ENGINEERING STUDENTS' WRITING SKILLS

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Abstract *¾ This paper considers the problems with engineering students' writing skills and their possible causes. It discusses the types of communication skills (including writing) needed by engineers, and how they have been successfully included in some engineering courses - perhaps with more success in the area of spoken skills than in writing. Studies of student writing in other subject areas are referred to, and these confirm the importance of context - of not scrutinising writing in isolation. Engineering students' perceptions to writing are explored using the results of a focus group study at Coventry University, and the paper ends with general conclusions about the development of students' writing skills in engineering courses. It is suggested that the keys to developing engineering students' writing skills are context and confidence. Context is created by embedding writing skills development throughout engineering courses and by showing students the relevance of developing these skills. Confidence is encouraged by creating opportunities for significant experiences that lead to its growth.*

Index Terms ¾ communication skills, focus group study, skills development, writing.

INTRODUCTION

Employers usually place communication near the top of lists of skills they consider important in graduates. Many employers identify a particular problem with writing. Lecturers and external examiners are also generally concerned about the writing skills of students. Developing engineering students' writing skills has significant benefits for students, lecturers, universities, graduates and employers.

It should be possible to convince engineering students that communication is important in both their course and their career. Examples are readily available in areas such as public safety, team-work, developing novel ideas, winning contracts, and straightforward self-advancement. Also engineering education is expected to be strongly vocational, and students should recognise the value of anything that prepares them for getting a good job and for doing it well. If engineering students are asked to answer a question like 'is communication important for engineers, and why?', they are likely to come up with good answers (though they tend to emphasise spoken communication). But many do not give enough priority to developing their ability to communicate formally, and in particular to *write*.

TYPES OF SKILLS

In 2000, New Civil Engineer magazine carried a revealing correspondence. On 20 January, under the headline 'ICE plans to be more lenient with CPR (Chartered Professional Review) essays' it was announced that 'Professional review essays will not in future be marked down for errors in spelling and grammar under proposals being put forward by the Institution of Civil Engineers ... ICE President Professor George Fleming said he would like to see mistakes in grammar, spelling and syntax overlooked if candidates show themselves to be "excellent" communicators in other ways ... More emphasis is needed on oral communication skills as the barometer of the engineer's communication skill ...'

The response to this was swift and passionate. On 3 February the letters page made it clear that the announcement had 'provoked a stream of correspondence'.

'Poorly written letters and contract documents are, at best, viewed as lacking in professionalism and at worst attract inflated tender bids ...' 'To describe a candidate as an "excellent" communicator, yet condone mistakes in grammar, spelling and syntax and thus allow corporate membership of this Institution is abominable.' '... the ability to use the written word is still a key skill for today's engineer.' 'Is it the intention of the President that members should no longer be expected to write a report that is both grammatically and correctly spelt ... Does he believe that clients will not be concerned if they receive letters from their engineers that are badly written and poorly spelt, or does he think clients will draw comfort from the fact that their engineers are only expected to be able to communicate verbally?'

This debate identifies two contrasting requirements in communication by engineers.

1. That they should come across well generally, with good spoken skills, confident and convincing, communicating effectively in an engineering context.

2. That they should write well, have good use of English, be able to produce accurate and professional documents.

There is probably no benefit in comparing the importance of these requirements - they are both extremely important. However the distinction is of value since it is likely that educators may need to use different methods for encouraging development of skills in these contrasting areas, and this will be considered later in the paper.

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INCLUSION IN COURSES

There are different approaches to including writing development, as part of communication skills development, in engineering courses. The three main approaches can be identified as: **embedded**, where skills development is implicit in the general content; **integrated**, where skills development is explicit in the aims yet is integrated in the technical and academic content; and **bolt-on**, where skills development is treated in separate modules.

Most published examples of good practice in engineering courses involve integration of communication with engineering studies. Even bolt-on courses in communication can be integrated with parallel engineering courses. Reference [1] describes how all communication classes can be made to coincide with written assignments in other parts of the engineering course. Reference [2] describes the timing of introductory courses on communication immediately before programmes of problem-based learning or projects. Communication can be integrated with a number of different aspects of the engineering curriculum, and examples of different models are given later.

The American literature tends to have a different emphasis. Engineering courses are more likely to depend on 'school-wide writing programs' (for example [3]). These may be integrated to some extent with engineering studies, but it is common for the writing aspects to be looked after by 'writing tutors' from outside the engineering staff [4]-[6].

In the UK there are many examples in the engineering education literature of successful integration of communication skills development with engineering studies.

At Queen's University, Belfast, students participate in mock planning and disaster inquiries designed to be beneficial to the students' 'general development and maturity in relation to their chosen topic of study, rather than solely enhancing communication skills' [7]. A similar exercise is reported at Aston University [8].

Formalised industrial links present further opportunities for integrating communication sklls development with engineering studies [9]-[10].

At many universities, Sandwich placements offer opportunities for developing communication skills in an industrial context. At Coventry University, for example, quarterly reports compatible with those submitted within an Institution of Civil Engineers training agreement are required from students on placement; and these are assessed by both the employer and the university visiting tutor. The opportunity to develop from one report to the next is of particular benefit. Returning students give a 15 minute presentation to invited staff and second year students, and a prize is awarded to the student whose presentation (and other activity) is deemed to be most effective in recruiting second year students to placements.

Design projects also offer an excellent opportunity for integration of communication skills development with engineering studies, [6] and [11].

SPOKEN V. WRITTEN SKILLS

We have seen that there are many good examples of integrating the development of communication (especially spoken) skills with civil engineering studies. But there appears to be less success in developing students' skills in *writing*.

For example, a study [12] of students' perceptions of their own skills development included the planning and disaster inquiry exercises at Queen's Belfast referred to above. Both exercises had included spoken and written elements but whereas 60% of students reported that the planning inquiry exercise had developed their spoken skills, only 10% felt it had developed their writing skills. In the case of the disaster inquiry, 67% felt the exercise had enhanced their spoken skills, yet 17% felt it had enhanced their written skills.

Writing skills may need different treatment. Studies relating to the development of writing skills in areas outside engineering are relevant.

OTHER SUBJECT AREAS

Most studies of student writing outside engineering relate to subjects that demand a reasonable level of ability in academic writing. These are subjects in which writing (essays, exam answers) is one of the main means for developing and exhibiting understanding of the subject. Some of the ideas in this area of the literature are relevant to developing writing skills among engineering students, but it must be pointed out that, in engineering studies, writing does not have the same major role in the learning process. Mathematics and graphics are the main media for developing understanding; writing is needed to *communicate* (for assessment, and certainly in the profession) but not generally to *learn*.

'Literacy by degrees' [13] is a collection of articles by academics in Australia. The central theme is that writing development is part of academic development, and that focusing on 'writing skills' in isolation is not the best way to improve student writing. 'While the tasks of academic writing do demand skills of one kind and another, academic writing is not fundamentally a question of applying skills'; 'there is a close connection between the nature and quality of our students' language and the nature and quality of their learning.' The authors 'refuse to reduce language behaviour - especially in an academic essay - merely to the manipulation of disembodied syntactic skills'.

A later volume in the same series 'Student writing in higher education - new contexts' [14] concentrates on 'writing practices emerging in settings other than traditional ones (for example, professional training, dance ..)' and 'non-traditional writing practices emerging within traditional

academic disciplines (for example, 'writing journals' in anthropology ...)'. The contributors 'approach writing in higher education as a *social practice* ... which is embedded in the values, relationships and institutional discourses constituting the culture of academic disciplines in higher education.' In one chapter, Simon Pardoe considers that 'apparent problems in student writing do not simply represent a *lack* of skills, knowledge or understanding by students. Unsuccessful texts are often the result of students drawing on familiar ways of learning and writing that have served them well elsewhere, in their previous education, or in other areas of their lives.' 'What I find particularly striking ... is just how difficult it is, for the novice or outsider, to work out what is required in a new context.' 'Equally, I am struck by just how difficult it is for tutors to make explicit what is required.'

'Thinking and writing in college' [15] describes an American study in which writing researchers were paired with lecturers of business studies, history, social science and biology to study students' writing and its relationship with learning. A useful observation is that lecturers would like to see their students write as 'professionals-in-training', whereas some students behave only as 'text processors' (concentrating on the text itself and not the issues), or as 'laypersons'. This can certainly be a problem in engineering, when students do not use the correct engineering terms, or are criticised for a style in a dissertation that is 'not academic'.

These studies confirm the importance of context in students' writing, and that although problems with writing may include basic use of English, it is not helpful to concentrate only on these.

THE STUDENT EXPERIENCE OF WRITING: FOCUS GROUP RESEARCH AT COVENTRY UNIVERSITY

In order to learn about engineering students' attitudes to writing, directly from the students themselves, eight focus group research sessions were conducted. Details of the composition of the eight groups are on Table I.

TABLE I
COMPOSITION OF FOCUS GROUPS

Group	Subject	Course/ Stage	Number of Male/Female students	Number Full-Time Part-Time
1	Civil Engineering	HNC 1	8M	all PT
2	Civil Engineering	HNC 1	5M	all PT
3	Civil Engineering	HNC/D 2	13M 2F	5FT 10PT
4	Civil Engineering	Degree 2	6M 1F	all FT
5	Civil Engineering	Degree 2 (overseas)	5M 1F	all FT
6	Civil Engineering	Degree 3	5M 1F	5FT 1PT
7	Biology	Degree 2	2M 3F	all FT
8	Biology	Degree 2	2M 4F	all FT

Six of the groups consisted of Coventry University civil engineering students at different stages of study, including full-time and part-time students. Since it was known that in the subject area of biology particular attention is paid by staff to the quality of student writing, two additional groups were held for biology students. All the groups were facilitated by experienced facilitators, not known to the students or connected with their studies.

Recognising the importance of writing

At progressively advanced stages of the civil engineering courses, the students in the focus groups exhibited greater appreciation of the importance of good writing. Those in the early stages (especially part-time students on the HNC, working in the industry as technicians and not needing to write much at work) rated writing skills as low in importance, especially when compared with spoken communication skills.

Q. Communication skills generally ... Are they important for the work you do?
Yes definitely (nods).
Q. What skills?
Formal presentations ... working with other people ... negotiation.
Q. What types of skills do you need most?
Being diplomatic ... getting a point across ... (mostly spoken).
Q. How important is learning about writing compared with the technical side?
Not that important. We don't do much writing at work.
(HNC 1 students)

Q. Are communication skills important to you?
Yes, because we use them in our work (general agreement).
Q. What do communication skills mean to you?
They are about spoken communication skills ... they are the kind we need for our work (general agreement).
Q. Would you say that being able to write well is irrelevant for the kind of work you want to do?
Yes (general agreement). (HNC/D 2)

Students in later stages, particularly those who had worked in the industry as engineers, either on industrial placements or full-time, had a far greater appreciation of the importance of writing within the industry.

Q. And (how important is) writing?
Writing is a fundamental part of the industry.
The first thing I did in an engineering job was writing not engineering.
The calculations you do on the job become second nature but writing quality is very important; it has legal implications if you are not clear and this is picked up later if there is a dispute. (Degree 3)

Clearly, engineering students have increased recognition of the importance of writing in the later stages of their

course. This may be the result of their experiences on the course, particularly getting to grips with the writing challenge presented by a major project in the final year. It can also undoubtedly result from an industrial placement (or full-time work for a part-time degree student) especially in work that requires them to take responsibility for documentation or written correspondence.

Assessing writing

Students were asked how they felt about having their basic use of English taken into account in the assessment of written assignments. There were mixed views, but there was a general feeling that quality of writing should be given a low priority in assessment compared with conceptual understanding. Some felt that spelling was not at all important and could be left to computer spellchecks.

Q. Do you think the quality of your writing should be included in assessment?
It depends ... if the errors get in the way of understanding what we are saying, then yes; but if we have communicated clearly, then only a small amount should be deducted (some said none). (HNC/D 2)

Q. Do you think that assignments should be marked down for poor grammar/spelling?
No, spelling doesn't count, it's not important.
It's only important if the writing is for the public; then it needs to be good.
We have spellchecks on computers so we shouldn't have to worry about spelling.
We should not get marked down for grammar or spelling. But we should get marked up if it's good. (Degree 2)

Q. Should assignments be marked down for poor grammar/spelling etc?
Yes. Obviously if your English is terrible, it's a problem; but it's wrong to mark down lab reports if the conceptual understanding is there. It's a question of balance.

If you want to improve writing, make it part of the assessment, but not tangled up with lab reports. Make us do an assessment that is just about the quality of our English but don't dock off marks from assignments where our subject knowledge is what matters. That's not fair. You can't give someone high marks for writing good English if their report shows that they don't understand anything. And you can't give someone low marks if they have understood things but have just made some grammatical errors.

(Degree 3)

Writing and the emotional

Some of the discussions dealt with measures that could be taken to help students improve their writing, including more detailed feedback on written work. Exploration of this area revealed some of the emotional issues known to be attached to confidence in writing and to vary generally according to a learner's 'psychological gender' and subject choice [16]. Briefly, research has shown that students, male or female, tend to exhibit less confidence in writing in some subjects than in others. While there are notable exceptions to these generalised findings, in the largely male cohorts we interviewed, there was evidence of this trend. As primary school teachers will affirm, gaining confidence in the skills of reading and writing is much more than a cognitive question, touching, as it does, an emotional dimension that can seriously obstruct effective learning. Educationalists refer to this complex dimension as the 'affective domain' in learning, and its presence, gendered or not, was clear in some of the comments our students made. For instance, there were hints that students' reluctance to develop their written work was associated with fear of exposure. As one group said when asked about the usefulness of more feedback on written work:

It depends on the quality of the feedback; we don't want trivial mistakes to be marked

One student put the issue more graphically:

Last year my spelling and grammar was marked with a red pen; it was like being in primary school again; I found it very degrading. I felt like I was being treated like a child again.

Another student said that too much feedback could be counter-productive:

It's OK to get some guidance ... but not every single thing you get wrong ... some comments might be helpful.
If there is red pen all over an assignment it's disheartening.

Clearly red ink creates strong associations with an unsuccessful side of schooling. A fear of infantalisation from feedback also came through in a request for students to word associate around the terms *grammar* and *spelling*. This request generated the following responses:

Nightmare. Infant school. Primary school. Horror. Dictionary (3 people). *Punctuation. Thesaurus. Help. Problem. Important. Reports. Fail. Difficult.*

To the question 'what do you feel are your academic strengths' none of the engineering students offered examples that could be linked to reading or writing. Responses clustered around 'problem-solving', 'mathematics' and 'oral communication', suggesting that a challenge for those wanting to develop increased competence in writing is to harness these strengths to such development rather than to remind students of their weaknesses.

From the focus group research, it emerged that feedback on the quality of writing in assignments needs to be very

carefully and tactfully managed. Ironically, attempts to point out difficulties in grammar and spelling could simply reinforce students' low confidence in their competence in writing.

In biology, views were mixed over the helpfulness of feedback on written work mainly because of differences in the level of detail in lecturers' feedback. However those students (in biology) who had become used to detailed (and if necessary critical, even red-coloured) feedback, generally appreciated it and felt they benefitted from it. When shown an example of substantial feedback on a piece of work, biology students (just over half of whom were female) offered the following comments :

It's good (feedback)... it shows you when things are wrong.
I don't get much feedback for mine.
It helps to improve writing
It's a good system.

In contrast to the engineering students' reaction to "red ink", when asked how they would respond to a heavily red ink marked assignment all the biology students said that they would find this helpful.

It would seem that issues of writing development and issues of confidence are best understood within the context of the subject culture. While standard study skill packs and centralised support are of some benefit to students, they are not sufficient in themselves as a means of developing students' competence. What is sometimes perceived to be a lack of motivation on the part of students who do not take up this kind of support, is more likely to be a lack of confidence and of recognition of the meaningfulness of such support to their subject.

It would also seem that students are less likely to hear that they need to improve their writing if the message is offered abstractly or in the early stages of their university career.

Another important aspect of the affection dimension concerns a student's identification with his or her prospective profession and the practices they expect to adopt when employed. If students perceive an engineer as 'someone who needs to write', this will increase their commitment to the development of the necessary skills to do this. This point is clear in the following example (not related to the focus group study).

Kevin was an enterprising, energetic and sociable student, interested in the welfare of his colleagues, usually year rep and so on. He had been part of a group of students who had agreed to write the 'student view' on the section of the School website intended for applicants to the degree course. The 'student view' was deliberately not vetted by staff - the students wrote what they wanted, how they wanted. Kevin had written a particular part - on night life in Coventry. It was very lively and informal, deliberately written in a casual style, but also full of misunderstandings about English usage of a surprising fundamental nature.

Kevin took a year-out 'sandwich' placement with a civil engineering contractor in the US. With typical enterprise, he had set the placement up himself. The work had been demanding, involving improvements to the underground railway system in Boston. He was in the thick of things, taking significant amounts of responsibility and coping with difficult situations.

In the quarterly reports that he was required to write to record and reflect on his experience, his use of English was much better than before. His reports were returned with the informal comment 'your writing is much better than it used to be'. He said, 'When I was working, there were a lot of disputes over when we could have access to a certain area to do a particular piece of work, and whether we should be compensated when there was a delay ..' . At first it seemed he had misheard the comment. 'Often these disagreements led to meetings at which who had said or written exactly what, and at what time, became crucial to resolution of the disagreement. I realised then that everything you write can have a significance later, and I've taken much more care with my writing since.'

WRITING IN ENGINEERING COURSES

Even in engineering courses there are places where writing becomes the natural focus of attention. Modules in management and related subjects are likely to place emphasis on written skills via seminar reports, essays and exam answers. Final year project work is a natural vehicle for development of writing skills. This is true for an individual 'research-style' project, or an MEng-style 'integrating project'. The skills developed in the latter are likely to include many other spoken and teamworking skills as well, but any style of the final year project report is likely to be the greatest writing challenge the student has faced.

Smaller written assignments throughout the course provide opportunities for paying attention to writing skills but, as the focus groups confirm, this must be handled carefully. Many courses have a standard assessment weighting for the presentation aspects of written work. At Coventry University in civil engineering there is a default minimum component of 15% of the assessment, with a suggested wording that this is awarded for 'Clarity of presentation - including quality of writing, presentation of data, and use of diagrams'. This wording acknowledges the fact that much of our written communication includes the alternative 'languages' of mathematics and graphics, and that some of our students are not first-language English speakers.

CONCLUSIONS

Many engineering students have problems with writing, and, at the early stages of their course at least, do not develop the powers of self-criticism they need to improve.

Both students and practising engineers have a tendency to allow the undeniable importance of spoken communication in the profession to distract them from the value of good writing.

Most successful recorded practice in communication skills development in engineering courses is **integrated** with engineering studies or engineering practice. These approaches are particularly successful in developing students' spoken skills, self-confidence and professionalism. But the area where engineering courses are having less success is in developing their students' skills in writing.

Studies of student writing in other subject areas confirm the importance of context - of not scrutinising writng quality in isolation.

Focus groups have confirmed the tendency of engineering students in the early stages of their course to under-rate the importance of good writing, but to have a greater appreciation of its importance later - when they have experienced more significant writing challenges or spent time working as engineers in industry.

The groups have revealed mixed views on taking writing into account in assessment, but have offered a consensus that writing quality should not be given a higher weighting than conceptual understanding. The groups have made it clear that writing is a personal matter, and that criticism and feedback need to be handled carefully.

The research pointed to the emotional investments students have in reading and writing, suggesting that supporting students in developing their skills is very much about building their confidence in their abilities.

The groups have suggested strongly that feedback on written work can be helpful in developing writing skills, but that it must be constructive; there is a danger that cursory feedback or overkill can do more harm than good.

More significant experiences, for example industrial placements, are needed to achieve a change in attitudes and increased motivation to write well.

It appears that the keys to developing engineering students' writing skills are *context* and *confidence*. The context is created by embedding writing skills development throughout engineering courses, by means of constructive feedback on written work and appropriate assessment weightings.

Confidence can be encouraged by creating the opportunities for significant experiences that lead its growth, allying this with exposure to the importance of developing writing skills, particularly in the workplace.

Once confident, students are more able to find support from the self-help material now widely available, with many universities offering web-based skills development resources. Help can also be found from books and in-house reference material, from within word-processing packages, and, at many universities, from specialist skills/writing support units.

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