

Design and evaluation of online courses containing media-enhanced learning materials

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With the current state of web technology, multimedia materials are readily accessible by students. This paper reports on the design and evaluation of three online courses from a university in Hong Kong which incorporate media-enhanced learning materials. These cases are at different positions with respect to the types of knowledge and levels of cognitive reasoning outlined in the revised Bloom's taxonomy. Evaluation data give qualified support for media-enhanced aspects of the courses being beneficial to student learning. The study has also highlighted factors that influence the success of the learning experience: attention to the quality and design of the media, considering student motivation and focusing on feedback on learning during the course. Media and learning design, thus, are inextricably intertwined in a complex relationship.

La conception et l'évaluation des cours en ligne contenant du matériel d'apprentissage enrichi par les médias

L'état actuel de la technologie en ligne offre aux étudiants un accès facile aux documents multimedia. L'article ci-joint étudie dans une université de Hong Kong. La conception et l'évaluation de trois cours en ligne dans lesquels on a intégré des matériaux d'apprentissage enrichis par les médias. Ces trois cas se situent à des positions différentes par rapport aux types de connaissance et aux niveaux de raisonnement cognitif décrits dans les versions révisées de la taxonomie de Bloom. Les données de l'évaluation font apparaître de façon nette que les aspects du cours qui sont enrichis par les médias ont une influence bénéfique sur l'apprentissage des étudiants. L'étude a aussi mis en relief certains facteurs qui influent sur le succès de l'expérience d'apprentissage : l'attention portée à la qualité et à la conception des médias, la prise en considération de la motivation des étudiants et l'accent sur la rétroalimentation et l'apprentissage pendant le cours. Les médias et la conception des matériaux d'apprentissage sont donc inextricablement liés dans une relation complexe.

Entwurf und Auswertung von Online-Kursen, die mediengestützte Lernmaterialien enthalten

Beim gegenwärtigen Stand der Webtechnologie ist Studenten der Zugriff auf Multimedia-Materialien leicht möglich. Dieser Beitrag berichtet über den Entwurf und die Auswertung von drei Online-Kursen einer Universität in Hongkong, in die medienverwendende Lernmaterialien integriert wurden. Diese sind an verschiedenen Stellen, abhängig von den Typen des Wissens und dem Niveau der kognitiver Überlegungen entsprechend der überarbeiteten Bloomschen Taxonomie, eingebaut. Auswertungsdaten unterstützen die medienverbesserten Aspekte der Kurse qualitativ in Bezug auf die Lernwirksamkeit für die Studenten. Die Studie nutzt auch

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besondere Faktoren, die den Lernerfolg beeinflussen: Berücksichtigung der Qualität und der Gestaltung der Medien, damit sie die Studenten als Motivation empfinden und sie auch Rückmeldung über ihr Lernen während des Kurses geben. Dadurch sind die Medien und die Gestaltung des Lehrgangs untrennbar in einer komplexen Beziehung miteinander verflochten.

Sobre el diseño y evaluación de los cursos en línea incorporando materiales de aprendizaje enriquecidos por elementos multimedia

El estado presente de la tecnología en línea ofrece a los alumnos un acceso fácil a materiales en formato multimedia. El presente artículo estudia en una universidad de Hong Kong el diseño y evaluación de tres cursos en línea que incorporan materiales de aprendizaje enriquecidos por elementos multimedia. Esos casos se encuentran en posiciones diferentes en relación con los tipos de conocimiento y niveles de razonamiento cognitivo descritos en la versión actualizada de la taxonomía de Bloom. Los datos de las evaluaciones confirman netamente el impacto positivo de los aspectos de los cursos enriquecidos por los multimedia sobre el aprendizaje de los estudiantes. El estudio destacó también algunos factores que influyen sobre el éxito de la experiencia de aprendizaje como el enfoque sobre la calidad y el diseño de los medios, la toma en consideración de la motivación estudiantil y la insistencia sobre la retroalimentación del aprendizaje a lo largo del curso. Hay entonces una vinculación muy estrecha y compleja entre los medios y el diseño para el aprendizaje.

Media and learning designs

The web is a highly complex environment, what Beaubien (2002) called a complex adaptive system. In such systems non-linearity is a feature, meaning that the outputs cannot be predicted from the inputs in any linear fashion. This is a useful way of thinking about the design of media-enhanced educational web sites. The outputs (learning) are difficult to predict from the inputs (components of the web site) because we are deliberately using multiple sensory channels and often allowing a variety of learning pathways. It is this complexity that makes evaluation of such sites interesting and important. The three cases considered in this paper involve multiple forms of media and the tasks that students are set have several components.

The increasing ability of the web to host high quality multimedia learning materials makes it a tool with the potential to enhance learning. Heinich *et al.* (1999) defined multimedia technology as the 'combination of two or more media formats that are integrated to form an informational or instructional program' (p. 229). Multimedia materials thus often combine text with video recordings, images, sound files, animations and/or simulations and can be interactive in nature. With the current state of technology, multimedia materials are not limited to stand-alone computers but are more readily accessible by students online and outside formal class times. The potential of multimedia materials to support student learning is thus enhanced (Hills, 2003). Media-enhanced materials allow learners to employ their different senses in learning. For example, there appears to be truth in the cliché that 'we remember 20 percent of what we read, 30 percent of what we do and 90 percent of what we see, hear, say and do' (Rose & Nicholl, 1997, p. 71).

Schank and Cleary (1995) defined a set of five 'teaching architectures': simulation-based learning by doing, incidental learning, learning by reflection, case-based teaching and learning by exploring. A decade later we are more likely to describe these as learning designs, in line with more learner-centric terminology. Reeves and Hedberg (2003, pp. 8–11) revisited Schank and Cleary's work and concluded that interactive computer-mediated environments, multimedia in nature, are useful in facilitating all of the five learning designs. Three of these, simulation-based learning by doing, learning by reflection and case-based teaching, are germane to understanding our three cases.

Animations and simulations can be effective in explaining complex concepts and ideas that can only otherwise be represented by a series of sequential diagrams in text. Ferry *et al.* (2005) experimented with the use of online simulations with pre-service teachers and concluded that well-designed simulations have the potential to engage these learners ‘in deep thinking about the virtual classroom environment’ (p. 3102). Case 1 is centred on student input to the design of simulations in computing principles.

Multimedia materials such as audio and video recordings can showcase scenarios and cases as more vivid representations of situations than traditional text-only cases. The enriched representations often increase students’ motivation to learn. Sanders (2005), for example, integrated multimedia elements in her African-American history course and reported that ‘the embedded audio media for each lesson stimulated and engaged the listeners in the readings for the weekly lesson ... brought the information “alive”’ (p. 4). Media-enhanced case material is the focus of Case 2.

Multimedia can also be used in student-generated multimedia projects. Green and Brown (2002) suggested that this type of project has a higher educational value than the more common text-only projects, as they ‘can be an exciting and highly satisfying activity. Working on multimedia production addresses the need for students to increase their ability to create and communicate, improving their media literacy skills as well as fostering their capabilities with computing technologies’ (p. 11). Reeves and Hedberg (2003) also called this form of student-produced multimedia materials ‘one of the most promising uses of multimedia’ as the students ‘are encouraged to construct their own representations of knowledge using multimedia construction programs’ (p. 19). This aspect of constructive reflection is an integral component of Case 3.

It is not our intention in this paper to open the Clarke–Kozma debate of the mid-1990s about whether or not the nature of the media used in an educational module can be shown to impact on learning (Clarke, 1994; Kozma, 1994). Many of the studies done on the effectiveness or otherwise of media elements have been short-term quantitative studies and it is our view that these studies underplay the complexities of real learning environments (Vargo, 1997). The intention in this paper is to explore some media-enhanced courses using a variety of evaluation strategies, so as to develop an interpretative framework which may assist further development and evaluation work. We use the term ‘media-enhanced’, rather than multimedia, to emphasize the teacher’s intentionality in terms of educational purpose when designing the nature of the media elements. In the three cases discussed in this paper the initial design stage was an essential stage of the project.

Classifying media-enhanced educational web sites

Media-enhanced experiences provided to learners through the web are able to relate to learning at the full range of cognitive reasoning levels specified by the original Bloom’s taxonomy (Bloom, 1956), namely knowledge, comprehension, application, analysis, synthesis and evaluation. The knowledge level of the original taxonomy is concerned with the retention of information. Comprehension refers to the understanding of this retained knowledge. At the application level, learners apply the theories and concepts to practical situations. At the analysis cognitive level, learners are able to break down the knowledge and concepts in a scenario

into their sub-components. The last two levels of cognitive reasoning are synthesis and evaluation. Synthesis focuses on the assembly and putting together of the learned knowledge in new ways. Evaluation is concerned with learners making value judgements about what they have learnt and produced.

There has been a great deal of debate about two aspects of the original Bloom’s taxonomy. Firstly, the ‘knowledge’ level has always been somewhat problematic because the word knowledge in common usage has a broad range of meanings. The revised Bloom’s taxonomy (Anderson & Krathwohl, 2001; Krathwohl, 2002) tackles this challenge and contains two dimensions instead of one. The knowledge dimension now clearly classifies and distinguishes between forms of knowledge: factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge. Anderson and Krathwohl (2001) described factual knowledge as ‘knowledge of discrete, isolated content elements’, conceptual knowledge as involving ‘more complex, organized knowledge forms’, procedural knowledge as ‘knowledge of how to do something’ and metacognitive knowledge as involving ‘knowledge about cognition in general as well as awareness of one’s own cognition’ (p. 27).

Secondly, the order of synthesis and evaluation has been reversed as the current consensus is that in order to produce something new, a process of judging and decision-based selection needs to have already occurred. The influence of the constructionists (see, for example, Papert & Harel, 1991), with their emphasis on the overt articulation of knowledge, may well have influenced this change. Further, the categories in the cognitive approach dimension are listed as verbs in order to emphasize the activity nature of a process dimension.

This paper reports three cases of using media-enhanced learning materials. The classification of the projects using the revised Bloom’s taxonomy is shown in Figure 1. The classification was based on the planned focus of the aspect of the course in which the media-enhanced materials

		Knowledge Dimension			
		Factual	Conceptual	Procedural	Metacognitive
Cognitive Process Dimension	Remember				
	Understand		Case 1 Simulations in computing principles	Case 2 Audio cases for English communication	
	Apply				
	Analyse				
	Evaluate				Case 3 Student-developed multimedia in public health
	Create				

Figure 1. Classifying the three cases with the revised Bloom’s taxonomy

were located. There was, of course, attention to levels below that indicated, in line with the loosely hierarchical nature of the taxonomy. For example, Case 3 concerns evaluating material and creating products in the domain of public health; students are intended to demonstrate metacognition in that they need to have an understanding of how people attend to and learn from information in order to design appropriate public health materials. However, in order to accomplish this, students need to operate, to some extent, in all other areas of the taxonomy. The shading in Figure 1 illustrates this.

Outline of the evaluation model used

The e3Learning (enrich, extend, evaluate learning) Project (<http://e3learning.edc.polyu.edu.hk/>; James *et al.*, 2003) assisted in the design, development and evaluation of the three cases. Overall, the e3Learning Project has worked with teachers in three Hong Kong universities in the design, development and evaluation of 70 course web sites since the beginning of 2003. The project operates with a process of pragmatic, individualized support and customized evaluation (McNaught & Lam, 2005a).

The overall approach of the evaluation is aligned with a constructivist approach rather than with an absolute measurement perspective (Scriven, 1993; Reeves & Hedberg, 2003). Thus, the data collected are not meant to be precise measurements of the learning enhancement. Instead, they are rich descriptions that aim at giving indications of the advantages and disadvantages of the learning intervention. The overall design of the evaluation is a reflection–improvement model in which the findings of the evaluation contribute to further improvements in each of the web-assisted courses under investigation. Our system (like all others) is not value free and tends towards a naturalistic model (Guba & Lincoln, 1981; Alexander & Hedberg, 1994).

While each e3L sub-project is self-contained and focuses on cycles of improvement in the designs of the courses involved, there is value in looking across a number of courses to see if there are lessons that might be of wider interest. It is difficult to make comparisons between cases where there are no ‘controlled variables’. However, trying to reduce the diversity and complexity of educational environments is usually not helpful. Instead, in this study we have examined variation along a number of dimensions across a group of cases. In this study we chose the dimensions of the desired cognitive demand and also the design elements of media, activities, motivation and feedback. In this way, the well-known educational framework of Bloom’s taxonomy can be linked to practical considerations in educational design.

The evaluations of each e3L sub-project (including our three cases) were done in a flexible manner to account for the individuality of each context. Managing the diversity of the cases has been challenging and illuminating. For example, our 70 evaluation plans contained 457 separate evaluation questions. McNaught and Lam (2005b) examined the evaluation intentions of teachers in these 70 sub-projects and classified their intentions into a number of recurring evaluation themes. There were 28 themes, clustered into four key areas. The evaluation focuses of our three cases are noted in relation to these key areas in Figure 2.

Multiple sources of data were collected as the evaluation data. As shown in Figures 3 and 4, four sources of data were used in these three e3Learning evaluations: teacher reflection, student perceptions, student performance and student actions (McNaught & Lam, 2005a).

Main evaluation themes of all 70 e3L projects	Key evaluation purposes		
	Case 1 Simulations in computing principles	Case 2 Audio cases for English communication	Case 3 Student-developed multimedia in public health
Pre-development investigations/ needs analysis <i>Including evaluation of previous work; expectation about value & feasibility; & IT skills/ habits of students.</i>	<ul style="list-style-type: none"> Needs analysis about the need for simulations Suggestions for topics and designs for simulations 		
Learning environment <i>Including improvement ideas for existing sites; usability studies; & opinions on web T&L in general.</i>		<ul style="list-style-type: none"> Amount of time spent online Students' opinions about web-facilitated self-directed learning 	
Teaching and learning processes <i>Including class management; technical processes; patterns of use of web resources & activities; meaningful/ effective communication; workload; & overall enjoyment.</i>		<ul style="list-style-type: none"> Usage pattern of web resources Effectiveness of student-student communication in peer reviews 	<ul style="list-style-type: none"> Effectiveness of student-student communication in groups Ways students revise work based on comments received
Learning outcomes <i>Including motivation and affect; confidence; approaches to learning/ learning styles; thinking skills; levels of understanding of course content; reflective learning; relationship/ sense of community; & intercultural awareness.</i>	<ul style="list-style-type: none"> The impact of simulations on levels of understanding (expected) 	<ul style="list-style-type: none"> The impact of cases on motivation to learn Levels of achievement of better English comprehension Level of ability to apply this in everyday conversations 	Level of ability to: <ul style="list-style-type: none"> Evaluate correct/ incorrect ideas Create representations Reflect on broad societal public health implications Reflect on group processes in the course

Figure 2. Evaluation focuses of the three cases

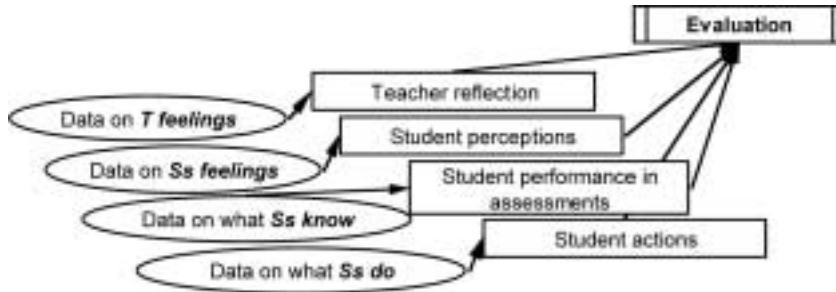


Figure 3. Evaluation data types (after McNaught & Lam, 2005a, p. 603)

Kennedy (2004) argued that we need to put an increasing emphasis on the cognitive processes of learners. While his work is with learner–content interactions in stand-alone computer environments, his ‘cognitive interaction model’ is of interest in evaluating the possible benefits of online media-enhanced environments. He defined ‘cognitive interactivity’ as being ‘a continuous, dynamic relationship between instructional events and students’ cognitive processes that is mediated by their behavioural process’ (p. 58). In the evaluation studies we have tried to distinguish between what students do and what students know in order to tease out some understanding of this relationship.

The evaluation strategies of the three cases were varied, depending on the pragmatics of the situation, such as the availability of the teacher and the class. Instruments used ranged from

Data sources	Case 1 Simulations in computing principles	Case 2 Audio cases for English communication	Case 3 Student-developed multimedia in public health
Teacher reflection on the experience (data on how the teacher <i>feels</i>)	Pre-development needs analysis of teacher	Teacher’s reflection on building and using the materials	Teacher’s observation of student behaviour and performance; Teacher survey
Student perceptions of their experience (data on how students <i>feel</i>)	Pre-development needs analysis of previous students in a focus group	Focus group	Survey & focus group
Student performance in assessments (data on what students <i>know</i>)	X	Quality of online peer critique	Quality of online peer critique
Student actions (data on what students <i>do</i>)	X	Site and forum logs	X

Figure 4. Sources of the evaluation data for the three cases

conducting a pre-development needs analysis to course end collection of teacher and student feedback (Figure 4).

Case 1. Animations and simulations for understanding and applying conceptual knowledge

The first case involved the process of designing animations and simulations in a computing principles course. These were designed in response to the students' feedback that the diagrams and flow charts in the textbook were difficult to understand as they are complicated and static, although they actually represent things that are dynamic. The simulations were expected to make difficult concepts easier to understand (understanding level, conceptual knowledge). By working with simulations where concepts can be applied, learning can be consolidated (application level, conceptual knowledge).

The overall design of the media-enhanced materials is portrayed in Figure 5. The media consist of text, animations and simulations. The learner activity involves viewing the animations and engaging with the simulations in order to learn correct application of the concepts and theories in practice. The motivation for the students to use the materials was intended to mainly come from teacher encouragement and the fact that the teacher would briefly show the materials in class. Lastly, the materials were intended to largely generate interaction between the students and the computer, with the students viewing text and animations or receiving immediate feedback after engaging with the simulations.

Needs analysis

The evaluation data collected for this case focused on the pre-development stage. Before starting the development of these multimedia resources the teacher and first author held a pre-development focus group meeting with four of the students who had taken the course the previous year. The objective of the meeting was to hear whether the students (and the teacher) anticipated that

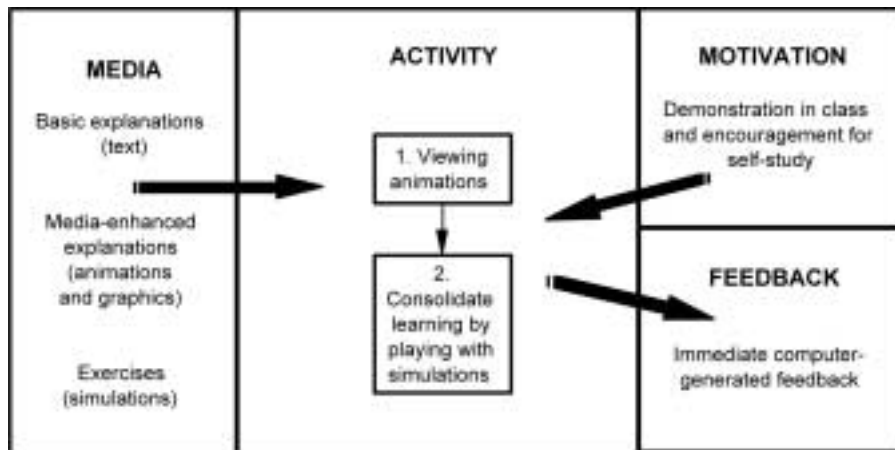


Figure 5. Design of the case 1 course involving animations and simulations

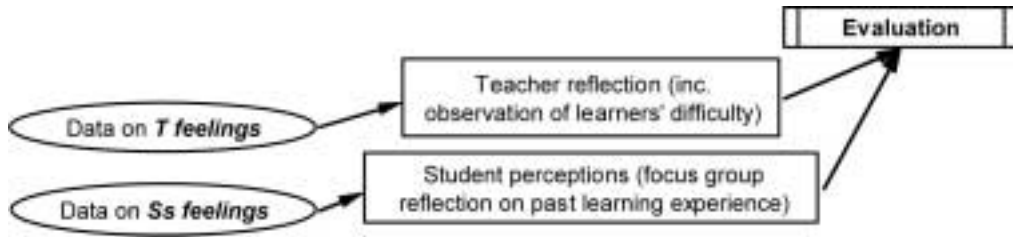


Figure 6. Evaluation data for case 1

multimedia would be helpful to learning and also to collect design ideas from the students about what types of animations and simulations they thought would be most helpful. Figure 6 illustrates this two-fold data source design.

Meeting notes were taken during the meeting by the first author. The focus group was audio-taped. The audiotapes were listened to and summarized within 24 hours. Transcription is often not necessary, but fairly immediate records are essential.

Data supporting potential understanding and application of concepts

The teacher's impressions of the difficulties of the course were confirmed by the students. Students found it difficult to understand the flow of operation of the computing system. For example, the topic 'interrupt' was regarded as the most difficult concept in the course. It was the last topic of the course and the teacher related this concept to the previous knowledge that he hoped had been learnt. Even with a flow chart, students found it difficult to understand the terms involved. The second difficult concept was 'memory address' or 'misalignment'. This involved difficult calculations. 'Decoding' was also quite difficult for some students. They found the illustrations to be complicated and struggled to convert the descriptive text into circuit diagrams.

Students also had not previously had many exercises practising application of the concepts and theories learnt, as exercises like these are difficult to write. In addition, students commented that the answers to these exercises (if present) were also difficult to understand as they were text-based, while the situation the text was describing was a multi-step dynamic process.

Challenge

The main challenge of this approach of using animations and simulations to assist learning is, from the teacher's perspective, the large amount of time and effort needed in the materials development process. In fact, despite the fact that many ideas were mentioned in the needs analysis meeting, the teacher only selected one animation and two simulations to go forward to the first trial. Evaluation of the materials will be carried out in the first semester of the 2005–2006 academic year, when the materials will be pilot tested by students. More materials will be produced for the other difficult areas of the course if the evaluation results are favourable.

This is quite a simple evaluation exercise, but is included here because it was conducted thoughtfully and, for little effort, a great deal of useful information was gathered. This case

illustrates the value of a needs analysis exercise before embarking on costly and time-consuming media development.

Case 2. Audio clips for applying conceptual and procedural knowledge

The teachers in the second case supplied short online audio clips of everyday English conversations for an undergraduate language communication course. They believed this would assist students in applying the theories in the course to conversations in real situations (application level, conceptual and procedural knowledge). This course was conducted by an online self-study mode. The students were provided with materials to self-study on the web and they met the lecturers in a one hour seminar each week to discuss learning problems. There were two parallel classes running with two different teachers.

The overall design of the materials is illustrated in Figure 7. The media consist of text explanations of basic terms and concepts, audio clips that either exemplify the concepts and theories in action or require the students to apply the newly learned concepts and theories to authentic situations and, lastly, text-based assignment guidelines which specify how students should use the site forum for discussions of group projects. A total of 61 audio clips, ranging from 10 to 20 minutes in length, were put up on the web site. They relate to six of the main topics in the course. Half of these clips are demonstrations while the other half are assignment related. The activity involved students listening to the clips and reading the associated model commentaries. Then they listened to the assignment-related audio clips, studied the transcriptions and wrote their own comments applying the theories and concepts covered in the topic. Students posted their work onto the course online forum for peer feedback. Students revised their drafts based on the peer reviews before final submission. At the end of the course students selected one piece of assignment work in each of the six units for submission to the teachers. Motivation to access the materials mainly came from the fact that the assignments were assessment related. Feedback on learning came from the follow-up online peer revision activity on the site forum.

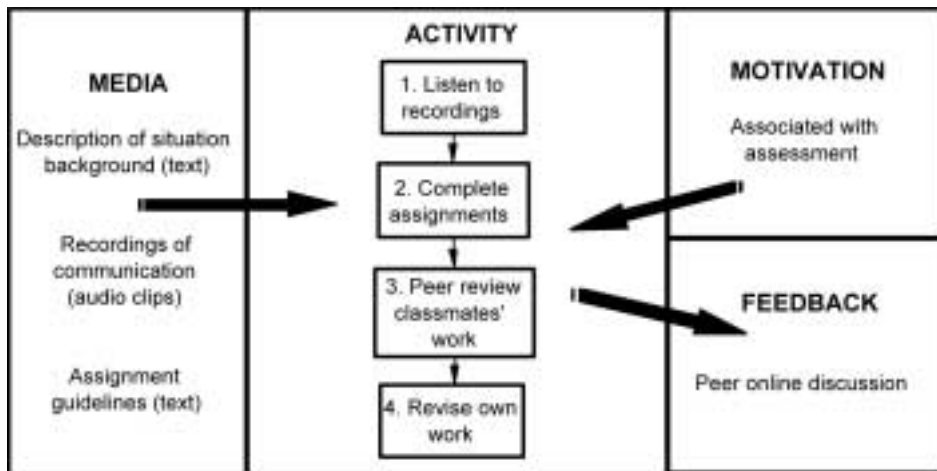


Figure 7. Design of the case 2 course involving audio clips

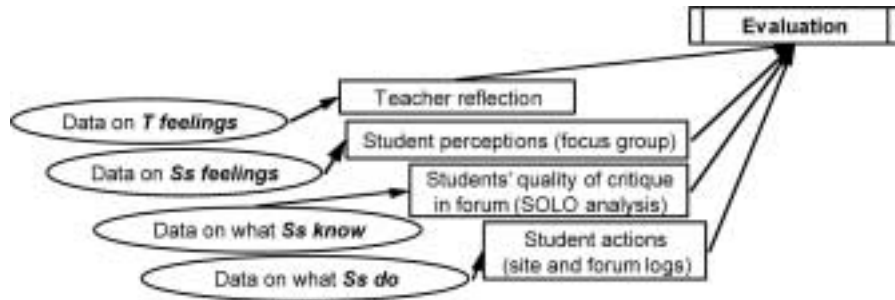


Figure 8. Evaluation data for case 2

Evaluation

Figure 8 illustrates that multiple sources of evaluation data were collected to study the case. To gauge students' feelings, an end-of-course focus group meeting with eight students from each class was conducted. As in case 1, a summary was produced within 24 hours. To examine how students critically review each others' work, an analysis of forum postings was conducted, looking at both the quality and quantity of the postings. The teachers also wrote down their reflections on the experience of teaching their course in this way. Lastly, forum and site logs provided information concerning the popularity of the forum and the site.

Data supporting student application

The evaluation showed that the addition of audio clips was generally welcomed. Students by and large agreed that audio clips were more helpful for learning how to apply language communication concepts and theories than text-based resources. They felt that the real intention and meaning could not be realized just by reading the script without listening to the actual intonation. In fact, the clips were found to be so useful that the most frequent improvement mentioned by the students in the focus group interview was that they would like to see more worked and unworked examples of audio clips on the site. If possible, students would like to have video recordings, rather than just audio, because they thought this would give them more contextual information about the conversation.

The associated online discussion also had good participation and good quality peer criticism. There were two forums available to students. The first one was the private forum, which was used for assignments; the second was a public one, with free access by all students, where any topic could be discussed. In general, forum analysis and site log data revealed a satisfactory to high degree of use of the assignment forum for discussions and learning. On average, each student posted about 20 messages. The access record over about 15 teaching weeks showed that, on average, students visited the course web site between seven and eight times a week, and each week they read about four articles. 'Thread length' indicates the number of messages posted in a forum which relate directly to each other. The average thread length of the postings was three, indicating that students were at least willing to reply to others' messages on the forum.

SOLO taxonomy categories (Biggs & Collis, 1982)	Explanation of SOLO categories	Postings classification categories	Type of posting
Prestructural	Misses the point	Non-substantive	<ul style="list-style-type: none"> • Social
Unistructural	Single point	Substantive	<ul style="list-style-type: none"> • Adding new points • Enhancement and clarification of points
Multistructural	Multiple unrelated points		
Relational	Logically related answer	Elaborated substantive	<ul style="list-style-type: none"> • Making clear contrary statements • Developing complex arguments • Referring to material with a new perspective
Extended abstract	Unanticipated extension		

Figure 9. Forum postings classification categories related to the SOLO taxonomy

About 10% of the postings were randomly selected and analysed with reference to their nature and quality of content. Postings were classified as non-substantive (usually social) (although we do recognize the value of social interaction in community building online, in this case the public forum was the social arena), substantive (related to the topic) and elaborated substantive. These classifications are related to the structured observation of learning outcomes (SOLO) classification (Biggs & Collis, 1982; Biggs, 2003), as shown in Figure 9. In column 1 the terms originally used by Biggs and Collis (1982) are given. A summary of the data is shown in Table 1. The data indicate a good level of engagement in the forum, especially so in class 2, where the percentage of elaborated substantive postings is relatively high.

Challenge

However, having an online peer critique activity was controversial. Opinions about the requirement to discuss online were mixed. Those who preferred traditional individual study did not like

Table 1. Summary of the analysis of the forum postings in case 2

	Class 1	Class 2
Number of postings analysed	100	100
Percentage of postings analysed	8.3	12.5
Percentage of non-substantive postings	0	0
Percentage of substantive postings	92	83
Percentage of elaborated substantive postings	8	17

having to contact all group members for discussions. Some students commented that the forum did not actually exist, as members of the group would first hold discussions on the phone and then post a summary of the phone discussion; they found this much more convenient than typing their questions in the forum and waiting for feedback. Some remarked that discussion did not start until a few days before the deadline of the assignment. When this was the case students did not visit the assignment forum often.

Some other students, however, expressed more positive feelings about the online forum assignments. They commented that they: (1) allow clearer presentation of arguments in black and white; (2) allow students to read multiple viewpoints; (3) help students to learn through critiquing others and reading others' criticisms; (4) allow more time for the students to prepare for giving and answering criticism, thus making more valid statements; (5) remove the fear of hostility in confronting others in face-to-face situations. These students generally agreed that online assignments helped them learn, as they needed to go back to their notes and books to re-read and clarify unclear concepts in the process. Many students, therefore, did more than one question because they found doing the task useful.

The second challenge revealed by the evaluation data relates to media quality. Students wanted better quality audio clips and a system of user control that was more user friendly. Students stated that the audio clips were often too long and complex, with several things that they had to pay attention to in each clip. They found it difficult to identify the exact points of relevance. They suggested that clips should be divided into shorter segments, each containing one or two points.

Case 3. Multimedia projects for evaluating material and creating products which demonstrate metacognitive awareness

The third case concerns student-generated multimedia projects. The teacher of a public health course required students to create PowerPoint slide shows, web sites or video clips that might be used to educate the public on various health issues. These were called 'Cybernet Shows'. The aim was to improve student ability to integrate the concepts and information. In doing so they needed to have their own personal views on the topics and also think about how members of the public learn (evaluation and creation levels, metacognitive knowledge). The metacognitive aspect was also reinforced by a reflective essay written by students at the end of the course.

As shown in Figure 10, the original materials were just the guidelines and regulations texts, which specified in detail the project production process the students had to follow. The multimedia component only came at a later stage, when the students uploaded their work onto the system. The site also contained an assignment submission system through which the students posted their multimedia projects for teacher and peer revision. Furthermore, there was a discussion forum for the exchange of comments. Motivation to use the site and the materials mainly came from the fact that the multimedia project was compulsory and related to assessment marks. Interaction mainly came from the teacher and peer comments on each others' work in the forum.

The project activity comprised three stages: (1) students were required to form groups of around 10 students and each group needed to produce and upload a draft Cybernet Show on

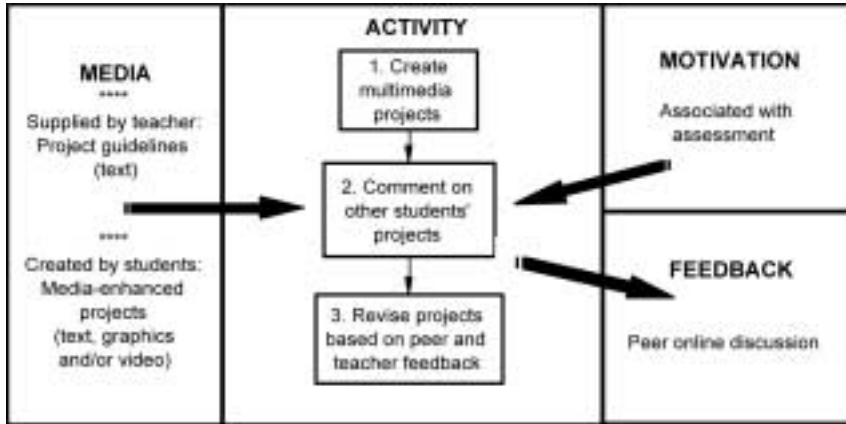


Figure 10. Design of the case 3 media-enhanced course with student projects

the course site; (2) these shows were subjected to criticism and comments by students of a pre-assigned group in the forum; (3) students revised their drafts according to both the teacher’s and their classmates’ comments.

Evaluation

As shown in Figure 11, data from both the teacher and students were collected. On the student side, a course end student survey was conducted. (The survey was constructed from a question pool of over 400 items which has been developed during the course of the e3L project. Items in the pool are related to the key evaluation focuses noted in Figure 2.) The response rate was 38% (87 students responded). A focus group meeting with eight students was also carried out. The postings on the forum were also collected and a forum postings analysis was conducted to evaluate the quality of work the students did in the forum. Average thread length, average postings per student and postings’ content type (whether the messages contained substantive or non-substantive information) were analysed. On the teacher side, a seven item teacher survey was conducted. The teacher also made qualitative comparisons with previous years on the quality of students’ work.

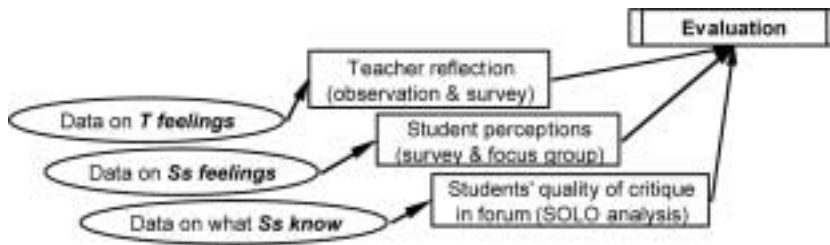


Figure 11. Evaluation data for case 3

Data supporting student evaluation, creative output and metacognition

Students largely confirmed, in both the survey and the focus group meeting, that the Cybernet Show was a good learning exercise. More than 80% of the respondents to the student survey gave positive responses to the statement 'Revising the other group's presentation was a meaningful activity that helped my learning'. However, participants in the focus group meeting noted that the instructions for, and the layout of, the forum were quite confusing. Students were confused whether they should give feedback as individuals or as a group as a whole.

The forum posting analysis generally shows that students were able to give constructive and useful comments to each other. There is still room for improvement, though, in the quality of the comments students give at this peer revision stage: although 62.9% of the postings were substantive comments (presenting new points and clearly explaining positions), few (0.6%) students were able to explain their comments in an elaborated way (e.g. were able to quote external information to substantiate their points).

Students also generally found it helpful to learning to go through the second stage that required them to critique each others' work. Sixty per cent of the respondents agreed with the statement 'After the cyber show activity, I found that I was more willing to and am more able to give critical comments on the work of others'. Nearly 80% of the respondents felt that they were now more willing to listen to and accept others' criticism and also felt that they were able to learn from others' ideas.

With respect to the third stage of the activity (modification of the Cybernet Shows based on the comments received), more than 80% of the respondents to the student survey agreed that it was useful to make amendments based on other students' comments and criticisms. However, the focus group meeting revealed that not many students actually modified their shows. Students in the meeting said that they were not motivated to modify their project because the amendments were not marked. Also, there were practical problems in amending their projects. This discrepancy between student survey data and focus group opinions shows how important it is to triangulate evaluation data. The reality is that students will not do extra work (even if they acknowledge it could be beneficial) and so it is important for the course teacher to provide students with sufficient incentive.

In general, in both the focus group and the survey, students agreed that the multimedia project work enhanced their creativity, trained them in a number of important skills (e.g. team collaboration, computer, video filming and analytical skills) and helped them understand more about, and have more confidence in, really promoting public health care. The project also gave students a sense of satisfaction, especially when the deliverable product was finished. The project helped the students to integrate and articulate the course concepts and theories through the process of producing Cybernet Shows. The project also helped them to associate personal values with different public health issues. In this sense the project has enabled students to move beyond application of course material in an academic way into a personalized expression of the material.

The teacher also reported that she saw more involvement and apparent enjoyment by the students when the task was conducted online compared with the in-class presentations in the past. She also remarked that she saw a significant improvement in the quality of the students' work, perhaps because the students received more feedback on their tasks when the tasks were

online, available for criticism by their classmates. The teacher reported that, overall, she enjoyed the addition of the web component to her course. Apart from the student–student communication required by the Cybernet Show activity, the teacher also noted that the forum had provided a better channel for teacher–student communication, an aspect she also valued very highly.

Regarding metacognition, there are data to support the view that several students gained a greater awareness of some aspects of learning. However, as few students acted on their stated awareness, the degree of achievement in this area was limited. Nevertheless, the personal engagement with and personalization of the task that many students showed are good indicators of metacognitive growth.

Challenge

The main challenge of the Cybernet Show activity came from the fact that the task was demanding and students needed help with both the procedural matters and the technical matters. For example, many comments called for better project guidelines. Difficulties concerning video filming, homepage building and project uploading were mentioned in the focus group meeting. As mentioned above, the project used up so much time that students did not find the extra time needed to complete the third stage, Cybernet Show revision, successfully.

The complexity of the task may have affected the use of online discussion. The total number of postings in the forum was just 167, which indicates, on average, 0.7 messages per student. The average thread length was 2.8, which means that, on average, only one or two replies were given to each leading post. Although students claimed that they became more willing to criticize, most of them still did not do so, or at least did not do so in a sustained way online.

Discussion

Several comments can be made about these three small studies. Individually, they provided valuable feedback to the teachers involved who appreciated and used the data. However, we set out at the beginning of this paper to see what lessons we might learn that could be valuable to a wider audience than the teachers in our three cases.

The cases revealed a number of decision points and challenges facing teachers when they implement media elements into their teaching. These challenges are seen to be closely related to the use of the multimedia in general. In order to bring together the lessons learned from the three cases, we considered the variation between the cases in terms of the desired cognitive demand and also the design elements of media, activities, motivation and feedback noted in Figures 5, 7 and 10. Figure 12 should be seen as an indicative ‘sketch map’ of this variation. The positioning of the cases along each dimension was a qualitative judgement based on our observations. The relative positions, and the resultant pattern, are more important than the absolute positions; we have tried to indicate the subjectivity of the position points by using ‘clouds’ rather than geometric shapes.

The media may differ in complexity and quality, though we have only indicated the complex–simple dimension. The more complex media, for example, integrate interactive quizzes with videos or provide simulations that are able to generate prefabricated feedback to users. The activities the students are asked to complete can differ in the rigidity of their

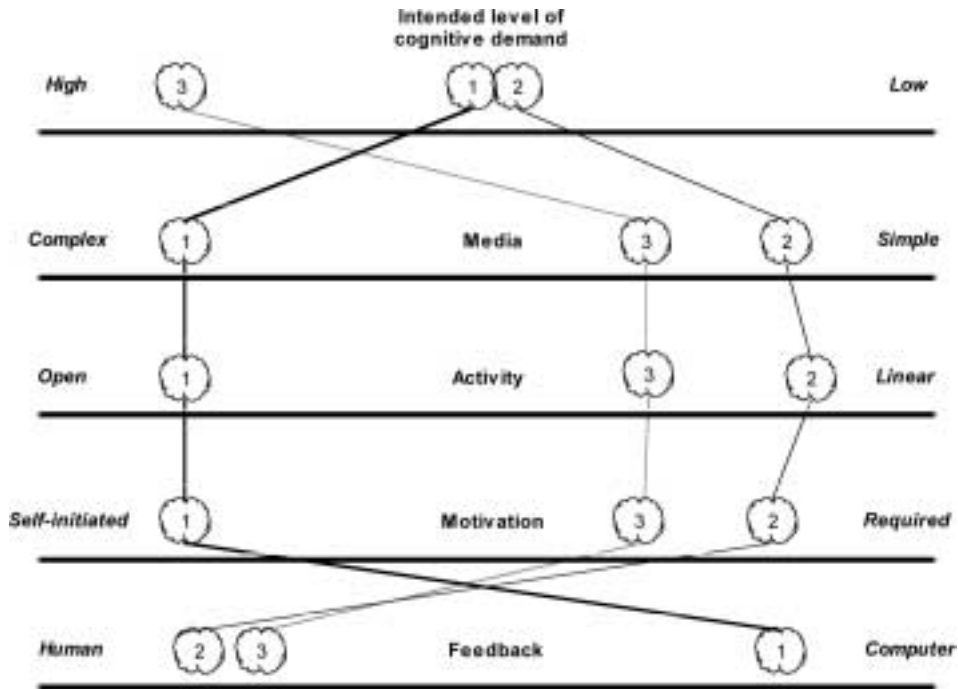


Figure 12. Variations in learning and media design in the three cases

structures. This ‘activity’ dimension ranges from tasks that are linear, closely monitored, with compulsory sub-parts and with clear deadlines specified to loosely structured tasks where the learners have free navigation. The designs also differ in the methods used to motivate students. Some resources are associated with course assessments, while some were made purely optional. The ‘motivation’ dimension thus ranges from required/extrinsic motivation to the other extreme of self-initiated/intrinsic motivation. Multimedia designs can differ in the methods of interactivity used to give feedback to learners. Computer generated feedback is at one end of this ‘feedback’ dimension, while human generated feedback (usually through forums) is at the other end.

There is often an implicit assumption that, in order for students to engage in personal knowledge construction, the online materials they use need to be designed as rich media with high interactivity. The results here indicate that this is a simplistic generalization. For this tiny sample of three cases there is no single point of best practice along any of the dimensions. There are always pros and cons of choosing one way or another. For example, students generally demanded higher quality media, but that means more effort in production and longer development times. Providing resources as optional self-study materials is a clear and easy way to provide opportunities for learning outside class, but this may not engage less motivated students and, without clear assessment incentives, the use of such resources may be low. Human–human online interactions are difficult to encourage and maintain, but seem to facilitate more genuine and in-depth discussion on difficult topics than human–computer feedback, which usually takes the form of supplying prefabricated answers to students’ replies. Loosely

structured activities in which the students are free to skip, jump and return to any part of the materials provide more learner choice and promote self-directed learning, but at the same time there is a risk that many students will skip the more demanding parts that require active participation (such as the forum discussion of case 3) and thus not engage with the purpose of the site's original design.

Teachers try to find the right balance along each of these dimensions (and no doubt other dimensions) so that their own teaching beliefs, their resource limitations and the student profiles are accommodated. For example, the teacher in case 1 chose the high quality end of the media dimension but has decided to develop three such resources in view of the time he has available and the effort he is willing to put in.

The 'profiles' of the three cases show the non-linear nature of the relationship between educational aspirations and media design quite clearly. There are no clear recipes to ensure student learning, no rules about choosing media and designing learning activities. A more helpful approach is to examine the coherence of each 'story'. Compromise is always involved but, taking that into account, the final decisions on the choice of media and the tasks students are set need to relate to course objectives. Making decisions with a clear educational focus in mind is more likely to lead to successful learning outcomes, even though the intervening pathways can vary.

Further, we suggest that evaluation is central to understanding the complexity of the role of media in effective course design. We believe that further studies that look at a number of 'real' cases of teachers and students working with media are needed. This paper has illustrated a practical system to conduct the evaluation of media-enhanced materials, based on a model that supports the collection of multiple sets of data. Do the media elements of the three cases described in this paper really contribute to enhanced student learning? Overall, 'yes', but with the qualifiers 'to some extent' and/or 'for some students'. However, the lessons learnt in these and other projects have enriched the educational understanding of the teachers involved, have provided feedback into the e3Learning Project and, we hope, the wider educational community.

Acknowledgements

We wish to thank Winnie Cheng, Isaac Fung, Martin Warren and Cynthia Wu for their assistance and support in the preparation of this paper. The e3Learning Project is funded by a Teaching Development Grant from the Hong Kong University Grants Committee.

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