

Encouraging Engineers to Read: A Book-Based Final Year Assessment

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Abstract

This paper describes an initiative within the final year of the MEng Chemical Engineering programmes at the University of Manchester, in which students were required to identify a suitable book, broadly related to Chemical Engineering, and read it and be assessed on it. Meanwhile, a similar number of academic staff also read the books in order to prepare the assessments. The reading was supported by a programme of lectures and discussion groups to engage students with the book as a concept and with the nature of reading more generally, in order to enhance and empower their own reading. The examination included assessment of these generic aspects as well as the students' technical mastery of their specific books. Feedback on this initiative was extremely positive, as many found it a refreshing alternative to traditional forms of teaching and learning employed in Chemical Engineering. They also remarked that it encouraged enhanced skills in communication and greater empowerment to read as the basis for lifelong-learning.

Introduction

Engineers as a group are traditionally not great readers. Even those who enter academia can soon lose the habit of reading entire books, or struggle to justify the necessary time commitment. Books tend to be consulted rather than read, dipped into for data, rather than being immersed in for knowledge and understanding. However, books read in their entirety convey ideas and give a coherence of thought and rationality that cannot be gained from selective consultation without context. Meanwhile, problem-solving engineers operate in a world in which the questions asked are increasingly complex, requiring ever-enhanced quality and coherence of understanding in order to conceive and implement solutions. It is important

that engineering graduates (and the academics who teach them) should be encouraged and enabled to read books as the basis for enhanced and ongoing effectiveness.

To this end, a book-related teaching activity was conceived and implemented within the final year of the 4-year integrated Masters programmes in Chemical Engineering at the University of Manchester. This was envisaged as ‘a student-driven learning activity based around the directed reading of a book relevant to the broader context of Chemical Engineering’. Three broad benefits from this ‘Book Module’ were expected:

1. first and foremost, a systematic and formalised approach to encouraging engineering graduates to view books as accessible and to have the inclination and interpretive tools to engage with them as a basis for lifelong-learning;
2. the opportunity for individual students to direct their learning towards areas of specific personal interest, through selection from a diverse pool of relevant books; and
3. a redirection of the teaching ‘burden’ in that staff, too, are encouraged and enabled to make time for reading, which would otherwise be viewed as a luxury.

Funding for this initiative was kindly provided by the Centre of Excellence for Enquiry-Based Learning (CEEBL) at the University of Manchester, in order to allow the purchase of the books. This paper briefly overviews the literature on the relationship of reading to education, the extent to which reading features within the sources by which engineers obtain information, and the benefits of reading to scientists and engineers. It then describes the implementation of the Book Module within the School of Chemical Engineering and Analytical Science’s undergraduate Masters programmes and evaluates its success.

Reading, Education and Engineers

‘Until lately the West has regarded it as self-evident that the road to education lay through great books’ (Hutchins 1952, p.xi). So opens Robert Hutchins’ *The Great Conversation: The Substance of a Liberal Education* (1952), which serves to introduce the *Great Books of the Western World* series. (The substance of this series is on great works of philosophical, religious, historical, dramatic, scientific, medical, economic and political literature produced within Western civilisation; the series includes Homer, Plato, Aristotle, Augustine, Chaucer, Shakespeare, Descartes, Newton, Gibbon, Kant, Fourier, Darwin, Marx and Freud, to name but a few). Hutchins goes on to observe,

*The disappearance of great books from education and from the reading of adults constitutes a calamity... the idea that a liberal education is the education everybody ought to have, and that the best way to a liberal education in the West is through the greatest works the West has produced, is still, in our view, **the best educational idea there is.*** (Hutchins 1952, p.xiv; emphasis added)

As educators in universities, it seems appropriate to pay attention to '*the best educational idea there is*'. To be fair, Hutchins' argument is specifically in relation to these literary classics, but it is more generally true, albeit at a more prosaic level, that education and reading are considered to go hand in hand. Covey in his *Seven Habits of Highly Effective People* (1989, p. 295-296) notes,

It is extremely valuable to train the mind to stand apart and examine its own program. That, to me, is the definition of a liberal education – the ability to examine the programs of life against larger questions and purposes and other paradigms. Training, without such education, narrows and closes the mind so that the assumptions underlying the training are never examined. That's why it's so valuable to read broadly and to expose yourself to great minds. There's no better way to inform and expand your mind on a regular basis than to get into the habit of reading good literature... 'The person who doesn't read is no better off than the person who can't read.

Meanwhile, Pandian (quoted in Abdul Karim and Hasan 2007) describes 'reluctant readers' as 'people who are "retarded" in terms of knowledge, intelligence and maturity'.

These arguments for the foundation of education being in reading and for the benefits of reading in relation to re-examining paradigms seem to be relevant for the education of engineers. The stereotypical picture of an engineer does not include a book in the engineer's hand; engineers are not generally regarded as great readers. Engineers also tend to be resistant to change (Tenopir and King 2004, p. 44), suggesting also a reluctance to 'examine... against other paradigms' that reading encourages. However, Tenopir and King (2004) examined exhaustively the communication patterns of engineers. They noted that engineers, particularly design, R&D and consulting engineers, are prolific seekers and users of information (*ibid.*, p.31-48). In contrast with scientists, however, engineers favour information retrieval via personal, oral communication rather than from literature (*ibid.*, p. 61-75). Although engineers do in fact read quite a lot, the source material for their reading is biased heavily in favour of internal reports and trade magazines, rather than scholarly journal publications or books. Nevertheless, a persistent finding is that those engineers who do read a lot are more successful than those who don't. Lufkin and Miller (1966) surveyed the reading habits of engineers and concluded, 'the people who have been singled out for excellence, whether by promotion, or by publication, or by special recognition for creativity, all read a great deal more than the average', a relation that has been confirmed in subsequent studies (see Tenopir and King 2004). A pragmatic and utilitarian consideration for engineers then, rather than the noble aspirations of a liberal education, is that a habit of reading tends to be associated with professional success.

Engineers do read, but tend not to read books in their entirety, reading instead primarily to obtain information from whatever sources are most readily accessible and trusted. But T.S Eliot lamented, ‘where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?’ (thus, inspiring the Information Science framework of Data-Information-Knowledge-Wisdom – see <http://en.wikipedia.org/wiki/DIKW>). With their focus on information, engineers are in danger of failing to develop the wisdom required to address the problems and challenges of the modern world – of being trained but not educated. This is where books have a unique power, relative to the other forms of written communication with which engineers and other professionals engage. As Hutchins observes “Great books are great teachers... they demand the attention of the reader and keep his intelligence on the stretch’ (Hutchins 1952, p.47). Books have a depth, complexity and coherence that give them an educational value beyond other forms of written communication.

The United States’ Accreditation Board for Engineering and Technology (ABET) has as one of its criteria for the accreditation of university engineering programmes ‘a recognition of the need for, and an ability to engage in, life-long learning’ (Spurlin *et al.* 2008, p xxi); the UK Standard for Professional Engineering Competence (UK-SPEC) similarly recognises the need for life-long learning (Anonymous 2004). Once graduates leave university, teaching and learning will no longer be served on a plate. Who, then, will be the life-long teachers of engineering graduates? Moreover, on what basis might an engineering programme demonstrate that it is giving its graduates the ability to engage in life-long learning? If great books are part of the answer to the first question, then inclining students towards books might well be considered an appropriate answer to the second.

Reading of books is widely recognised as foundational for education. The anecdotal and formal evidence that engineers are not great readers implies a worrying conclusion regarding their status as ‘educated’. Therefore, the motivation for this project was to enhance the educational status of our engineering graduates by exposing them to the reading of books, as both a concept and a reality.

Approach

This section describes the practicalities of how the Book Module was incorporated within the degree programmes of the School; how it was ‘sold’ to students and to staff; how it was operated; how the students were assessed; and how the project was evaluated.

Incorporating the Book Module within the undergraduate MEng programmes – and getting staff and students on board!

The School of Chemical Engineering and Analytical Science at Manchester (CEAS) runs several undergraduate integrated Masters programmes: the straight MEng in Chemical Engineering, MEng with Biotechnology, MEng with Environmental Technology, MEng with Chemistry and MEng Chemical Engineering (Business Management). (The use or otherwise of brackets reflects the University’s regulations on the naming of joint degrees.) The first three of these MEng programmes are taught entirely with CEAS, drawing on research expertise within the School to provide the distinctive content, while the latter two involve modules delivered by the School of Chemistry and the Manchester Business School, respectively. The final year of these programmes is dominated by a Research Project and Dissertation, which comprises 50 credits out of the total of 120 for the year. (CEAS also runs the MEng with Industrial Experience and the MEng with Study in Europe, in which students spend their third year in industry or at a European university. These students return for a final year that does not involve a research dissertation, but instead features the 30-credit Design Project that is a requirement of an accredited engineering degree programme. The BEng with Industrial Experience, the BEng (Hons) and the BEng (Ord) make up the ten undergraduate Chemical Engineering programmes offered at Manchester.) Our Chemical Engineering graduates are recognised by employers as among the very best in the UK, and our programmes are subject to a culture of constant scrutiny and enhancement.

The Book Module was included as a 10-credit unit within the final year of the straight MEng programme, the MEng with Biotechnology and the MEng with Environmental Technology. It was not included within the Chemistry and Business Management programmes, because their timetables require a certain number of credits from external Schools, and, thus, there was no room for the Book Module. It was also not included within the programmes for which the students are away from the University for their third year of study, because of the obligation to fit sufficient specified engineering content into their final year of study.

The 'Aims' of the Book Module were described in the Undergraduate Student Handbook as:

- To allow students the opportunity to develop in-depth knowledge in a subject area of their choice, closely or loosely related to their research project, through reading and mastering a book on the subject.
- To develop an appreciation of the unique features of books as communication media, and to give students the skills and inclination to engage with books as the basis of lifelong-learning and ongoing education.

while the 'Intended Learning Outcomes' were that the students should be able to:

- Describe, insightfully and engagingly, the content, merits and significance of a selected book.
- Demonstrate mastery of the subject matter of a selected book and understanding of its context within the discipline and practice of Chemical Engineering.
- Communicate an appreciation of the advantageous and disadvantageous features of books, compared with other communication media.

The Book Module was introduced for the academic session 2008-09, for which there were a total of 35 students on the five 'standard' MEng programmes, of which 23 were on the three programmes that included the Book Module. Originally, it was intended that a limited selection of around four to five books would be offered, from which students would select one, and that a group of students would be reading a given book and could discuss it and learn together. However, it was decided to try to align the students' choice of book with their Research Projects and to have the Research Project supervisors read the books in order to provide the assessment. This was clearly a more ambitious endeavour, requiring the involvement of a larger number of academics, with greater issues over comparability of books and of assessments, as well as logistical issues over identifying and obtaining the books within a reasonable timescale. It also meant that most books were read by a single student, precluding opportunity for detailed technical discussion and cooperative learning. In the end, a pragmatic, hybrid system was implemented: first, on the basis that a very small number of academic staff simply refused to participate; and second, other members of staff, while being willing, were not actually competent to read and prepare an assessment for the book their students wanted to read. (For example, one student chose a straightforward Chemical Engineering textbook, *Dispelling Chemical Engineering myths*, but his research project supervisor was a chemist with limited Chemical Engineering understanding; the supervisor was willing, but it was decided to have a chemical engineer read the book instead.)

The module had been ‘sold’ to staff on the basis that: first, they could keep the book, so this was an opportunity to obtain a book they had had their eye on; second, this gave them the encouragement and opportunity to read a book which they might otherwise have struggled to find the time; and third, this was educationally ‘a good thing’ to be doing with our students and was in itself sufficient motivation to do it. Most staff were willing, in principle. One commented, ‘I think the book module is a great idea!', but also confessed, ‘I can't remember the last time I read a book!'

To introduce and sell the idea to the students, they were gathered for an introductory session at the beginning of the year, having spotted this strange new ‘Book Module’ in their timetables. They were told, ‘this year, instead of us academics reading, predigesting and serving up knowledge to you, you will have to read a book yourselves, master its content and be ready to sit an exam on it’. While several of the students were delighted with this opportunity, many looked aghast, some commenting, ‘b-but... I don't read books!’ The Business Management and Chemistry students were then highly relieved to discover that they did not have to do this module. It is, thus, fair to conclude that the majority of students responded with apprehension, but with a few who were highly supportive and the rest simply resigned. The introductory session then continued by presenting the motivations for the module in terms of the accepted educational benefits of reading and the limitations of engineers who fail to read. Although not necessarily convinced, the students were informed that they were obliged, in discussion with their Research Project supervisor, to identify a book and get it approved by the book module co-ordinator, who then, via the University Library and with the CEEBL funding, arranged to purchase the books.

Operating the Book Module

As noted above, some supervisors refused to read a book alongside their student, or preferred not to if possible, while others were very willing to engage. Thus, a pragmatic approach was taken to ensure that a book was identified for each student and read by a suitable academic. Once books were agreed upon by a particular student and supervisor, those books were also offered to other students via a regularly updated list. Meanwhile, as other students identified books that their supervisor was unwilling to read, an alternative academic was identified to read the book (usually the module leader, who ended up reading several books). Thus, ultimately, a total of 19 books were read by 23 students and 16 academics. Issues included, of course, ensuring students chose books that were roughly equivalent in terms of size and difficulty. The module leader provided guidance regarding length (200 to 300 pages, as a rough guide) and took an overview regarding the suitability of each book. The books were required to be broadly relevant to Chemical Engineering, but Chemical Engineering is the broadest of the engineering disciplines and a very broad view was taken regarding relevance. (Thus, for example, one book

was on the history leading up to the Industrial Revolution, as the student was interested in history, and the Industrial Revolution is intimately linked with the rise of the chemical industries and the development of Chemical Engineering as a discipline.) In some cases, equity in terms of the size of book was approached either by requiring a student to read only selected chapters of a longer book or by supplementing a shorter book with another book chapter or related review article. (Thus, for example, the history book mentioned above was only 192 pages, with many illustrations, and, therefore, it was supplemented with a 30-page book chapter on 'Chemical Engineering – the First 100 Years'.) The size and difficulty of the chosen book was also taken into consideration later when assessing the student's examination script.

Having chosen the books, and having understood they were obliged to read and master these, themselves, as independent learners, the students' engagement with their books was nevertheless facilitated through a structured programme of lectures and discussion groups. As well as the introductory lecture, a lecture was scheduled entitled 'The Concept of the Book'. This lecture was delivered by Mr John Blunden-Ellis of the John Rylands University Library, whose remit includes library provision for Chemical Engineering, and who regularly contributes seminars on library and information provision for undergraduate and postgraduate programmes and activities in CEAS. It was intended that the Book Module should not only develop technical mastery of the particular book chosen by the student, but would serve to cultivate an appreciation of books and the nature of reading in general, in order to encourage and facilitate ongoing reading as the basis for lifelong-learning. Thus, the lecture covered four main topics: the evolution of the book; the present status and likely future of the book; the nature of reading and how we deal with information (e.g., contrasting reading books with reading from the Internet); and the way in which engineers obtain information. The lecture also highlighted the documented benefits of reading for professional scientists and engineers.

As well as the lecture, two discussion groups were held, in order to give students a forum for discussing their books, in terms of its nature and content and their reaction to it (and, subliminally, to ensure that students were reading their books in a timely fashion). It so happened that many of the books were related to energy, so one of the discussion groups was devoted to these books, while the second featured a more eclectic range. As well as giving students the opportunity to verbalise the subject of their books, these discussion groups emphasised a critical consideration of the nature of each book. For example, students discussed how literary devices were employed and whether they were used successfully. They also talked about how the books were structured and how the authors attempted to engage with the reader. These discussions, in relation to each student's own book and in comparison with the other books, served to help students see and appreciate the nature of books and the structures and devices employed in written material to inform and engage. Having this appreciation, it was hoped, would encourage and empower students' future reading of books.

Assessing the students' achievements on the Book Module

The Book Module contributed 10 credits to the final year of the MEng programme, which is made up of 480 credits in total. These are split equally over the four years, but the final years are weighted more heavily in relation to deciding a student's degree classification, the weighting being 1:3:6:6 for the four years. It was important, therefore, to design adequately robust and accurate assessments for this module, within the context of its contribution to the students' degree classifications.

The module was assessed via a book review and a written exam. The book review was undertaken to help the students engage with their books and contributed 10% to the overall assessment for the module. The written exam contributed the other 90%, and comprised three sections covering:

1. Part A: Generic questions on the book as a concept and the nature of reading, drawing largely on the 'Concept of the Book' lecture and associated material, and contributing 20% (e.g. *Contrast the nature of reading when applied to the Internet with that applied when reading a book. What are the relative merits and disadvantages of these two broad extremes of reading style? Given that engineers tend to do less of the latter, what are arguably the benefits to engineers and scientists of more reading of books? Support your answers with reference to relevant research in these areas.*);
2. Part B: Generic questions about books and reading, answered in relation to each student's particular book, contributing 30% (e.g. *Discuss how the author(s) of your book sought to engage the reader, i.e. devices or approaches they employed that sought to go beyond merely providing information, but sought more ambitiously to involve the reader and to draw them into (as books have been described) The Great Conversation.*)
3. Part C: Specific questions related to the technical content of each book, contributing 40%.

The questions for parts A and B were devised by the module leader, while the specific questions for each book were provided by the 16 academic staff members who had read the books, with the module leader advising and taking an overview with respect to the length and difficulty of the questions for each book. The 19 books resulted in an exam paper of 23 pages in length, the largest exam paper offered across the Faculty of Engineering and Physical Sciences! The examination paper was sent to the External Examiner, who was kept informed of the nature of this initiative and was approving of it. The examination was two-hours long, unseen and held under examination conditions, but 'open book' in relation to the particular book the students were studying, i.e. they were allowed to bring that book, but no other material, into the exam.

The book reviews and sections A and B of the exam were assessed by the module leader, while section C was assessed by the academic staff member who had read the particular book. Thus, the majority of the marking was performed by the same academic, thus ensuring equity of marking for the majority of the assessment. Equity on part C was sought by providing instructions in the form of descriptors of the type of answer that would attract a 2:2, 2:1 or 1st class mark, e.g. 'A 1st class mark should show evidence of insight, critical analysis and/or wider reading'. Students were told at the start of the module that they were unlikely to get a first class mark if they did not read beyond their chosen book.

Evaluating the Book Module

In order to evaluate the success of the Book Module, in terms of the students' experience and perceptions of it, and to gain feedback, a questionnaire was devised and distributed to the students following the examination. Appendix 1 reproduces the questionnaire, which consisted of a series of statements, against which students responded on a Likert-type scale from 1 to 5, where 1 indicates strong disagreement with the statement and 5 indicates strong agreement. Prompts were also given to elicit further written responses in the spaces provided. A similar, shorter questionnaire was designed for academic staff feedback (Appendix 2). The module was also evaluated using the University's standard quantitative questionnaire.

Results and Discussion

This section presents the books selected by the students, comments on the level of achievement as indicated by the examination and presents the results of the student and staff evaluation questionnaires. It then draws together conclusions about the merits and success of the Book Module.

The Books

Table 1 lists the 19 books chosen by the students.

<i>Antioxidants in Food: Practical Applications.</i> Pokorny J, Yanishlieva N and Gordon M H (Eds.). CRC Press (2001)
<i>Biofuels for Transport: Global Potential and Implications for Energy and Agriculture.</i> Worldwatch Institute, Earthscan Ltd. (2007)
<i>Bionanotechnology: Lessons from Nature.</i> Goodsell D S. John Wiley and Sons Ltd. (2004)
<i>Capitalism as If the World Matters.</i> Porritt J. Earthscan Ltd. (2005)
<i>Chemical Formulation: An Overview of Surfactant-based Preparations Used in Everyday Life.</i> Hargreaves, A E. Royal Society of Chemistry (2003)
<i>Cytochrome P450: Structure, Mechanism and Biochemistry.</i> Ortiz de Montellano, P R (Ed.). Springer (2005)
<i>Dispelling Chemical Engineering Myths.</i> Kletz,T A, CRC Press (1996)
<i>Elements of Physical Chemistry,</i> 4th ed. Atkins P and de Paola J. Oxford University Press (2005)
<i>Fuel Cell Systems explained.</i> Larminie J C and Dicks A. John Wiley and Sons Ltd. (2003)
<i>Fundamentals of Industrial Catalytic Processes.</i> Farrauto R J and Bartholomew C H. John Wiley and Sons Ltd. (2005)
<i>Fundamentals of Natural Gas Processing.</i> Kidnay A J and Parrish W R. CRC Press (2006)
<i>Future Energy: How the New Oil Industry Will Change People, Politics and Portfolios.</i> Paul W. John Wiley and Sons Ltd. (2007)
<i>Optimization of Chemical Processes,</i> 2 nd ed. Edgar T F and Himmelblau D M. McGraw-Hill Higher Education (2001)
<i>Optoelectronics: An Introduction.</i> Wilson J and Hawkes J. Prentice Hall (1997)
<i>Sustainable Development for Engineers.</i> Mulder K (Ed.). Greenleaf Publishing (2006)
<i>Sustainable Energy: Choosing Among Options.</i> Tester J W. MIT Press (2005)
<i>The Day the World Took Off – the Roots of the Industrial Revolution.</i> Dugan S and Dugan D, Channel 4 Books (2000); and <i>Chemical Engineering – the First 100 Years</i> , Chapter 2 of <i>Chemical Engineering: Visions of the World.</i> Darton R C, Wood D G and Price R G H (Eds.). Elsevier Science (2001)
<i>Tomorrow's Energy: Hydrogen, Fuel Cells, and the Prospects for a Cleaner Planet.</i> Hoffmann P. MIT Press (2002)
<i>Who Wants to be a scientist?: Choosing Science as a Career.</i> Nancy Rothwell, Cambridge University Press (2002)

Table 1. The books selected for reading by the 2008-09 cohort of final year MEng students.

Clearly, a very broad and eclectic range of books were read. It can be concluded that if these subjects were all mastered to some extent by the staff and students of the School of Chemical Engineering and Analytical Science, then the School would be well read across a vast field! As noted above, a dominant emphasis was on energy, with books on *Sustainable Energy*, *Tomorrow's Energy* and *Future Energy*, as well as biofuels, fuel cells and natural gas. Sustainability was another key theme, with *Sustainable Development for Engineers* and *Capitalism as if the World Matters*, in addition to *Sustainable Energy*. Several of the books were straightforward traditional Chemical Engineering (e.g., *Dispelling Chemical Engineering Myths*, *Fundamentals of Industrial Catalytic Processes*, *Optimization of Chemical Processes*), while others reflected the more novel areas with which chemical engineers are now engage, such as *Bionanotechnology*, *Chemical Formulations*, *Optoelectronics* and the enzyme system *Cytochrome*.

P450 (this being a vast book on a complex subject, and one that the student regretted choosing, despite its relevance for his Research Project). The remaining books included more general interest choices such as *Who Wants to be a Scientist?* (which apparently had the effect of deterring the student from a scientific career) and the already mentioned *The Day the World Took Off: The Origins of the Industrial Revolution*. Around two-thirds of the books were selected as being directly or broadly relevant to the students' Research Projects, while the others were selected for broader interest, rather than specific relevance.

The Examination Performance

The average mark for the module was 61.4%, very much in line with the performance of this cohort of students across all their final year courses. Marks ranged from 85% (a high first class mark) down to 43% – a bare pass, and lower than would generally be achieved by final year MEng students, perhaps reflecting the very different nature of this module, relative to most Chemical Engineering courses and the difficulty some students experienced in coping with something so atypical. The students scored on average very similarly for parts A and B (*i.e.*, the generic questions) when compared with part C (*i.e.*, the specific questions for each book). In general, the students found the two hours for the examination too short to write discursively on the general and specific questions. The book reviews received an average mark of 6.57/10, slightly higher than the examination performance. It was intended that the best of the book reviews should be sent to the Institution of Chemical Engineer's professional magazine *The Chemical Engineer (TCE)* for publication; the review, on 'Sustainable Energy: Choosing Among Options', was published in the June 2009 issue of *TCE* (Matten 2009).

Evaluation of the Module

A total of 15 out of the 23 students (65%) returned their evaluation questionnaires, from which average scores were calculated against each item and the comments compiled. A total of 125 individual comments were received, comprising a rich and eloquent resource of feedback on the module and areas for attention or improvement.

Figure 1 presents the breakdown of 1s, 2s, 3s, 4s and 5s for each item on the student questionnaire, ordered from highest to lowest average score, against an abridged version of each statement (refer to Appendix 1 for the full version of the statements).

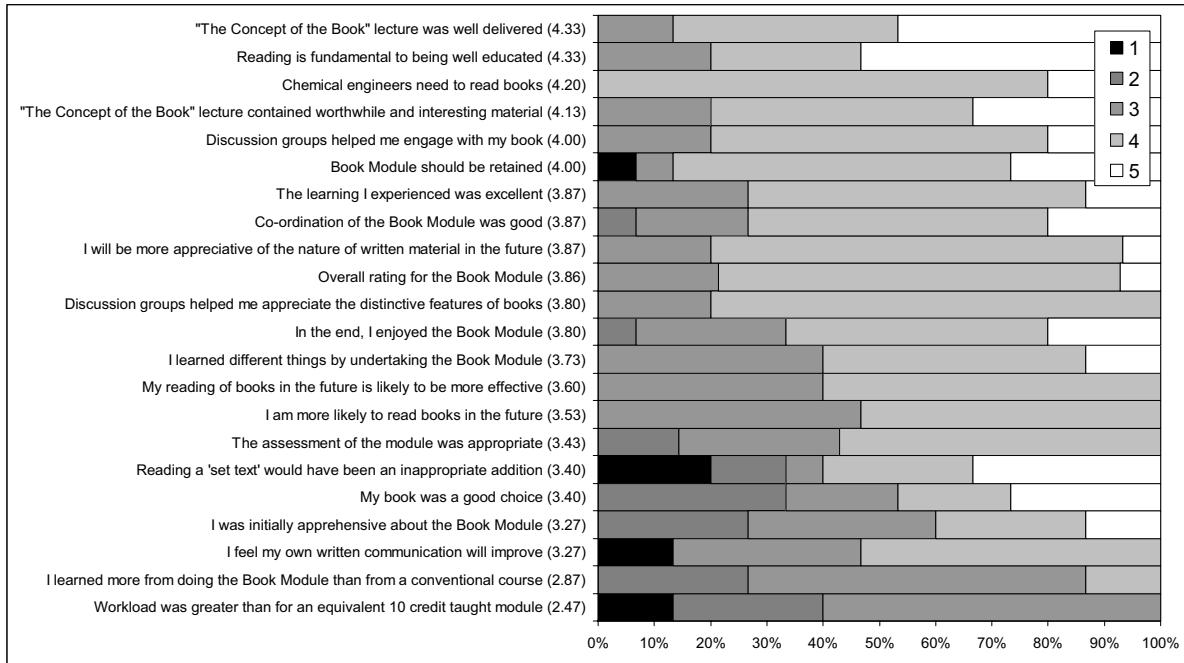


Figure 1. Breakdown of student responses to questionnaire statements, in which 1 corresponds to 'Strongly disagree' and 5 to 'Strongly agree'.

A general observation is that, against statements that were mostly positive in nature, fewer than 10% of the responses were 1s or 2s (strongly disagree or disagree), while nearly two-thirds (64%) were 4s or 5s (agree or strongly agree), while around 27% were a neutral 3. Thus, it can be concluded that in general the Book Module received highly positive endorsement from the students.

Looking at the detail in Figure 1, it can be seen that 'The Concept of the Book' lecture scored the most highly. Comments included:

I love history and I think the history of books is really interesting.

Although the content of the lecture was not technically challenging, it encouraged me to think about books in a different way and complemented the objectives of the module well.

I really enjoyed this lecture, it introduced and caused me to evaluate my own learning styles, i.e. how I always print items out, then highlight and take notes. Especially focusing me on how my time is most productively spent – which should help guide my studies throughout the remainder of the year.

The next two highest scores were against the statements: 'Reading is fundamental to being well educated' and 'In my opinion, chemical engineers need to read books in order to undertake their professional activities effectively', scoring 4.33 and 4.20, respectively, and indicating that

most of the students had, indeed, been persuaded of the value of reading. Thus, the goal of 'encouraging engineers to read' appears to have been addressed successfully. Eight of the 15 students 'agreed' that they will be 'more likely to read books in the future' as a result of having undertaken the module, while the other seven were neutral on this point. However, they felt more strongly that their reading in the future will be 'more effective', and even more strongly that they will be 'more appreciative of the nature of written material' as a result of having undertaken the module. Comments on these aspects included:

As my main learning source has always been books, I do not think it will affect my reading; however, it has made me concentrate on how I use other media sources, i.e. the Internet and electronic books/journals.

Having read and thought of the book outside of the pure factual content it has focused why I find some more engaging and effective.

I have always preferred reading the news compared to television – I feel that wider reading helps to put subjects into context rather than popular or politically biased opinions. I feel that this applies to learning also – through reading rather than pre-digested notes you become more aware of other issues. Create links which may be useful later, creating a more effective engineer.

Similarly, eight of the 15 students 'agreed' that their own written communication will have improved as a result of the module; although, the two responses of 1 against this statement reduced its overall average. Lufkin (1968) noted an assumption of 'a direct correlation between reading habits and writing ability' – it is, thus, hoped that the Book Module will enhance students' writing skills, as these students acknowledged. However, a recurrent theme in the feedback was the advice that the module

could be extended into much more of a communications module with emphasis on understanding and being able to communicate effectively. Us students often comment on how people's presentation skills and ability to write English well are often the same when they start and leave university! (sic.)

Tenopir and King (2005, p. 5 and p. 97) note that 'engineers and scientists spend a majority of their time communicating' and that 'writing is the most important skill an engineer can possess'. Despite this, numerous commentators have lamented the poor communication skills and information literacy of engineers, particularly in relation to writing (Yackel 1988; Tenopir and King 2004; Keilson and Cooperstein 2007). There is clearly a need for a communications emphasis, and particularly a writing emphasis, within the undergraduate programme. However, this needs to be sustained coherently across the three or four years of the programme, with increasingly sophisticated elements introduced in later years. Report writing is introduced within laboratory modules in the earlier years of the course. Higher-level written communication is then emphasised within the Research Project that runs alongside the Book Module. The instructional emphasis occurred in the second semester, at a time when students are focussed on writing their dissertations and, therefore, more receptive to the instruction.

That being said, it is planned next year to enhance the connection between reading and writing skills by replacing part of the exam with a coursework exercise that involves learning about the features of essays as distinct from books, critiquing an essay and then writing an essay related to books and communication (as suggested in the feedback below). In addition, students will be given the opportunity to critique their books in relation to document design. Drawing on the paper by Silyn-Roberts (2002), he notes that engineering students who naturally think in terms of design react well to the concept of document design. It is, thus, hoped that this structural analysis of the books will impact on the subsequent design of their dissertations.

Recognising the benefit of the Book Module in relation to communication, some students felt it would have been valuable to have located the module in an earlier year of the course. On balance, we feel that the module is best located in the final year of the MEng programmes serving *inter alia* to encourage independent learning, which is one of the factors specified by the Engineering Council as distinguishing MEng-level accreditation from BEng-level (Anonymous 2004).

Against the statements, 'the Book Module should be retained within the final year of the MEng Chemical Engineering programmes'; 'the learning I experienced through undertaking the Book Module was excellent; 'overall rating for the Book Module'; and 'in the end, I enjoyed the Book Module', the score profiles were well above neutral, and combined give a positive endorsement for the Module. Students made numerous supportive comments:

It was a nice change from traditional engineering modules.

It was nice to have a module that was such a contrast to the regular modules we do. The book module allowed me to learn about something I was particularly interested in and develop my literature critic skills.

I really took to and engaged with the book as a concept and enjoyed the personal learning. I feel it was a good module to make the distinction between how you take responsibility for your own learning at this stage of the course.

Great experience for me.

It was such a cool subject

I didn't feel like I was studying for the course more like I was just acquiring knowledge for myself.

However, one comment that represents those who were more apprehensive and also illustrates the numerate and strategic, but perhaps unimaginative, character of some engineering students:

Did not want to read a book and get examined on it during my final year especially as the final year's weighting is six times more than in the first year and twice as much in the second year. When considering the hard work that went in to learn the fundamentals of chemical engineering during the first two years, it is hard to imagine that reading a book in terms of assessment is much more important.

Two of the statements sought to elicit perceptions regarding the *amount* and *type* of learning facilitated by the Book Module, relative to traditional Chemical Engineering modules, while a further statement related to the amount of work involved in this Module. The amount of work received the lowest average score; students found that the workload was similar to or less than a conventional 10-credit course. The average score regarding the amount of learning achieved relative to a conventional course was also less than neutral; two students felt they learned more, against four who felt they learned less, and nine who were neutral. However, students were much more united in agreeing that they 'learned different things by undertaking the Book Module, things that would have been difficult to learn using the usual course structures':

Most definitely this was the most important aspect of the book module, it allowed the development of skills that had not previously been addressed in the course.

Different type of learning, conventional courses have more volume to remember/regurgitate whereas this was more of an experience!

Students highlighted specific skills and benefits of undertaking the Book Module, which included: learning how to read and analyse a book; broadening knowledge; thinking about wider issues; developing critical thinking and analysis skills; reading 'properly'; enhancing writing skills; writing a book review; using information sources more effectively; appreciating reading more; and being more 'patient and committed in reading a book'.

The students found the discussion groups valuable, both to help them engage with their own book (average score of 4.0) and 'to appreciate the distinctive and helpful features of books and of written communication' more generally (average score of 3.8). The discussion groups themselves were lively and interesting, each lasting around two hours.

Most students (eight of 14 – one of the 15 didn't enter a score for this statement) agreed that the assessment was appropriate, four were neutral, and two disagreed. With respect to assessments, students generally have an advanced sense of justice and are happy to be vocal on the subject. On this occasion, the students seemed relatively content with the assessment. The main concerns were about the lack of time to answer the questions adequately and the relative difficulty of some questions in Part C. Students suggested weighting the book review more heavily and adding an oral examination component.

I was pleasantly surprised by the exam questions – I liked the way you weren't expected to 'pull' it apart but more take the general themes and compare them to other sources in a more general context.

The exam itself was enjoyable... the questions allowed the student to expand on and express their knowledge well.

The statement proposing to add a set-text that all students read, on top of the individual books, met with a very mixed response (although this may indicate that the negative wording of the statement confused some students, as sometimes the score and the comment seemed to be at odds). A few of the comments seemed to indicate that the students would find this fairer in terms of assessment and that it would encourage collective appreciation and cooperative learning.

One-third of the respondents disagreed that their book was a good choice, while three out of the 15 agreed and four agreed strongly. The feedback included advice to warn future students not to choose books that are too heavily technical. Finally, the majority of students agreed that the module had been well co-ordinated, but suggested that books be obtained sooner in the semester to allow more time for reading. Students also commented that additional structured activities should be introduced, such as more discussion groups, training on essay writing and specific coursework on aspects of the book/history/communication in science.

The response to the staff questionnaire was less forthcoming, with only five responses and few comments. Figure 2 shows the breakdown of the staff responses.

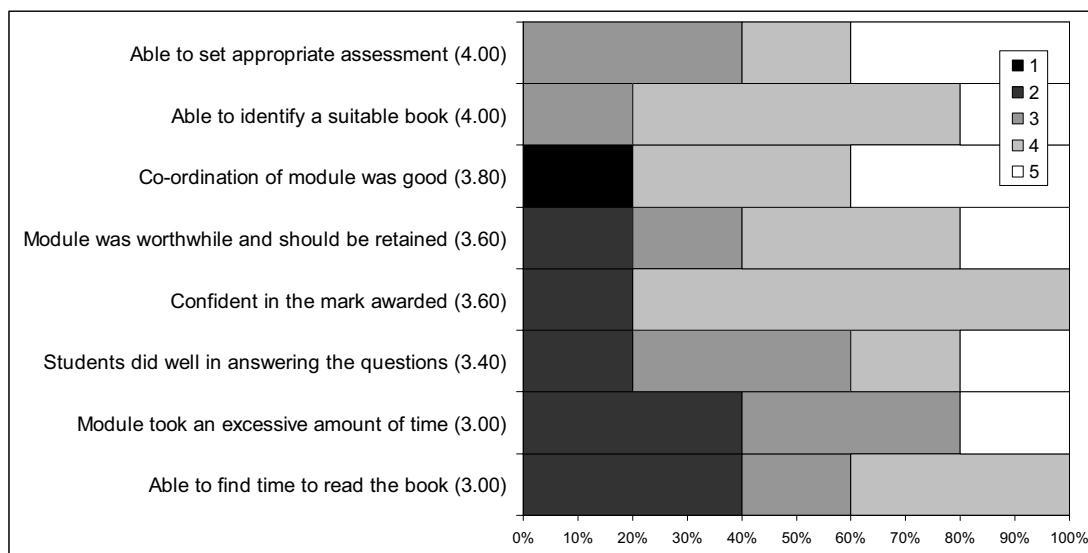


Figure 2. Breakdown of staff responses to questionnaire statements, in which 1 corresponds to 'Strongly disagree' and 5 to 'Strongly agree'.

In general, staff felt able to identify a suitable book and set an appropriate assessment for which they were confident in the mark they awarded. There appears to be a reluctant agreement that the module is worthwhile and should be retained, with reluctance arising, principally, from the difficulty to find time to read the book and from a conclusion that it was 'too much effort for one student per exam paper'. Anecdotal evidence supports the perception of grudging acceptance that this is a worthwhile but staff-intensive venture. Staff recognised the value of the opportunity for students and the tangible benefits the module offers, in principle, for staff, but these benefits are hard to enjoy in practice.

Reflection

The Book Module was introduced and implemented successfully and was very well received by students and, to a lesser extent, by staff. It largely met its stated 'Aims' and 'Intended Learning Outcomes', as well as its implicit aim of encouraging engineers to read.

The initiative has been presented at several internal teaching and learning symposia, where it has elicited substantial interest. Principal responses have been in relation to robustness and parity of assessment. Others commented that 'you're very brave to have done this!', with respect to implementing an activity in which it was so hard to be confident of demonstrating equitable treatment of all students and to securing the contributions of so many staff.

This unexpected identification of bravery is a reminder that a component for success was the championing of the Book Module by the module leader, who had conceived of the project and implemented it despite the difficulties. The module leader has a certain degree of respect within CEAS as a dedicated and high-quality teacher, which may have inclined other academic staff to a degree of forbearance, and the students a degree of trust, in going along with this quite demanding and unusual initiative.

Having implemented the module and confirmed its value, the ongoing practical issues for future years revolve principally around two issues: retaining staff engagement in an activity that could be perceived increasingly as an imposition; and funding the purchase of books. The Book Module is resource-intensive, both financially and in terms of staff time. The CEEBL funding has allowed the purchase of the initial resource of books that, combined with the existing and increasing library resource, could provide a sufficient pool for future students, but an important aspect of the Book Module is the opportunity to read the latest and most up-to-date books. Thus, the substantial benefits of the Book Module with respect to the education of engineering graduates must be weighed against the tangible costs and demands on staff. Next year, with 32 students doing the Book Module, the challenges will be even greater...

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Appendix 1

Statements on the student feedback questionnaire (to which students responded on a scale of 1 to 5, where 1 corresponds to 'Strongly disagree' and 5 to 'Strongly agree') and additional prompts.

Please write comments about any aspect of the module (even if not specifically requested) in the spaces provided or at the end.
I was initially apprehensive about the Book Module. Why or why not?
In the end, I enjoyed the Book Module. Why or why not?
My book was a good choice. Why or why not? (briefly)
I feel I learned more by doing the Book Module than I would have learned from a conventional 10-credit taught course (1 = No, I learned a lot less; 3 = about the same; 5 = a lot more). Why or why not?
I feel I learned different things by undertaking the Book Module, things that would have been difficult to learn using the usual course structures. What sort of things?
The assessment of this module was appropriate. Please add comments on the assessment and any suggestions for improvement.
The co-ordination of the Book Module was good. Any comments or suggestions for improvement:
The lecture on 'The Concept of the Book' contained worthwhile and interesting material. Comments:
The lecture on 'The Concept of the Book' was well delivered. Comments:
The discussion groups helped me engage with my book. Omit this if you did not attend a discussion group. If you did attend, what, if anything, did you find helpful?
The discussion groups helped me appreciate the distinctive and helpful features of books and of written communication.
I am more likely to read books in the future as the result of having undertaken this Book Module. (3 = not more likely but not less likely; 1 = less likely – I've been put off books!)
My reading of books in the future is likely to be more effective as a result of having undertaken this Book Module.
I will be more appreciative of the nature of written material in the future, through having undertaken this Book Module.
I feel my own written communication will improve as a result of having studied books and the nature of reading and communication through this Book Module. If so, in what way?
Reading is fundamental to being well educated.

In my opinion, chemical engineers need to read books in order to undertake their professional activities effectively. Why or why not?
The Book Module should be retained within the final year of the MEng Chemical Engineering programmes. Why or why not? Should it be dropped, extended, placed elsewhere, modified in some way?
The workload associated with this module was much greater than for an equivalent 10-credit taught module. (1 = No, it was a lot less work; 3 = about the same; 5 = a lot more).
Reading and being examined on a 'set text' comprising a chapter from another book, on top of the book I chose, would have been too much work and an inappropriate addition to this module.
The learning I experienced through undertaking the Book Module was excellent.
Overall rating for the Book Module. Any other comments:

Appendix 2

Statements on staff feedback questionnaire (to which staff responded on a scale of 1 to 5, where 1 corresponds to 'Strongly disagree' and 5 to 'Strongly agree'), and additional prompts.

I was able to identify a suitable book to offer for the book exam – one that was of interest to me to read, and one that was suitable for students to study. Comments:
I was able to find time to read my chosen book, and doing so was a worthwhile investment of my time.
I was able to set appropriate assessment questions based on my book. Any difficulties in setting the assessment?
The student(s) did well in answering the questions I set . (1 = disappointed my expectations; 3 = met my expectations; 5 = exceeded my expectations).
I am confident that the mark awarded was appropriate.
The co-ordination of the Book Module was good. Any suggestions for improvement:
The Book Module took up an excessive amount of my time, relative to the teaching and learning achieved.
The Book Module was worthwhile and should be retained as part of the MEng final year programme. Any further comments or suggestions: