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Using ICT To Motivate And Achieve Learning Outcomes In Live Teaching Of 650 Students

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ABSTRACT

This paper describes efforts and practices used in teaching a *Communication skills* course with two full time teachers to approximately 650 enrolled students. It is focused on issues including motivating students if they consider this course to be non-essential for their professional development and a nuisance in their study, achieving learning outcomes in an efficient way, and using of ICT for assessment and self-assessment of communication skills. The ways and means of leveraging ICT in achieving these goals are presented in the paper. The potential of ICT and multimedia to motivate, keep students on schedule, gain their attention in lectures and assess their knowledge is discussed, and lessons learned from six generations of students and how they influenced course re-design are elaborated.

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1 INTRODUCTION

1.1 Communication skills in engineering

It has long been recognized that engineering students need strong communication skills (Denning 1992) and it is even more so today. The engineering profession demands not only technical expertise but also the capacity to collaborate with diverse teams, interact with clients, and present complex ideas to non-technical stakeholders (Caeiro-Rodríguez et al. 2021). Engineers today work in multidisciplinary environments, where effective communication bridges the gap between different fields and facilitates the integration of diverse perspectives. Moreover, engineers frequently engage with clients, both internal and external, necessitating clear and concise communication to understand client needs, manage expectations, and deliver successful project outcomes. Effective communication, therefore, has emerged as a fundamental skillset for engineers. It is based on engineers' communication skills, which typically refer to a set of skills including oral communication, listening, writing, visual communication, decision making, conflict resolving, intercultural communication, group communication, and interdisciplinary communication (Mohan et al. 2010; Riemer 2007). According to some research, a lot of engineers spend a majority of their working hours communicating (Tenopir and King 2004).

Many technical universities offer communication skills courses as part of their curriculum, recognizing the importance of strong communication skills for success in engineering and other technical fields. Communication skills are integrated into the curriculum either as a separate (sometimes even two-semester (Caeiro-Rodríguez et al. 2021)) course with its own learning outcomes, or implicitly within other engineering courses (Winberg et al. 2020). Still, there is a prevailing perception that communication skills in engineering education are undervalued compared to technical knowledge (Willmot and Colman 2016). Engineering students often prioritize the acquisition of technical expertise, perceiving communication skills as secondary or unnecessary for their future professional roles (Alshare, Lane, and Miller 2011). This perspective stems from a traditional emphasis on mathematics, sciences, and problem-solving in engineering curricula, with limited attention given to communication competencies.

Numerous factors contribute to the hesitation or resistance of engineering students towards developing communication skills. The rigorous demands of technical coursework, heavy workloads, and time constraints may leave students feeling overwhelmed, with little incentive to allocate time and effort to non-technical aspects. Additionally, the limited exposure to communication training and lack of integration within the engineering curriculum may reinforce the notion that communication skills are not essential for engineering success.

1.2 Teaching communication skills to electrical engineering and computing undergraduates

Due to their recognized importance, communication skills are a part of the curriculum at the University of Zagreb Faculty of Electrical Engineering and Computing. The course *Communication skills* is an obligatory first-semester course worth 4 ECTS credits or approximately 100 to 125 hours of work. Typically, about 650 new students are enrolled in the course every year and the course is delivered both in English (for Erasmus students and students enrolled in the English program) and Croatian language.

The two main issues pertaining to the *Communication skills* course are that

- the ratio between the number of lecturers and students is very low (just like in many other higher education institutions and courses)
- course learning outcomes should, ideally, be assessed by evaluating them in practice, which is often difficult.

Combined, those two issues result in significant limitations related to design of teaching and assessment practices within the course and are amplified by engineering students' general lack of interest towards communication skills and focus on technical knowledge.

1.3 Objectives of this paper

In this paper, we report on the details of *Communication skills* course implementation and outcomes in context of the two main identified issues: low lecturer to student ratio and needs for an authentic assessment of learning outcomes. Due to the prevalence of those issues in today's higher education we hope and believe this will help other teachers or researchers in transferring our implementation to different settings or building upon it.

The rest of this paper is organized as follows. Chapter 2 presents more information about the *Communication skills* course: its structure, content, and implementation. In Chapter 3, key issues resulting from course implementation as well as approaches to dealing with them are described. Final conclusions are presented in Chapter 4.

2 COMMUNICATION SKILLS COURSE STRUCTURE AND CONTENT

2.1 Course topics and general structure

The *Communication skills* course taught at the University of Zagreb Faculty of Electrical Engineering and Computing has a 15 weeks structure with a 2x45 minutes lecture to cover each of the following 10 topics: e-mail communication; creating slideshows; writing a curriculum vitae; speaking, listening and solving conflicts; popular, technical, and scientific writing; negotiating and meetings; oral presentations; finding and evaluating information; key concepts in photography and video; and cultural differences. Additionally, one week is reserved for course introduction, two weeks are reserved for the midterm and final exams, and two weeks are reserved for students' presentations – pitches.

A total of 110 assignment credits can be achieved in the course. The achieved result is capped to a maximum of 100 assignment credits (for compatibility with other courses), and grades are assigned based on it with the threshold for the highest possible course grade being 90 assignment credits, and for the lowest passing grade 60 assignment credits. Course passing conditions, other than at least 60 assignment credits in total, include achieving at least 50% of assignment credits in each of course activity categories, which are: class preparation assignments (maximum 10 assignment credits), homework assignments (maximum 25 assignment credits), participation in live lectures (maximum 15 assignment credits), final course project (maximum 30 assignment credits), and final exam (maximum 10 assignment credits).

2.2 Activity categories

Class preparation assignments. Every course lecture topic has a class preparation assignment – a short assignment students should complete as preparation for the course topic of that week. Those assignments should give students basic information about a topic or point out its relevance. They are short and are designed to require as little effort in grading as possible, although they typically cannot be graded automatically. Examples of such assignments include a Moodle quiz where students should in a short text describe main differences between Microsoft PowerPoint and LibreOffice Impress, submitting a screenshot of an email account configured in Mozilla Thunderbird, or answering several questions about a video on the topic of cultural differences.

Homework quizzes. After every lecture, students should solve a short Moodle homework quiz related to the topic of that lecture. Those quizzes consist of approximately ten questions randomly selected from a larger database. Quizzes graded automatically and are aimed to help students revise basic concepts from the corresponding lecture topic.

Exams. There is little emphasis in the course on the midterm and final exam as it is difficult to assess communication skills in such a way. Both are implemented as Moodle quizzes with offered answers and are together worth 20% of the overall course credits.

Homework assignments evaluated using peer review. In order to include more practical assignments into the course, six such assignments were designed in the homework category: writing a formal e-mail according to a custom scenario, creating a slideshow with a narration, writing a narrative resume and a motivation letter for a job application, capturing a photograph and a video, and delivering a short presentation – pitch. All those assignments are graded by students (peer review) and aim to reflect something engineers are likely to face in their professional practice. Peer review is used for evaluating those assignments not only to achieve scalability and grade all assignments in a limited time, but also to make students aware of their peers' approach to the same assignments and to foster their critical thinking.

Peer reviews are performed using structured evaluation criteria – typically about 10 questions about the graded assignment with 3 to 5 offered answers. For every assignment, every participating student can submit their own assignment and evaluate assignments of up to five other, randomly selected students. The assignment credits each student gets for their submitted assignment are based on the average number of assignment credits obtained through peer reviews of their work, excluding the worst and the best evaluation. A small percentage of assignment credits is achieved for peer reviewing other students' assignments.

Technically, peer review is conducted by having students upload their assignments to OneDrive and submit the public access link in a Moodle activity. All submitted links are downloaded using Linux *wget* command and made available to students under randomized names through one of the Universities servers. Students are sent an email with a list of five links to assignments they should peer review and they can evaluate each of those five assignments in one of the five corresponding Moodle activities. The evaluations submitted by students are finally checked by course lectures. A percentage of randomly selected assignments, as well as assignments with large discrepancies in their evaluations are manually checked and assigned assignment credits by course lecturers. If assignment evaluation significantly diverges from its objective quality, then the student who evaluated the assignment receives no assignment credits for the corresponding homework assignment.

Some properties of submitted assignments are evaluated automatically – for example, presence of audio narration in a slideshow, and the obtained information is used as another benchmark of peer review quality during lecturers' controls.

Pitching is an activity conducted in a slightly different manner than other homework assignments. Pitching is introduced in the course to reflect a need of engineers to present their idea to an audience in a limited time (*elevator pitch*). It is graded by students, but right after it was performed in front of a live audience – other students from the same group – using AudIT audience response system (http://audit.altii.online). Since there are too many students to enable each of them to deliver a pitch in front of the whole lecture group, students of each lecture group are divided into groups of five members. Each group has approximately three weeks to prepare a pitch as a one-minute presentation about something they would like to change at their institution and one member from each of those groups will be chosen by the course lecturer to deliver the pitch. Assignment credits are assigned in part by course lecturer and in part by the audience as the average number of assignment credits for that group. Assignment credits are afterwards distributed among group members so that students within a group can award assignment credits within a group based on group members' contributions.

Participation in live lectures. Since live lectures are held in groups of between 200 and 250 students, maintaining students' focus is challenging. To help with it, AudIT audience response system is used. AudIT enables classical audience response system features including some innovative features like grouping textual answers to questions based on text similarity or redirecting textual answers to other applications.

AudIT is in live lectures used mostly for two kinds of questions: questions in which only correct answers result in assignment credits, and questions in which an opinion is asked for, so any meaningful answer will result in assignment credits. Both types of questions are used to maintain students‘ attention, while questions with correct answers are used, additionally, to facilitate retention. Students can also use audit to pose questions, anonymously or not.

Final course project and its alternatives. The final course project is the single course activity with most course assignment credits associated to it (30). In its default form it is a two-minute video presentation about a student's topic of interest that they hope to work on in context of later projects and their bachelor thesis. This short video presentation should be a demonstration of students' developed ability to find and evaluate information and communicate it in an understandable and pleasant way. Students, however, are also offered final project alternatives which are more aligned with course learning outcomes but also more challenging. Students have at least two alternatives to the final course project.

The first alternative is for them to independently organize and deliver a lecture on a topic of their choice, of at least 30 minutes in duration in an institution of their choice (for example, a library or high school) in front of an audience of at least 20 people. This is a practical way of practicing or proving one's communication skills since students must organize everything themselves and finally submit a video recording of the lecture as proof.

The second alternative is to take part in a community-based service learning cooperation established with the *Institute for Youth Development and Innovativity* where students develop simple hardware projects with technologies like *micro:bit* (https://makecode.microbit.org/) and *mBot* (https://www.makeblock.com/pages/mbot-robot-kit) and teach them to elementary school pupils. While this is more demanding than the final course project, it is beneficial for students and for the community.

3 RESULTS, OUTCOMES AND CHALLENGES

The *Communication skills* course has been held in its described form since 2016 with slight changes and improvements implemented every year based on students' feedback as well as lecturers' feedback and impressions. Every year, students are at the end of the semester asked to write their opinions on specific course elements like peer review and final course project and to provide general feedback about the course in the final survey. The survey is not anonymous so that participating in it can be rewarded with a small amount of assignment credits, but it also includes a separate fully anonymous activity where students can submit anonymous feedback if they feel more comfortable that way. On average, approximately 550 students would fill in the feedback survey and approximately 15 would comment in the anonymous part of the survey.

Key observations obtained by course lecturers' reports and students' final course survey responses over the last three years of the course, as well as lessons learned and changes introduced to the course based on them are listed here:

1. **Using an audience response system is helpful for both lecturers and lecture audience**. Typically, about 75% of students enjoy using AudIT or report that using AudIT helps them to remain focused on the lecture. An additional feature of the AudIT audience response system that students would like is instant feedback about the assignment credits they receive for their answers. Since AudIT is designed not to force a lecturer to prepare their questions or correct answers in advance, this feature is currently not supported, but will be implemented so that the system prompts the lecturer for the correct answer to the current question before advancing to the next one. For lecturers, AudIT, or an audience response system in general, is essential for live lectures since it is impossible to engage such a large audience without it. Students only occasionally engage in submitting inappropriate answers or content. The flexibility of the AudIT tool allows course lecturers to use ad-hoc questions, which the lecturers find useful for adapting the course of a lecture.
2. **Most students prefer the minimal effort approach and few of them (~2%) choose activities like final project alternatives** - a self-organized lecture or the community-based service learning opportunity. Furthermore, approximately 20% of students do not participate in pitching. Students report that they find such activities interesting but avoid them because they require more work or because they do not feel ready to pitch in front of such a large audience. Students who do take part in such activities typically report being most satisfied with their outcomes, since they get to share something they like with an audience that is most appreciative of their work (lecture audience or elementary school pupils who typically enjoy such hardware projects). Still, motivating additional students to do more than is required from them in a non-technical course will probably remain a challenge.
3. **Some students dislike peer review**, but this percentage is now below 5% and has a declining tendency. Factors that helped in reducing the percentage of such students over the years are: better elaboration of peer review grading criteria; providing examples of good and bad assignments; awarding assignment credits for peer review faster; providing students with their peers' textual comments as feedback; and enabling a transparent procedure for re-grading assignments in case students think they were unjustly graded in per review. A small percentage (~1%) of students are affected by the rule that they will lose all assignment credits if they evaluate another student's assignment not in line with its objective properties. Overall, peer review is another important element of the course both for achieving its scalability and target learning outcomes.
4. **Students appreciate fast feedback on submitted assignments and achieved assignment credits**. This was one of the most common concerns raised by students in the final course survey. Most delays in assignment credits' updates were caused by the need for the lecturers to check peer reviews with significant differences in their evaluations and course lecturers' perspective, manual checking of peer reviews is one of the most time-

consuming tasks in the course. Further automation of some peer review procedures on the lecturers' side helped in dealing with this issue and improving the assignment credits' update time over the last three years.

5. **Still, students dislike too many email notifications regarding assignment credits**. Those notifications are automatically sent and, given there are more than 60 activities associated with assignment credits in the course (a class preparation assignment, assignment credits for participating in live lectures, homework quiz, and homework assignment for every week), they are sent often. A relatively simple solution to this issue is automatic sorting of emails related to assignment credits updates, but this must be implemented by students in their mailboxes and in a way that won't make them completely unaware of them.
6. **Students are generally satisfied with the course**. Overall, a lot of students submit positive comments about the course and its implementation and appreciate lecturers' efforts.

4 CONCLUSIONS

This paper describes the structure, key technologies and implementation results of a Communication skills course held at the University of Zagreb Faculty of Electrical Engineering and Computing. Two key challenges regarding the course are its low ratio of lecturers to students and implementation of activities that can assess students' communication skills in an appropriate way but using limited resources. Technologies used to achieve this (Moodle, AudIT audience response system, and custom software support for peer review) all positively affect course outcomes, as indicated by students' feedback, but are also essential from the lecturers' perspective. Those technologies and approach taken in the course seem to be sufficient to offer a quality *Communication skills* course, yet additional measures are needed to foster students' interest and increase course engagement.

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