LEARNING WITH INTERACTIVE MULTIMEDIA:
A CASE STUDY

Chunyu Cong and Bernard Scott
Cranfield University
Defence Academy of the United Kingdom
UK

Abstract

The purpose of the paper is to present a case study reporting detailed investigations of how students experienced learning with interactive multimedia learning materials. The learning materials were designed following a principled approach to course design. As well as a study of how students learn, the case study is also an evaluation of those principles.

Introduction

Today's technology supports the design of more and more sophisticated multimedia learning environments. However, the multimedia technologies are merely information resources and tools, unless we provide an interactive and meaningful learning content. How to design a good course is always a challenge to course designers. Principles that are based on learning theories can give courses designers a good guide. The primary aim of this paper is to set out a principled approach to course design for interactive multimedia learning environments. The principled approach is based on conversation theory (CT), a theory of learning and teaching. Its secondary aim is an evaluation of the principled approach to course design for interactive learning environments, using case studies of courses, where one or all of the principled have been applied. In the course design/instructional design/learning design literature, various principles and prescriptions are provided. However, in general these principles and prescriptions have not been fully evaluated. This evaluation study is thus a major contribution to the field.

Learning as Conversation

CT originated in the 1960s from a cybernetics framework and attempts to explain learning in both living organisms and machines in (Pask, 1975; Scott, 2001). The fundamental idea of CT is that humans are dynamic self-organising systems with a need to learn and that learning is mediated by external and internal conversations about a topic or subject matter. In an external learning conversation very often one participant has the role of teacher and subject matter expert. The teacher aims to develop a learner's understandings. Part of this process requires the learner to externalise his/her understandings as explanations and models for purposes of formative assessment. In CT, this process is referred to as "teachback." When

engaged in a productive learning conversation, the participants typically share access to external representations of the subject matter in the form of texts, diagrams, concept maps, models, examples and so on. Figure 1 shows the form of a learning conversation.

Figure 1: The 'skeleton of a conversation'
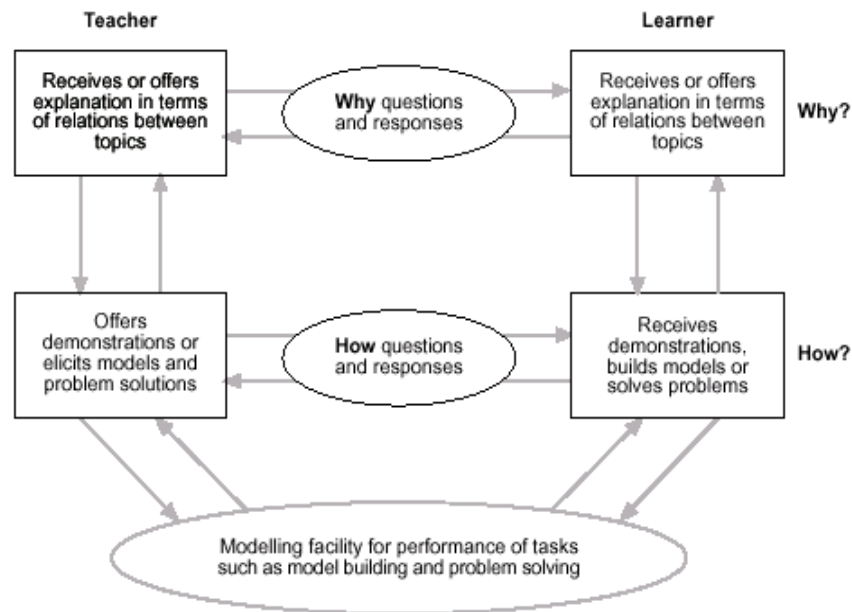
(Source: Scott, 2001)

Pask (1975, 1976) refers to this model as the "skeleton of a conversation." It shows a 'snapshot' view of two participants (learner and teacher) in conversation about a topic.

All such exchanges have, as a minimum, two logical levels ("how" and "why"). The "how" level is concerned with how to 'do' a topic: how to recognise it, construct it, maintain it and so on; the "why" level is concerned with explaining or justifying what a topic means in terms of other topics. External representations mediate these conversations and assist the participants to negotiate agreements, including agreements to disagree. Apart from these external conversations, each participant has a continual internal conversation or 'inner dialogue' where concepts are constructed and assessed for logical coherence and consistency of naming with other concepts within a participant's conceptual system.

Pask (1975) also defines a generic term, "modelling facility," to describe the resources that enable the teacher to demonstrate and exemplify the topic. Here, the teacher can use non-verbal demonstrations. Modelling facilities can be

laboratories, computer based micro-worlds and simulations or parts of the real world.

What Basic Principles of CT Are Relevant to Course Design?

To support conversational learning as characterised by CT, we believe a multimedia learning environment should have four major components, as exemplified in Pask and Scott's (1973) seminal Course Assembly System and Tutorial Environment (CASTE). The four components are:

- Learning outcomes that are clearly specified. These may be conceptual, procedural or attitudinal.
- Course content should be analysed in terms of knowledge and tasks to ensure logical coherence and consistency of terminology.
- Learning designs (also referred to as "tutorial strategies") need to be specified to ensure effective learning takes place.
- Assessment procedures need to be specified, both formative and, where relevant, summative. Formative assessments play a key role in eliciting "teachback" activities within a learning design.

A key principle to be followed is that all items of each the four components should map onto corresponding items of the other components. This is illustrated in Figure 2.

Figure 2: A framework for course design
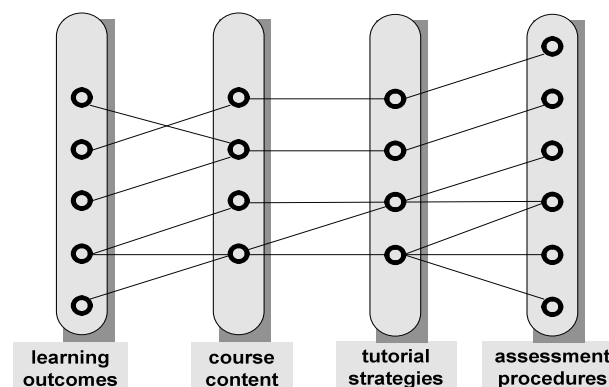
(Source: Scott, 2001)

In similar spirit, John Biggs (1999) has coined the term "constructive alignment" for the idea that course components should work together coherently and

consistently. We will now look at the whole process of course design, development and delivery.

A Process Model of Course Design, Development and Delivery

To help ensure that the fundamental principles of course design are followed when designing, developing and delivering courses, a ten step process model has been developed (Ryan et al., 2001; Scott, OLKG). The steps in the model are summarised in Figure 3.

Figure 3: Processes involved in course design, development and delivery

(Source: Scott, 2006)

Although the model follows a particular sequence to ensure that all the components are designed to fit with each other, it is understood that they interact with each other. This means that the decisions of later steps may influence the earlier steps that may then need to be revised. This is indicated by anti-clockwise arrows at the centre of the diagram in Figure 3.

There are some features of this model of course design which contribute to and account for its effectiveness in the design of interactive multimedia learning environments. They are:

- All components are designed to work together.
- Components are analysed and developed in a planned sequence; although each is reviewed again as new components are specified.
- The entire design process is orderly but flexible. There is both "feedback" and "feed forward" in iterative cycles of work.
- The key step of knowledge and task analysis is supported in CT by a well defined methodology (Scott & Cong, 2008).
- The design process includes formative evaluation using pilot studies and technical testing.

Summative evaluation of a course once it has been delivered is seen as a key step in the design, development and delivery process. This step is one which is, in practice, often skimped on or even omitted in. Summative evaluation may use summative assessments to provide data on how well the course as a whole is doing its job of helping learners achieve learning outcomes. As below, it may also look to see how relevant and effective are the various components built into the course design.

In the following section we present a case study in which a course designed, developed and delivered following the ten step model is being evaluated to see how effective has been the principled approach that underlies the ten step model.

Case study: Evaluation of Courses on Military Knowledge

Cranfield University supports military colleagues at the UK Defence Academy in the delivery of a wide range of educational courses. We have been engaged in developing quality web-delivered distance learning courses for junior officers in the British Army. The courses are known as Military Knowledge 1 and Military Knowledge 2 (MK1 and MK2) and provide in total some 200 hours of self-directed learning. The courses are self-contained and designed to be worked through by learners working individually. In formal support groups do exist and, as noted in the evaluation findings below, many students would welcome more opportunity to interact with peers and tutors.

The MK courses are divided into parts, modules, sections and lessons. Each lesson is further divided into as many as five topics, which may in turn have subtopics. The MK courses are structured in such a way as to give total freedom to the student in terms of the order in which each lesson, and indeed each topic or subtopic is accessed. To this end, students are provided with a "Knowledge Map", a visual representation of the course with a mechanism for browsing and launching lessons. Students are permitted to browse lesson content or to go directly to any given topic within the lesson via the lesson's topic menu internal navigation. Students are also provided with a "Lesson Map" which allows them to navigate to a given topic or subtopic. The learning design used for lessons follows the principle that for each topic there is (i) a clearly defined learning outcome; (ii) expository text supported by multimedia resources (graphics, animations, video clips); (iii) one or more interactive learning activities with formative feedback; (iv) self-assessment activities with formative feedback; (iv) summaries that can be downloaded for review purposes. Summative assessments are delivered online using a dedicated assessment engine.

Summative evaluation data is collected for all MK students using a short questionnaire. Here we present some data from the period May–August, 2006. The questionnaire consists of a mixture of direct yes/no and indirect "free-text" entry questions. Questions covered three topics: (1) course content, (2) learning designs and (3) assessments.

Table 1 shows the data about course contents. Overall it can be seen that the course content was favourably received.

Table 1: Course contents

Questions	No of Respondents	Yes (%)	No (%)
1. Was the content relevant for the learning outcomes?	3602	94%	6%
2. Was the content the correct difficulty level?	3604	85%	15%
3. Was the content accurate?	3605	86%	14%
4. Was the content up to date?	3592	91%	9%

Table 2 shows data about aspects of the learning designs that were used. Again it can be seen that overall responses were very positive.

Table 2: Learning designs

Questions	No of Respondents	Yes (%)	No (%)
1. Did the lessons have a flexible learning route?	3598	94%	6%
2. Was there clear and consistent signposting of where you were?	3610	94%	6%
3. Were the activities relevant?	3602	96%	4%
4. Was the time indicated for the activities accurate?	3590	87%	13%
5. Did you find the activities interesting?	3586	93%	7%
6. Did you find the activities reinforcing?	3603	96%	4%
7. Was the feedback for the activities useful?	3601	96%	4%

Table 3 shows data about aspects of the summative assessment procedures.

Table 3: Assessments

Questions	No of Respondents	Yes (%)	No (%)
1. Was the assessment an accurate reflection of your knowledge?	3599	85%	15%
2. Was the assessment the correct length?	3522	88%	12%

In order to gather more detailed feedback from students other evaluation studies are being carried out.

To elicit in-depth information about students' perceptions of the course design methods, semi-standardized, open-ended oral interviews are being conducted, together with deployment of an online questionnaire. Four students thus far have served as interviewees. Each student was interviewed by the researchers for about one and half hours. After the student interview, the dialogues between students and researcher were transcribed into texts. The "constant comparative method" of grounded theory (Bogdan & Biklen, 1992) was then used to analyse all the written scripts and recorded transcripts in order to obtain the repetition in perceptions among these participants.

The student's responses were useful in developing an online questionnaire. The questionnaire contains Likert scale questions and four open-ended short essay questions. Table 4 shows major components within the framework of questions used in the interviews and questionnaire. Thus far we have received response from twenty two students. More data is expected in due course.

Table 4: Major components within the framework of exploratory questions

EXPLORATORY QUESTIONS	
What variables affected the perspectives of learners in the courses?	• Learners' e-learning experience background • Learners' IT skills • The situations of learners' study • Access to an internet connection • Learners' learning style preferences • Learners' study time • Learners' motivation to learn
What are learners' perceptions of the features of the learning designs used?	• Learning outcome statements • Knowledge Map and Lesson Maps • learning activities • lesson assessments • summaries • summative assessments • animated graphics • embedded hypertext items (i) • menus (study guides, faqs, assessment policy and download of summaries) • the topic navigation bar
Learners' overall satisfaction with aspects of the course	• Structure • Content • Navigation • Assessments

Preliminary findings from the interviews and questionnaires show very interesting individual differences between students in terms of their preferred learning strategies. Some students clearly favoured a holistic approach, others adopted a

serialist approach. This corresponds to Pask and Scott's (1973) findings about how students learned using CASTE.

With respect to the evaluation of the course design model, the questionnaire data show that a large majority of students consider the course to have been well designed. In a short paper, it is not possible to detail all our findings. By way of summary, we have carried out a SWOTS analysis to illustrate and interpret the data. (See Table 5.)

Table 5: A SWOTS analysis of the MK courses

Elements	Related dimension of the MK courses
Strengths	1. Learner oriented 2. Flexible access to the courses 3. Students decide individually about the sequence and pacing of learning 4. Students like to use learning outcomes to preview their knowledge 5. Good structure 6. Good navigation 7. Good learning activities 8. Students appreciate checking their knowledge using lesson summaries. 9. Students appreciate testing their knowledge using self-assessment quizzes 10. Visualization (graphics, animation)
Weaknesses	1. Lack of teamwork 2. Content is over filled 3. Screen-handling is exhausting 4. Poor quality of summative assessment questions 5. Students need to be quite well motivated 6. 'Self-management' culture difficult for some students 7. Needs to be balanced with traditional methods-some students don't like interacting with machines 8. Loss of face-to-face richness
Opportunities	1. More flexible access to learning 2. Can reach more students over a range of times and locations 3. Can deal with more students
Threats	1. Influence of traditional teaching approaches 2. Lower motivation 3. Drawbacks of using technology (need for training, access, accessibility)
Strategies	1. To update the content 2. To improve the quality of summative assessment questions 3. To provide opportunities for collaborative learning 4. To employ intelligent tutoring /adaptive teaching

A SWOT analysis is a common method of strategic analysis for strengths (S), weaknesses (W), opportunities (O), and threats (T). We have added a fifth

component of "strategies" (S) to capture suggestions for how the MK courses could be improved.

Concluding Comments

This paper has reviewed a principled approach to the design of multimedia interactive learning materials based on conversation theory and deployed in the form of a ten step model for course design, development and delivery. A case study was described using course on Military Knowledge as the context for ongoing detailed evaluation studies aimed at validating the principled approach to course design. We are not aware of any other large scale evaluations of course design practice and so consider our work to be a valuable contribution to the research literature.

Data from the evaluation studies show that:

(1) Overall, learners find the course design satisfactory and do make use of the many features built into the course with the aim of making it pedagogically effective More specifically, the learning design features employed (statements of learning outcomes, use of multimedia assets and interactive activities, use of self-assessment questions, use of a course knowledge map and lesson maps and so on) are all seen to be working together constructively and effectively.

(2) There are many, still to be explored, interesting individual differences amongst the learner population.

(3) Many learners would value more opportunities to work collaboratively with peers.

We are feeding back our findings to our MOD colleagues with the view to discussing how the course might be improved. Topics being addressed include (i) how to ensure all learners make best advantage of the course features, (ii) how to implement and manage elements of collaborative learning, (iii) how to best support a range of different learning styles, and (iv) to investigate a possible role for adaptive teaching where access to lessons and topics within lessons is made contingent on successful completion of lessons and topics at subordinate levels within the Knowledge Map and Lesson Maps.

References
Bogdan, R., & Biklen, S. K. (1992). *Qualitative research for education*. Boston: Allyn and Bacon.

John, B. (1999). *Teaching for quality learning at university.* Buckingham: SRHE and Open University Press.

Pask, G. (1975) .*Conversation, cognition and learning*. Amsterdam: Elsevier.

Pask, G. (1976). *Conversation theory: Applications in education and epistemology.* Elsevier: Amsterdam.

Pask, G., & Scott, B. (1973). CASTE: A system for exhibiting learning strategies and regulating uncertainty. *International Journal of Man-Machine Studies*, *5,* 17–52.

Ryan, S., Scott, B., Freeman, H., & Patel, D. (2000). *The virtual university: The Internet and resource based learning.* London: Kogan Page.

Scott, B. (2001). Conversation theory: A dialogic, constructivist approach to educational technology. *Cybernetics and Human Knowing*, *8*(4), 25–46.

Scott, B. (2006). *The Online Learning Knowledge Garden* (OLKG). Retrieved February 18, 2008, from http://olkg.cranfield.ac.uk/

Scott, B., & Cong, C. (2008). Analysing and representing 'conversational domains'. In *Proceedings of the 19th European Meeting on Cybernetics and Systems Research*, University of Vienna, March 25-28, 2008 (pp. 132–137).