SHIFTING STUDENT PERCEPTION ON ONLINE AND IN-PERSON ENGINEERING LABORATORY SESSIONS DURING THE COVID-19 PANDEMIC

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Conference Key Areas: *Methods, formats and essential elements for online/blended learning, Lab courses and projects in online/blended learning*
Keywords: *Please select one to four keywords*

ABSTRACT

During the academic year of 2020/21, because of the COVID-19 pandemic, universities were forced to make certain decisions about different types of classes and their nature. Depending on the ability of the university to ensure a safe environment, classes were held in person, or online. While most types of classes are easily transferred to an online environment, engineering laboratory sessions are not. This paper discusses the approach taken by the lecturers of the course „Fundamentals of electrical engineering" in professional study of electrical engineering at the Zagreb University of Applied Sciences, where students were able to choose between online and in-person laboratory sessions. The paper examines student choices and their gradual shift towards online sessions during the subsequent increase in cases in Croatia and following a series of earthquakes that hit Zagreb and the surrounding area at the time.

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1 INTRODUCTION

1.1 Laboratory sessions in an engineering course

For a student attending an engineering based study programme, laboratory sessions are unavoidable reality for most of the courses during the course of an academic year. The idea of these types of classes is to provide students with hands on experience with different types of equipment and practical examples that validate theoretical knowledge that was gained through instructions during the typical ex cathedra classes.

The objectives of these practical engineering laboratory sessions, among others, are [1]:

- familiarize students with instrumentation and tools for measurements necessary to observe certain occurrences of particular interest to the course subject matter
- teach students specific methodologies necessary for design and building certain parts and systems
- help students identify limitations of theoretical models
- foster a research based approach to practical problems
- develop the ability to collect and interpret data
- develop the ability to communicate about their findings, both orally and through the written word

Since Zagreb University of Applied Sciences is a “polytechnic” type of study programme, practical experience is one of its core principles and laboratory sessions are of utmost importance. The same can be said for the course that is studied in this paper, a first semester course called Fundamentals of Electrical Engineering. The course is worth 9 ECTS points and covers the most important topics necessary for a student to adopt to be able to successfully handle third and fourth semester courses.

In this specific course, students have five laboratory sessions during a 15 week semester. Each session is three academic hours long and the contents of the five exercises are:

- Ohm’s law and Kirchhoff’s laws
- transient state, RMS and mean value of a signal
- voltage and current analysis in RLC circuit with sine excitation
- voltage, current and power measurements
- resonance

Considering the fact that most of the students that enroll the course posses very limited experience with the necessary equipment, time spent in the laboratory surroundings is invaluable for them and for the teachers.

1.2 COVID-19 pandemic disruption

During the 2019/20 and 2020/21 academic years, a disruption happened, caused by the COVID-19 pandemic. The teaching and the learning process shifted for the most

part online which meant that the usage of technology helped build a bridge between the teachers and students, who suddenly, for the most part, were not in the same room, as has been the case before. The bridge was formed by usage of streaming applications, presentation software, use of graphics tablets and other tools. This change has been the biggest challenge for the typical laboratory sessions.

This paper examines a shift in student perceptions on online and in-person engineering laboratory sessions during the COVID-19 pandemic in an engineering course named Fundamentals of Electrical Engineering at the Electrical Engineering department of the Zagreb University of Applied Sciences during the 2020/21 academic year and examines the possible rationale for student choices.

2 LABORATORY SESSIONS IMPLEMENTATION

2.1 Laboratory sessions during the pandemic

In early September of 2021, just before the start of the 2020/21 academic year, a decision was made by the Expert council of the Zagreb University of Applied Sciences by which all types of lectures, except for laboratory sessions and evaluations of knowledge were to be held online, while for the former, the decision of the type of implementation was left up to the teachers for every course separately. If the teachers decided to perform laboratory sessions or evaluations of knowledge in person, anti-epidemic and prevention measures had to be implemented.

After a brief discussion by the course lecturers, a decision was made for the laboratory sessions for the course Fundamentals of Electrical Engineering to be held in parallel; online and in-person. The students were given a choice between doing their lab work in person, or just following it online, trough prerecorded lectures from the lab, which resulted in practical laboratory sessions becoming demonstration exercises.

The lecturers felt that it was against anyone's interest to force one specific choice on the students and by doing so, possibly cause an infection or a local outbreak of COVID-19. Another reason for doing things in parallel was a sentiment that insisting on in-person laboratory sessions was impossible without an online alternative, simply because of the possibility of students inability to attend said in-person classes; either due to being a high-risk individual, or living with one, or getting infected during that time period.

As seen in *Table 1.*, 52.27 % of the students enrolled in the course chose to attend the in-person laboratory sessions, while the rest opted out and decided to attend the online versions.

Table 1. Initial poll results for the course Fundamentals of Electrical Engineering

Students enrolled in the course	In-person	Online
220	115	105

2.2 Anti-epidemic measures

In order to comply with anti-epidemic and prevention measures, which included a minimum distance of 2.5m between all students, the number of people in the laboratory had to be reduced to 6, from the previous 12 to 16. This meant an increase of number of groups in the lab during the week. Mask wearing was also mandatory. Also, in order to minimize potential contamination, after every group of students in the lab, all surfaces and the used equipment was sanitized. This all also led to the increased length of a laboratory session which was very problematic from an organizational point of view.

From an organisational standpoint, a course plan had to be made on an institutional level that would accommodate online and in-person classes done in parallel. In practice, a typical week was divided in two sections; one for online classes and one for in person. The number of days for each depended on the semester and number of students attending in-person classes.

One of the implemented measures was shifting everything unnecessary for the experiments themselves online. By doing so, a reduction in potential contact among temporary occupants of the labs was achieved. So, while typical laboratory sessions had a duration of three academic hours (135 minutes in total), by shifting pre-lab activity (homework relevant to the session and its evaluation) and laboratory report writing and evaluation online, which in turn meant they've become unproctored, a reduction of length for the sessions was done to two academic hours.

While pre-lab activity itself was unproctored even during the pre COVID-19 pandemic, a novelty was a sudden transition to online exams [2]. It was assessed that proctored online examinations after laboratory sessions could be done in various ways [3,4,5,6], but not without significant technical challenges facing lecturers and students in an already difficult situation and therefore, unproctored examination was chosen. After careful examination and research [7], this was implemented using a Learning management system (Moodle).

3 SHIFTING PERCEPTION

3.1 Data collection

Considering the students were given a choice to switch between the two types of laboratory sessions, a record of said choices had to be kept. Although the pre and post lab activities were shifted online and with that evaluations of student effort during the laboratory sessions were the same for students attending them in-person or online, a record of their choice was instrumental in organizing the in-person session. A fluctuating number of students translates to a fluctuating number of sessions and considering the additional work load on the lecturers, it was beneficial to know if enough students opted out of the in-person laboratory sessions to warrant a shuffle and reduction of available time slots in the lab during the semester. In short, a record has been kept for every individual and their choice and the possible change of said choice.

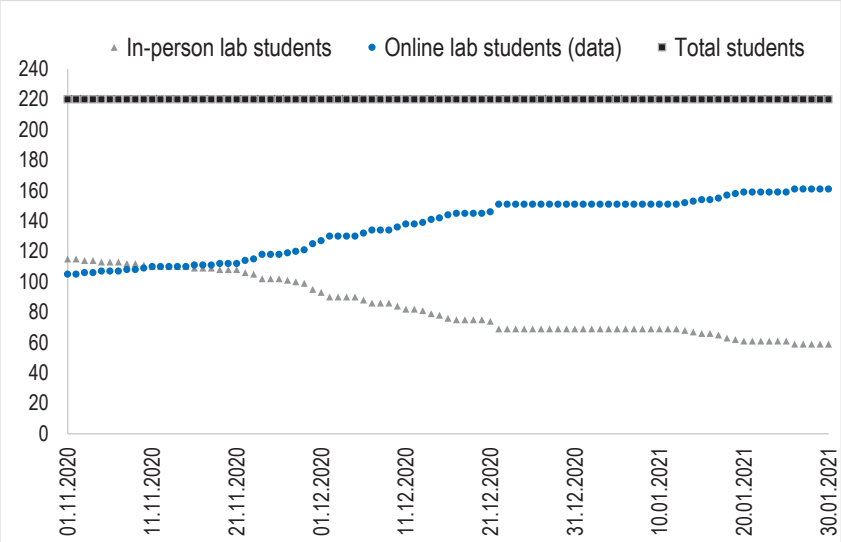

Fig. 1. Student choices through the semester

As seen on Fig.1., while a majority of students wanted to attend the laboratory sessions in-person at the start of the semester, after only 10 days, the numbers were right in the middle and after that a shift of perception towards online laboratory sessions gradually happened. This paper examines the role the COVID-19 pandemic had on said perception.

While the data collection for student choices were done in-house, the data on total cases in Croata was sourced from the "Our World in Data" website and can be publicly accessed on this link: https://ourworldindata.org/coronavirus/country/croatia

3.2 Data modelling

In order to properly study the possible connection between student choices and the COVID-19 pandemic, a Multi-Logistic Growth Model [8] was used to model the dynamic of infected inhabitants of Croatia and the dynamic of change in students opting for online laboratory sessions. The specific model with two successive life cycle intervals was chosen as it is a typical choice for modelling of spread of infectious diseases.

$$ML(t) = M_0 + \frac{M_1 - M_0}{1+\left(\frac{1}{u}-1\right)^{1-2(t-t_S)/\Delta t}} \quad (1).$$

Table 2. Multi-Logistic Growth Model parameters

Model parameters	Dynamic of infected inhabitants of Croatia	Dynamic of students opting for online laboratory sessions
M_0	30059	97
M_1	232387	159
t_s	-2.31	0
Δt	63.1	63.3

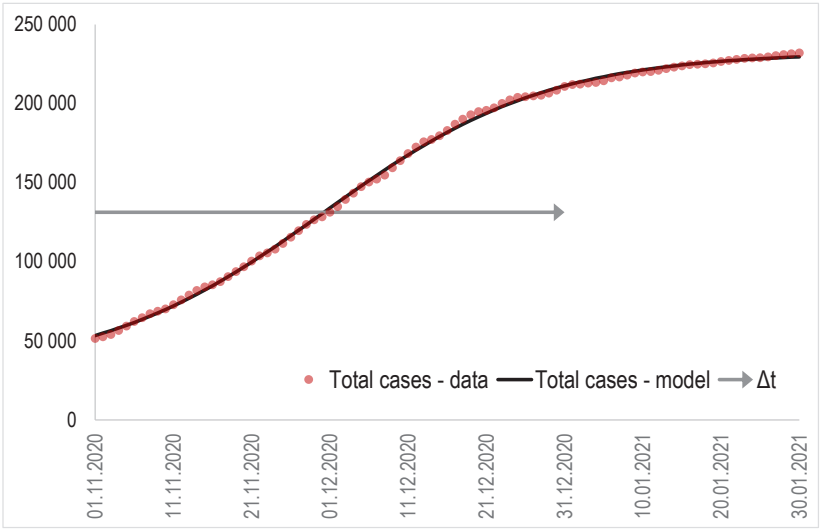

Fig. 2. Dynamic of infected inhabitants of Croatia

The t_s variable in the given in *Eq. (1)* represents the starting time of the model, while Δt represents the characteristic duration i.e. period needed for the diffusion to grow from $u*(M_1-M_0)$ level to $(1-u)*(M_1-M_0)$ level. u is a parameter that ranges from 0 to 1, but was set at 0.1 so that Δt in this case would represent time period needed for the diffusion to grow from 10% to 90%.

For the modelling of the dynamic of infected inhabitants of Croatia, the resulting optimal set of parameters M_0 and M_1 were calculated using the input data and the least squared method and can be seen in Table 2, specifically column 2. The same set of parameters was calculated using the same method for modelling the dynamic of change in students opting for online laboratory sessions and can also be seen in Table 2, specifically column 3. A visualisation of both models can be seen on Figures 2 and 3.

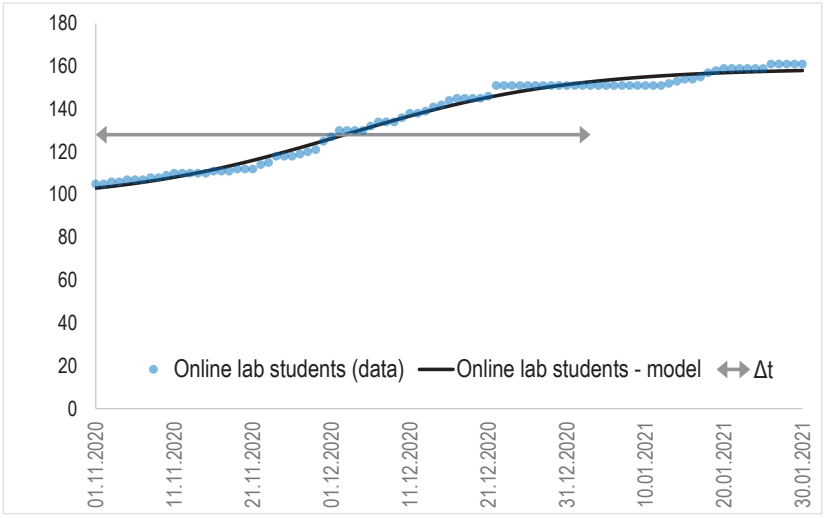

Fig. 3. Dynamic of students opting for online laboratory sessions

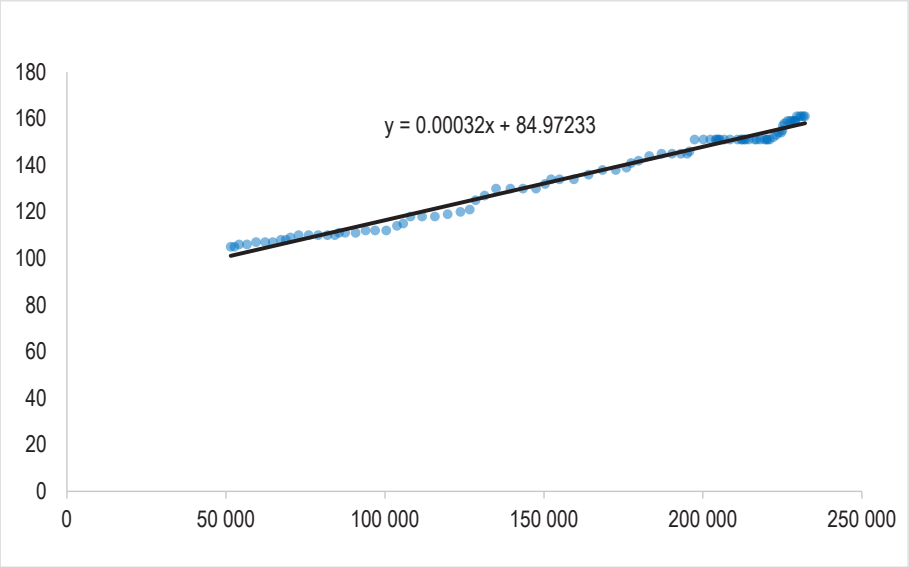

Fig. 4. Functional relationship between the number of infected inhabitants of Croatia and number of students opting for online laboratory sessions

3.3 Data interpretation

As seen in both cases, the model fits the data very well. The most significant connection between the two and a possible indicator of causality is approximately the same value of the Δt parameter, that represents the time period needed for the diffusion to grow from 10% to 90%, for both models. We further test this premise by studying the functional relationship between the number of infected inhabitants of Croatia and number of students opting for online laboratory sessions. As sen on Figure 4, a linear model can be applied, that can best be described by Eq. (2).

$$N_0(t) = 0.00032 * N_i(t) + 84.97 \quad (2).$$

This premise could and should be investigated in future research with internal student polling on student motivation in making a switch from in-person laboratory sessions to online ones.

Another interesting data point was the difference in the t_s parameter between the models. As seen, the difference was 2.31 days, and could be possibly explained by the slow fluctuation of data of severity of the COVID-19 pandemic in Croatia to students and time to process the data and decide to opt out of in-person laboratory sessions. This is also a topic of possible future research and could be answered by internal student polling.

3.4 Future data points

When we take into consideration that data collection and analysis was done for a course that was held in the first semester of the 2020/21 academic year, certain questions are left unanswered that could be answered next semester. Would the trend of more and more students choosing online laboratory sessions instead of in-person ones continue with the continued rise of total number of infected inhabitants

of Croatia? Considering the fact that three courses, which have the same student population as Fundamentals of Electrical Engineering, have also decided to let students choose their method of attending laboratory sessions, by studying that initial choice, we could have an indication towards an answer. As seen on Table 3, the decrease of students with a preference for in-person laboratory sessions is noticeable.

Table 3. Initial poll results for the summer semester courses

Course	In-person	Online
Electrical Measurements	52	168
Electronic components	36	184
Electricity and magnetism	53	167

4 CONCLUDING REMARKS AND FUTURE RESEARCH PERSPECTIVES

In this paper, we examine a balancing act that is laboratory sessions during COVID-19 pandemic. We articulate the importance of said sessions but also the difficult choices put in front of the lecturers, who had to decide on the form of the session while keeping in mind possible risks and ways of mitigating them. The main focus of the paper was in examining student preferences when faced with a choice between in-person and online laboratory sessions in a pandemic. Through modelling and fundamental analysis we believe that the main reason behind the shifting perception on online and in-person engineering laboratory sessions during the COVID-19 pandemic was the fear of a possible infection. A future research perspective is of course evaluating that premise through internal student polling after the end of the academic year and also data collection on subjects in the next semester and subsequential analysis.

Another interesting possible avenue of research is a comparison of future student success in courses that benefit from knowledge and skills acquired through laboratory session in one or more of courses mentioned in this paper. This would give us a unique opportunity to evaluate the difference in effectives of online and in-person engineering education. While there is some recent research done on inclusion of online pre-lab activities [9] [10] [11] and online homework [12] there is almost none on said subject.

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