% | 70.0% | 50.0% | 41.7% |
| EC15 | 80.5% | 66.7% | 81.8% | 85.0% | 50.0% | 87.5% | 50.0% |
| None | 4.9% | 8.3% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

Figure 6. Entrepreneurship competences - analysis per study program

in professors' perception of contribution of different study programs to all 15 competences are present.

Figure 7. shows how professors saw contribution of the courses they teach in the third year of the 1st study cycle, the first and second year of the 2nd study cycle to development of entrepreneurship competences. It can be seen that there was no substantial difference in contribution to entrepreneurship competences within the years of the study. These results could be expected because professors saw entrepreneurship as transversal competences which resulted in the course they taught not as primary learning outcomes.

3.3 Hypothesis testing

Table 3 shows results of hypothesis testing as well as 95% confidence intervals (CI) for difference of two proportions regarding research Hypothesis 1: Students' perception with regard to their entrepreneurship competences development based on courses they attended differs from professors' perception based on the courses they teach. Hypothesis tests were performed using $\alpha = 0.05$ level of significance. For this research two tailed test was performed. The null (H_0) and the alternative hypothesis (H_1) for this research were:

$$H_0: p_1 - p_2 = 0, \quad (1)$$

$$H_1: p_1 - p_2 \neq 0, \quad (2)$$

where:

p_1 - proportion of students who perceived they developed certain entrepreneurship competence.

p_2 - proportion of professors who perceived that courses they teach helped in developing certain entrepreneurship competences.

The p value for each hypothesis test was calculated and based on the p value decision was made whether to reject or not reject the null hypotheses H_0 . The p value is the probability of obtaining statistic equal to or higher than the sample result, given that the null hypothesis H_0 is true. All results with $p < 0.05$ were considered statistically significant, meaning that there was statistical evidence for the claim stated in the research hypothesis H_1 was true.

If the null hypothesis was rejected the conclusion was that there was evidence of a difference in two proportions. However, if the null hypothesis was not rejected the conclusion was that there was insufficient evidence of a difference between two proportions.

From Table 3 it can be seen that there is enough evidence to conclude that there is difference in proportions of students and professors regarding development of following entrepreneurship competences: spotting opportunities, creativity, valuing ideas, ethical & sustainable thinking, motivation and perseverance, mobilizing resources, financial and economic literacy, mobilizing others, taking the initiative, working with others, learning through experience. Also, from Table 3 it can be seen that there is not sufficient evidence to warrant rejection of the claim that

| | 1st study cycle 3rd year | 2nd study cycle 1st year | 2nd study cycle 2nd year |
|------|-----------------------------|-----------------------------|-----------------------------|
| EC1 | 45.1% | 45.6% | 41.4% |
| EC2 | 72.5% | 73.7% | 72.4% |
| EC3 | 49.0% | 49.1% | 48.3% |
| EC4 | 47.1% | 50.9% | 44.8% |
| EC5 | 47.1% | 43.9% | 51.7% |
| EC6 | 43.1% | 35.1% | 37.9% |
| EC7 | 45.1% | 42.1% | 37.9% |
| EC8 | 51.0% | 38.6% | 41.4% |
| EC9 | 43.1% | 35.1% | 24.1% |
| EC10 | 35.3% | 36.8% | 48.3% |
| EC11 | 43.1% | 45.6% | 44.8% |
| EC12 | 47.1% | 35.1% | 41.4% |
| EC13 | 19.6% | 21.1% | 27.6% |
| EC14 | 74.5% | 77.2% | 82.8% |
| EC15 | 70.6% | 77.2% | 75.9% |
| None | 3.9% | 3.5% | 0.0% |

Figure 7. Analysis per study program and per study year – responses by professors

Table 3. Number of answered questionnaires for students per study year or alumni

| Competence | p_1 | p_2 | (p_1-p_2) | 95% CI for (p_1-p_2) | p value | Decision |
|---|-------|-------|-------------|------------------------|-----------|---------------------|
| Spotting opportunities | 0.329 | 0.445 | -0.116 | -0.214; -0.018 | 0.020 | Reject H_0 |
| Creativity | 0.498 | 0.730 | -0.232 | -0.324; -0.139 | 0.000 | Reject H_0 |
| Vision | 0.438 | 0.489 | -0.051 | -0.152; 0.049 | 0.315 | Do not reject H_0 |
| Valuing ideas | 0.348 | 0.482 | -0.134 | -0.232; -0.035 | 0.008 | Reject H_0 |
| Ethical & Sustainable thinking | 0.217 | 0.467 | -0.250 | -0.345; -0.155 | 0.000 | Reject H_0 |
| Self-awareness and self-efficacy | 0.374 | 0.387 | -0.013 | -0.111; 0.085 | 0.793 | Do not reject H_0 |
| Motivation and perseverance | 0.537 | 0.423 | 0.114 | 0.014; 0.213 | 0.025 | Reject H_0 |
| Mobilizing resources | 0.230 | 0.438 | -0.208 | -0.303; -0.113 | 0.000 | Reject H_0 |
| Financial and economic literacy | 0.240 | 0.358 | -0.118 | -0.211; -0.025 | 0.013 | Reject H_0 |
| Mobilizing others | 0.288 | 0.387 | -0.099 | -0.195; -0.004 | 0.042 | Reject H_0 |
| Taking the initiative | 0.278 | 0.445 | 0.177 | -0.264; -0.070 | 0.001 | Reject H_0 |
| Planning and management | 0.422 | 0.409 | 0.013 | -0.086; 0.112 | 0.797 | Do not reject H_0 |
| Coping with uncertainty, ambiguity and risk | 0.205 | 0.219 | -0.014 | -0.097; 0.068 | 0.730 | Do not reject H_0 |
| Working with others | 0.543 | 0.774 | -0.231 | 0.320; -0.141 | 0.000 | Reject H_0 |
| Learning through experience | 0.441 | 0.745 | -0.304 | -0.395; -0.212 | 0.000 | Reject H_0 |

proportions of students and professors is same regarding development of following entrepreneurship competences: vision, self-awareness and self-efficacy, planning and management, coping with uncertainty, ambiguity and risk.

Thus, Hypothesis 1 is partially supported only for development of vision, self-awareness and self-efficacy, planning and management, coping with uncertainty, ambiguity and risk or in other words when the null hypothesis is not rejected. For all other entrepreneurship competences: entrepreneurship competences: spotting opportunities, creativity, valuing ideas, ethical & sustainable thinking, motivation and perseverance, mobilizing resources, financial and economic literacy, mobilizing others, taking the initiative, working with others, learning through experience, Hypothesis 1 is not supported.

Table 4 depicts results of hypothesis testing and 95% lower bound for difference of two proportions regarding research Hypothesis 2: Students' perception of entrepreneurship competences development improves during the third year of bachelor study program. Hypothesis tests were performed using $\alpha=0.05$ level of significance. For this research upper tailed test was performed. The null (H_0) and the alternative hypothesis (H_1) for this research were:

$$H_0: p_1 - p_2 \leq 0, \quad (3)$$

$$H_1: p_1 - p_2 > 0, \quad (4)$$

where:

p_1 - proportion of students who perceived they developed certain entrepreneurship competence during the third year of bachelor study program.

p_2 - proportion of students who perceived they developed certain entrepreneurship competence during the first two years of bachelor study program.

All results with p value < 0.05 were considered statistically significant, meaning that there was statistical evidence for the claim stated in the research hypothesis H_1 was true. If the null hypothesis was rejected the conclusion was that there was evidence that $p_1 > p_2$. If the null hypothesis was not rejected the conclusion was that there was insufficient evidence that $p_1 > p_2$. From Table 4 it can be seen that following competences: spotting opportunities, creativity, valuing ideas, self-awareness and self-efficacy, mobilizing resources, financial and economic literacy, mobilizing others, taking the initiative and working with others improved during the third year of bachelor study program, while there was no improvement of the following competences: vision, ethical & sustainable thinking, motivation and perseverance, planning and management, coping with uncertainty, ambiguity and risk and learning through experience.

Thus, Hypothesis 2 of this research is partially supported only for the development of spotting opportunities, creativity, valuing ideas, self-awareness, and self-efficacy, mobilizing resources, financial and economic literacy, mobilizing others, taking the ini-

Table 4. Hypothesis testing for difference of two proportions of perceived entrepreneurship competences development during the third year of bachelor study program

| Competence | p_1 | p_2 | (p_1-p_2) | 95% Lower Bound for (p_1-p_2) | p value | Decision |
|---|-------|-------|-------------|---------------------------------|-----------|---------------------|
| Spotting opportunities | 0.329 | 0.213 | 0.116 | 0.002 | 0.047 | Reject H_0 |
| Creativity | 0.562 | 0.404 | 0.157 | 0.031 | 0.021 | Reject H_0 |
| Vision | 0.521 | 0.415 | 0.106 | -0.022 | 0.086 | Do not reject H_0 |
| Valuing ideas | 0.411 | 0.245 | 0.166 | 0.047 | 0.011 | Reject H_0 |
| Ethical & Sustainable thinking | 0.233 | 0.181 | 0.052 | -0.052 | 0.206 | Do not reject H_0 |
| Self-awareness and self-efficacy | 0.397 | 0.266 | 0.131 | 0.011 | 0.036 | Reject H_0 |
| Motivation and perseverance | 0.548 | 0.447 | 0.101 | -0.027 | 0.096 | Do not reject H_0 |
| Mobilizing resources | 0.288 | 0.085 | 0.203 | 0.103 | 0.000 | Reject H_0 |
| Financial and economic literacy | 0.288 | 0.138 | 0.149 | 0.044 | 0.010 | Reject H_0 |
| Mobilizing others | 0.342 | 0.181 | 0.162 | 0.049 | 0.009 | Reject H_0 |
| Taking the initiative | 0.260 | 0.149 | 0.111 | 0.007 | 0.039 | Reject H_0 |
| Planning and management | 0.397 | 0.351 | 0.046 | -0.078 | 0.270 | Do not reject H_0 |
| Coping with uncertainty, ambiguity and risk | 0.151 | 0.160 | -0.009 | -0.102 | 0.563 | Do not reject H_0 |
| Working with others | 0.603 | 0.426 | 0.177 | 0.051 | 0.010 | Reject H_0 |
| Learning through experience | 0.479 | 0.383 | 0.096 | -0.030 | 0.105 | Do not reject H_0 |

tiative and working with others, or in other words when the null hypothesis is rejected. For all other entrepreneurship competences: vision, ethical & sustainable thinking, motivation, and perseverance, planning, and management, coping with uncertainty, ambiguity, and risk, and learning through experience, Hypothesis 2 is not supported.

Table 5 depicts the results of hypothesis testing and the 95% lower bound for the difference of two proportions regarding research Hypothesis 3: Students' perception of entrepreneurship competences development improves during the first year of master study program. Hypothesis tests were performed using $\alpha=0.05$ level of significance. For this research upper tailed test was performed. The null (H_0) and the alternative hypothesis (H_1) for this research were:

$$H_0: p_1 - p_2 \leq 0, \quad (5)$$

$$H_1: p_1 - p_2 > 0, \quad (6)$$

where:

p_1 - proportion of students who perceived they developed certain entrepreneurship competence during the first year of master study program.

p_2 - proportion of students who perceived they developed certain entrepreneurship competence during the first three years of bachelor study program.

Results with p value < 0.05 were considered statistically significant, meaning that there was statistical evidence for the claim stated in the research hypothesis H_1 was true. If the null hypothesis was rejected the conclusion was that there was evidence that $p_1 > p_2$. If the null hypothesis was not rejected the conclusion was that there was insufficient evidence that $p_1 > p_2$. From Table 5 it can be seen that all null hypotheses were not rejected meaning that the none entrepreneurship competence improved during the first year of master study program.

Thus, Hypothesis 3 of this research is not supported for development of all entrepreneurship competences.

It is important to notice that if a student in one course developed certain competence as a transversal competence with a thread and with its level of progression, all successive courses which offer the development of the same competence with the same learning outcomes (the same thread and the same level of progression) didn't contribute to new development of that competence. That is why the null hypothesis for certain entrepreneurship competences was not rejected, meaning that there was no improvement of that particular entrepreneurship competences during the third bachelor study year or the first master study year.

Table 5. Hypothesis testing for difference of two proportions of perceived entrepreneurship competences development during the first year of master study program

| Competence | p_1 | p_2 | (p_1-p_2) | 95% Lower Bound for (p_1-p_2) | p value | Decision |
|---|-------|-------|-------------|---------------------------------|-----------|---------------------|
| Spotting opportunities | 0.384 | 0.329 | 0.055 | -0.070 | 0.235 | Do not reject H_0 |
| Creativity | 0.558 | 0.562 | -0.004 | -0.133 | 0.518 | Do not reject H_0 |
| Vision | 0.430 | 0.521 | -0.090 | -0.221 | 0.873 | Do not reject H_0 |
| Valuing ideas | 0.349 | 0.411 | -0.062 | -0.189 | 0.790 | Do not reject H_0 |
| Ethical & Sustainable thinking | 0.174 | 0.233 | -0.058 | -0.164 | 0.819 | Do not reject H_0 |
| Self-awareness and self-efficacy | 0.477 | 0.397 | 0.079 | -0.050 | 0.156 | Do not reject H_0 |
| Motivation and perseverance | 0.605 | 0.548 | 0.057 | -0.073 | 0.235 | Do not reject H_0 |
| Mobilizing resources | 0.256 | 0.288 | -0.032 | -0.148 | 0.674 | Do not reject H_0 |
| Financial and economic literacy | 0.244 | 0.288 | -0.043 | -0.159 | 0.732 | Do not reject H_0 |
| Mobilizing others | 0.314 | 0.342 | -0.029 | -0.151 | 0.649 | Do not reject H_0 |
| Taking the initiative | 0.326 | 0.260 | 0.065 | -0.053 | 0.182 | Do not reject H_0 |
| Planning and management | 0.407 | 0.397 | 0.010 | -0.119 | 0.450 | Do not reject H_0 |
| Coping with uncertainty, ambiguity and risk | 0.244 | 0.151 | 0.094 | -0.009 | 0.067 | Do not reject H_0 |
| Working with others | 0.570 | 0.603 | -0.033 | -0.162 | 0.663 | Do not reject H_0 |
| Learning through experience | 0.453 | 0.479 | -0.026 | -0.157 | 0.628 | Do not reject H_0 |

3.4 Analysis of informal entrepreneurship learning

As planned series of lectures delivered by entrepreneurs were organized at the Faculty of Mechanical Engineering of the University of Sarajevo. The intention was to have speakers, preferably young entrepreneurs, and owners of successful companies. Two lecturers were female, while two were male. Table 6 provides information regarding the number and gender of participants who attended these lectures delivered by entrepreneurs.

Table 6. Number and gender of participants who attended lectures delivered by entrepreneurs

| Lecture No. | Number of female students | Number of male students | Total number of participants | Gender of lecturer |
|-------------|---------------------------|-------------------------|------------------------------|--------------------|
| 1 | 26 | 18 | 44 | Female |
| 2 | 21 | 18 | 39 | Male |
| 3 | 19 | 14 | 33 | Female |
| 4 | 16 | 15 | 31 | Male |

Satisfaction of students with lectures delivered by entrepreneurs was measured by five questions as follows:

Q1: The lecturer showed enthusiasm and interest in transferring knowledge to students.

Q2: The lecture improved my previous knowledge of entrepreneurship skills.

Q3: The lecturer clearly explained his/her entrepreneurship story.

Q4: The lecture gave a certain level of self-confidence to start thinking entrepreneurially.

Q5: I would like more such events to be organized at the Faculty with examples from the practice of entrepreneurship (first two events).

After the second lecture, there was no point to have Q5 in the questionnaire since the organization of third and fourth lectures was agreed upon with students. Table 7 depicts percentages of satisfied students with regard to the five questions above.

Results from survey presented in Table 7 show very high percentage of satisfaction among students and that this kind of informal learning can be used as an effective tool.

Table 7. Percentages of satisfied students

| Lecture No. | Q1 | Q2 | Q3 | Q4 | Q5 |
|-------------|------|-------|-------|-------|------|
| 1 | 100% | 100% | 100% | 97.7% | 100% |
| 2 | 100% | 97.3% | 100% | 100% | 100% |
| 3 | 100% | 100% | 96.8% | 96.8% | N/A |
| 4 | 100% | 100% | 100% | 96.8% | N/A |

4. Conclusion

In this paper comprehensive analysis of the perception of entrepreneurship competences development of engineering students was done based on the EntreComp framework as a reference with 15 competences. Two questionnaires were developed, one for students and one for professors. Response rates for both questionnaires were high and completing of the questionnaires was anonymous. Based on the responses of students it can be concluded that a high percentage of students think they developed all 15 entrepreneurship competences. However, competences that were most developed during their engineering studies were: working with others, motivation, and perseverance followed by creativity, vision, and learning through experience. It is important to emphasize that the syllabuses of the courses were not created with the intention to develop entrepreneurship competences as a learning outcome, and thus the development of certain competences could be considered as a side effect of the didactic of the course and pedagogical delivery of the classes. Based on the responses of professors it can be concluded that creativity, working with others, and learning through experience were the most frequent entrepreneurship competences that students could develop attending courses they taught, although these competences were not written in the learning outcomes of the syllabuses.

Informal learning was performed by organizing four lectures delivered by local entrepreneurs and owners of successful companies. They presented to students their own business cases and shared knowledge and experience. It can be concluded that such informal learning improved students' previous knowledge about entrepreneurship, and that the speakers clearly explained their entrepreneurship business cases and stories. Students stated that such lectures delivered by entrepreneurs gave them a certain level of self-confidence to start thinking entrepreneurially. Students highly recommended that more such lectures delivered by entrepreneurs should be organized with examples from the practice and real sector. As indicated in [24], entrepreneurial intention and willingness to become entrepreneur increases by organizing such events out of formal learning with entrepreneurs as guest lecturers.

Statistical hypothesis tests showed that the following entrepreneurship competences: spotting opportunities, creativity, valuing ideas, self-awareness and self-efficacy, mobilizing resources, financial and eco-

conomic literacy, mobilizing others, taking the initiative and working with others improved during the third year of bachelor study program, while there was no improvement of the following competences: vision, ethical & sustainable thinking, motivation and perseverance, planning and management, coping with uncertainty, ambiguity and risk and learning through experience. Also, none entrepreneurship competence improved during the first year of master study program. This is an important finding for the future planning of students' entrepreneurship competences development since if a student in one course developed certain competence as a transversal competence with a thread and with its a level of progression, all successive courses which offer development of the same competence with the same learning outcomes (the same thread and the same level of progression) didn't contribute to new development of that competence. There was enough evidence to conclude that there is difference in proportions of students and professors regarding development of following entrepreneurship competences: spotting opportunities, creativity, valuing ideas, ethical & sustainable thinking, motivation and perseverance, mobilizing resources, financial and economic literacy, mobilizing others, taking the initiative, working with others, learning through experience. However, there was not sufficient evidence to warrant rejection of the claim that proportions of students and professors is same regarding development of following entrepreneurship competences: vision, self-awareness and self-efficacy, planning and management, coping with uncertainty, ambiguity and risk.

Although engineering students perceived they developed certain entrepreneurship competences during their studies, it was unintentional process, since syllabuses of courses and learning outcomes were not created for that purpose. However, it can be concluded that courses provide learning environment for students to develop certain entrepreneurship competences as part of regular delivery of formal learning. This research shows that it is important to pay attention to informal learning as well, out of regular classes, for the purpose of entrepreneurship competences development, since students expressed high level of satisfaction with such kind of learning.

Many scientific papers, like [9, 15, 22, 25] deal with impact of entrepreneurship education on development of certain entrepreneurship competences and entrepreneurship intention which can be considered as intentional development of entrepreneurship competences. Less intention was made to analyse non-intentional development of entrepre-

neurship competences. Similar findings to those in this research were suggested in [6], where it was stated that non-entrepreneurship professors in addition to teaching their own courses can increase students' entrepreneurship competences. Also, in [32] it was stated that entrepreneurship competences can be developed without entrepreneurship teaching, which is also similar finding as in this research.

However, the novel approach in this research reflects the fact that perception of improvement of students' entrepreneurship competences as they progressed through their study was investigated, as well as comparison of perception between students and professors regarding development of entrepreneurship competences through formal non-entrepreneurship learning. The limitation of this study is that it was carried out at one engineering Faculty of the University.

Long term strategy should be to review syllabuses of the courses this time with intention to systematically and intentionally develop entrepreneurship competences as well as innovation capacity of engineering students as learning outcomes. Syllabuses of engineering courses should be designed in a way to include development of certain entrepreneurship competences as well. Current assessment of learning outcomes of the courses based on tripartite model consisting of knowledge, skills and attitudes, jointly referred to as competences, should include tripartite assessment of entrepreneurship competences as well that are included in the syllabuses of the courses as learning outcome.

In future research revision of selected syllabuses should be done with the aim to intentionally include EntreComp competences as learning outcomes and then to measure difference in competences development and entrepreneurship intention before and after this revision of syllabuses. Also, future research should include analysis of development of entrepreneurship competences through informal entrepreneurship learning by organizing lectures delivered by entrepreneurs.

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Appendix

Questionnaire for students

Dear Students,

The aim of this questionnaire is to get the students' perception and analyse how much the courses you studied at the Faculty of Mechanical Engineering helped in developing your basic entrepreneurship competences. It takes only a few minutes to answer the questions.

The mentioned entrepreneurship competences were created within the publication *EntreComp: The Entrepreneurship Competence Framework*, published by the European Commission.

- If you are enrolled in the 3rd year of the 1st study cycle, your answers should only refer to the first two years of your studies
- If you are enrolled in the 1st year of the 2nd study cycle, your answers should only refer to the three years of the first study cycle of your studies

- If you are enrolled in the 2nd year of the 2nd study cycle, your answers should refer to the 1st year of the second study cycle and to the three years of the first study cycle of your studies
- If you have graduated from the Faculty, your answers should refer to your entire studies during the second and first study cycles

How to complete this questionnaire:

Below is a list of competencies with clarification in parentheses, and you will:

- leave the square blank if you did not acquire the specified competence during your studies at the Faculty

- click on the box if you acquired the specified competence during your studies at the Faculty

Filling in this questionnaire is anonymous.

Q1: Please select study cycle and year of study you are currently enrolled:

- 1st study cycle 3rd year
- 2nd study cycle 1st year
- 2nd study cycle 2nd year
- Alumni

Q2: Please select study program you are currently enrolled in (that you graduated):

- Energetics, process technics and environmental engineering
- Industrial engineering and management
- Machine production engineering
- Machine constructions
- Engines and vehicles
- Defense technologies
- Wood technologies

Q3: According to the instructions written above, select entrepreneurship competences, noting that it is possible to choose one, more than one or none of the competences:

- Spotting opportunities (Identify and seize opportunities to create value)
- Creativity (develop creative and purposeful ideas)
- Vision (develop a vision to turn ideas into action)
- Valuing ideas (recognise the potential an idea has for creating value and identify suitable ways of making the most out of it)
- Ethical and sustainable thinking (assess the consequences of ideas that bring value and the

effect of entrepreneurial action on the target community, the market, society and the environment – act responsibly)

- Self-awareness and self-efficacy (believe in ability to influence the course of events, despite uncertainty, setbacks and temporary failures)
- Motivation and perseverance (stay focused and don't give up - be determined to turn ideas into action and satisfy your need to achieve)
- Mobilizing resources (get and manage the material, non-material and digital resources needed to turn ideas into action and make the most of limited resources)
- Financial and economic literacy (estimate the cost of turning an idea into a value-creating activity)
- Mobilizing others (Inspire, enthuse and get others on board)
- Taking the initiative (initiate processes that create value, take up challenges and act and work independently to achieve goals)
- Planning and management (set long-, medium-, and short-term goals, define priorities and action plans, adapt to unforeseen changes)
- Coping with uncertainty, ambiguity and risk (make decisions dealing with uncertainty, ambiguity and risk)
- Working with others (work together and cooperate with others to develop ideas and turn them into action and network)
- Learning through experience (learn by doing)
- None of the stated competences

Questionnaire for professors

Dear Professors,

The aim of this questionnaire is to analyse how the syllabuses of the courses taught at the Faculty of Mechanical Engineering contribute in developing students' entrepreneurial competences. It takes only a few minutes to answer the questions.

The mentioned entrepreneurship competences were created within the publication *EntreComp: The Entrepreneurship Competence Framework*, published by the European Commission.

Please fill in the questionnaire only for the syllabuses of the courses you teach in the 3rd year of the 1st study cycle and in the 1st and 2nd years of the 2nd study cycle. Please fill in the questionnaire for each course you teach separately.

How to complete this questionnaire:

Below is a list of competences with explanation within brackets, and you will:

-leave an empty circle if the course syllabus does not offer the student to acquire the specified competence after attending and passing the course

-click on the circle if the course syllabus offers the student to acquire the specified competence after attending and passing the course

It is not necessary that the mentioned entrepreneurship competences are explicitly stated in the learning outcomes of the course syllabus.

When filling out the questionnaire for other subjects that you teach, it is necessary to fill in the questionnaire again. You can use the 'submit another response' option or open the sent link again.

Q1: Please write name of the course:

Q2: Please select study cycle and year of study when the course is taught:

- 1st study cycle 3rd year
- 2nd study cycle 1st year
- 2nd study cycle 2nd year

Q3: Please select study program where the course is taught:

- Energetics, process technics and environmental engineering
- Industrial engineering and management
- Machine production engineering
- Machine constructions
- Engines and vehicles
- Defense technologies
- Wood technologies

Q4: According to the instructions written above, select entrepreneurship competences, noting that it is possible to choose one, more than one or none of the competences:

- Spotting opportunities (Identify and seize opportunities to create value)
- Creativity (develop creative and purposeful ideas)
- Vision (develop a vision to turn ideas into action)
- Valuing ideas (recognise the potential an idea has for creating value and identify suitable ways of making the most out of it)
- Ethical and sustainable thinking (assess the consequences of ideas that bring value and the

effect of entrepreneurial action on the target community, the market, society and the environment – act responsibly)

- Self-awareness and self-efficacy (believe in ability to influence the course of events, despite uncertainty, setbacks and tempo-rary failures)
- Motivation and perseverance (stay focused and don't give up - be determined to turn ideas into action and satisfy your need to achieve)
- Mobilizing resources (get and manage the material, non-material and digital resources needed to turn ideas into action and make the most of limited resources)
- Financial and economic literacy (estimate the cost of turning an idea into a value-creating activity)
- Mobilizing others (Inspire, enthuse and get others on board)
- Taking the initiative (initiate processes that create value, take up challenges and act and work independently to achieve goals)
- Planning and management (set long-, medium-, and short-term goals, define priorities and action plans, adapt to unforeseen changes)
- Coping with uncertainty, ambiguity and risk (make decisions dealing with uncertainty, ambiguity and risk)
- Working with others (work together and cooperate with others to develop ideas and turn them into action and network)
- Learning through experience (learn by doing)
- None of the stated competences

Questionnaire for informal learning

After attending the lecture, please take a few minutes to fill out the questionnaire. The questionnaire consists of 5 questions.

Please answer questions 1 to 3 with:

- 1 - very satisfied
- 2 - satisfied
- 3 - not satisfied.

Please answer questions 4 and 5 with:

- 1 - Yes
- 2 - No.

Q1: The lecturer showed enthusiasm and interest in transferring knowledge to students:

- 1 - very satisfied
- 2 - satisfied
- 3 - not satisfied

Q2: The lecture improved my previous knowledge of entrepreneurial skills:

- 1 - very satisfied
- 2 - satisfied
- 3 - not satisfied

Q3: The lecturer clearly explained his/her entrepreneurship story:

- 1 - very satisfied
- 2 - satisfied
- 3 - not satisfied

Q4: The lecture gave a certain level of self-confidence to start thinking entrepreneurially:

- 1 - Yes
- 2 - No

Q5: I would like more such events to be organised at the Faculty with examples from the practice of entrepreneurship (first two events):

- 1 - Yes
- 2 - No