Review of current or historical interest

Agriculture, environment and higher education - a personal view of the past, present and future.

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Abstract
Agricultural and environmental higher education has changed greatly over the past four decades. This article provides a personal review of the factors influencing this change. Economics, social attitudes and developments in technology and in theories of learning have all affected both what and how students need to learn. This is illustrated with examples from distance learning, where the need to provide students with a clearly structured educational experience is paramount. The paper also examines the implications of changing conceptions of environment, of the role of agriculture and a more constructivist epistemology for education and environmental action.

Keywords: Environment, Agriculture, Systems, Educational Technology

Introduction

The period from 1960 to the present saw major changes in the agricultural industry, in related research, in the University sector and in society as a whole, affecting both the content and methods of agricultural and environmental higher education. At one level, agriculture has been enormously successful; Malthusian predictions of mass starvation have not yet materialised and the output of agricultural products has more than kept pace with economic demands. Starvation still occurs on an unacceptable scale, but there is no global shortage of food materials. Yet the state of agriculture and its interaction with the environment still cause concern (Pretty, 1998). Behind all this is economics. In the 1960s, feed wheat was selling in the UK for around £120 per tonne, a new tractor (albeit with only 35bhp) cost around £600 and a hectare of land cost under £400. Forty years later, a tonne of grain fetches only about £75, while the price of a tractor has increased fifty-fold and of land ten-fold. No industry could survive such a cost/price squeeze without major change.

In the 1960s, deficiency payments and the annual price review insulated the UK agricultural industry from world markets and food production was still regarded as a priority land use. It was less than ten years since food rationing ended and also, surprisingly, since the number of tractors first exceeded the number of working horses on UK farms (Blaxter, 1974). Adopting new technology to increase product yields was the unquestioned direction of “agricultural progress” (the name used then for the journal of the Agricultural Education Association). Extensive Government-funded research and advisory services supported the adoption of new technology.

Expansion of higher education took concrete form in the 1960s in Lancaster, York and elsewhere, supported by what now look like amazingly generous student maintenance grants. Paralleling the enthusiasm for the "white heat of technology", there was a growing concern about "the environment" (Carson, 1962). Environmental scientists were widening understanding of the living world, and it appeared that same "white heat" might also be singeing important aspects of it. Although there were some links between ecology and the study of grazing ruminants, (Spedding, 1965) ecology and agriculture were surprisingly divorced. Holdgate (1994) captured this in his comment that at an early stage "scientific ecology stalked off into the wilderness - almost literally", concentrating on areas apparently free from human interference. So when ecologists began to question agricultural practices, agriculturalists often reacted with surprise and incomprehension.

Forty years on, student finances are much more straitened. Agriculture has all but disappeared as a subject in higher education in the UK, along with half the farmers and employed farm workers. Agricultural advisory services are entirely privatised. In the interim, environmental science has flourished, although student numbers peaked in the late 1980s and have since declined. Food shortages are a distant memory and the concept of national self-sufficiency in food production is largely discredited. The agricultural industry attracts attention mainly for questions about the perceived costs of agricultural policies, intensive animal production and other environmental damage, public access to land and the effects of globalisation.

As a result, higher education in agriculture has also had to change. This paper examines these changes, and considers their implications for higher education in the biosciences more generally.

Some key developments

What follows is a personal selection and interpretation of developments in the subject area and in educational theory, over 40 years as a student, staff member and external examiner; it makes no claim to be comprehensive.

Developments in the subject area

Developments that have changed the nature of the subject over the period are:-

- the ideas and concepts of systems
- The emergence of energy analysis and associated concerns for the hidden costs of human activities
- "the digital revolution" of microprocessors, personal computers, the internet and mobile communication, remote sensing and Geographic Information Systems
- the technology of genetic engineering

While none of these appeared in undergraduate courses in 1960, it would be hard to justify their omission today.

The ideas of systems can be variously traced back to von Bertallanfy (1950), Ashby (1956), Forrester (1961), Checkland (1981) and other luminaries, but within agriculture, Colin Spedding and his colleagues (Spedding 1979) were major figures. Recognising that it was inadequate to study the biology of plant and animal growth in isolation from the agricultural production systems of which they were a part, and from the economic, social and political systems within which agriculture operated, was a sea-change in outlook (Open University, 1978, Collinson, 2000). Recognising the linkage between systems ideas and constructivism (Bawden, 1997) is also likely to change views in the future.

In the 1960s, few were concerned that human activities depended crucially on fossil fuel. Oil was relatively cheap and the cost of nuclear-produced energy to consumers was predicted to be minimal. Oil price rises in 1972 forced recognition that this was a finite resource. Chapman (1975) and, for agriculture, Leach (1976) highlighted the need to consider the energy, primarily fossil fuel, efficiency of production processes. Studies such as *Limits to Growth* (Meadows *et al* 1972), the work of Ehrlich and Ehrlich (1970) and lately Wackernagel and Rees (1996) widened concern to the whole relationship between human activity and natural resources. The enhanced Greenhouse Effect (IPCC, 2001) is now centre stage. The concept of sustainable development (WCED, 1987) represents one response to this, while Avery (1997) advocates "business as usual".

Digital technology has led to an enormous increase in our ability to monitor, model and sometimes control, the behaviour of dynamic systems. Applications vary from the use of robotic vision for control of field machinery through robotic milking systems and spatially variable use of inputs (precision farming, Blackmore *et al*, 1995), to models of whole ecosystems and catchments (Aspinall and Pearson, 2000). This increased ability has not necessarily meant more effective management, but the growth in information and communication technologies looks to have major long term effects.
There has been an almost explosive growth in understanding and application of genomics, in plant and animal breeding and in medicine, changing our conceptions of species and of human potential to invent new products and services and to control our environment (Duvick, 1995). However, the possible application of the technology in the field has also engendered major conflict. This has both increased the apparent polarisation between agricultural and environmental interests and may have hardened public perceptions of the divide.

Developments in educational technology and theory

The media potentially available for education, especially at a distance, have developed enormously over this period. Paper and the telephone can be complemented by computer mediated communication, virtual learning environments and the resources of the internet. However, their impact depends on a strong underpinning of educational theory about the way students learn, the materials involved, relationship between teacher and student, situations in which learning occurs and methods of assessment. Awareness of all this was crucial for the Open Unversity, working at a distance with students many of whom had limited previous educational experience. The OU put into practice and tested developments in the theory of education from the 1960s and 70s, in a very public way. This public demonstration of changing theory may represent the University's major long term impact on education.

On joining the Open University in 1972, I thought my job was to impart knowledge to students and to assess their ability to reproduce this in examination or essay scripts. This naive "transmission" model of education was probably not uncommon at the time, but its inadequacy rapidly became apparent. Despite the "University of the Air" title, the main teaching medium was print, read by students under a wide range of different circumstances, supported by occasional meetings with a local tutor. The rapid feedback processes available on campus did not exist between OU teacher and distant student. Teaching materials had to be clear and unambiguous, and students needed to know what they should be able to do from working with these materials. Precise statements of Aims and Behavioural Objectives, deriving from behaviourist models of learning (Skinner, 1974) were initially the cornerstone of teaching materials. Although this paradigm is now outdated, it was evident that "being able to reproduce…" was only part of the picture. Other verbs such as "calculate….", "identify….", and even "design…." were needed to represent what was required. One difficulty with the rigid behaviourist model was controversy over the term "understand" in situations where no directly observable change occurred in the student.
The intervening years saw a number of changes in educational theory, in particular, the growth of a constructivist view (Berger and Luckman, 1967). This recognises that the meaning attached to events, concepts etc. varies between individuals, and so shifts concentration from observable behavioural change to cognitive change occurring within each student, formalised as learning outcomes. The ideas of key transferable skills, derived from vocational education, have also reshaped the way learning is structured and assessed.

As an external examiner, it is my impression that the content-led transmission model of education still prevailed into the 1990s, though with many exceptions. Practical classes and student projects went some way to enable students to use their knowledge to address new situations, but the focus was often on content rather than behaviour or outcomes. This has now changed enormously, and overall, beneficially, though I sometimes suspect that elements of the change may be a linguistic game, in particular the over-use of the terms "reflection", or "reflective practice" (Schon, 1982).

Political pressures

The political climate around Higher Education has also changed since 1960, with increasing emphasis on quantitative targets and value for money. First came the Teaching Quality Assessment, then the Quality Assurance Agency, Subject benchmarks and pressure for professional registration of staff, paralleled by an increasingly draconian Research Assessment Exercise. While high quality education is a must, the instrumental attitude embodied in the most recent White Paper on Higher education (DfES, 2003) feels profoundly depressing.

A possible comparison?

It is interesting to compare the development of agro-environmental education with that of information and communication technologies (ICT), a subject area that hardly existed in the 1960s. Understanding the interactions between individual components that, in the 1960s formed its nearest equivalent, is now only of specialist interest, and the focus within the Open University curriculum has moved much more towards communication *systems*. Faced with rapidly changing technology, students' ability to learn new facts and new skills becomes more important than the detailed content. Teaching has to stress students' learning about how to learn. While the science and technology of agriculture and environment may not have changed as greatly, the context has, leading to similarly changing demands on students. The current benchmarking statements for environmental and agricultural curricula now place considerable emphasis on such transferable skills.

Where does the cursor point?

The information revolution itself apparently offers great opportunities for new forms of learning. Broadband allows data, images, voice etc. to be brought to the student's desktop from anywhere in the world. Virtual learning environments could provide many of the benefits of personal interaction, without the need for the campus. The elision of economic/political pressure, understanding of learning processes and growth of communication technology could mean that the future of higher education is digital (Morris and Naughton, 1999). However, is there a danger of a reversion to the transmission model, and a call-centre culture of higher education? A "good" implementation of a specific aspect of skills or content teaching available on the web, could be available to every educational institution. To a Government looking to minimise cost, or a research-focused academic wishing to minimise teaching, this is an enticing picture. Could the Higher Education sector be reduced to a cohort of machine-minders who keep the internet connections functional and assess student progress, complemented by a few research stars who need only enough exposure to students to select new postgraduates?

In some senses, we have been here before, and it has not been quite that simple. Web-based individualised learning has some similarities to the original "University of the Air" idea, with cameras pointed at star lecturers, broadcasting to home-based students. In reality, since students could not interrupt broadcasts to check their understanding, broadcast lectures had to be clear, but could also be s-l-o-w, and unrelievedly boring. Consumer video, after the brief battle between VHS and Betamax, was expected to avoid this by allowing students to rewind and review video material as necessary, but the reality was so fiddly that few would bother. Many students also found it difficult to regard video as education, not entertainment. Videos are impossible to use on the train and the old technology of text has a lot of advantages - it fits into a briefcase, can be annotated, needs no power supply and can be made relatively interactive, with self assessment questions and activities for students.

Computers initially promised better interactivity, and the ability to run sophisticated models to explore different situations. In 1975, my students were expected to visit their local study centre to run a diet-mix linear-programming model on the University mainframe via a teletype - not a resounding success! The advent of the personal computer offered improved computer access and the price barrier was expected to fall rapidly. Yet 15 years later the initial cost of a computer is little changed. What has changed is their capabilities, especially in terms of communication.

Producing good distance learning materials, web-based or otherwise, involves a large investment of time by skilled staff. There is also a significant cost in providing the continuing human support to students which most find an essential part of a good learning experience. The variable costs of distance education delivery are generally lower than on campus, but a large student population is still essential to amortise the initial fixed cost. Despite the apparent attraction of distance learning for the dispersed populations involved in agro-environmental activities, economics effectively killed some early forays into this area (Open University*,* 1984).

Economic problems and consistent over-optimism about technological advances should not obscure the advances that have occurred. Computer-based conferencing, introduced on a mass scale to OU students in 1996 (Morris *et al*, 1999) has provided immense benefits to distance learners, substituting for campus peer group interaction. The web allows all students unparalleled access to high quality library and information resources, and to environments that would otherwise be out of reach. The difficulties of random access to visual and other resources have been removed by DVD. The challenge now is to ensure that access to the technology is reliable, equitable between students and regions, and to create an effective, experiential (Kolb, 1984) learning system, rather than just a cheap one.

Implications for agricultural and environmental Higher Education

The benchmarking statements suggest this area has moved a long way towards a more constructivist approach with students expected to work independently to solve relatively open-ended problems. This perhaps brings us back full circle to the context and problems of agriculture and environment. In the 1960s, the objective was achieving high product yields in the most economical way. Even by the mid-1970s, this was changing. Food was still important, but so were other outputs such as landscape, wildlife habitat etc. (Morris, 1977). The pressures for multiple outputs from land have continued to increase, but these are much more difficult to specify in scientific or economic terms. The idea of landscape as a stable, climax-type biotic community that can be maintained or restored is largely a fiction (Holling, 1986). Different people also value different, often incompatible, aspects of landscape and wildlife (Morris, *et al*, 2002). This is partly recognised in European legislation such as the Water Framework Directive (CEC 2000) that stresses stakeholder participation in environmental issues, However, the standards for surface water in the UK that are likely to underpin the Directive's implementation are still assumed to be "scientific" (Logan, 2001). The contested nature of environmental issues (Bingham et al, 2003) poses challenges for agricultural/environmental education.

The global extent of human impact on the biosphere (Vitousek *et al*, 1986, Wackernagel and Rees 1996) and its importance in supplying human needs (Costanza *et al*, 1997) means that humans have to take responsibility for their environment. Science represents the most effective means of discovering how environments function and developments in information technology allow better modelling of the consequences of different actions. But decisions about environmental management require informed debate about what sort of environment society wants, which is likely to be a constantly moving target. Bawden (1997) has characterised this in language that mirrors the change in paradigms of education. He suggests that the situation can be characterised on dimensions of reductionist-holist and positivist-constructivist. The dominant model of human-environment interaction has probably moved from positivist-reductionist to a more holistic, but still positivist stance. Wider re-recognition that environment is a constructed concept, without a clear and unambiguous physical existence, is still needed. Students and academics need to recognise that their understandings of the world are personal and provisional.

The old certainty that the purpose of agriculture is food production has gone and conflicts like that over GM crop introduction highlight the need to take seriously the issue of purpose. The ethical and human side of environmental and agricultural/environmental education is at least as important as the purely technical. The science that students need may be largely self-evident and can be taught effectively with careful and critical use of new technology, but in future they will also need to be able to interact and negotiate as equals with the whole range of stakeholders in managing natural resources. Finding effective ways for them to learn how to do this may pose the biggest educational challenge. The most difficult questions facing higher education in biosciences may not be how and what, but why.

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References

References

Ashby, W.R. (1956) *Introduction to Cybernetics*. London: Chapman and Hall.

Aspinall, R. and Pearson, D., (2000) Integrated geographical assessment of environmental condition in water catchments: Linking landscape ecology, environmental modelling and GIS. *Journal of Environmental Management*, 59, 299-319.

Avery D.T., (1997) *Saving Nature's Legacy Through Better Farming. Issues in Science and Technology*. Hudson Institute, National Academy of Sciences and the University of Texas at Dallas, Fall/1997 Dallas.

Bawden, R.J. (1997) Learning to persist. In Stowell, F.A., Ison, R.L., Armson, R., Holloway, J, Jackson, S. & McRobb, S. (eds) *Systems for sustainability: People, Organizations and Environment* , New York, Plenum1-5.

Berger and Luckman (1967) *The Social Construction of Reality. A treatise in the sociology of knowledge* , Garden City Middlesex: Doubleday.

Bingham, N., Blowers, A.T. and Belshaw, C.D.(2003) *Contested Environments.* Chichester: Wiley/Open University.

Blackmore, B.S., Wheeler, P.N. Morris, J. Morris, R.M. & Jones, R.J.A. (1995) The Role of Precision Farming in Sustainable Agriculture: A European Perspective. in: PC Robert, RH Rust,and WE Larson, (eds) 1995 *Site-Specific Management for Agricultural Systems*. Madison: ASA, CSSA and SSSA.

Blaxter K. (1974) Power and the agricultural revolution. *New Scientist,* 14 Feb 1974

Carson, R. (1962) *Silent Spring*. London: Hamish Hamilton

Chapman, P.F. (1975) *Fuels paradise: Energy Options for Britain*. London: Penguin Books.

Checkland, P.B. (1981) *Systems Thinking, Systems Practice* , Chichester, Wiley.

Collinson, M. (2000) (Ed) *History of Farming Systems Research.* Wallingford: FAO and CABI,

Costanza, R., d'Arge, R., deGroot, R., Farber, S., Grasso, M., Hannon,B., Limburg,K., Naeem,S., O'Neill, R.V., Paruelo. J., Raskin, R.G., Sutton, P. and van den Belt, M. (1997) The value of the world's ecosystem services and natural capital. *Nature*, (London) 387, 253-260.

Council of the European Communities (2000) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy. *Official Journal of the European Communities* L327 43 1-72.

Department for Education and Skills, (2003) *The Future of Higher Education* London: DfES.

Duvick, D.N. (1995) Biotechnology is compatible with sustainable agriculture. *Journal of Agricultural and Environmental Ethics* 8,112-125

Ehrlich, P.R. and Ehrlich, A.H. (1970) *Population, Resources, Environment*, San Francisco: W.H. Freeman.

Forrester, J. W. (1961) *Industrial dynamics* Cambridge, Mass.:Productivity Press.

Holdgate, M.W. (1994) Ecology, development and global policy. *Journal of Applied Ecology,* 31, 210-211.

Holling, C.S. (1986) The resilience of terrestrial ecosystems: local surprise and global change. In: *Sustainable Development of the Biosphere* Eds: Clark C.W. and Munn, R.E. Cambridge: Cambridge University Press.

Intergovernmental Panel on Climate Change (2001) *Climate Change 2001: The Scientific Basis. Third Assessment Report of Working Group 1*, UNEP/WHO, Cambridge: Cambridge University Press.

Kolb D. (1984) *Experiential Learning: Experience as a source of learning and development.* New York: Prentice Hall.

Leach, G. (1976) *Energy and Food Production.* Guildford: IPC Press.

Logan, P. (2001) Ecological quality assessment of rivers and integrated catchment management in England and Wales *Journal of Limnology* 60 Supplement 1, 25-31.

Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W. (1972) *Limits to Growth*. New York: Universe Books.

Morris, R.M., (1977) The systems component in teaching resource planners. *Agricultural. Systems* 2, 227-37.

Morris, R.M., Mitchell, N. and Bell, M. (1999). Student Use of Computer Mediated Communication in an Open University Level 1 Course: Academic or Social? *Journal of Interactive Media in Education*, 99 (2). <www-jime.open.ac.uk/99/2>

Morris, R. M. and Naughton, J., (1999) The future's digital - isn't it? Some Experience and Forecasts Based on the Open University's Technology Foundation Course. *Systems Research and Behavioural Science,* 16, 147-56

Morris, R.M., Oreszczyn, S.M., Stoate, C. and Lane, A.B.(2002) Farmers' Attitudes, Perceptions and the Management of Field Boundary Vegetation on Farmland. In: Frame, J (Ed) *Conservation Pays? Reconciling environmental benefits with profitable grassland systems* Occasional Symposium No. 36 British Grassland Society, 151-5.

Open University (1978) *T273, Food Production Systems.* Milton Keynes: Open University.

Open University, Agricultural Training Board and Royal Veterinary College (1984) *P589, Health and Productivity in Dairy Cattle.* Milton Keynes: Open University.

Pretty, J. (1998) *The Living Land*. London: Earthscan.

Schon, D. A. (1982) *The Reflective Practitioner.* New York: Basic Books.

Skinner, B. F. (1974) *About behaviorism*. New York: Knopf.

Spedding, C.R.W. (1965) *Sheep production and grazing management.* London: Bailliere, Tindall and Cox.

Spedding, C.R.W, (1979) *An Introduction to Agricultural Systems.*Barking: Applied Science Publishers.

Vitousek, P.M., Ehrlich, P.R., Ehrlich, A.H. and Matson, P.A.(1986) Human appropriation of the products of photosynthesis. *Bioscience,* 36, 368-373.

von Bertallanfy (1950) The theory of open systems in physics and biology *Science*, 3, 23-29.

Wackernagel, M. and Rees, W. (1996) *Our ecological footprint* British Columbia: New Society Publishers.

World Commission on Environment and Development, (1987), *Our Common Future* Oxford: Oxford University Press.