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Electrical Engineering Students' Attitudes About Elective Economics/Business Related Courses – A case study

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A survey with 53 questions was carried out among the second-year students of the Faculty of electrical engineering and computing, University of Zagreb, Croatia, in June 2020, to acquire feedback about the motives of engineering students to elect economics/business-related courses when they have alternatives, their previous knowledge of economic topics, and basic financial literacy. The gender differences in the answers were statistically tested, showing no important differences. However, the structure of the population implied that the female students were less interested in the economics/business courses.

Universities play a critical role in developing the intellectual capabilities of students and providing the educational foundation necessary for economic development in knowledge-intensive societies (Drucker 1969; Powell and Snellmen 2004). For students to make the most of the opportunities provided by university education, professors and programs attempt to offer courses that capture student attitudes and interests as motivational variables that promote positive attitudes and performance in the classroom (Krapp and Prenzel 2001). In the case of engineering students, promoting a greater interest in business can help ensure that students not only understand the technical skills needed to acquire and build a career but that they also learn about business and the economic context in which they apply those skills.

Students who find relevance and interest in a subject are often seen to develop greater mastery in their chosen field. This has been demonstrated in studies examining the technological literacy of students (Svenningsson et al. 2016). Thus, understanding student preferences and the factors that distinguish those preferences allow professors and programs to not only promote certain courses, but also student success.

This study examines the level of interest shown by engineering students in taking business-oriented elective courses offered in their program. Through this examination, one of the factors this study sought to explore was a connection in the gender gap in male/female participation in STEM fields, like electrical engineering and computing, and the interests of male and female students in those programs in pursuing business and economics electives. A previous study comparing preferences in academic entrepreneurship education in Croatia and Slovenia found there were no significant differences between genders when examining student perceptions and preferences in the importance of academic activities in the program (Potocan, et al. 2021). However, given the well-documented gap in between the genders in the STEM fields generally (OECD 2008, Ceci, et al. 2009), this study sought to understand how gender would impact the students' interest in economics and business oriented courses as electives in the STEM field. The study focused on the use of Mann-Whitney tests as a way to better understand the data and make recommendations for further research.

The study sampled students from the Faculty of Electrical Engineering and Computing (abbrev. FER; https://www.fer.unizg.hr/en) which is a part of the University of Zagreb, Croatia (http://www.unizg.hr/homepage/). FER offers research-oriented undergraduate, graduate, and post-graduate programs (specializations and doctoral) in the areas of electrical engineering and computer science/engineering. Although the study programs at FER are concentrated on engineering/computing topics, the students must take, each semester, at least one of the elective, so-called "transversal courses," outside the school's mainstream. Within the undergraduate programs, there are currently three economics and/or business-oriented elective courses called Management in Engineering (2nd and 4th semester), Engineering Economics 1 (3rd and 5th semester), and Engineering Economics 2 (4th and 6th semester). The latter is also offered to the graduate students (2nd and 4th semester). The survey was organized in June 2020 for the students enrolled in Engineering Economics 2. The basic contents of these courses can be found at the following web addresses:

- https://www.fer.unizg.hr/en/course/mui_a (Management in Engineering)
- https://www.fer.unizg.hr/en/course/engeco1 (Engineering Economics 1)
- https://www.fer.unizg.hr/en/course/engeco2 (Engineering Economics 2)

Table 1 contains the description of the sample of students who took the survey, and the wider student population, by gender. Table 1 reveals some general features related to male/female student participation in FER's programs in general and economics courses in particular. The percentage of female students in the grand population was about 23%. However, there was a notable gender difference in choosing Engineering Economics 1: 45,40% males vs. 29,22% females, giving a big gap of about 16 index points. This data shows male students were more interested in economics and business-oriented content. However, this gender gap significantly diminished in the next semester, when Engineering Economics 2 was elected by 31,51% of male students and 23,88% of females, giving less than 8 index points of difference. However, the total enrollment in economic courses fell by almost a third. The reason for that is presently not known, and it was not investigated in this research.

Regarding the sample size relative to the population, 93,91% of students who were offered to fill in the survey completed it. Whereas all female students enrolled in Engineering Economics 2 took part in the survey, the percentage of males was 92,55% - still a high number. Therefore, one can conclude that the sample was highly representative of students who elected to pursue courses in business and economics as a part of their engineering program.

To establish a more general context, female student participation at FER across time should also be briefly mentioned. To this end, some very basic data were obtained from FER pertaining to the last ten academic years. The authors expected (probably due to the usual cultural prejudices) the share of female students to have been growing slowly yet consistently. However, this expectation was not met. During the period from 2010/11 to 2019/20, the average share of women was 20,28%. The fluctuations from that average were notable, to some ±4 percent points, which is about plus/minus a fifth of the average, and were seemingly not of a random walk kind (see Fig. 1). Be it a periodical occurrence or not, the fact remains that about 20% of female students enroll in a locally prestigious study[1]. This is in a significant disproportion with the fact that, in total, much more than half of all tertiary school students in Croatia are women. This is also reflected more broadly by trends seen across OECD countries and other international trends (OECD, 2011). Fig. 2 shows the age and gender structure of all students that graduated/completed university or professional tertiary education in Croatia in 2018 (CBS, 2019, p. 13). Altogether, the share of female students at FER is about 3,5 times lower than in all tertiary schools in Croatia, which shows how deep the gender divide is when considering women pursuing STEM careers through higher education.

It is also interesting to observe the share of women in university programs in economics in Croatia. At the four largest tertiary schools of economics in 2018, the percentage of female graduates was 65,8% (CBS, 2019, p. 27) – a 3,9 times higher figure. That indicates the preferences of aspiring students (and quite possibly their parents) when choosing which field of study to pursue may be significantly different depending on the student's gender, at least when one compares engineering and economic professions. Therefore, studying other gender differences in engineering students' attitudes related to economics/ business courses creates an important point to gauge interest, engagement and draw comparisons.

[1] FER is, in popular perception, probably the most prestigious tertiary school in Croatia. However, we could not find any published scientific or at least professional reference to corroborate that. The only „hard evidence" that can support it is the fact that the best-performing high-school graduates at math and physics state SATs do enroll in FER (Gelenčir, 2022, based on the official statistics by the Croatian Ministry of Education and Science).

The Survey Design

The survey had the following main parts:

- A brief introductory letter from teachers to students.
- Quick instructions on how to fill out the form.
- A set of 53 questions out of which only the first 32 were analyzed for the purpose of this study:
- Q01 – Q02: General information (age and whether they were enrolled in the course Engineering Economics 1).
- Q03 – Q17: Student's previous knowledge and experience in finance, economics, business, and similar.
- Q18 – Q32: Students' attitudes about Engineering Economics and similar courses and related additional learning resources.

The detailed table of questions was omitted here for brevity, but it can be obtained from the authors with the statistical analysis results across all the 53 answers. Partial results from this study were presented in an initial form in Sabolić (2020).

The multiple-choice answers offered to students were organized on a Likert scale (Joshi *et al*., 2015) with 5 points, as described in Table 2.

Methods

After a total of 185 students filled in the survey[2], the obtained data set was analyzed using the following methods and techniques:

- Computing basic descriptive statistics across questions and students (mean, standard deviation, skewness, kurtosis, median, adjusted median[3], other selected relations between these parameters).
- Statistical analysis of gender differences in answers to all the questions and their interpretation.

As already mentioned, the answers to most of the survey questions were distributed non-symmetrically and non-normally. In most cases, they could not be regarded as similar enough to the Gaussian distribution, nor to any other standard one. Therefore, the usual parametric tests for the equality of means could not have been used. The reasons for non-normality can be sought in too small samples (probably not the case here), and/or the non-Gaussian nature of the responses, or both.

The students' answers to each question were tested for equality of medians using the Mann-Whitney *U*-test for two independent groups (Mann and Whitney, 1947; Conover, 1980; Nachar, 2008; Moore *et al*., 2011).

The results of the Mann-Whitney tests

Table 3 presents the *p*-values for six survey questions with the null hypothesis of the equality of female and male answer medians that can be rejected with a statistical significance of 10% or better. Out of these six, only two can be rejected with a significance of 5% or better.

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2 The raw data with students' personal data deleted are available upon request sent to the corresponding author's e-mail.

3 Because of the coarse raster of answers offered in the Likert scale that was used, the median can take only five discrete values. However, as the number of responses was quite high, the median could be too rough a measure of central tendency. Thus, the notion of "adjusted median" was devised in the following way: Suppose that the median obtained from the population response equals 4, and that the answer 4 was returned by R responders out of the total of N. Next, say that L responders returned a valuation lower than 4. Let "adjusted mean" be somewhere between 3,50 and 4,50 so that the value 3,50 is assigned to the ordinal number of L, and 4,50 is assigned to the ordinal number of $L+R$. The "adjusted mean" then simply equals: $3{,}50 + [(N/2) - L]/R$. For example, if the sample size N was 137, the response 4 was given by $R = 32$ people, and the response lower than 4 was returned by $L = 43$ persons, the adjusted median would equal 4,30, which is higher than the true value of 4. That indicates that the true median position is considerably closer to the next-higher class than to the next-lower one, giving a somewhat better signal of central tendency. The details and the rationale are available from authors.

Table 1. Basic statistics of the student sample and population. All data pertain to the spring semester, 2019/20. Source: FER and authors' calculation.

	Male	Female	All	Male (%)	Female (%)	All (%)
Grand population	511	154	665	76,84	23,16	100,00
Population	161	36	197	81,73	18,27	100,00
% relative to Grand population	N/A	N/A	N/A	31,51	23,88	29,62
Grand population members previously enrolled in Engineering Economics 1	232	45	277	83,75	16,25	100,00
% relative to Grand population	N/A	N/A	N/A	45,40	29,22	41,65
Sample	149	36	185	80,54	19,46	100,00
% relative to Population	N/A	N/A	N/A	92,55	100,00	93,91
% relative to Previously enrolled in Engineering Economics 1	N/A	N/A	N/A	64,22	80,00	66,79
Sample members previously enrolled in Engineering Economics 1	129	30	159	81,13	18,87	100,00
% relative to Sample	N/A	N/A	N/A	86,58	83,33	85,95
% relative to Population	N/A	N/A	N/A	80,12	83,33	80,71

Definitions:

Grand population consists of all the second year's FER students enrolled in the spring semester of 2019/20.

Population consists of all the students enrolled in Engineering Economics 2 in the spring semester of 2019/20.

Sample consists of all the members of the population who took the survey.

Note:

Grand population members previously enrolled in Engineering Economics 1 are members of the grand population who were previously enrolled in Engineering Economics 1 in the spring semester of 2019/20.

Sample members previously enrolled in Engineering Economics 1 are members of the sample who were previously enrolled in Engineering Economics 1 in the spring semester of 2019/20.

The incoming students from the Erasmus+ or other exchange programs are omitted.

Table 2. Answers offered in the 5-point symmetric Likert scale used in the survey. Source: authors.

Standard answers to the questions organized on a Likert scale		
Answers in the five points of the Likert scale	**Type**	**Numerical code**
I fully disagree.	Totally negative	1
I disagree.	Basically negative	2
I do not agree or disagree.	Neutral	3
I agree.	Basically positive	4
I fully agree.	Totally positive	5

Table 3. The list of survey questions with *p*-values lower than 10%. Source: authors.

Q	**Q8**	**Q18**	**Q21**	**Q25**	**Q39**	**Q46**
***p*-value (%)**	8,24	9,49	8,84	1,35	5,93	4,50

Figure 1. Share of the female students at FER enrolled in the first year of study, expressed as the deviation from the 10-year average of 20,28%. The year at the abscissa pertains to the beginning of the academic year (e.g., 2011 denotes 2011/12). Corresponding R^2 values for the regression lines are: 0,629 (linear), 0,912 (sine), and 0,916 (poly). Source: authors, based on data obtained from FER.

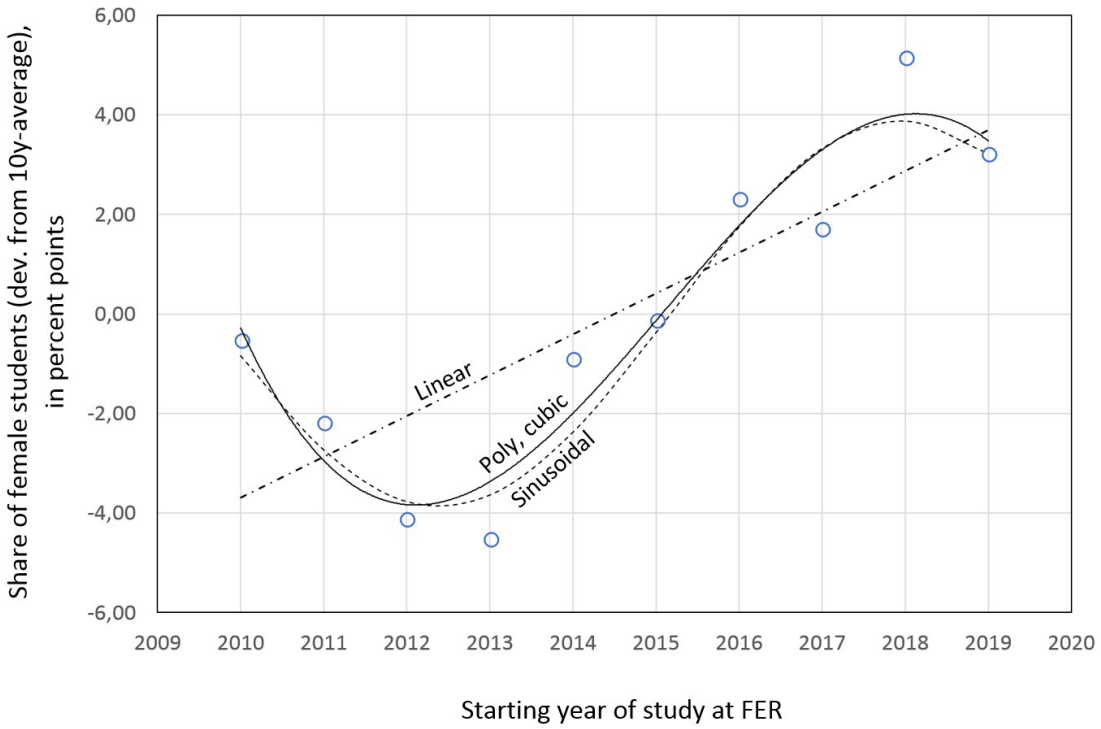
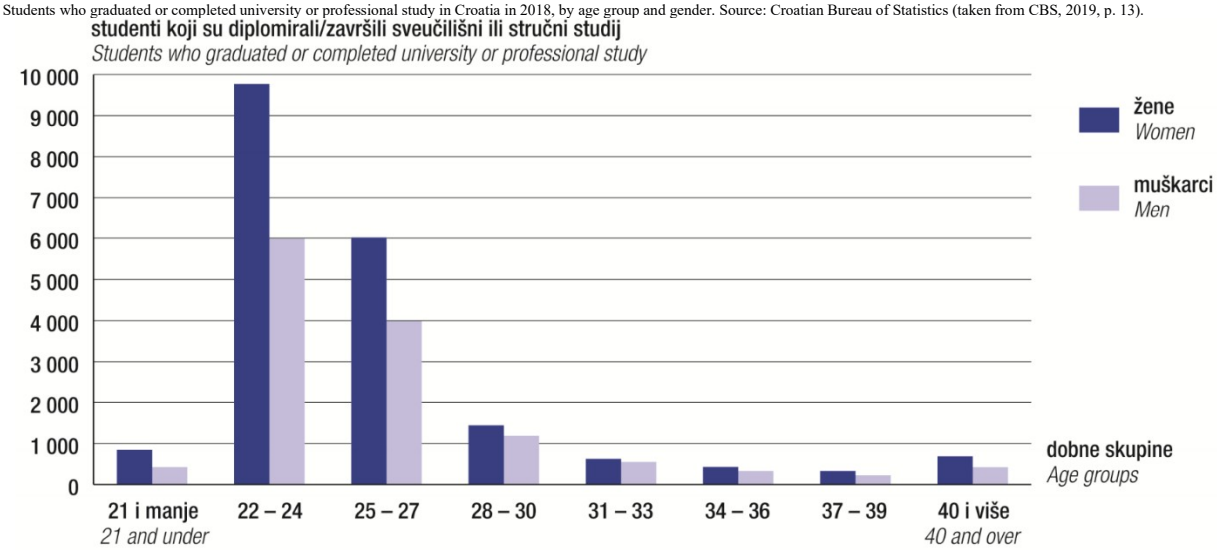


Figure 2. Students who graduated or completed university or professional study in Croatia in 2018, by age group and gender. Source: Croatian Bureau of Statistics (taken from CBS, 2019, p. 13).



The two questions answered with the most significant observable gender differences were:

- Q25: *I would like to present my own entrepreneurial idea or already started project, or my own business-related knowledge/experience, at a FER Business Workshop*.[4]

The male students expressed more enthusiasm regarding that. It was an expected outcome, though, and it was in line with the observed lower level of interest of female students in business/economics topics. However, one should also note that the share of students who gave a positive answer was pretty low: about 6,5%. It would not be very surprising even if that figure was lower. Not many second-year undergraduate students have already seriously contemplated an entrepreneurial project, let alone have realized one.

- Q46: *I think it is good to use the online medium to invite as many as possible guest lecturers from Croatia and abroad who are esteemed professionals, businesspersons, scientists, or professors in business economics*.

The female students gave a more positive response. It cannot be firmly explained without further investigation, and it is at least partially inconsistent with the Q25 results. It can only be hypothesized that bringing in foreign guest lecturers usually means more diversity and broadness regarding the topics and styles. This may mean that female students are more interested in networking opportunities presented by the courses. In contrast, domestic guests are traditionally businesspeople strictly focused on their particular narrow line of work and not belonging to the academy.

Anecdotally, The authors believe they noticed over the years that the male students in their discussions often go deeply into the operative or strategic issues related to the presenter's concrete business. In contrast, female students are more oriented to general matters such as business ethics, carrier management, accounting, financial reporting, etc. Also anecdotally, the male students at FER

[4] An extra-curricular business-oriented activity regularly performed at FER once a week. It hosts either notable people from real business or business education, or less frequently, students with their own business-related projects.

are much more active with their discussions and questions in the sessions with guest lecturers, while the female students are less active or likely to raise questions.[5]

Regarding the Q39, where the median equality hypothesis was rejected at the significance level of about 6%, it seems that male students preferred the online mode of learning somewhat more than their female colleagues. However, an interesting split in attitudes (in both genders) was observed here: about 42% of all students prefer online mode over in-class, about 40% do not, and about 18% are neutral. There is a significant binary division among students about this.

As for the rest of the Q's exhibiting possible attitude differences with a modest level of significance, they will be only stated briefly here:

- Q08: It seems that the male students slightly more often express a want/intention to stay in the technical field for the whole career (however naive that may seem).
- Q18: Female students seem to care more for non-mainstream courses/skills than males.
- Q21: A larger *percentage* of female students visit FER Business workshops (although the males heavily outnumber them because there are about 80% of male students in the whole population).

It can be concluded that statistically significant differences in attitudes occurred in merely a few survey questions. However, the topics covered by those questions appear to not carry enough weight to draw overarching conclusions. Therefore, the gender differences proved not to be of significant relevance, except for the previously commented differences in the interest in the business/economics topics, which is consistent as being more prominent among male students.

It is vital for the tech students because they, almost by necessity, see the business/economics courses as an opportunity to acquire additional practical skills rather than classical book knowledge. On the other hand, the tech students usually do not have problems with mathematics, so they do not have problems understanding mathematical modeling, either. Therefore, when economics is presented to them as something that is, in a *philosophical* sense, actually quite close to engineering (both deal mostly with optimization of resources, just different ones), they can start seeing the whole field of economics in a different light. They can also break the "mental barrier" usually created by considerable differences in meta-languages of the two professions and by cultural prejudices, equally as well.

Conclusions and Further Work

An ad-hoc survey with 53 questions was carried out among the second-year students of the Faculty of electrical engineering and computing, University of Zagreb, Croatia, in June 2020. The studied population comprised 197 students who enrolled in an elective course called "Engineering Economics 2". Out of them, 185 chose to participate in the survey, so the sample group had about 94% of the population.

The gender differences in the answers to all survey questions were statistically tested. Although there were statistically significant differences in average answers to only a few questions, the female and male attitudes generally did not show significant differences.

However, as may be the most essential gender-related difference, it was observed that the female answers were notably more grouped around neutral responses. It may be attributed to the female engineering students being less interested in the business/economics-related content and a cultural tendency of women to be less prone to express opposing views. Thus, these results are consistent with similar findings from other Slovenian and Croatian universities (Potocan et al. 2016) where limited differences were found between male and female interest. This supports the call for a more systematic approach to encouraging female participation in economics/business-related courses and attending workshops and other extracurricular activities. The encouragement of participation and promoting interest through the activities that female students already show interest in, such as global guest speakers, could help increase interest. It can also help overcome general prejudices about "business not really being for women," which are still quite present in Croatian society despite notable improvements over the last decades.

[5] None of it can be corroborated with any meaningful analysis that would emanate from the piece of research presented in this paper. It is just the authors' impression, but that can also be under influence of omnipresent cultural prejudices. Therefore, it will be left here as-is, for anyone with similar experiences, or interested in further discussions or research of the gender differences in students' interests and may generate suggestions for further research.

Given that in Croatia, women enroll in university programs in the technology areas in a proportion almost four times lower than their general share in tertiary study programs, this research makes a contribution in highlighting a significant challenge faced in technology-oriented schools. Regardless of whether female preferences in tertiary study are sociocultural or psychobiological (Ceci et al. 2009), the benefits of promoting interest in both areas of study for both genders should be a goal for universities as they seek to develop the knowledge economy (Purkovic et al. 2020).

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