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Using Science Project Work in Distance Learning for a Personal Perspective on Science and Society

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Abstract

The UKOU Masters module *Science and the Public* includes a project element, where students undertake original self-selected research that addresses a specific and meaningful instance of science's impact on society. Students choose topics of personal significance, often related to their professional interests. Using a rich mix of questionnaires, interviews and content analysis, students were able to test many of the theoretical constructs developed in the module texts. Problems associated with project work in ODL institutions can be eased by extensive computer-based support. In this instance, the limited familiarity of science-based students with the research methods of social science made such supervision yet more crucial. Establishing a personal perspective via individual project work provided students an opportunity to develop a deeper and more meaningful understanding of the influence of science on the lay public.

Introduction

This paper explores two related areas of potential interest to those concerned with the development of distance education. First, it looks in general terms at how project work can provide educational benefits within open and distance learning (ODL) programmes, yielding outcomes that are comparable with the use of project work in more conventional learning situations. Secondly, the paper explores how a specific initiative in project work at the United Kingdom Open University (UKOU) has helped provide students with vivid and personal experience of the interactions between science and society, in ways that re-enforce key themes of a newly-developed UKOU course, *Science and the Public*.

Project Work and Open Learning

The sentiments of the American educational pioneer John Dewey have a contemporary relevance, reflecting a present-day consensus about the value of project work. He felt that the passive absorption of particular facts was both artificial and 'unnecessarily narrow' (Dewey, 1900) tending 'very naturally to pass into selfishness'. Dewey looked for a deeper, more socially significant form of school learning. This he felt could be achieved if 'active work' prevails, 'a spirit of free communication, of interchange of ideas, suggestions, results … becomes the dominating tone', (see Waks, 1997). For Dewey, the problem-solving inherent in project work was more likely to be successful if topics for investigation were volunteered by students rather than being imposed by teachers.

Since that time, project-based activities have been a widely recognized part of all levels of school learning. Some innovative approaches, notably those related to science, technology and society (STS), (see Solomon and Aikenhead, 1994) attach a particular importance to their benefits, emphasizing their potential to motivate students and to nurture the skills of locating, selecting and transforming information. In keeping with its conservative traditions, higher education (HE) in the UK was initially hesitant about embracing project work. But from the 1960s onwards, project work was increasingly used to provide advanced-level undergraduates with experience of independent learning and, especially for students of science and technology, with opportunities for extended self-directed practical work. For example, Chambers, 1972, reports that between 1964 and 1970, the proportion of science departments offering project work to its final-year undergraduates increased from 14 to 67 percent. By the 1980s, almost all chemistry courses in the UK featured project work. In most instances, a single major project comprised virtually all of the practical experience in the final undergraduate year of study (Hoare, 1980). Some HE institutions currently place a major emphasis on project work and problem-solving, most notably the Universities of Roskilde and Aalborg in Denmark, where a wide range of group programmes flourish, see Legge, 1997. 'Project-orientated' HE teaching, where the theoretical and practical needs of projects determine course content, has a surprisingly long pedigree, with persuasive claims to success (see Cornwall and Schmithals, 1977).

Whatever doubts may have existed about the feasibility of project work for ODL, the institutions that flourished in the wake of the establishment of the UKOU in the early 1970s swiftly and successfully absorbed this element into their curricula. Henry (1994) reports that one in nine of the course descriptions in the International Centre for Distance Learning database included the term 'project' or 'project work'. (About 15% of postgraduate courses in the current ICDL database include one or other of these key words in their descriptions.) In the Science Faculty of the UKOU for example, many such projects provide 'hands-on' experience of practical methods – helping to ensure that UKOU students are not significantly disadvantaged in terms of practical techniques, compared to students of more conventional institutions, (see for example Varley, 1975). Other UKOU science-based project work is more concerned with the exploration and re-enforcement of major course concepts, often via one or more of the new technologies that are an increasing part of ODL, see for example Hodgson and Murphy, 1984. Most UKOU-based projects involve students in different forms of independent investigation but group projects are a feature of some ODL programmes, for example in business studies, see Helms and Haynes, 1990. As Henry (1994) reveals, project work is an area of continuing innovation in ODL institutions, alongside other innovations linked with the new technologies, (see for example, Petrie *et al*, 1998).

The UKOU Course: Science and the Public

This newly-written ODL module is a constituent of the UKOU's Taught Masters (M.Sc.) programme and relates in particular to the *Studies of Science* study strand. In 1998, the module was presented to an initial student population of about 80 graduates, based in UK and the EU. To set the scene for a discussion of the outcomes of the project work and before reflecting on their educational significance, the next sections describe the content and method of delivery of the module and outline the controversial field of 'The Public Understanding of Science' that is its central theme.

Structure and Content

The text element of *Science and the Public* consists of 30 freestanding booklets, many of which are related to specific case studies of social relevance. They describe contemporary or historical events where science has played a key role, in ways that led to public controversy or confusion and had an impact on public perception of science and of scientists. Examples include;

- the BSE debate (Bovine Spongiform Encephalopathy or Mad Cow disease),
- the relationship between electromagnetic fields (especially from overhead power lines) and particular forms of cancer,
- the disposal of a North Sea Oil exploration platform (the Brent Spar controversy),
- the reported existence of a 'gay gene' and
- the likely causes of 'cot deaths' in very young infants.

These examples fuel a broader debate about 'science issues' that comprise the middle section of the module – issues such as whether scientists engender trust amongst the public, perceptions of risk, policy-making in a climate of uncertainty and conflicts between science and other forms of belief, notably religion. The final sector of the module examines the many-layered meanings behind the phrase the Public Understanding of Science (PUS), viewed from the perspective of scientists, educationalists and the public.

All of the booklets include already published material, mainly drawn from primary source journals (and some book chapters and newspapers articles) in areas of science studies, philosophy and sociology. Students have an opportunity to 'read around' the topics via the 50 or so additional articles provided on the *Science and the Public* CD-ROM, providing a 'library' of relevant sources which is accessible via the student's own personal computer.

Tutorial support for the module is provided via a small, geographically dispersed team of Associate Lecturers (ALs), whose role combines assessment (marking of extensive essays), project 'supervisor' and more general pastoral and academic support. Most student/AL contact is via telephone and computer conferencing using the FirstClass software that is an increasingly important feature of UKOU course presentation in science. Five networked groups, each of fifteen or so students, helps provide a social and co-operative dimension to study that complements the many hours of individual study - about 350 hours per module – that is a major feature of UKOU learning at Masters level, (Thomas, 1999).

Why is the Public Understanding of Science Controversial?

The 'PUS debate' in the UK developed in the wake of the Royal Society report (Bodmer, 1985), which identified what it saw as a lamentable lack of public understanding and appreciation of science. It attempted to persuade hitherto diffident scientists of their duty to communicate to the public, which it optimistically characterized as eager to learn more science, though lacking sufficient opportunity. Bodmer's diagnosis of public ignorance soon acquired an unflattering epithet – the *cognitive deficit model*, see Wynne 1991 and Thomas, 1997a. The encouragement to 'inform the public of science' soon spawned a range of activities and informal educational initiatives designed to that end, much of it encouraged by the newly

created COPUS (Committee for the Public Understanding of Science), with support from the British Association for the Advancement of Science (BA). For example, the SET (Science, Engineering and Technology) week is now a major event in the PUS calendar, comprising a busy, eclectic national programme of science-based activities, which succeeds in attracting in excess of an estimated 1 million or so of the UK public.

But the SET programme and its like has its critics, (see for example Thomas, 1997b and Fuller, 1998), who claim that the programme epitomizes the cognitive deficit model, with its implication that the lack of public appreciation of science can be rectified simply by 'showing-off the acceptable face of science to the public'. Sociologically-inspired analyses of how the public sees and uses science knowledge paint a richer, more complex picture. For example, David Layton and colleagues were concerned with the social processes whereby adults give meaning to science and with the difficulties of integrating it into 'the grain of everyday life'. (Layton *et al*, 1993). Their studies implied that 'the representation of science as a coherent, objective and unproblematic entity characterized by certainty and direct applicability to every day life received little support'. In consequence, they developed an *interactive* model for PUS. Rather than occupying a central, deterministic role in decision-making, science was often Americanised as it became integrated with other kinds of knowledge. In opposition to the deficit model, lay persons saw science as inseparable from its social and institutional connections. According to the interactive model of PUS 'ignorance could be functional and defensible'. Alan Irwin has argued a broadly similar position in the context of lay attitudes to environmental controversies. He maintains that lay opinion is far from being the irrational and uninformed stance that the deficit model implies – in his view 'citizen expertise' is necessary and legitimate. He also emphasizes the habitual placement of science by the public in broader contexts – to become 'situated knowledge'. Irwin sees belief in the deficit model as particularly damaging to the search for new forms of dialogue that might help bridge the current scientist/citizen divide, (Irwin, 1995).

Science and the Public Project Work

Such models of PUS are critical to questions that dominate *Science and the Public* - how can 'science' and 'public' be defined, how much science does the public know, how does the public use scientific information, do SET-style activities influence public perceptions? Empirical research that addresses these areas is presented to students in the module texts but much of it is surprisingly sketchy and over-generalized – as if the public could be regarded as a homogeneous whole. The wide geographical spread of our students and their very different backgrounds and interests provides an opportunity to find out more about lay experiences and perceptions of science, as expressed by a rich *variety* of publics. Focussed and personalized research of this type would;

- provide direct experience of relevant 'social' research methods,
- immerse students in key literature of a specialized area of study, and foster skills of research writing at post-graduate level,
- provide opportunities for assessment and for 'feedback' to students (from ALs) on their level of research competence and understanding of a key area of the module,
- encourage students to develop their own model of science/public interaction and to create meaning behind the notion of PUS.

At a relatively early stage in their study, students of *Science and the Public* therefore selected a project topic that was of individual interest, amenable to research and relevant to the core issues of the module. The aim was for students to seek out original information, sometimes by extensive use of the literature and/or Internet, but more often by gathering data anew, for example, by interview and/or questionnaire.

Thus, generating *new* qualitative or quantitative information for oneself was a high priority. A free choice of topic was permitted, though approval of relevant research questions and intended methodology was required from the assigned supervisor (AL) before the research began. The intended project needed to be modest in scale (a minimum of 30 or 40 hours investigation), but stretched over the UKOU academic year, from February to October. Consultation with their assigned AL throughout the research period provided opportunity for advice and feedback, often as electronic-exchanges, up to the formal submission of the project write-up in October. The write-up was then assessed independently by two ALs (against a previously agreed marking scheme) and the conflated mark contributed to each student's end-of-year module grading. The analysis of the 66 student write-ups submitted reveals both problems, opportunities and insights, which are discussed in the remainder of this paper.

What Benefits and Problems?

Henry (1994) identifies a range of practical concerns that are frequently associated with ODL project work. Some of those of greatest relevance to *Science and the Public* are briefly described below, together with some facilitative and remedial tactics that were adopted to ease such problems.

- Students' initial intentions were frequently over-ambitious and lacked focus; research questions were nearly always scaled down on the advice of the AL. Focussed projects, of limited scope, were generally the most successful.
- Access to literature has traditionally been problematic for ODL students. The increased availability of databases that allow searching for key words, authors, etc. has eased the problem; *Science and the Public* students were able to access search facilities (such as BIDS (Bath Information and Data Service)), though relatively little material was available on-screen in full-text form.
- Selection of relevant 'public domain' information was often problematic, in view of the large amount of information on the WorldWide Web of uncertain origin and veracity.
- *Organizing* the research work proved difficult for many, in view of the part-time nature of study. Input was necessarily spread over a long period of time, with inevitable loss of momentum. Some students left too high a proportion of the research and writing to the last few available weeks. Henry (1978) found that students who started their project work late were more likely to fail to get enough information and were more likely to subsequently advocate to others the good practice of starting earlier.
- Patchy knowledge of appropriate research methodologies caused significant problems. In particular, the methods of social science research were not well known to *Science and the Public* students, the majority of whom had a background in science. Many assumed that methodologies such as questionnaire-setting, structured interviews and content analysis required no more than 'applied common-sense', whereas issues of design, of consistency, and interpretation of data for example are crucial in these areas, just as they are in science (see for example Cohen and Manion (1985) and Denscombe

(1998)). Using qualitative approaches (from interviews for example) proved especially difficult for students with a science background – few structured their interviews effectively and some were too intrusive in their questions.

- Many students had difficulty adopting a suitably detached and rigorous authoring style in their project write-up. Sometimes the style was too personal and anecdotal, as student's departed too enthusiastically away from the objective and detached style of 'scientific' writing with which they were more practiced. Sometimes, the faults in presentation were more deep-seated – uncertainty for example about the precise function of an Abstract.

- Students were sometimes reluctant (despite encouragement) to be self-critical within their project write-ups. For example, some of the samples used for questionnaires were small and their representativeness was uncertain. However, relatively few such students explicitly drew attention to this key feature or expressed an appropriate note of caution in their conclusions. It is striking that concerns about the accuracy and precision of data likely to be developed in students with a science background did not always transfer to this new research arena.

- But some students appreciated the limits of their research methodologies only too well. For example, one student reported 'my questionnaire was of limited value because of the absence of free speech' and astutely comments that its use in her hands 'demonstrated that a research question may not necessarily be answered by the research results obtained'. Another wrote perceptively 'the qualitative approach enabled me to read between the lines; it enabled me to carry out the project work in a non-scientific way'.

Easing the Difficulties

Advice and guidance were provided from two sources. First, the central designers of the project activity based at the UKOU provided (on FirstClass) guidance on social science methodology, for both quantitative and qualitative approaches. (Some students used their own initiative to access Web sites or published texts relating to the design and use of questionnaires for example.) Secondly, each student's assigned AL provided detailed and individualized guidance, sometimes by phone but more often computer-assisted, via a widely-used 'conference facility' dedicated to the project on FirstClass.

As mentioned, negotiation between student and AL was critical to an early and appropriate choice of research topic. The student's first proposal was submitted in writing to the AL, who offered feedback, which in turn prompted the re-submission of modified plans. Where feasible, a preliminary 'pilot study' proved invaluable. One student wrote 'the trialling of the questionnaire proved to be a useful process in that a number of misleading/confusing questions could be subsequently modified prior to the preparation of the final version'.

Successful project work depended on extensive liaison between AL and student throughout the full period of the research. Guidance on writing-up the project was especially important. Some students were unaware of the language and culture of report writing, expressing themselves in inappropriate and overly informal or colourful sentiments. In the Methods section for example, One student writes 'I was pleasantly surprised by the number of people who wanted to help'. Another reports 'the local Clinical Science library, attached to the local hospital, was also visited on a couple of occasions to obtain further information. The first time it was closed, the

next, time was very limited, but some information was found. It did proved (sic) to be fruitful.' (Most descriptions of method were of a significantly higher standard.)

The informal student networks developed using FirstClass facilitated individual project work. Through their professional links (or because of prior study) many *Science and the Public* students could offer fellow students particular expertise or opinion, via an informal 'peer learning' process that the use of FirstClass encouraged. The project work was an expression of individual effort, but networking helped break down a sense of scholarly isolation. Frequently, electronic networking had pragmatic benefits; for example as students enlisted colleagues to help distribute detailed questionnaires in different geographic areas.

The Significance of Students' Methods and Choices

There are two intriguing questions relating to student choice of area of research. First, what research *methods* did students chose to adopt, given what was in effect a 'free-choice' from the many available? Secondly, what *topics* were selected and what thinking may have underpinned such individual choices?

Quantitative methods of gathering information were preferred, with individual students using a mix of different survey techniques. Approximately 60% of student write-ups included questionnaires; only about 20% made significant use of interviews. Approaches involving group discussion or telephone interviews were much less frequent, <5%. Content analysis of texts was a popular approach (used in 45% of write-ups), mainly for the coverage of topical science-based issues in the popular media. FirstClass was used extensively to elicit views and opinions from fellow students. For many researchers, the Web represented a particularly valuable source of information, though few used Web sources exclusively. (At least one individual set up his own Web site to elicit opinions from a wider public.) The generation of *original* data was a hallmark of the great majority of projects.

In terms of choice of topic, *Science and the public* students accessed a large number of distinct and diverse publics, as the following individual examples reveal;

- school children were quizzed on their attitude to science,
- patients at a breast clinic were interviewed on attitudes to screening,
- harbour-masters and fishermen were approached for their views on the accuracy of Government figures on fish stocks,
- a research scientist interviewed colleagues about their views on the value of SET-style events for the promotion of science,
- a member of an environmental NGO looked critically at the strategies and outcomes of recent environmental campaigns,
- a volunteer worker in a zoo examined the role of volunteers in promoting greater public understanding of the zoo's activities,
- shoppers were asked about their scientific understanding of the action of antibacterial products purchased for household cleaning,
- the attitudes of doctors were investigated, with respects to chronic effects of long-term exposure to organophosphates,

- a college lecturer investigated his engineering students' perception of the importance of science.

What was striking was the richness and heterogeneity of the public views identified. It was clear that those sampled had very different experiences of science, reflecting the nuances of individual issues and broader social influences. These widely-varied reports of science/public interaction, from so many discrete 'mini-publics', exemplify the impossibility of identifying *unified* views of science that can be said to characterize the public as a whole. This is most evident from my own analysis of the full range of project write-ups – an experience not of course available to the individual student. But what is striking is that the complexity of the PUS debate was so often revealed to individual students with great vividness as they wrote-up their *own* project work, as the following student comment exemplifies:

> 'One of the achievements of the project was obtaining findings that agree broadly with the information supplied during the module but conversely also being able to explain when findings differed from that presented in the course material. The project has certainly increased my own personal knowledge (of lead and the environment) and through the questionnaire raised the issue in the eyes of at least two public groups. It has uncovered a vast rich wealth of 'lay expertise' in the public…'

In selecting topics, the 'banner headline' issues of the day were of particular appeal. For example, the following controversies were prominent in the UK in 1998 and each episode provided the inspiration for several student projects:

- the supposed risks associated with the use of the 'triple MMR' vaccine (i.e., the 'combined' measles, mumps and rubella vaccine),
- attitudes towards the use of genetically-modified (GM) foods,
- public attitudes to risks of impact of asteroids with the Earth,
- cloning (of mammals, in the tradition of Dolly the sheep).

Research topics were very seldom 'plucked out of the air'. In the great majority of cases they derive from individual students prior interests and experiences. Very often the chosen topics reflected professional concerns. For example, a psychiatric nurse chose to investigate the public understanding of the medical condition of schizophrenia from the perspective of a family member. For this student, 'the process of describing the project to colleagues became a test for the validity of the research process adopted'. Another student employed as a health visitor looked at the effect of the controversy surrounding the MMR vaccine on decision-making of her patients. A teacher of science at a secondary school examined how her school students reacted to scientific claims within TV advertisements. A keen amateur astronomer investigated levels of public understanding of the total solar eclipse due in southern parts of the UK in August 1999. Sometimes professional allegiances and a proper sense of objectivity may have been in conflict, but most in this position assumed a close professional involvement in the topic was helpful – 'being familiar with the main players from the industry side enabled me to obtain 'inside information' about the importance the industry attached to favourable public information'.

As a result, many students integrated major themes of the module – different models of PUS for example – into personal and professional contexts. For example, the psychiatric nurse looked for analogies between the relationships between therapist and client and between

scientific experts and members of the public. Integration of this type brought an added bonus; it led students to challenge the usefulness and validity of some of the key theoretical constructs that underpin the PUS debate. For example, several students considered attitudes towards the genetic engineering of crops in relation to Urlic Beck's theoretical notions of 'the risk society', as discussed in the module material (see Turney, 1998). Another student looked at the influence of statistical data in decision-making, in relation to individuals' preferences for different modes of transport. Irwin's notion of 'situated knowledge' was critically evaluated with reference to lay perceptions of 'a healthy diet', in a project which looked at (non-science) influences that individuals brought into decision-making.

Project work often gave students the confidence to relate the *general* and the *particular*. Notions of trust, expertise and of uncertainty for example – all broad issues of public concern prominent in the module texts, became embedded in a whole range of specific contexts. Both the power and limitations of science were brought home, as were suggestions for helping resolve deep controversies. For example, one project considered the extent to which science can resolve disputes about fish stocks. The student sought ways for the public and scientist to work together to formulate new, imaginative policy.

Project work therefore encouraged students to develop their *own* perspective on issues at the core of the *Science and the Public* module – for example, is there value in the cognitive deficit model of PUS? Many students indeed felt that their work demonstrated 'the need for greater understanding of science by the public'. Some students highlighted the need for more information and awareness – for example one student was unsettled by 'the 'ignorance' of the public about the health threats of electromagnetic fields associated with of mobile phones'. Some were alarmed at what they saw as irrational views and urged 'greater understanding of the facts'. For example, public attitudes to different forms of drinking water (tap or bottled) 'did not seem rational'. Others stressed the understandable difficulty the public had in knowing what 'the facts' were, as their analysis of recent public health controversies demonstrated.

Although students did highlight what they saw as 'public ignorance' few students wrote as if simply 'knowing more' would ease public anxieties. Worries about the genetic engineering of crops were evident from the better informed of the sampled population. And what the public 'wanted' was far from clear. One student survey found little evidence of public support for a 5-year moratorium on the development of GM food, even though environmental NGOs claim public support for such a move. Some project authors leant to the view that greater information would heighten scepticism. For example, in a project on perceptions of the quality of local bathing water, a student reports that 'greater understanding would enable the public to 'see through' the publicity that seaside resorts produce in promotional material'.

Conclusion

This paper has emphasized the virtues of project work – for students of ODL institutions no less than those of more conventional establishments. Indeed, the new technologies that form an increasingly important part of ODL should give extra momentum to learning programmes that highlight problem-solving and self-directed learning. But this creates a challenge for ODL institutions; if the intended outcome of project work is to enhance the research skill of independent problem-solving, this can be nurtured only through extensive and skilled instruction, supervision and support.

On the evidence of their writing, project work for our students provided first-hand experience of the public impact of science and engendered greater regard for the methodologies and strengths of social research. It provided an opportunity for students to test the robustness of key concepts from the module and to integrate theoretical and practical components – to test their understanding by putting it to work.

Conducting research helped our students develop their own meaning of the problematic notion of 'the public understanding of science' – a meaning which, as an expression of 'self', is particularly vivid and relevant. On this evidence, the presentation of a written account of individual project work is a significant 'rite of passage', for ODL students no less than others. It helps define a transition from 'learner as recipient' to active researcher, where emerging skills of reflection and critical analysis contribute to greater independence and self-affirmation.

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