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Debunking the 'Nerd' Myth: Doing Action Research with First-year Engineering Students in the Academic Writing Class

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Abstract

First-year engineering students are disinclined to view writing skills, and communication skills at large, as a core element of the engineering curriculum. Instead of arguing away this student skepticism, we aimed to harness it by way of an action research project in the writing class. Students were challenged to find out for themselves whether, and if so, which communication skills are important for professional engineers, and to write out their recommendations for the curriculum in a brief research paper. The teaching staff supported the research project by providing an online questionnaire, which 443 engineers filled out on the students' invitation, and by offering support sessions on academic writing, research and ICT skills. What the students learned from the questionnaire was that the respondents spend a significant amount of their working time communicating, while many of them struggle with several aspects of both written and oral communication. Abandoning their initial beliefs, the students recommended in their papers that communication skills take a central place in the engineering curriculum. The action research approach helped students develop not only their academic writing skills, but also their attitudes towards communication courses and, more generally, their understanding of 21st century engineering.

Introduction

This paper describes the redesign of an academic writing course for first-year engineering students, at FI² (the Faculty of Industrial Engineering) of KHLim/Xios in Belgium. The writing course (1 ECTS credit) is a component of a communication course (3 ECTS credits), which is, in turn, part of the 'research and communication' course (6 ECTS credits) (see Fig. 1). The redesigned course was taught in the first term of 2010 and 2011.

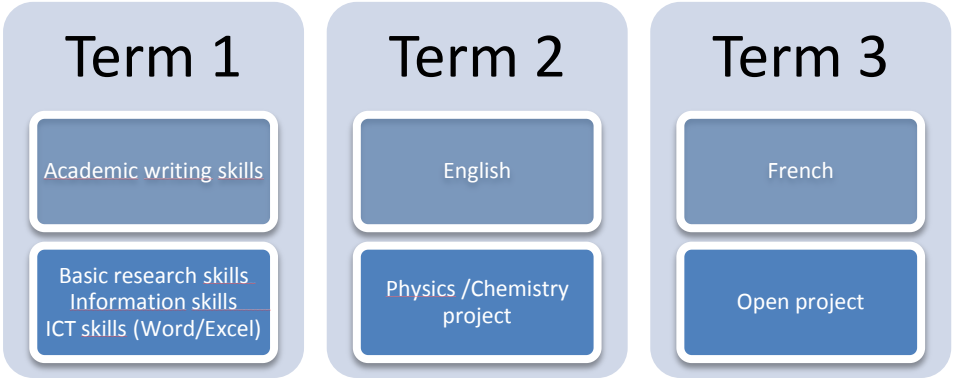

Figure 1: Program for the research and communication course (6 ECTS) in the first year of the academic bachelor in industrial engineering at FI².

The redesign of the academic writing course was partly prompted by contextual factors: the merger of the university colleges KHLim (Catholic University College Limburg) and Xios into FI² (Faculty Industrial Engineering), and the simultaneous integration of all university college academic bachelor's and master's degrees (amongst which sits the degree in Industrial Engineering) into a university faculty structure (Faculty of Industrial Engineering Sciences at the Catholic University of Leuven and Hasselt University). The course, 'Research and Communication', and its program came about both as a conflation of existing courses at KHLim and Xios and as a way of meeting the university's demands for an increased emphasis on academic research skills. At the same time, the curricular redesign offered teaching staff a unique opportunity for redesigning the content and approach of the existing academic writing courses, which were felt to be unable to fully engage the first-year engineering students.

Typically, incoming students are attracted to an engineering education because of the emphasis on sciences, technology, mathematics, problem-solving and research. It is within these areas that students identify their signature skills and competences. Communication skills in general, and writing skills in particular, are usually felt to be at a significant remove from these signature engineering skills. Beer and McMurrey (1997: 1) capture this sentiment in the opening words of their well-known *A Guide to Writing as An Engineer*: 'Many engineers dislike writing. After all, don't we go into engineering because we want to work with machines, instruments and numbers rather than words?'

What amplifies the challenge for teachers of academic writing is that engineering students not only feel that their innate, core competences lie elsewhere than with writing, but also they feel that writing skills, and communication skills in general, are of only tangential importance for their later careers. The traditional image of engineers heavily emphasises technical skills at the expense of social skills and communication skills. Beder (1998: 57) terms this view 'the "nerd" stereotype'. An oft-quoted point of reference for this traditional view of engineering is Florman's 1976 publication *The Existential Pleasure of Engineering*, where he states that '[e]very engineer has experienced the comfort that comes with total absorption in a mechanical environment. The world becomes reduced and manageable, controlled and unchaotic' (Florman 1976: 137, also cited in Beder 1998, and Kleif and Faulkner 2003). Implicit in this quotation is an image of the engineer as one who shies away from the social world, preferring the uncomplicated intimacy and direct understanding of communicating with the machine, using machine language.

In all, it seems that a significant portion of first-year engineering students display low motivation levels for academic writing (and communication) courses because of what appears to be a powerful compound of perceptions: students feel they are not good at writing (and communication), that they will never be good at it, that they dislike it anyway, and that they simply do not need writing (and communication) skills to be successful as an engineer. Teachers of academic writing in engineering curricula can and will dismiss these unfounded beliefs. They will state that nowadays, engineers write a lot, that they write many different kinds of documents, that a successful career as an engineer requires strong writing skills and that writing is something you can learn (Beer and McMurrey 1997: 2–6). They will argue that, due to fundamental changes in the structure of economies and the operational structures of companies (horizontalization, collaboration, interdisciplinary teamwork, globalisation,…), communication and literacy skills are a much more vital part of the engineer's competence profile than they were before the 1970s. In the words of Beder:

> T[he] image of the engineer as technically-inclined and socially introvert is increasingly outdated. Engineering is an intensely social activity and engineers today are well aware of the social dimensions of their work. Engineers manage socio-technological systems; they bring together, work with, coordinate, manipulate and build upon various elements of a system which include not only things, but also social organisations, laws, financial and cost considerations, scientific theories, natural resources and public perception. The new engineer doesn't shrink from the social aspects of engineering work but embraces them and gives them full consideration. (Beder 1998: 57)

To substantiate their discourse on the 'new engineer', writing teachers refer to the many research reports and articles published following the pioneering works of Selzer (1983) and of Paradis, Dobrin and Miller (1985), all of them arguing for the importance of communication skills, and writing skills in particular, for engineers (for instance: Craig, Lerner and Poe: 2008, Ford and Riley 2003, Heilmeier

1995, Inman 2006, Katzel 2006, Kaye 1998, Koen and Pankaj 1999, Lang 1999, Lynn and Salzman 2007, National Academy of Engineering 2004, Riley, Furth and Zelmer 2000, Varhol 2001, and Williams 2003).

But the impact of this research evidence on students' often very firm beliefs about what they 'really' are and what engineering 'really' means should not be overestimated. Firstly, teachers of academic writing are not considered credible when making the case for writing themselves. Evidence suggests that the efforts of 'soft topic' teachers to demonstrate the importance of social skills to engineering students are successful only in so far as they are shared and reiterated by 'hard topic' teachers and backed by testimonials from workplace professionals (Melin Emilsson and Lilje: 2008). And even then, educational research has amply shown that it takes more than simply listening to third-person accounts – teachers' or others' - to have students effectively revise their deeply-held beliefs, and moreover, that it is precisely these underlying beliefs that are key to triggering attitudinal changes.

Strikingly, it is not just students whose attitudes are influenced by these deeply held beliefs about what it means to be an engineer. Despite the wealth of evidence to the contrary, other prominent stakeholders in the organization of engineering education (teachers of 'hard' topics, heads of department, educational directors and curriculum designers) are not always inclined to recognise the importance of writing (and communication) skills for a career in engineering. The clichéd image of the engineer as a technical problem-solver still weighs heavily on the discussion of what students need to learn in their engineering education. Testimony to this persistence of the 'nerd' myth is the ongoing struggle of 'soft topic' teachers to keep their courses in the curriculum, when technology is ever specialising and budgets ever decreasing.

Redesigning the Academic Writing Course: the Objectives

The goal of the redesign was to directly impact the students' fundamental attitudes towards academic writing, while at the same time improving their skills in and their knowledge of this field of academic and professional practice. The existing courses aimed almost solely for the latter, while the effort at influencing students' attitudes was limited to teacher discourse on the importance of writing skills. What also limited the courses' appeal to student attitudes and beliefs, was that they were taught separately from the rest of the curriculum and on an 'elements-first and only' basis. Students were handed the elements of academic writing, but they were not challenged to execute an authentic writing task where these elements could combine.

Finding inspiration in Graves' *Teachers as Course Developers* (1996), we decided that this particular challenge could only be met by positioning ourselves as course developers. More particularly, we decided that, in order to have it meet our most fundamental objective, the new course should be developed from within a didactic framework with three principal dimensions. Firstly, the redesign should aim for a *learner-centred* approach, where the student is at the centre of the learning process, not the teacher. The student takes responsibility for the learning process, while the teacher's role is that of a coach. Crucial in this approach is that students themselves actively reflect on 'how and why that topic might be an interesting one to study' (Burnard 1999:244), instead of just following a preset curriculum. One of the challenges for the new course was, therefore, to find ways to have students actively engage with the engineering curriculum, and more particularly, with the place of a communication course therein.

Secondly, the redesign aimed for the integration of the academic writing course with other components of the curriculum. This approach, also known as *content-based* language learning, starts from the assumption that language does not exist in isolation but always functions as part of a larger social process that necessarily involves other forms of knowledge, other skills and attitudes. One could argue that this principle ties in with talent-oriented teaching, as the content-based language learning opens up a way of appealing to what students perceive to be their signature competencies.

Thirdly, the redesign aimed for a *task-based* approach. Instead of simply offering the elements of academic writing, we aimed to present students with an authentic and functional writing task so that they would first recognise the desirability of the elements before acquiring them. Traditionally, language-related courses are often taught using an element-based pedagogy: the elements are

taught first, enabling students to execute a functional task afterwards (either during or following their formal training). Task-based language learning, however, assumes that students learn more when acquiring 'the elements' only when their desirability is first recognised in the execution of a functional task (Vandenbranden 2006).

Action Research in the Academic Writing Class

In the attempt to put student experience at the centre of the learning process, we decided to take the very question on the lips of many a first-year engineering student as the starting point of the academic writing course: 'Should communication skills in general, and writing skills in particular, really be part of the engineering curriculum?' Of course, we had clear - and informed - opinions, but instead of laying them out for the students, we invited students to find out for themselves whether communication skills are important or not for the professional engineer, living in in the Flanders region of Belgium, anno 2010 or 2011. At the same time, we were also looking for a set of hard, empirical data – gathered very recently and in a local context – that could help us weigh more effectively on curricular design debates.

This situation set the ground for an action research approach, in which students and teachers work together on a small research project, investigating a didactic or curriculum-related situation with a view to improving it (Norton 2009, Koshy 2005, Sagor 2000, Wallace 1998). Action research is also known as participatory research, collaborative enquiry or action learning. O'Brien lists some of the attributes of action research:

> Primary is its focus on turning the people involved into researchers, too - people learn best, and more willingly apply what they have learned, when they do it themselves. It also has a social dimension - the research takes place in real-world situations, and aims to solve real problems. Finally, the initiating researchers, unlike in other disciplines, make no attempt to remain objective, but openly acknowledge their bias to the other participants. (O'Brien 2001)

This description makes clear that action research lends itself very well to a learner-centred and task-based approach: students 'learn by doing', more particularly, while tackling a relevant research question and researching a real-world situation. We, the teaching staff of the research and communication course, initiated the research while openly acknowledging our bias to the students.

The task

The task we gave students was to research whether communication skills were important for present-day engineers in Flanders, and if so, which skills were important (foreign languages, writing, public speaking, negotiation skills, etc.) and which difficulties the engineers experienced in the field of professional communication. Students were asked to lay their findings side by side with the current FI[2] curriculum to see if it would adequately prepare them for the marketplace, and to present their research and write out their recommendations in a brief academic research paper. The scope of the action research thus involved all the participants of the educational control cycle: student, school and workplace.

To gather the empirical data needed for the research, the teaching staff developed an online questionnaire[1] to be completed by professional engineers. The questionnaire contained ten multiple choice questions, polling the relevance of several communication skills in the engineering workplace[2]. Following these questions, the respondents were asked to give the following information: age, profile, sector and company size. The questionnaire was made available using Zoho Creator, an online

[1] It would be preferable to have students come up with survey questions themselves. But considering the limited time-frame and the desirability of a questionnaire that is stable over the years, we decided to make the questionnaire ourselves.

[2] The questionnaire includes a passage stating that by submitting the form, the respondent agrees to surrender the submitted data for purposes of research and publication. The passage guarantees that, even if the respondent should choose to submit his name alongside the data, the name of the respondent will not be made public.

database software service. The entire student population – some 200 students *per annum* – was divided into three person teams, and each team was asked to invite at least three engineers from their personal or their parents' networks to fill out the online questionnaire. Students were asked to invite their contact persons via e-mail, which generated an authentic writing task – writing a (semi-)formal e-mail in a real-world situation – that created a meaningful context for addressing aspects of e-mail etiquette, register and structure.

Zoho Creator aggregated all of the respondent answers and conveyed them in an all-inclusive Excel sheet. This sheet allows for a very wide array of data analyses, with a large number of answers, but also many correlations between answers and respondent parameters, to be investigated. Each group of students was invited to debate on and formulate a more focused research question, which allowed students to attune their research path to their personal interests and ambitions. For instance, a student with an interest in construction engineering, but with a dislike for French, would propose to investigate the importance of French for construction engineers. Another student in the group might extend this suggestion by proposing to compare the importance of French for construction engineers to the importance of French for mechanical engineers. And a third student might propose to compare the importance of French to the importance of German or English for construction engineers. The questionnaire allows for so many research questions that it forms the basis of a fruitful discussion amongst students and enables them to come up with a customised, and therefore more motivating research question.

Integrating research and information skills and computer skills

The group discussion on the research question created a meaningful context for the teaching staff to address issues of research methodology, a core element of the engineering curriculum. What makes for a good research question? What does not? Which research questions have an appropriate scope for a brief academic paper? What is too narrow and what is too broad a research question? Can the research question be answered on the basis of the questionnaire? Is extra information needed? Can such information be retrieved, and if so, where would be the best place to look? Furthermore, the need for interpreting the questionnaire findings prompted students to develop such research skills as setting forth hypotheses, retrieving trustworthy and relevant information from online and offline sources and establishing links between divergent elements. For instance, why is it that French is the most important language for construction engineers, while English is key for a career in electronic engineering? Hypotheses connecting aspects of language on the one hand, and knowledge about the national and global economy and politics on the other hand, needed to be developed and checked using secondary sources. Engineering students typically consider researching as a signature skill for an engineer. The writing task created an authentic research situation in which the teaching staff could coach students in deepening their research skills.

Another part of the curriculum that was meaningfully integrated in the writing task was basic computer skills, more specifically: the use of Excel, and later on in the writing process, word processing. Zoho generates an inclusive Excel-sheet containing the entire set of data from the questionnaire, which students need to mine efficiently and correctly. Efficiently processing this extensive set of data requires several Excel skills. Thus, the writing task created a knowledge gap between the students and the teaching staff which generated an occasion for the latter to explain such Excel techniques as using formulas, macros and filters, and generating graphs.

Supporting the writing process

To present their research findings and their recommendations for the curriculum, students were invited to write a brief academic paper in group. To ensure that questions about writing arose before the answers were given, we relied strongly upon writing group methodologies. In preparation for one of the six two-hour class-teacher contact sessions, each student of the three-person writing group was asked to prepare the same task, for instance, drawing up a macrostructure, writing a particular part of the paper (e.g. the introduction, the methodology), generating and laying out a certain graph, making a reference list, etc. In class, the students of the same group read and compared each other's preparation and discussed the merits and drawbacks of each. Teaching staff supported this collaborative learning process step by step, from higher order to lower order concerns, by providing source materials and answering questions on such topics as the accepted macrostructure of a research paper, the appropriate register for an academic paper, layout (headers, use of colors, fonts, margins), APA guidelines, grammar and spelling. In the final phase of the process the teaching staff

offered support on digital word processing issues such as setting margins, automatic generation of a table of contents, lists of graphs and tables, and a reference list.

Survey Results

In the Autumn of 2010, when 210 students were enrolled for the course, 228 engineers filled out the questionnaire, and in the Autumn of 2011, when 185 students were enrolled, 215 engineers completed the same questionnaire. That means that over the course of two years students gathered research data from a total of 443 engineers[3].

A first finding is that engineers spend a very significant amount of working time actively communicating (writing e-mails, reports, making phone calls, having meetings). Half of the respondents spend 60% or more of their working time actively communicating and on average a respondent spends 57% of his or her working time on active communication. This figure is even higher than anticipated. Beer and McMurrey (1997: 1), for instance, estimate that engineers averagely use 20–40% of their working time communicating.

A second finding is that engineers perceive their communication skills to impact their careers strongly. If 'factor 1' amounts to 'irrelevant' and 'factor 5' amounts to 'all-defining', then the majority of engineers selected a factor 4 to describe the impact of communication skills on their career. The graph below (Fig. 2) represents the results in function of three of the main engineering profiles (commercial, managerial and technical engineers). The remaining engineer profiles are grouped into the category 'other'.

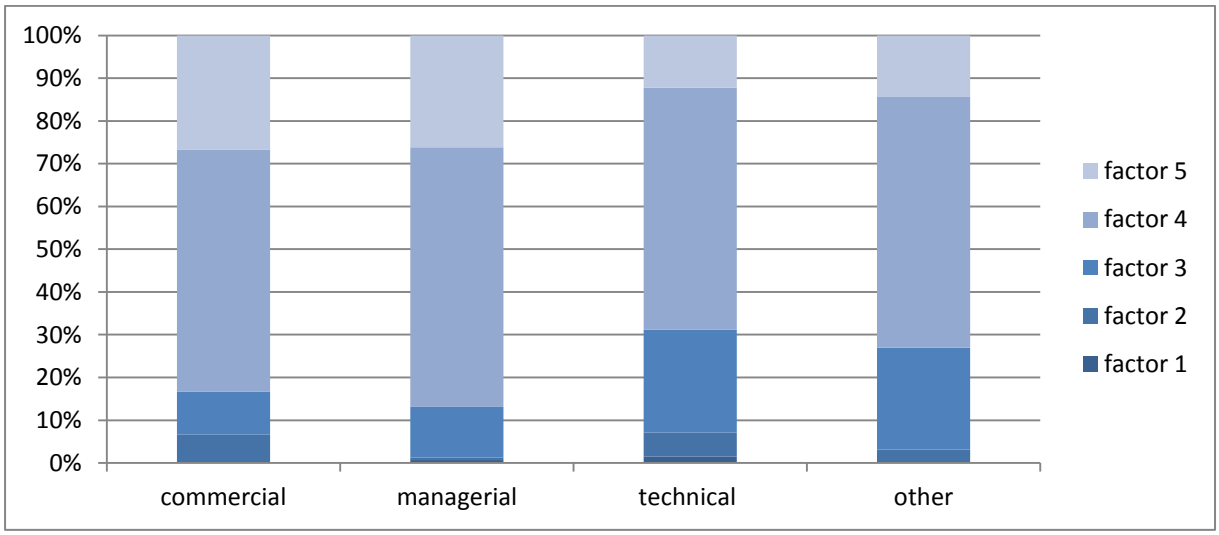

Figure 2: The perceived impact of communication skills on the career of the engineer, from factor 1 (irrelevant) to factor 5 (all-defining).

Close to 70% of technical engineers stated that communication skills were defining for their career, a finding that in itself does much to debunk the 'nerd' stereotype. A third finding is that engineers perceive written communication to be at least as important as oral communication. Only commercial engineers spent slightly more time communicating orally than in writing. Even managers, who are typically associated with oral communication tasks like meetings, networking and presenting, spent significantly more time writing than speaking. Figure 3 shows which types of written communication engineers perceive to have a determining impact on their careers[4].

[3] The 2011 students used the aggregated 2010–2011 data set. It should also be remarked that the e-mails of the 2011 students specified that respondents who had already completed the 2010 questionnaire should kindly refrain from filling out the questionnaire again. It should also be remarked that the 2011 data set affirmed the 2010 findings: there were differences of course, but they were slight.

[4] Respondents could select more than one type of written communication.

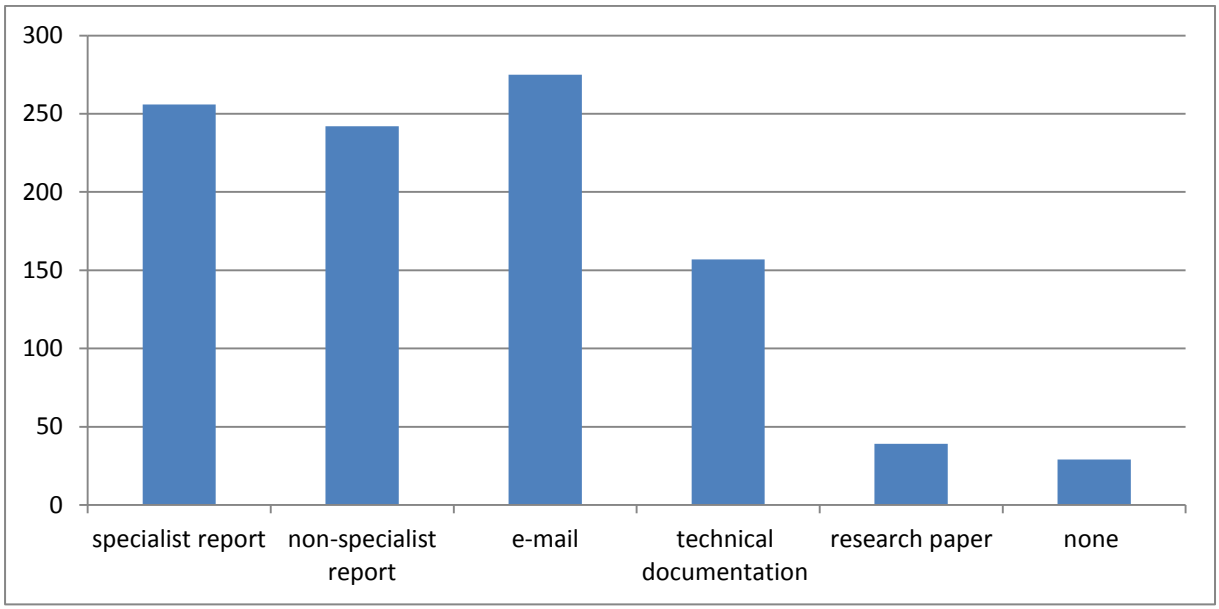

Figure 3: The importance of various types of written communication for the engineering career.

Perhaps the most striking finding here is that the least selected answer was 'none': 93.5% of all respondents felt that at least one type of written communication has a determining impact on their careers. Writing e-mails and reports for both specialists and non-specialists were cited as the most important types of written communication, while the research paper was perceived to be the least consequential genre. The ability to write technical documentation was considered crucial by over one third (35.4%) of the respondents.

Figure 4 shows which aspects of the writing process respondents find themselves struggling with[5].

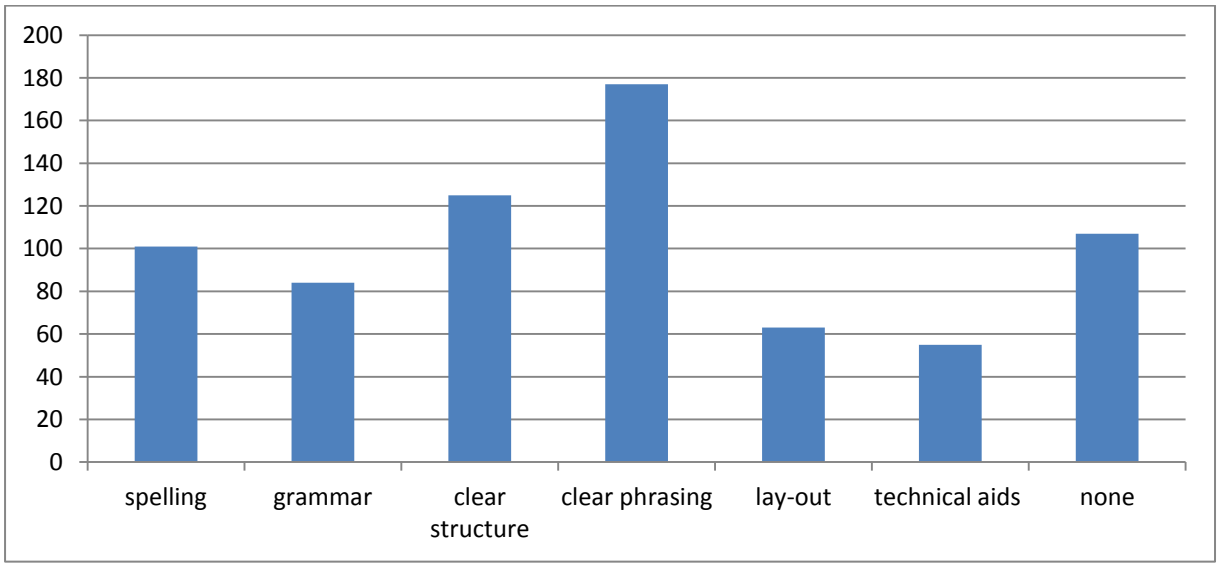

Figure 4: Aspects of the writing task that engineers struggle with.

Clear structure and especially clear phrasing are felt to present more difficulties than spelling and grammar. These findings once again support the idea that any course in academic writing should first be concerned with the so-called 'higher-order concerns' (structure, register, phrasing) and only then (but without disregarding), the 'lower-order concerns' (spelling, grammar). Close to one quarter of the engineers (24.1%) claimed to experience no difficulties while writing in the professional context, which means, at the same time, that three quarters do.

[5] Respondents could select multiple answers.

All in all, none of the above findings are in any way surprising. The findings corroborate what teachers of academic writing have been telling students all along, i.e. that engineers write a lot, that they write many kinds of documents, and that a successful career in engineering requires strong writing skills. The crucial difference is that now students are not simply given these facts, but that they find them out for themselves by investigating a large set of authentic and local data that they have helped to build.

Student Recommendations

For students, the results of the survey came as something of an eye-opener: they learned that three quarters of the professional engineers contacted experience difficulties with writing tasks, even though these tasks represent a very significant amount of their working time and their writing skills heavily impact their professional careers. In other words, students learned that a core part of the profession presents problems to the majority of engineers. The recommendations that students proposed in their paper were, therefore, and without exception, to keep the writing course in the curriculum or even to increase its ECTS weighting. In other words, students that were skeptical about the relevance of a writing course at the outset of the course were pleading for its expansion at its conclusion[6].

At the same time, the students made some critical observations. One first observation was that the writing course is an academic writing course, while academic writing is not considered a genre of great importance by the working engineers. Students recognise the importance of academic writing for their academic careers - they still have a bachelor's thesis and a master's thesis to write – but they plead for increased attention to other more professionally relevant types of writing. The research and communication curriculum consistently trains the skill of writing reports for a specialist audience (WiD), but writing reports for *non-specialist* audiences is a skill that is, as yet, completely absent from the curriculum.

When it comes to oral communication, students recommended that the teaching staff pay more attention to meeting and negotiation skills. The questionnaire reveals that these skills are considered exceptionally important by the professional engineer, though their acquisition is not sufficiently supported through the existing curriculum. When it comes to foreign languages, students recommended that both English and French should be kept on the curriculum. German is only relevant for electromechanical engineers, so students advised that German only be taught in that focus group.

Evaluating the Action Research Approach

When describing the attributes of action research, Gilmore, Krantz and Ramirez (1986: 161) explain that ‘there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction’. The system we studied with our action research was the triangular interaction between the student, the school and the workplace with respect to writing skills in particular, and communication skills in general. Did we manage to change this system in ‘a desirable direction’?

A first objective was that students gain a stronger awareness of the importance of writing and communication skills for the engineering profession. We aimed to influence their attitudes and underlying beliefs in relation to the extent to which a 21st century career in engineering depends on writing and communication skills. Judging by the recommendations in their papers, we seem to have succeeded. A second objective was, of course, that students improve their writing skills in the process of conducting the action research. For now, we are limited to teacher observations of the growth process that students went through while attending the consecutive academic writing sessions and writing the research paper. These observations are uniformly positive.

[6] Students were informed in writing that their findings could be used for research and publication purposes, and that they could withdraw their submitted essays from further research should they wish to do so.

For us, teachers, a first objective was to redesign the existing writing courses which were taught in isolation from the curriculum, and on an element-first and teacher-centred basis. The action research approach provided the framework for a successful redesign: academic writing is now taught in tandem with research and information skills and ICT skills; the task created knowledge gaps in the fields of writing, research and ICT to which the teaching staff could then respond; the students' experience was taken as the starting point of the action research, and students could customise the course of their research to their particular interests, questions and concerns, which greatly increased their sense of ownership. A second objective for us was to gather local and recent empirical data that would allow us to weigh more effectively on curricular debates with other stakeholders in the organisation of engineering education. Already, our set of data has proven decisive in curricular debates, both to make the case for the necessity of communication skills in the curriculum and to fine tune the content and build-up of the communication courses over the curriculum. Every year the course is taught, empirical weight will be added to the data set, further increasing its administrative clout.

Finally, the workplace also benefits from its involvement in the research project. As it is given a systematic voice in curricular debates, it plays out its part in the educational control cycle and helps ensure that students enter the market place as well-prepared as possible, from which it benefits in turn.

Follow-up research should focus on ways of validating the perception that students' skills in, and attitudes towards, academic writing have developed positively. A psychometric pre- and post-test, for instance, could be developed to find out if student perception and motivation has effectively changed. To find out if writing skills have improved, one could compare writing products preceding the research and communication course (e.g. a paper or report written in secondary education) with the research paper written during the course – or even have students themselves compare the writing products and invite them to reflect on the learning process.

Conclusion

The underlying beliefs of several stakeholders in engineering education on what it means to be an engineer are still influenced by the 'nerd' myth. The idea of the engineer as a technically skilled loner was outrun years ago by the profound reorganisations of the post-Fordist economy, but continues to carry significant weight in the popular imagination. These outdated beliefs hinder teachers of communication skills, and writing skills in particular, in motivating students for their courses, while motivation is known to be key in triggering and facilitating lasting learning outcomes. Also, these beliefs appear to be oddly tenacious in the managerial circles of the education system, where decisions on curriculum design are made. Communication courses, not considered the 'core' business of an engineering education, are perennially under threat, while there is ample evidence available that communication skills truly are an essential part of the 21st century engineering profession. Since, apparently, this evidence does not really speak to the students, or to the managerial circles, we decided to develop an action research approach that challenged students to find out for themselves whether communication is important and that, in the process, brought into existence a set of local and recent empirical data. The action research approach studied – and, simultaneously, hoped to improve – the triangle of interaction between the student, the school and the workplace. At the same time, the action research approach was the framework within which several principles for creating a powerful learning environment were implemented: learner-centred teaching, task-based teaching and content-based language teaching. We conclude, tentatively for now, that the redesigned course not only helped students acquire knowledge and skills in the field of academic writing, but that it also helped them revise the beliefs underlying their attitudes towards communication courses in general. At the same time, we – as 'soft topic' teachers – developed a 'hard' way of speaking to the managerial circles. Moreover, the workplace was given a systematic voice in the process of curricular redesign. In the end, what we believe was crucial for the redesigned course's success, was that it enriched the students' writing experience with a sense of ownership: they became (action) researchers of their own future, and co-engineers on the path towards it.

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