

Developing Research Pathways within Undergraduate Programmes in the School of Technology: Review Report

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In this part of the project, our objective was to carry out an audit of current programme provision, within the School of Technology at Oxford Brookes University, in order to identify and report on the modules and programmes in which research or research-related skills contribute to student's learning.

To achieve this objective, we have followed the following avenues:

1. Interviews with members of staff working in different roles within the School. Interviewees included teaching and research staff, as well as people playing key roles in curriculum development and policy implementation, such as field chairs, the heads of department, and the Dean of the school.
2. A review of the documents produced by the School of Technology describing all programmes offered by its two departments: Mechanical Engineering and Mathematical Sciences, and Computing and Electronics, to obtain detailed information about the learning outcomes of modules taught in the School, and investigate which of those are research-related.
3. Background reading of relevant literature (references provided at the end of this report), to understand what is being done towards the implementation of research-led curricula at other institutions of higher education, and thus have a point of reference for our finding at Brookes.

Results

We begin this report by discussing the findings of interviews with our colleagues at the School, as they are insightful and representative of the current research activity in the undergraduate curriculum in the School of Technology. Then we discuss how interview findings relate to the formal description of programmes and modules made by the School in programme handbooks. Finally, we contrast this with findings in educational publications that discuss what research activity is undertaken by undergraduate students at other institutions.

Interviews

There are currently 72 academic members of staff in the School, of which we interviewed around 36 between September and December 2008. Previous to the interviews, we had a meeting to design the list of questions we wanted to use (cf. Appendix A), but we did not rigorously stick to the structure outlined, going for a guided dialogue instead.

A first observation is that research-only staff, of which we tried to interview two, were initially reluctant to participate in this study. In fact, we only got a response and interview from one of two we approached for this project. This suggests that people who are not required to teach in the School, due to their excellent record in research, may be difficult

to engage where this kind of initiative is concerned, thus making it difficult to feed the research work they so successfully carry out into the undergraduate curriculum.

Interviews would start by asking the interviewee what his/her idea of research was. It is very striking that in nearly all cases the person responded with a question: "Are you asking about research or undergraduate research?" This, backed up by later questions (about enlisting student collaboration into their research work), clearly shows that academics regard their own professional research work as different to that undergraduates can carry out. This should not be taken as staff having a dismissive attitude towards students. On the contrary, when questions about the inclusion of research (references, lecturer's own work, or activities) in lectures were asked, it became clear that most lecturers are using enquiry-led approaches that clearly fall within a research paradigm, if they are not recognised research methods themselves. For example, one of our colleagues, when asked if she used research in her lectures, immediately answered negatively. But later on she described how one of the first activities in her first-year computing module would be to ask students to compare a given "exercise" website with published web pages and give a critical appraisal of the model, referencing to working web pages where necessary. That is to say, a subjective like or dislike was not enough to qualify the "model" page; students are required to back up their criticisms and the solutions to the problems they spot in it.

This led us to conclude that the recognition academic staff can give to research within the undergraduate curriculum rests heavily on their own working definition of research. They have very high aims. When they say research, they not only mean systematic work that will advance knowledge (the student's), but (internationally) publishable work that produces ground-breaking knowledge in the corresponding discipline; they talk about the research output they aim to achieve, as scholars in their field, not about a method of enquiry. In this sense, it is not surprising they have a different notion of *undergraduate research*. In the more ambitious definition, then, the majority of academic staff firmly responds they cannot bring undergraduate students on board their research, as the amount of background they would have to acquire before being able to collaborate in "proper" research is well beyond the undergraduate curriculum. They place such work within PhD-level.

We have also found that while the feeling described above changes from one discipline to another within the School, from the strong sense of impossibility of the task declared by Mathematicians and Statisticians to the more optimistic responses of Mechanical Engineers, with Computing and Electronics in between. Only two of the people interviewed declare the task achievable and actually had examples of undergraduate work that had made its way into established journals in Engineering. Considerably more than two people said a research-led curriculum would be nice for the students, but questioned the feasibility and the interest of the students themselves. Even people who have recently supervised successful undergraduate research work pointed out that research is in the best of cases a difficult activity that requires a very determined and patient character, and a deep focused interest. These characteristics are not to be found in all students, they added, and one should be careful about developing a learning pathway that would attract only a few. Also, a concern about the resources that such a move would require was uniformly expressed by both lecturers and those with managerial roles.

All interviewees welcomed the discussion, many expressing that the interview itself had helped them to focus on the research aspects of their own module. Only a couple of

voices were completely against, just as only two were all-in. In the middle there was an interested but cautious reception of the idea of a research-led curriculum. Also, in general, we observed that nearly every person interviewed had embedded research or enquiry-led learning activities into their lectures, but only a few identified them as such (usually those whose modules are literally called study or survey methods, for example). With respect to this, we have found that most lecturers have moved away from chalk-and-talk lectures, interacting with their students and trying to engage them into appropriating their own knowledge. The use of this approach is widely spread and ingeniously tailored to the needs of each discipline and module within. Marrying these observations to research-oriented developments described in the literature on undergraduate research curricula, it should not be difficult to bring about more recognition of the work that is already being done in the School, and perhaps even make people interested in reshaping the curriculum to make research components more obvious. Finding ways to achieve this recognition and involvement will be part of the second phase of our project.

Academic offer in the School of Technology

The two departments of the School of Technology currently offer 17 different programmes (*warning: have not included Electronics yet*). The descriptions of these programmes, and the modular progressions that make them up, are readily available in printed course handbooks, and through PIP. Within each module description, *learning outcomes* and *teaching and learning experiences* are clearly identified, using the standard Brookes template for module descriptions. It is under these headings that some of the research-related skills that undergraduate students develop through their programme can be found, but they are not identified as such since the template does not include a heading where the word research is present.

All programmes in the School adhere to University policy that six identified transferable skills should be developed. Of those, *self-management, communication, problem solving and information technology* play a key role in research activity. But again, it is less clear how these, together with *learning skills*, are developed in each module and exactly how they relate to research or develop research skills. In the Mathematics and Statistics courses, for example, only one module, *Quantitative Research Methods*, uses research in its title, with *Basic Survey Methods* and *Sampling and Surveys* following in conveying a sense of research activity in their title. In Computing, *Study Methods Using IT Skills* is the clearest one, followed by *Multimedia IT Skills* and *Database IT Skills*. It should be said, however, that module titles are, in most cases, describing what the module is about (e.g. Linear Algebra, Chassis Engineering, Graphics and Animation). It would be extremely artificial to try to convey a research direction in all titles. It would be more pertinent, we feel, to either rename transferable skills or add a “research skills” rubric.

It is more difficult to identify, from their titles, modules that develop research-related skills in the Engineering courses, but there, as in Computing and Mathematics, the *Project* double modules, or *Independent Study*, appear in the third year. It is in these modules that, according to those interviewed who are also in charge of curriculum development, the clearest opportunity to undertake research work could be found. Students may not necessarily end up producing original or publishable work, but they have 24 weeks to work on one topic. Lecturers also feel that it is here where they would have an opportunity to lead a project approaching research, due to the amount of time.

Appendix A. Interview Questions

We include here a copy of the research questions we designed for the purpose of conducting the interviews with colleagues at the SoT. As we indicated before in the report, we used these as guidance only. Interviews were conducted with staff working at different levels and roles. We had to include policy-making questions, in some cases, or simply let our interviewee express a point of view in an extended manner, later extracting an answer to a specific question.

Reinvention Project: Developing Research Pathways within Undergraduate Programmes in the School of Technology at Oxford Brookes University:

An interview –friendly version of the list of topics or questions.

Questions have been grouped by the themes they address.

-----Interviewee's own view of research-----

0. What do you understand by research?

(If interviewee mentions “undergraduate research”, what does s/he mean?)

1. Are you currently engaged in research? What about?

-----Interviewee's current teaching and use of research therein-----

2. What modules are you currently teaching? What stage are they?

3. In your undergraduate teaching, do students...

- a. learn about current research issues?
- b. learn how research issues are investigated?
- c. learning how research can be critically appraised
- d. learning about research done by lecturers
- e. learning by helping lecturers with their research
- f. learning by carrying out research

In each case prompt for:

Module number and level/year

Activity

-----Asking interviewee about use of research skills-----

4. Can you identify research skills/activities in the modules you lead/teach?

If yes, Prompt for module and skills/activities

If yes, Are the students aware those skills can be used to do research?

If no, what do you think the problems are in including research skills/activities

-----Research activity in the 1st and 2nd year-----

5. To what extent do 1st/2nd year students have the opportunity to appreciate/carry out research in their modules ?

5a. To what extent do 1st/2nd year students have the opportunity to learn research-related skills in their modules ?

6. Do you consider that 2nd year modules deliver material that is strongly research-based?

6a. If no to Q6, explain why;

if yes to Q6, should adjustments be made to the module description or delivery to make it more obvious?

-----Research outside the classroom-----

7. Do you envisage any opportunities to engage students in research for the community?
Prompt for ideas or reasons why not.

8. In your research, could students participate outside the curriculum in a project managed by you? Prompt for details/reasons why not. (8a In your research projects/proposals, is there scope for the inclusion of student work? If yes ask for details, if no ask why not...)

9. Do you think students could publish in existing academic journals?

9a... or student-directed journals?

-----Undergraduate research in the School of Tech-----

10. Do you think there are enough resources to create a student journal in the School of Technology?

11. Would you consider an undergraduate student conference feasible in the School of technology? If no – what do think the problem would be?

12. Do you have any concerns about making the undergraduate curriculum more research-based?

Appendix B. The Literature Consulted

Although a full list of the literature consulted during the first phase of the project is given here, we would like to make comments on one of them: 'Integrating Inquiry/Discovery Based Activities into the Mathematics Curriculum', by Brown and Yürekli, because of its detailed description of the process we are interested in as it took place in Ithaca College (IC), in the USA. Notice that this article is about Mathematics only, so we will also restrict the comparison to the Mathematics group within the SoT.

A case comparison

In common with IC, we can find the following:

1. A continued shift to a student-centred approach to teaching and learning.
2. A group that is keen on curriculum development, where novel approaches are welcome but carefully scrutinised for purposes of quality and relevance.
3. A first-year module, U08604, with an important project-based component that is also supported by the production of effective reports and oral presentations to communicate results and the use of Technology (Mathematica).
4. An enquiry-based approach to our lecturing.

Steps towards an enquiry-based approach IC has taken and we could consider:

1. A freshman (1st year) enquiry-based course, *Mathematical Experimentation*, coupled with
2. A 2nd-year weekly *Sophomore Seminar* exploring mathematical ideas.
3. An optional research two-module sequence that begins in the junior (3rd) year of a four-year programme.
4. Spreading project-based work to other modules (e.g. Calculus).
5. Regular presentation and publication of student work in suitable undergraduate fora (IC's Research Conference, the National Conference on Undergraduate Research, the Nebraska Conference for Undergraduate Women in Mathematics, and the Hudson River Undergraduate Mathematics Conference).

References

Brown, D. and Yürekli, O. 2006. Integrating Inquiry/Discovery Based Activities into the Mathematics Curriculum. *Mathematics and Education Reform Forum*, **19**(1): 1-4.

Brown, D. and Yürekli, O. 2007. Undergraduate research in Mathematics as a curricular option, *International Journal of Mathematical Education in Science and Technology*. **38**(5): 571-580.

Crook, S. 2008. *Undergraduate Research Resources*. [Online] (Updated August 2008) Available at: <http://math.la.asu.edu/~crook/undergrad.html> [Accessed: 23rd February 2009]

Healey, M. and Jenkins, A. 2009. *Linking Discipline-Based Research and Teaching through Mainstreaming Undergraduate Research and Enquiry*. [Online]. Available at: <http://resources.glos.ac.uk/shareddata/dms/838C82FDBCD42A039FF7263F16F25270.pdf> [Accessed 24th February 2009]

Jenkins, A., Healey, M. and Zetter, R. 2007. *Linking Teaching and Research in Disciplines and Departments*. York: The Higher Education Academy.

McGuinness, C. 2008. *Meanings of "Research-Led Teaching" within the Queen's context*. [Online] Available at: <http://web.gq.qub.ac.uk/people/staff/whalley/teaching/resled.html> [Accessed: 23rd February 2009]

Oxford Brookes University. 2008. *University Strategy 2010 to 2020*. Oxford: Oxford Brookes University.