



**Developing Writing in STEM Disciplines:
A South West HE STEM Project Conference
at the University of Bath
Monday 12th September 2011, 10.00 am – 4.15 pm**

Dear delegate

Thank you for joining us at our Conference. It is the culmination of our 10-month project, during which a network of learning/writing development practitioners and subject specialists has become established, research undertaken, reports written, papers presented and much good practice shared.

I would particularly like to thank the many people within the Learning and Teaching Enhancement Office (LTEO) at the University of Bath, the wider University, and in the SW HE STEM network, who have made this Conference possible. You know who you are.

Trevor Day,
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on STEM Graduates' Writing Skills,
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Overview paper

This project Conference is a comparatively rare phenomenon, in the UK at least – a forum where writing development specialists and STEM subject specialists can come together to inform each other's practice and encourage working in partnership.

The National HE STEM project on STEM Graduates' Writing Skills focuses on:

1. Evaluating the requirements, concerns and expectations of regional employers regarding the writing skills (abilities) of undergraduate placement students and graduate employees; and
2. Identifying and disseminating good practice in developing writing skills (abilities) and appropriate writing-related attitudes and identities in undergraduate STEM programmes, in order to devise an effective response in meeting the needs of both employers and HE institutions.

Implicit in the second statement is that it is part of an HE institution's role to prepare students for gainful occupation within their discipline – whether in academia or not. For engineering disciplines, for example, this is borne out by our project's research, which shows that placement students and their industrial supervisors consider that it is schools and university that are mainly responsible for preparing students for the kinds of writing they carry out on placement and that early-career graduates are required to do (Day, 2011).

Survey responses from, and interviews with, engineering students, industrial supervisors and Faculty staff, suggest an instrumental, skills-driven agenda for writing development, with students becoming socialised into the writing conventions of their discipline. This contrasts with the more contested forms of disciplinary discourse encouraged by many writing developers, which are often influenced by academic literacies theory (Lea and Street, 1998) and notions of identity and authorial presence (Ivanic, 1995; Lillis, 2001). Many writing development specialists talk of 'transparency', power, authority and identity. Such concepts may lie outside the disciplinary discourse of many STEM specialists when giving feedback and discussing written work with undergraduates. There can, nevertheless, be a meeting ground between writing specialists and subject specialists, which involves helping to make explicit the features of disciplinary discourse that were previously implicit, for the benefit of students. Many of the presentations at today's Conference support such a view.

Science, technology, engineering and mathematics disciplines, like any other academic discipline, have their own methodologies and epistemologies – the methods, assumptions and distinctions by which practitioners, and the community of practice, generate knowledge (Pace and Middendorf, 2004). Despite each STEM discipline having its own particular ‘flavour’ of such qualities, they also share many features in common. Most STEM disciplines, for instance, have an emphasis on positivistic and quantitative approaches, coupled with practical field work or laboratory work, scientific methodology, and at least some of the time, strict conventions on reporting, such as practical reports commonly written in the impersonal and adopting conventional document structures. Even so, budding scientists and engineers may be expected to write for a wide range of audiences (academics, other students, the general public, potential employers, perhaps children, and so on) as well as for a variety of purposes (to foster learning, for assessment, for research, to further public understanding of science, educating children and informing prospective students, convincing work providers, and so on).

As will be reported by Clare Wilkinson of the University of West of England’s Science Communication Unit, employers of graduates in scientific and technological disciplines require new graduates to demonstrate effective writing skills, and most employers expect universities to play a major role in such writing development. At the same time, subject programme leaders do not necessarily feel confident in all areas of such skill development.

There is therefore good reason to support the development of both academic and workplace writing identities during an undergraduate programme, particularly if the requirements of different writing genres (in terms of purpose, audience, viewpoint and conventions such as style, structure and format) are made explicit. Doing so would encourage students to develop their identities as authors, their writing expertise and their confidence in writing within their discipline and for the workplace.

An approach I have been developing at the University of Bath for four years, working with hundreds of undergraduate and postgraduate students, both one-to-one and during courses and workshops, employs the IPACE model (Day et al, 2009), adapted and extended from Hickman and Jacobson’s (1997) SPACE model (see Box).

Making more explicit that which is implicit. Using the IPACE model for an assignment (adapted from Day et al, 2009).

Identity Student: Who am I as a writer within my discipline? How would I express that identity? What qualities should a person with that identity have?

Purpose(s) Student: What is/are my purpose(s) in writing this assignment? What is/are the department’s purpose(s) in setting this writing assignment?

Audience(s) Student considers: Who is the primary audience for my work in this assignment? Is there a secondary audience? What assumptions can I make about their prior knowledge and understanding?

Code Student: What format, structure, and writing style should I use for writing this assignment? What are the conventions? Are there good reasons for them? How did they come about?

Experience Student: What am I bringing to the task in terms of the *content* of the assignment and the *process* of writing it? What knowledge, skills (abilities), values, attitudes and other qualities do I need to develop that will help me with this task?

Answering such questions can swiftly move from acceptance of the way things are within a discipline, to a deeper understanding of the ways of thinking and communicating within that discipline, and how they might have emerged. Such questions can be asked of students at the planning stage of a given writing assignment. A dialogue between lecturer and students,

and/or between students' themselves, can make explicit some of that which is currently implicit. For example, why has this assignment been set in the first place? What function does it serve in the programme? How might this differ from the function as perceived by students? What identity does the student believe they should adopt in this situation? Is this aligned with what the programme is seeking to nurture? And so on. Such questions have been addressed by project members as you will see from the presentations today.

By exploring audience, code and experience, students can gain insight into the 'for who', 'what', and 'how' of writing even before they engage in a task. Using the IPACE model in this manner seeks to deepen students' understanding of the writing process and strengthen their sense of identity as a writer. To achieve this, staff would first have had to tussle with their own understandings of the IPACE constructs and with their own interpretations of them for a given assignment. Working with a writing specialist is one way of doing so. What emerges is a much more explicit consideration of what is required of a student in a given writing task. For example, regarding audience or readership, in completing an assignment it is commonly expected that a student will write as though another student at a comparable level will read the assignment. Doing so seeks to ensure that the student *explains* key concepts, thus demonstrating to the assessor their knowledge level for a concept and their ability to express it. Such expectations are not always explicitly stated, but could be.

Whether the IPACE model, or some other writing development model is employed, there is plentiful evidence from this project to suppose that both academic and workplace writing identities can be developed in an undergraduate programme for a STEM subject. Examples from the project, and presented at this Conference, show that such development can come about through subject specialists working with students, writing specialists working with students, and subject and writing specialists collaborating to provide empowering learning experiences for students.

Several of the Conference presentations deal explicitly with the issue of disciplinary identity in writing. Lawrence Cleary's work at Limerick with Engineering undergraduates uses examination of practical report texts as a means of revealing key conventions and expectations within a discipline. Barrie Cooper at Exeter, working with first year mathematicians, encourages them to consider 'What is a mathematician', and in so doing moves them from group work to expressing individually the qualities of a mathematician through writing for two very different audiences – prospective students and graduate employers. He also encourages these mathematicians to reflect on their early learning experiences at university and their position in the mathematical community, and express these in writing. At an early stage in a degree programme mathematicians are therefore encouraged to write for different purposes and audiences, and in very different styles, to nurture academic development while also enhancing future employability.

Nicola King's work with bioscience students at Exeter encourages them to be researchers and 'change agents', identifying the needs and concerns of their student peers, and working with staff to mobilise effective responses. Empowering students is a common thread among many of the Conference presentations. Lawrence Cleary and Íde O'Sullivan's approach at Limerick develops student peer-tutors who work inductively and non-intrusively with students, 'drawing out' rather than 'putting in'. Laura Bonner and Barrie Cooper's structured 'audit toolkit' approach at Exeter has mathematics and engineering students reviewing the development of employability skills within their undergraduate programme, and making links for themselves between their academic studies and future employability.

Several Conference presentations, including one of Lawrence Cleary's, focus on close engagement with text. Mary Deane's review of her own and others' research suggests ways of helping students engage with their own text at multiple levels during re-writing. John Hilsdon's online project employs a collection of students' written assignments, in various disciplines, where assessor's feedback is given through the lens of a critical thinking

framework. Doing so reveals aspects of viewpoint/authority, structure, voice and style. The feedback highlights both good practice and areas for improvement.

Mary Deane's presentation, which introduces the 'Engaging with students and staff' theme, also brings us to a major strand of this Conference – how subject specialists and writing specialists can work together to effect productive change in the curriculum. She will survey the 'Writing in the Disciplines' (WiD) approach, which is strongly developed in the US and is gathering momentum in the UK (Ganobcsik-Williams, 2006; Deane and O'Neill, 2011).

Nurturing academic writing within the discipline, and writing for future employability whether within the discipline or not, can be encouraged at one and the same time. This does not necessarily require major redesign of the curriculum. Existing assignments can be adapted rather than completely recast, and writing requirements made explicit, drawing upon a writing development model such as IPACE.

This can happen through writing/learning development specialists working with subject specialists in a manner that takes account of the unique features of the STEM discipline, and drawing out those features that the subject specialist knows implicitly, but does not necessarily express to students. Writing specialists and subject specialists have potentially much to learn from such engagement. And doing so would help ensure that when students finish their STEM degree they are in a more robust position to write effectively for a range of purposes and audiences, and have a stronger sense of themselves as a writer, whether within their discipline or not.

For those of you who prefer a visual depiction of the ideas expressed above, along with relevant curriculum development prompts, see Figure 1.

Reference list

- Day, T. (2011). 'What writing expectations do UK employers have of engineering graduates? And how might universities respond?' A paper presented at the European Association for the Teaching of Academic Writing (EATAW) Conference, 29 June – 1 July 2011, Limerick: University of Limerick.
- Day, T., Pritchard, J. and Heath, A. (2009). 'Final-year undergraduate students' experience of dissertation writing on their journey to becoming graduate engineers.' A paper presented at the European Association for the Teaching of Academic Writing (EATAW) Conference, 30 June – 2 July 2009, Coventry: Coventry University.
- Deane, M. and O'Neill, P. eds. (2011). *Writing in the Disciplines*. Basingstoke: Palgrave Macmillan.
- Ganobcsik-Williams, L. ed. (2006). *Teaching Academic Writing in UK Higher Education: Theories, Practices and Models*. Basingstoke: Palgrave Macmillan.
- Hickman, D.E. and Jacobson, S. (1997). *The POWER Process: An NLP Approach to Writing*. Carmarthen: Crown House.
- Ivanic, R. (1995). 'Writer identity.' *Prospect: The Australian Journal of TESOL*, **10** (1), pp. 8-31.
- Lea, M.R. and Street, B.V. (1998). 'Student writing in higher education: an academic literacies approach.' *Studies in Higher Education*, **11** (3), pp. 182-199.
- Lillis, T.M. (2001). *Student Writing: Access, Regulation, Desire*. London: Routledge.
- Pace, D. and Middendorf, J. eds. (2004). *Decoding the Disciplines: Helping Students Learn Disciplinary Ways of Thinking*. New Directions for Teaching and Learning No. 98: Summer 2004. San Francisco: Jossey-Bass.

Trevor Day 8/9/11

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Figure 1. Developing writing in STEM disciplines: An emerging model of engagement

Progression
(undergraduate years
1 – 3/4)



A **metacognitive framework** for writing (IPACE):
Identity, Purpose, Audience, Code, Experience
(Day, Bath)

Emerging identity, values, attitudes, capabilities (skills) and ‘voice’ w.r.t. disciplinary writing and future employability

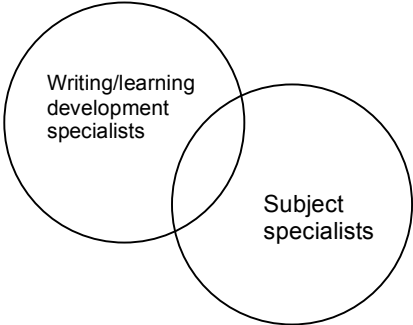
Supporting students’ re-writing
Incorporating **diagnosis**
(Deane, Oxford Brookes)

Developing **identity** through analysis of texts
(Cleary, Limerick)

Informed by **surveys of what employers say they want** e.g. Wilkinson et al. (UWE), Day (Bath)

Critical thinking – a framework for **feedback** on writing
(Hilsdon, Plymouth)

Peer-mentoring and **student empowerment**
(Cleary and O’Sullivan, Limerick)



Engaging with subject specialists: developing students’ **writing in the disciplines (WiD)**
(Deane, Oxford Brookes)

Bloom’s taxonomy:
Evaluating
Synthesising
Analysing
Applying
Comprehending
Remembering

Reflective writing
Encouraging **teamwork** and peer review
(Cooper, Exeter)

Empowering students through investigation of disciplinary writing requirements
(King, Exeter)

Student-led **employability** audit toolkit
(Bonner & Cooper, Exeter)

Special features re. writing in STEM disciplines include:
• emphasis on **positivistic and quantitative approaches**, with a **practical** ‘hands on’ approach
• in most cases drawing upon a **scientific methodology** (mathematics an exception, with its different working methods and epistemology?)
• **strict conventions on reporting** e.g. practical reports often written in the impersonal, using established structures

Bruner’s spiral curriculum

Enhancing **employability**: CPD portfolios
Developing **identity**: ‘What is a mathematician?’
(Cooper, Exeter)