

Developing and implementing a feedback and assessment tool for written and oral communication across the engineering curriculum

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INTRODUCTION

Increasingly, engineering schools and universities are taking up initiatives to integrate and improve communication instruction in engineering curricula. These schools and initiatives are at the forefront of meeting the demands of industry and reforming engineering education.

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A common approach to embed written and oral communication into science and engineering curricula is by organizing stand-alone communication courses. Engineering schools sometimes prefer to include communication instruction and writing and speaking assignments in engineering courses or to offer elective communication courses. Highly exceptional, engineering schools or faculties create engineering communication centers to enhance communication skills. These centers provide engineering students with additional and individualized coaching and support in writing and speaking [1,2].

The Faculty of Engineering Science of KU Leuven started an educational project (OWP2011/13) in 2011 to further integrate written and oral communication skills into existing engineering courses across the five-year programme of study. In this paper we will first discuss the way communication instruction is integrated in our curriculum and present the results of a student questionnaire. Afterwards, we will present a feedback and assessment tool for written and oral communication recently implemented in multiple courses. In this respect we will also refer to the suggestions we received from didactic staff involved, professors and teaching assistants, for improving the tool. Finally, we will discuss and recommend future work.

1 ENGINEERING CURRICULUM AT KU LEUVEN

1.1. Communication instruction across the curriculum

In the Bachelor's engineering programme at KU Leuven communication instruction is integrated within four required project-based courses of Problem Solving and Engineering Design (P&D)². Also, in the Master's programmes at the Faculty of Engineering Science a series of similar courses are organized. The Master's thesis is the final integrative research project students are involved in. In the context of this final project, students report their results in an extensive written report and are required to deliver a well-structured oral presentation.

Since the introduction of Problem Solving and Engineering Design, the communication instruction offered in these courses has significantly expanded the regular coursework in the curriculum. As such, this integrated instruction entails a real curricular enhancement depending on several characteristic features. One of the characteristic features of this approach is that projects and consequently writing and presenting are done in teams of two to eight people throughout the curriculum.

A second characteristic feature as well as an important asset is that communication instruction is discipline-specific. Students submit preliminary project proposals, final project reports, perform demonstrations and project presentations. Hence, students gain practice in technical writing and speaking in the discourse of the engineering discipline. Communication instruction in academic writing (journal articles, research proposals,...) or business communication is rather limited.

² Students take three subsequent P&D courses with a study load of 3 to 4 ECTS credits in the first three semesters of the Bachelor's engineering programme. In the fifth and the sixth semester each student attends one similar P&D course of 9 ECTS credits in the context of their major subject. Throughout three years of study in the Bachelor's programme, students attend four courses of Problem Solving and Engineering Design in total.

Another characteristic is that students receive substantial guidance throughout Problem Solving and Engineering Design. Evaluation is carried out through a combination of formative and summative assessment. Though, the final product usually is the decisive factor in the final evaluation.

A last characteristic feature is that communication instruction is mostly delivered by engineering professors, only occasionally by communication instructors. Although the engineering projects have a substantial communication component, engineering design remains the core of Problem Solving and Engineering Design.

1.2. Student questionnaire

In order to obtain feedback from students concerning the course concept, communication instruction, communication skills development and guidance and support, data were collected from Bachelor's engineering students³ through an anonymous online questionnaire taking between 10 and 15 minutes to complete. Our online survey was conducted in early 2013 and consisted of two sections:

- Section 1: personal information;
- Section 2: perceptions on communication instruction in and communication skills development throughout the Bachelor's programme and in the courses of Problem Solving and Engineering Design (20 items).

The personal information section included items on gender, enrolment in the curriculum, major and minor subject⁴. In the second section of the questionnaire students were asked to indicate to what extent they agreed upon each statement on a 4-point Likert-scale (1= disagree, 2= slightly disagree, 3= slightly agree, 4= agree). Statements were related to the perceptions of students on communication skills development in general, at programme (Bachelor's) level and at course (Problem Solving and Engineering Design) level. These questions were mandatory to ensure as many responses as possible.

The survey was distributed through Toledo, our online learning platform, and sent directly to all 1,259 Bachelor's engineering students' institutional e-mail addresses. In addition, several teaching assistants and programme managers called for student participation in this survey. A total of 573 students responded to the survey after one follow-up e-mail, yielding a response rate of 45,5%. Respondents whose questionnaires featured missing data were eliminated from the analysis, resulting in an overall response rate of 32,8% (N=413).

78% of respondents was male, 22% was female. 42% of the respondents was enrolled in the first year, 30% in the second year and 28% in the third and last year of the Bachelor's programme. Students of the major subject mechanical engineering, electrical engineering and civil engineering were particularly well represented. Students from the other major subjects were slightly underrepresented.

³ Our survey was conducted only among Bachelor's students as the courses Problem Solving and Engineering Design are part of the Bachelor's engineering curriculum. In other words, the P&D module does not enclose the Master's programmes offered at the Faculty of Engineering Science of KU Leuven.

⁴ After three semesters of shared basic courses, students choose one major subject ranging from civil engineering, chemical engineering, computer science, electrical engineering, geotechnical and mining engineering, materials engineering to mechanical engineering and one minor subject ranging from business management, civil engineering, chemical engineering, computer science, electrical engineering, geotechnical and mining engineering, materials engineering, mechanical engineering to technology of living systems.

It is clear from the survey that our engineering students acknowledge the relevance of communication skills in the engineering profession. In our survey, 93% of respondents agreed with the statement that communication skills are important for an engineer. According to 89% of our respondents communication skills are (rather) important in the courses of Problem Solving and Engineering Design, although less central in the remainder of the Bachelor's engineering curriculum. Below we will focus on the results obtained at course level.

At course level, 82% indicated that communication instruction in P&D courses (preparing project reports, giving demonstrations and project presentations) generally imposes a significant workload. Yet, 60% claimed that sufficient course and teaching material for developing communication skills is provided and approximately the same number of students reported that communication instruction and assignment objectives are made clear.

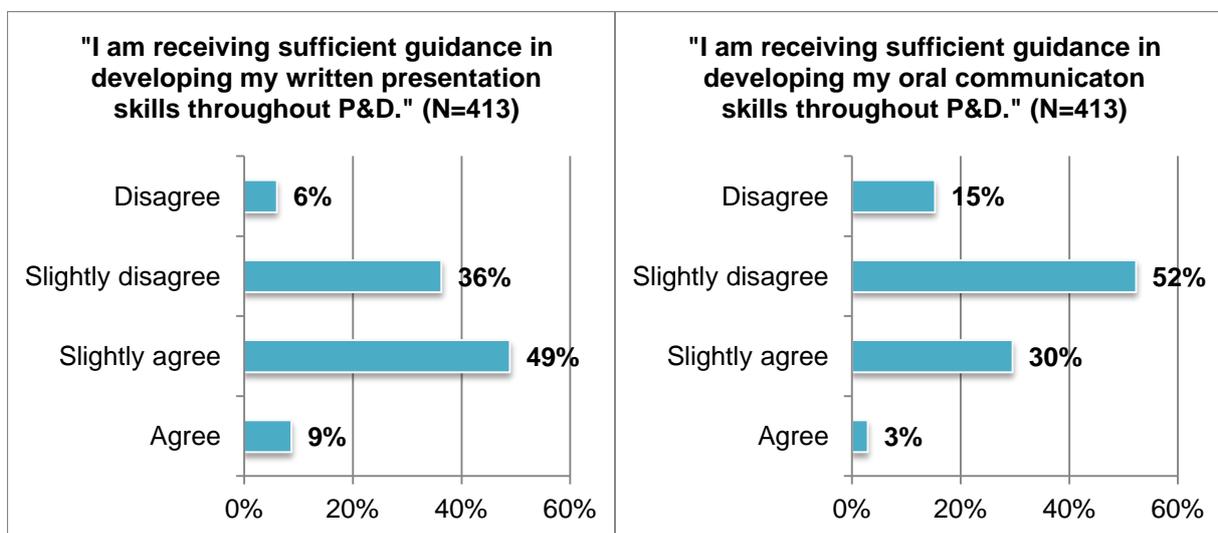


Fig. 1. Throughout P&D, students are receiving sufficient guidance in developing their writing skills.

Fig. 2 Throughout P&D, students are clearly not receiving sufficient guidance in developing their oral speaking skills.

On the whole, more than half of our participants pointed out receiving sufficient guidance in developing writing and reporting skills (Fig. 1). However, only one third reported receiving sufficient support in developing oral presentation skills throughout the P&D courses across the Bachelor's programme (Fig. 2). This is related to the perceived amount and value of the feedback to students, which we covered in another item in our survey. Of students graduating with a Bachelor's degree (N=117), 61% agreed to be trained in written communication whether only 43% stated mastering oral communication skills. However, this finding is particularly striking as teaching assistants and engineering educators perceive most students are lacking effective writing skills rather than oral speaking skills.

As indicated in previous work [3]: "mainly providing team feedback as well as individual feedback on learning outcomes needs further improvement [across Problem Solving and Engineering Design]." Indeed, 62% and 80% of students responding to our survey indicated receiving insufficient individual feedback on written and oral communication. To develop their communication abilities students find individualized feedback and assessment of teaching staff the most beneficial. As

to the type of feedback, written or oral, students indicate that a grading or assessment rubric would be useful for developing their written and oral communication skills. Finally, students would also appreciate course material on communication skills tailored to their needs: learning material with guidelines, tips and tricks and various examples.

To conclude, students perceive communication skills as important and also relatively well represented in the engineering curriculum. Overall, students are under the impression that P&D courses are communication-intensive and imposing a significant workload. Students report receiving sufficient guidance on and feedback for developing written communication skills but a lack of support for developing oral speaking skills. As a result, students feel they have been trained in writing and reporting but less in oral communication. Students' comments indicated a desire for more individualized feedback irrespective of whether this feedback is written or delivered orally.

2 DEVELOPMENT AND IMPLEMENTATION OF A FEEDBACK AND ASSESSMENT TOOL

To set consistent standards and in order to satisfy students' need for guidance and feedback, we have developed and implemented a feedback and assessment tool for written and oral communication across Problem Solving and Engineering Design in the Bachelor's programme.

2.1 Structure and design of the feedback and assessment tool

At first, we proposed a framework specifying levels at which communication competencies should be demonstrated throughout the programme of study [4]. Instead of further establishing these performance levels and criteria for each stage of the Bachelor's programme, we have decided to set up generic grading criteria for written and oral communication that would apply to the different P&D courses and assignments. This would provide consistency of expectations for students across the designated courses in the curriculum [5].

In preparing the feedback and assessment tool we have taken a bottom-up approach, actively involving academic staff. In particular, we were able to draw on existing material used across Problem Solving and Engineering Design, as a number of teaching assistants listed specific criteria and common mistakes occurring in student papers and oral presentations. Our feedback and assessment tool for written and oral communication contains the following attributes⁵:

- It is divided into two main sections: one section including all criteria regarding content and one section comprising formal criteria. Each section is describing in detail the criteria used in evaluation;
- It is holistic in the sense that rater's are able to assign an overall holistic score;
- It is analytical in the sense that rater's are able to judge performance separately for each criterion in a simple checklist and a grade from 0 (very

⁵ The feedback and assessment tools for written and oral communication can be consulted through <https://eng.kuleuven.be/english/education/reporting/>.

inadequate – if the outcome is not met) to 4 (very good – if the outcome is met) with an increment of 1;

- In the tool, the checklist allows graders to indicate and situate every problem, while the tool also allows for additional written feedback and remarks if needed;
- It is widely applicable as teaching staff is able to add or omit criteria and add weights if desirable;
- It contains neither differing levels of student performance (performance levels), nor elaborate descriptions of each level of student performance.

The feedback and assessment tools are highlighting several categories. On the one hand, the tool for written communication is built along *Content, Structure and Organization, Writing Style and Presentation and Design* with a total of 46 items or criteria. Each criterion has its own two- or three-letter code allowing easy reference in the student's paper or text. On the other hand, the tool for oral communication is built along the categories *Content, Verbal Communication* and *Non-verbal Communication* comprising a total of 29 items or criteria.

Our main goal was to ensure consistency in feedback and assessment of communication skills across the multiple P&D courses across the curriculum. By developing a common feedback and assessment tool we also aimed to improve the quality of feedback for each assignment and in this way, provide students more clear, specific and insightful feedback on their skills. In this manner teaching staff could continuously emphasize the same set of principles and guidelines and communicate these to students.

Since numerous students are enrolled in P&D in the Bachelor's programme, we reason that the tool we developed is the most appropriate way to provide feedback. Moreover, we are confident that both students and teaching staff benefit from its implementation. Students will value the transparency of grading criteria and improved feedback whereas teaching staff will be able to achieve greater consistency in feedback and evaluation.

2.2 Implementation and feedback

The feedback and assessment tools for written and oral communication were tested in designated P&D courses across the curriculum (Table 1). In the first two years of the Bachelor's programme these were implemented in the shared basic courses P&D Part 1, 2 and 3. In the third year of the Bachelor's programme, the tools were used in three major subject P&D courses for either assessing written or oral communication or both. In each course students were provided with the tool in advance to ensure that grading criteria and assessment expectations were transparent.

Table 1. Courses in the Bachelor's programme in which the feedback and assessment tool was implemented.

Bachelor's programme					
Year	Semester	Course	ECTS	W*	O*
1	1	P&D Part 1	4	✓	
	2	P&D Part 2	3	✓	✓
2	3	P&D Part 3	4	✓	✓
	4				
3	5	P&D Chemical Engineering	9	✓	✓
	6	P&D Computer Science	9	✓	✓
		P&D Electrical Engineering	9		✓

*W and O refer to the feedback and assessment tool for written communication and oral communication respectively.

In general, the implementation of the tools enabled us to gather comments and suggestions of didactic staff. Most professors and teaching assistants reported the applicability of the different categories and grading criteria, as well as the comprehensiveness, exhaustiveness and concreteness of the tools. In one course, the feedback and assessment tool for written communication was used for peer feedback: students reviewed each other's written reports and gave each other feedback based on the assessment tool. As for the feedback tool for written communication, teaching staff reported that the letter codes enabled them to quickly refer to the appropriate feedback. As for oral communication, staff greatly appreciated the conciseness of the feedback sheet (limited to one page). In this manner, the efficiency of the assessment and feedback process was enhanced.

Suggestions for improving the tool focused typically on opening the possibility for didactic staff to complement the tool with their own (course) objectives and grading criteria. Instructors are mostly concentrating on content and expressed their desire to incorporate their own criteria into the tool. This feedback was highly valuable to further adapt the tools and to ensure its correct implementation. In the future, the material will be structurally incorporated in all courses of Problem Solving and Engineering Design in the Bachelor's programme.

3 CONCLUSION AND FUTURE PERSPECTIVES

In the Bachelor's engineering programme at KU Leuven communication instruction is integrated into four required Problem Solving and Engineering Design courses over students' three years of study. Throughout these courses, repeated written and oral communication instruction and continued practice are ensured. Nevertheless, from a student questionnaire conducted in 2013 it was clear that engineering students need more guidance and support in developing their communication skills. In particular, students perceive a lack of feedback on their oral speaking skills across the Bachelor's curriculum.

By developing and implementing a feedback and assessment tool for written and oral communication used across Problem Solving and Engineering Design, we believe teaching staff are now able to provide specific and explanatory feedback on students' skills development. In the future, we would like to determine whether students display significant improvements in writing and oral communication as a result from the

regular feedback through our feedback and assessment tool. Also, efforts to increase communication skills should be continued in the Master's programmes.

In addition, we are currently preparing online documentation and guidelines for students for written and oral communication in accordance with the established grading criteria. These are including general principles of good writing and oral communication, tips and tricks as well as different examples from previous student work (e.g. do's and don'ts). As noted in the literature, such examples could make the grading criteria concrete and help students to meet the objectives [6]. Therefore, all students, teaching and academic staff will have full and free access to this documentation.

Finally, the Faculty of Engineering Science has developed an educational programme for teaching assistants. In this context, each year a workshop is organized providing teaching assistants the opportunity to discuss ideas about standards, evaluation and feedback. To prepare all (future) instructors for achieving consistent grading standards in assessing communication skills, participants will be made familiar with the feedback and assessment tool for written and oral communication.

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