INTEGRATING NATIONAL INITIATIVES AND LOCAL DEVELOPMENTS: STREAMING VIDEO TO SUPPORT NURSE EDUCATION IN THE UK

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Abstract

This paper identifies key elements of the broader processes that contributed to the implementation of an educational innovation involving streaming video. Streaming video was used to support the learning of first year student nurses on a Life Sciences module. The use of streaming video was one of several innovations within the module designed to expand the range of learning resources available to students following a considerable increase in recruitment to this nurse training programme. This innovation was one of several supported by the Lifesign project; itself one of many nationally-supported development-projects designed to research and develop a Distributed National Electronic Resource (DNER) aiming to provide easily accessible, comprehensive information resources for use by learners, teachers and researchers within UK higher and further education. Lifesign project staff worked closely with staff in the School of Nursing and Midwifery to produce and evaluate the use of learning resources that embedded video streams. Evaluation demonstrated that many aspects of this innovation worked well. Using this innovation as an illustrative case study, this paper explores interactive processes that integrate national initiatives, the operation of multi-professional project groups and the aspirations of lecturers and learners. It highlights the factors that contribute to successful educational innovation and those that potentially limit the overall success of the processes.

Keywords

Streaming video; Evaluation; Learning resources; Integration; Process threads.

Introduction

Successful educational innovation depends on the effective integration of a large number of relatively separate but mutually dependent factors and events. These generally include attributes of the learning resource, of the learners, of their lecturers, and of institutional support mechanisms and infrastructure. They may also include the development of new technologies, research and development of new pedagogical methods, and support, leadership and drive from outside of the institution. These latter factors often extend far beyond learners and their institution.

Measuring the success of educational innovation is itself not straightforward but reliable methodologies, tools, and toolkits, are available that do enable evaluators, developers and tutors to measure success, to a degree, and to identify key factors that limit success. Numerous evaluated case studies have been described and these have lead to a wide range of generic conclusions; about what works and what does not (reviewed for Nurse Education, for example, by Lewis et al 2001), and about the general environment of evaluation (Rice, 1997). They have also lead to significant debate about what limits the potential success of innovations involving learning technologies (Warburton, 2000). The majority of these studies focus on developments within institutions. The impact of factors and events outside of the institution rarely receive the same level of analysis. Of course, in general there are fewer opportunities to control these external factors so focusing evaluation more proximately makes sense. But it is possible that some

educational interventions do depend heavily on successful integration of a broader range of events and, whether they can be controlled or not, their impact needs to be assessed as far as possible, to appreciate fully the reasons why an intervention succeeded or failed.

The 'research aim' for this paper is to identify key elements of the broader processes that contributed to the implementation of an educational innovation involving streaming video. The innovation was one of several supported by the Lifesign project (Lifesign, 2002a). This innovation is used as an example to examine the processes that operate to bring about innovation and that have successful learner activity as their final aim. Formal evaluation of some of these processes (those that directly involve lecturers and students) is identified and other processes that probably have an equally important impact are described. This paper also, ambitiously, sets out to develop the theme of 'limiting factor analysis' in the exploration of educational innovation and intends to establish a case for more widespread 'implementation-evaluation'.

Broad description of the key processes so far identified

At its simplest interpretation, streaming video was used to support the learning of first year student nurses on a Life Sciences module. Delving more deeply it is possible to identify a broad range of activities, events and circumstances that made this innovation possible. Large numbers of students were involved in this project because the University had recently substantially increased its recruitment to Nurse Education and had started to operate over several campuses. This was in response to a national need, and increased institutional funding, for new nurses. It resulted in substantial investment, support and encouragement within the School for innovative teaching. Academic staff became receptive to support from an Educational Researcher/Developer with interests in innovative learning and teaching and particular interests in using video. This researcher's activities were funded by a national research project (Lifesign) that aimed to evaluate the use of streaming video in higher education; as part of the development of a Distributed National Electronic Resource (DNER). This researcher's post was supported by the University as part of its commitment to support staff development; particularly in relation to the learning technologies. The theme was one of several encouraged, with funding, by the UK's Higher Education Funding Council (HEFCE) under the banner of quality enhancement. Parallel to this was the ongoing development of 'streaming technology'; the developing acceptance of learning technologies in higher education; the availability of purpose-made video recordings to support learning and teaching in higher education; substantial investment in computing infrastructure within the University and more widely. An additional dimension was the general level of IT skills of students and staff, and indeed of the general population, that has developed to the extent that the Internet can potentially deliver learning resources. All of these processes, and probably others not yet explicitly identified, integrated seamlessly to converge and yield improved student learning. Well not quite! Evaluation suggests that they integrated to the extent that the project worked reasonably well for many students for some learning activities. Discovering what led to the successes, what limited the success of the project and, then, working on these limitations are clear and exciting goals for educational research. The sections below describe a restricted range of these processes and focus on those aspects that received extensive evaluation. To emphasis the sequential nature of stages in many of the processes, they are described here as 'process threads'.

Description of identified Process Threads

Process Threads outside the University Environment

JISC and the DNER

Lifesign is one project of many that contribute to the development of a Distributed National Electronic Resource (The DNER) funded by the UK's Joint Information Systems Committee (JISC 2002a). The DNER is a managed environment for accessing quality-assured information resources on the Internet. These resources include scholarly journals, monographs, textbooks, abstracts, manuscripts, maps, music scores, still images, geo-spatial images, as well as moving picture and sound collections (JISC 2002b). The development of the DNER was entrusted to eight national working groups set up to increase interaction and consultation with the Further and Higher Education communities, to harness enthusiasm and expertise from those communities and enable them to focus on key strategic themes (JISC 2002c). The aims and aspirations of JISC reflected a substantial national move to improve the availability and quality of learning resources in higher education. This was coupled with ongoing extension and

improvement of the national 'communications infrastructure' including the introduction of a new regional area network connecting local educational institutions together and to SuperJANET 4, the UK academic community network.

National developments in Higher Education
Alongside the developments implemented by JISC, UK's Higher Education has in recent years seen substantial change and development to improve the quality of student learning. HEFCE have adopted a range of Teaching Initiatives, including: Teaching Quality Enhancement Fund; Widening Participation; Fund for the Development of Learning and Teaching; Teaching and Learning Technology Programmes; and Learning and Teaching Support Network (HEFCE, 2002) These initiatives offer support and encouragement but also require Universities to adopt internal quality assurance and enhancement activities and to develop strategies for learning and teaching, human resources and information systems. The development of the Pilot Project described here needs to be seen 'against this backdrop' of national encouragement for institutional change that results in improved student learning (as well as a range of other 'improvements' including cost efficiency and increased participation!).

Developments in Nurse Education
The UK's Royal College of Nursing claimed, in 1999, that there was then more than 12,000 nursing vacancies in the UK and that the National Health Service was suffering "the worst recruitment crisis in 25 years" (BBC, 2000). The UK's Government had pledged to increase, by 6,000, the number of training places (BBC, 1998; Department of Health, 1999) and the National Health Services was set a target to recruit 20,000 more Nurses by 2004 (10 Downing street, 2002). Southampton's response is described within the description of the University process threads.

Process Threads within the University

Within the School of Nursing and Midwifery
In response to the UK-wide need for new nurses and Government-backed initiatives to increase Nurse Training Places, the University's School of Nursing and Midwifery announced, in 1998, a 200 per cent increase in student nurse numbers by 2001, despite a national 15 per cent fall in applications to nurse training courses. The development was in relation to a significant contract with the UK's National Health Service Executive and resulted in the construction of study centres in several locations in central southern England and the development of multi-campus teaching initiatives. Student Nurses were recruited with a wide range of backgrounds through a 'wide entry-gate'. Significant investment occurred also in staff recruitment and training, particularly in the area of Information and Communication Technology (ICT), including appointment of an e-Learning Officer and a Senior Educational Learning Technologist. IT infrastructure, training and support for students and staff were significantly increased. The School also developed a range of Pilot Projects to further develop and implement its Learning and Teaching Strategy. The Life Sciences module described here was one.

More widely within the University
The University has developed in line with the external pressures from HEFCE, but also in line with internal pressures from its constituent Faculties, Departments and Schools. Considerable progress has been made in recent years with the introduction of Learning and Teaching Strategies; Faculty Learning and Teaching Coordinators; the assistance of a Centre for Learning and Teaching as well as faculty-based learning-technology support. Considerable investment has been made in IT support, training and infrastructure for students and staff.

The Pilot Project as a process thread
Central to the project described here was an undergraduate, first year module in Life Sciences. The module acts as a central core to Nurse Education and has to support the needs of a wide range of students; from those with limited academic background returning to education after many years raising families, to those with substantial prior educational experience in biology. Students are also widely distributed over several campuses. The module was designated as a Pilot Project with a specific brief to increase opportunities for independent and self-directed learning within a context of individualised learning routes. Developments, categorically, did not aim to replace existing face-to-face learner support with on-line support. In general, learning resources placed on-line supplemented those available through traditional

routes. Blackboard (www.Blackboard.com) provided the Virtual Learning Environment through which students accessed on-line learning resources.

The module was organised around 12 biological 'systems' and an introduction to pharmacology; each of which was taught by academic staff expert in the area. Each system had a number of lectures, as well as extensive learning resources available via Blackboard. Revision tutorials, Practice Skills Sessions (also related to another module) and conventional library resources complemented these resources. Systems included 'Directed Learning Sessions' designed to provide further support for student learning. Each Directed Learning Session took place on-line and generally involved students in accessing an on-line resource and undertaking directed activity. Three systems 'The Immune System', 'The Neurological System' and 'The Endocrine System' incorporated streamed video. Three different videos were chosen. For 'The Immune System', the Shotlist video 'Staying Alive: A Thoroughly Modern Microbe', was used (http://www.shotlist.co.uk/biology/vid16.html). This video is primarily narrative in nature and describes the investigations of an Environmental Health Officer in the Robertson E-coli 0157 outbreak. Another Shotlist video was chosen for 'The Neurological system'. 'The Human Brain In Situ' presents an anatomical examination of the human brain before and after it is removed from a cadaver. The video is both instructional and procedural (http://www.shotlist.co.uk/biology/vid7.html). 'The Endocrine System' used a different type of video. 'Endocrine System - The Human Body Series' is an instructional video produced by Biomedical Associates and distributed by Viewtech (http://www.viewtech.co.uk/). The three videos were 'embedded' within the Directed Learning Sessions by establishing hyperlinks, in Word documents, either to complete video streams; or to segments of video via 'redirector files' (Microsoft, 2002). In all cases the Directed Learning Sessions set tasks for student activity, to encourage them to engage with the video. Tasks included set questions to answer, drawing diagrams based on information from the video and the production of summary notes. Where possible students were encouraged to link content from the video with that from recommended textbooks. Where questions were set, academic staff gave correct answers on-line at a later date for students to check. Each session was also associated with a Multiple Choice Quiz (MCQ) designed primarily to allow students to assess formatively their own progress. Extensive IT support was available to students and to staff. Students had 'IT Induction Sessions' to introduce them to Blackboard, and general IT support sessions including one-to-one tuition where requested. A Senior Educational Technologist attended some lectures and offered support. Students who had accessed the Blackboard 10 times or less in the first Semester were sent a personal letter offering further assistance. All groups had access to the University telephone 'Help' service and academic staff responsible for the module offered further support by email.

Process threads related to the Lifesign Project

The Lifesign project aims to develop, catalogue and evaluate the use of streaming video to support student learning in the Life Sciences in higher education (Lifesign, 2002a). It is a multi-institutional and multi-professional research and development project supported by JISC. Three additional process threads can be distinguished in relation to the innovation described here.

Working with academic managers and teaching staff

A key stage in this development was a meeting between the Educational Researcher and the Head of Education in the School of Nursing and Midwifery more than a year before the start of the Pilot Project. This meeting identified opportunities for linked activity between Lifesign, the School and the University's Centre for Learning and Teaching. This was rapidly followed by meetings between the Educational Researcher and the Coordinator of the Life Sciences module during which the attributes of the learning resources, of the learners, of their lecturers, and of institutional support mechanisms and infrastructure were identified. Streaming video was identified as a potential contribution to new learning resources and this enabled the Lifesign Project to focus its attention on particular aspects of its brief. Some months after these meetings the Life Sciences module was identified as a School Pilot Project and the support and development structures identified in the previous section were established.

Developing the capacity to stream video

A central feature of the Lifesign Project was to stream video. The process is multi-faceted and involved digitising and editing analogue video; establishing and maintaining servers and monitoring usage of streams. Lifesign partners at The Media Development Centre, University of Portsmouth, undertook much of this activity. A significant aspect of this work was to develop a reliable authentication and authorisation system to comply with the copyright elements of licensing. The system, developed

primarily to restrict access to the streams to UK Higher Education, was based on individual computer IP addresses. Its development continued throughout the duration of the Pilot Project.

Building the video collection and working within the law
Lifesign aimed to build a collection of streamed video of a 'critical mass'; essentially to include sufficient video within an identified category so that academic staff working within the area would generally consider looking within the resource-base when compiling their learning resources. The initial category was 'Laboratory Techniques' within the 'Broad Life Sciences'. Early needs-analysis by the Lifesign Project failed to identify sufficient interest in using streaming video within this category and opened the area to almost all Life Sciences in an attempt to engage academic staff in the processes of evaluating the use of streamed video to support learning in higher education. Even so, from an early stage, limits to the collection were not imposed internally by restricting the scope but externally by difficulties in obtaining licences, from copyright holders, to stream video. Negotiating licences to digitise and stream otherwise suitable video became a significant limiting factor in the building of the Lifesign Collection. The project was not significantly aided by the UK 's Managing Agent and Advisory Service, a new national service acquiring moving pictures and sound for delivery online to the higher and further education communities in the UK (http://www.bufvc.ac.uk/maas/), which was itself encountering difficulties over copyright clearance. A considerable body of video, produced by Universities and currently used extensively within Universities, was also generally unavailable pending exhaustive negotiation over copyright. General concerns over authentication and authorisation no doubt added to the problems here. Never the less a substantial body of video was acquired for streaming; including the 'Shotlist' collection, previously commissioned by the UK's Teaching and Learning Technology Programme (Shotlist, 2002).

Integration and Interaction between process threads
Many process threads are involved in streaming video to support the learning of first year student nurses on a Life Sciences module. Each process thread has its own particular objectives but is interpreted here in relation to the generic aim of contributing to student learning and to the specific aim of contributing to student learning via learning resources that include streaming video. Each process thread probably provides an essential contribution to this aim. So without JISC's aspiration for a DNER there would be no Lifesign project, and without Government initiatives to train more nurses there would not be the need to develop innovative learning and teaching to teach such large numbers of diverse students over several campuses. Inadequacies in any of the process threads, or in integration between them, would probably result in limited success of all of the objectives that depended on multiple process threads.

Evaluation

Evaluation methodology
Extensive evaluation occurred. This paper formally reports only evaluation of the operation of the module and associated broad support that involve the use of streaming video. The evaluative commentary is extended to related process threads where data is available but a key aim of this paper is also to emphasis where data is not available. The primary focus of evaluation was to determine how effectively streaming video supported student learning, but the evaluation methodology adopted was much broader in operation. Lifesign's evaluation methodology (Lifesign, 2002b) is based on that of Alexander and Hedberg (1994) and emphasises the role of evaluation in all aspects of an educational innovation; from design to post-mortem. In that sense it has affinity with action-research and Rothman and Friedman's Action Evaluation (Friedman and Rothman, 2002) and encourages the participation of stakeholders in a continual process. Evaluation data, however, was primarily processed using a matrix described by Stake (1967) as a key element of his 'Countenance model of evaluation'. Information in the form of descriptive or quantitative data is divided into 'antecedents', 'transactions' and 'outcomes'. For each, a separate description of 'intentions' and 'observations' is made and congruence between them ascertained. A common theme to these evaluation methodologies is the emphasis on processes that lead to outcomes, as well as on outcomes themselves.

A range of formal and informal research tools were developed to contribute evaluative data. The research tools were aimed at three groups: academic and support staff responsible for the educational module; the students enrolled on the module; and Lifesign project staff. Data from more peripheral groups that relates to process threads other than the Pilot Project was more informally gathered. For example, interaction between the Lifesign and Pilot Project process threads and other process threads occurred frequently in

relation to: generic IT support from the University for students; generic IT infrastructure availability and maintenance; JISC's wider aspirations for the DNER; the University's developing Learning and Teaching, and Learning Resources, Strategies. Information from these process threads contributed evaluative data but was often confidential (to individuals, the School, University or elsewhere) and its applicability, and openness to evaluation, therefore limited.

Academic and support staff designed the 'Directed Learning Sessions', introduced them to students and, where possible, maintained contact with students as the resources were used. These staff contributed information on the development of these Directed Learning Sessions and use of streaming video during periodic meetings and by periodically sending a 'reflective email' to the Educational Researcher. In addition this group met, towards the end of the module, with the Educational Researcher for a 'Focus-Group Analysis' of staff perceptions of the wider educational programme.

Students' use and their perceptions of the value of streaming video in this module were assessed using data provided via Blackboard. Students were informed in the Module Booklet that their use of Blackboard would be monitored so as to evaluate the use of the resources. Each Directed Learning Session was a Word Document providing links to video streams. Each Word document was 'tracked' so that it was possible to periodically determine which student had accessed the document and how often they had done so. The fact that a student had accessed the Directed Learning Session document did not guarantee that they had accessed or watched the video streams. Each session was associated with a Multiple Choice Quiz (MCQ) designed primarily to allow students to assess formatively their own progress. The three Directed Learning Sessions that used streaming video all included three non-scored 'survey questions' designed to ascertain students' access to streaming video; and enjoyment of, and learning-confidence in the way that it was used. Blackboard's on-line grade-book gave access to the responses of each student. Other research tools to determine the views of students and the influence of streaming video on learning could have been developed and could have provided better data than that reviewed here. The module, however, was already 'heavily evaluated'; and the research tools used were the best tools that circumstances permitted.

The Lifesign project made the delivery of the video streams and evaluation of their use possible, but superimposed another level of complexity onto the evaluation. In particular Lifesign continued to develop its resources and operation during the course of the educational module that it was supporting. Interactions between Lifesign and the module's academic and support staff occurred primarily via the Educational Researcher and the research tools used to track these interactions consists of emails and minuted records of Lifesign meetings (Lifesign, 2002c). They relate primarily to the changes in the URL of streams of video and hence the stability of hyperlinks to streamed resources.

Results of evaluation

Results are considered as Antecedents, Transactions and Outcomes. In the context of this study Antecedents are the conditions and processes that precede the delivery of video streams to students but make such delivery possible and potentially worthwhile. Transactions, here, include the processes that enable the delivery of streams in ways that could facilitate learning. Outcomes include all information that indicates the efficacy of streaming video in supporting student learning. Antecedents, Transactions and Outcomes are described here as 'Intentions' and 'Observations'.

As antecedents to the innovation, the intentions were that staff and students should have skills, support and access to 'technology' to enable them to evaluate the potential of streaming video. Staff were to see a range of video to evaluate its potential usefulness to support student learning and they were to be able to embed the video in on-line learning activities. Staff also had to have the time to engage with streaming video and related on-line resources. Many of these antecedents were observed. Suitable video was identified and supported by Lifesign. Lifesign staff supported the embedding of the video into Directed Learning Sessions. Many students accessed on-line resources primarily via student workstations provided at all campuses. There were some problems. Some staff computers initially lacked sound cards. Staff time to engage with new learning resources remained an important problem area. A range of unanticipated student-skills were identified including the patience to wait for a stream to 'buffer.

As transactions, video streams were to be reliably transmitted to student workstations and, where appropriate, to students 'anywhere (with internet access), anytime'. Staff were to be enthusiastic about

video streaming. Many of these intended transactions were observed. Video was streamed by the Lifesign project with high levels of reliability. From just over 750 students, approximately 350 made some use of video streams and approximately 150 claimed that access was easy. There were some problems. Access for students to some streams was made difficult by Lifesign changes as part of the 'authorisation and authentication' process. Also most streams were unavailable outside of University networks. Those that were available were very slow due to restricted bandwidth. Nevertheless, academic Staff remained enthusiastic about both the potential for streaming video to support learning and its ongoing reality.

'The' Intended outcome was to 'increase opportunities for independent and self-directed learning'. Observed outcomes were generally congruent with this intention. A key element of this analysis is the emphasis that students use of these on-line resources, including those that made use of streaming video, was optional.. Of those students who used video streams, approximately 59% confirmed that they did enjoyed using the learning resources that included the streamed video, and 25% confirmed that they were very confident that they had learned from the resources. Staff also expressed general, but reflective, satisfaction. It is clear that not all students used the resources but there is no indication, from this and from related evaluations, that lack of support or availability of equipment was a factor. The intention was to 'increase opportunities', not to ensure that 'all opportunities were taken up'. Time to acquire new skills was probably an important factor for some students, as it was for some staff.

Discussion

Successful features of this innovation

The learning resources developed here were optional for students, yet they were widely used and appreciated. In this respect the innovation was particularly successful and certainly more successful than some innovations involving streaming video supported by Lifesign. An examination of the process threads that contributed to the innovation suggests that several features need to be emphasised. In this innovation there was substantial support and encouragement for innovation from within the lecturers' own department. In addition there was widespread support for the innovation from students. Students clearly appreciated extension to the range of learning resources and the efforts of their lecturers. These factors resulted in highly motivated academic staff; motivated to the extent that other factors became more obviously limiting to the success of the innovation. There is some support for the suggestion that the level of uptake reported here is encouraging. Evaluation of a CD, produced to support student learning and distributed to large numbers of students on distance learning courses, demonstrated that only 50 % of students made extensive use of the video (Whitelock, 1998). Given the complexity of streamed video, its inherent restrictions and its limited provenance, the level of uptake reported here is comparatively very promising. There is an interesting parallel in other uses of video in Higher Education. Video is now extensively used to support continuing-professional-development. Researchers on a recent project in Dentistry identify a 'learning line' from 'face-to-face, through 'video-conferencing', 'web-casting' to 'on-line learning (Reynolds and Mason, 2002). Each step on this learning line requires students, and tutors, to acquire new skills and confidence. Successful migration along this line requires opportunities and support for these developments. By not attempting to do too much, too rapidly, a good balance was probably struck in the innovation reported here. Staff here also expressed satisfaction that they remained responsible for the delivery of learning resources and that their confidence grew; important staff perceptions in the development of educational technologies (Steel and Hudson, 2001).

Diverse interactions

Streamed video made a successful but relatively minor contribution to the learning resources for this module, in comparison with other on-line activities and conventional resources. But this 'minor contribution' depended on many parallel process threads functioning effectively and congruently to deliver streaming video in a way that could support learning. Yet information about interactions between process threads is quite limited and the interactions themselves are quite diverse. Some interactions no doubt occurred at a distance. JISC's DNER strategy, for example, was maintained by eight working groups; one of which maintained a steering link to Lifesign. Others relate to University responses to national policy initiatives. Development of the University's IT infrastructure, for example, clearly involved significant interaction between institutional management structures and national funding bodies. Closer to the Pilot Project itself, key interactions occurred between process threads within the Lifesign project, between Lifesign and the Pilot Project, and between the University and the Pilot Project. It is worth mentioning the pivotal role of the Educational Researcher in this respect. This role included project

development within Lifesign and within the Pilot Project, educational evaluation within the Pilot Project, and learning technologies support and staff development within the University. Evaluation does suggest that there were not enough interactions between some process threads, or that some interactions were ineffective. For example; it was necessary to ensure that the University's workstations on several campuses, held the correct software to support the video streams used. These checks were made (interaction between the Pilot Project process thread and the University process thread) at an early stage; but subsequently the University changed the software to correct a potential error, with no feedback to the Pilot Project or to the Educational Researcher.

Incongruent objectives

Working within these diverse interactions, this evaluation identified a range of events where particular process threads were incongruent. Some in-congruency is inevitable. For example; streaming video is not the only new technology that several process threads had to work with. On the large scale, it is probably not even a particularly important one and inevitably many decisions were made in all process threads with other concerns in mind. There is, for example, an on-going concern that video streams used extensively would monopolize too much bandwidth. Also, that too many students would be using University workstations for long periods to 'watch television'. Quite rightly the University is currently exploring the merits of streaming technology without necessarily embracing it.

There were more important in-congruencies between process threads within Lifesign. To meet expectations related to authentication and authorization (effectively to comply with copyright licenses), Lifesign continued to develop its resources whilst they were in use. Its objectives in one process thread (Developing the capacity to stream video) were incongruent with those in another (Working with academics in the Pilot Project). The impact of the changes were limited by the intervention of the Educational Researcher, but they caused some disruption to students using streaming video and this was no doubt a contributing factor to the limited use of the resources by some students.

There were also clear in-congruencies between the Pilot Project process thread and other areas not explicitly explored here, but related to the JISC/DNER process thread. Copyright issues produced a severe restraint on the videos that could be streamed by Lifesign, as well as on the way that videos were streamed. It seems unlikely that the aspirations of JISC, to produce a managed environment for accessing quality-assured information-resources on the Internet to include moving picture and sound collections, are themselves congruent with current copyright law. All of the videos used within the Life Sciences Pilot project were produced specifically for education; yet all entailed lengthy negotiation of licenses by Lifesign and all involved restrictive delivery. Many other videos, produced by Universities to support the learning of their own students will be slow to come forward for streaming.

Limiting factor analysis

Perhaps ideally, the fundamental limitation to the extent to which streaming video supported student learning in this innovation should have been the design of the learning resources and the way in which they were embedded within the Pilot Project. This was the main focus for the Educational Researcher. Streaming video is new and it is necessary to experiment with it and it is unlikely that established pedagogy defines how best to use it (Shephard, 2001). This analysis, however, does suggest that other factors also limited the extent to which streaming video supported student learning in this innovation and that some of these factors depended on process threads significantly removed from the Pilot Project. It is important to stress that this analysis needs to be interpreted in the context of provision of optional learning resources. If these resources had been essential elements of the learning programme, it is likely that stronger pressures would have influenced the severity of these limitations or alternative processes used.

- The availability of copyright-cleared video imposed a significant limitation to this innovation.
- Staff time to participate and innovate was a significant limitation to this innovation but possibly not as great a limitation as in other projects as staff were highly motivated.
- Research and development projects, such as Lifesign, contribute much to innovative education; but they also bring problems when their own objectives are different from those of the educational innovation. Clearly there is a balance to be struck but this should not obscure the potential threat of limitation to student learning.

- Bandwidth was a clear limitation for some students. Lifesign's videos were configured to produce high quality streams to University workstations. Viewing even lower-quality streams configured for modems, via a modem, is a much more difficult process. This is likely to limit significantly the effectiveness of streaming video to support the learning of those students unable to use campus-based workstations. The problem compounded and interacted with authentication and authorisation problems.

This analysis attempts a broader 'implementation-evaluation' than is often used in educational evaluation. In so doing it identifies several factors, some external to the Pilot Project and to the research and development project supporting it, that imposed limitations to the extent to which an innovation succeeded. Although the analysis is based on one particular area of interest, that of streaming video, it confirms that making progress with educational innovation requires considerable integration between many constituent process threads. Investment in one or a few process threads is unlikely to yield overall improvements in student learning. Understanding and overcoming key limiting factors will require considerably more 'implementation-evaluation' than is currently generally undertaken.

Conclusion

This paper identifies key elements of the broader processes that contributed to the implementation of an educational innovation involving streaming video. Evaluation confirms that the innovation was particularly successful in many respects but also that there were significant problems that relate to the broad processes involved in its implementation. The analysis suggests that some successes and many of the problems were consequences of processes far removed from the pilot project itself. The paper emphasises the need for 'implementation-evaluation' and 'limiting factor analysis' in the exploration of educational innovation.

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