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Apprendre avec les médias ou apprendre d'eux ? une vue constructiviste sur les nouveaux médias comme outils cognitifs

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Introduction

The traditional view of educational media is based on the idea of a *product* such as film, video tape or CD-ROM produced, much like a textbook, to provide information and structure for learners. In this traditional view, students learn *from* the program, much as they learn from a teacher. Good educational programs, like good lessons, are logically constructed, have clear objectives and employ advance organisers and graded assessment tasks. In the USA a new profession of «instructional design» has been articulated by theorists such as Robert Gagné (Gagné, 1982) David Merrill (Merrill, 1997) and Charles Reigeluth (Reigeluth, 1992). I.D. is taught in American universities.

The constructivist approach to teaching and learning, first articulated by Jerome Bruner (Bruner, 1986) and based on the work of Jean Piaget (Piaget, 1987) and Lev Vygotsky (Vygotsky, 1978), turns this traditional, objectivist approach on its head. Constructivism is a relativist epistemology which Thomas Reeves (Reeves, 1995) defines as follows:

> Knowledge does not exist outside the minds of human beings.
> Learners construct unique cognitive structures based upon their previous knowledge and their present experiences.
> Reality is individually and socially constructed based on prior experience.
> Learning consists of acquiring viable strategies that meet one's objectives.
> Learning can only be estimated through observation and dialogue.

In a constructivist world the media are no longer texts to be learned – they are tools wielded by the learner to construct his own knowledge. The computer is a particularly powerful tool as it incorporates so many other media and possibilities. A constructivist credo for educational multimedia might read something like this:

> Students do not learn from computers; students learn from thinking in meaningful ways
> Thinking is engaged by different learning activities which can be embodied in computer applications
> Some of the best thinking occurs when students try to present what they have learned

In this seminar I propose to examine two pedagogical activities from the constructivist position: firstly the production of educational media; secondly, evaluating student learning.

PART 1. Inputs to the production process

A producer of educational media needs to consider the production process from three distinct perspectives: the learner, the teacher and the creative artist.

(a) The learner

There are many factors we might include in a definition of the learner. The traditional approach envisages the learner in terms of categories such as age, maturity, prior knowledge, language, etc. and media are tailored to meet these criteria. A constructivist approach, by contrast, assumes that the student is responsible for his own learning. A media producer does not make top-down assumptions about the student but seeks to encourage good learning behaviour.

Marton , Entwhistle, Ramsden, and Biggs (Biggs, 1987; Marton, 1986, 1988; Marton, Hounsel, & Entwhistle, 1984; Marton & Ramsden, 1988; Marton & Säljö, 1976) developed a framework to describe a student's approach to learning according to three parameters:

Surface approach: the motivation is extrinsic — one carries out the task because of either positively or negatively reinforcing consequences. Surface learners tend not to see the interconnections between elements nor the meanings and implications of what is learned.

Deep approach: based on intrinsic motivation or curiosity and a strategy which is aimed at seeking meaning. There is a personal commitment to learning, which means that the student relates the content to personally meaningful contexts, or to existing prior knowledge.

Achieving approach: as with the surface approach, focused on product: the satisfaction which comes from proficiency. The strategy involves maximising the chances of success and while this may involve using the optimal strategy, this is the means rather than the end in itself.

The student's approach will be a combination of these parameters and is based on the expectations of the course. As teachers we need to be clear about which approach we expect from our students - which approach will be rewarded in the final assessment.

(b) Teaching style

The traditional approach to teaching emphasises the careful formulation of behavioural objectives and the provision of graded materials to assist the student attain mastery of the content or skill. By contrast, the constructivist approach emphasises problem solving, extensive resources and activities designed to assist the student develop his own conceptions. The table below contrasts these two approaches.

Traditional	**Constructivist**
Teach sequences of skills graded from low-level to high-level	Assist students to learn through problems, explore possibilities, develop products and presentations
Match clear objectives with assessment tests	Develop global goals which require generalised abilities such as problem solving and research
Stress on individual achievement	Stress on collaboration and group work
Formal classroom instruction, lectures, worksheets, mastery activities, tests	Informal atmosphere, open-ended questions, research and development, learning portfolios, descriptive narratives (Jonassen, 1991)

(c) Aesthetic approach

Creativity plays a central role in the production of any media. Over-designed material produced «by the book» is often pedestrian and fails to hold the learner's interest for long. On the other hand, strongly individualistic and/or abstract programs may not provide the structure or depth required for learning. If you look at the range of current educational CD-ROMs and WWW sites it is not difficult to distinguish three broad categories:

In a **classical** approach, content is the major concern and realism is the paradigm. However, a strictly classical, content-heavy approach can lead to worthy but ultimately boring programs.

The **modernist** approach accentuates the vision of the artist and the content is simply a means of achieving a personal vision. This approach can lead to exciting and intriguing but ultimately unrewarding or unrealistic educational material.

A **postmodern** approach places observer/reader at the centre of the process: the meaning of the work is ultimately the interpretation of the viewer. But if this is overdone, it can lead to a lack of structure and an idiosyncratic approach to content.

(d) Theory into practice
David Jonassen (Jonassen & Rohrer-Murphy, 1999) proposes a number of procedures for converting constructivist ideas into practical approaches to media production.

Constructivist theory	**Practical consequence**
Learning is a process of constructing knowledge	Provide experiences with knowledge construction through problems, research, & presentation.
Many worlds and world views can be constructed	Provide experiences of and appreciation for multiple perspectives
Knowledge is dependent on context	Embed learning in realistic and relevant contexts
Learning is a process of social dialogue	Embed learning in social experience, through collaboration and group work
Learning is mediated by tools and signs	Encourage the use of multiple modes of representation
Knowing how to know (metagognition) is the highest form of knowing	Encourage self-awareness of the knowledge process

The qualities we need consider in a constructivist-style project are: a collaborative problem-based approach in a realistic setting, an appreciation for multiple perspectives and multiple media, and an emphasis on metacognitive skills. These precepts are particularly well illustrated in the award-winning CD-ROM productions from the University of Wollongong's Interactive Multimedia Learning Laboratory and in most of the other examples which follow.

PART 2. Outputs: constructivist-style programmes

If there is time I propose to show three constructivist-style approaches to the media: a CD-ROM for secondary school Science; a web site supporting a PBL course for university teachers; a university-level foreign language course.

Exploring the Nardoo: an Australian produced, problem based, exploratory simulation on CD-ROM that enables students to develop an understanding of environmental interrelationships. The student enters an environmental research station and is presented with a choice of realistic problems concerned with water management. Armed with his own «Personal digital assistant», he investigates the environment, takes scientific measurements, conducts simulations, collects qualitative data, and finally presents his findings (with the aid of a variety of templates) as a multimedia document.

CAUT on the Web a Web based resource for university teachers at the University of Hong Kong who are developing web based teaching materials. The site supports a problem based course on the use of WebCT (or any other software) and provides both theoretical and practical information on: educational theory, production processes and aesthetics, media formats and evaluation. It uses the presentation style of the Web to encourage university teachers to develop their presentation ideas beyond content.

The Web broadcast Italian **Telenovela** «Navigare il fiume d'amore senza remo» was written, produced and acted by students of Prof. Thomas Simpson at Northwestern University in Chicago. The course was entitled «Italian through performance.» The students first studied examples of the Italian «telenovela» (soap opera), then developed their own stories and filmed them on DV. The programs were edited on an iMac in the Multimedia Language Centre and uploaded to the Web each week.

PART 3. Researching constructivist learning

At the beginning of this paper I stated some beliefs about learning:

> Learning consists of acquiring viable strategies that meet one's objectives.
> Learning can only be estimated through observation and dialogue.

A question often asked about constructivist style education is: how do we know whether students have learned anything? And if they have, what is it?

Five years ago the Department of Architecture at the University of Hong Kong installed a powerful computing laboratory to enable students to develop digital modelling skills. They decided at the same time to change the style of teaching from a structured lecture-tutorial system to a more flexible problem-based approach. With financial support from the University Grants Commission, we set up a project to track the first students through these new problem based courses and to investigate the differences between the outcomes of conventional, lecture based teaching and this new style of problem-based, computer-centred, collaborative learning.

Rather than take a conventional experimental approach and use a control group, we consider it would be more rewarding to conduct a long-term ethnographic study of the 24 students and their tutors. In the tradition of ethnographic research, the question was open-ended:

> *In a problem based, computer intensive learning environment, what is the relationships between student characteristics, computers and cognition?*

(a) Data collection

Data was collected over an 18 month period, primarily from observations and interviews with individual students, with teachers and with groups. One of the primary sources of data collection was a special workstation in the laboratory equipped with a camera (which recorded image and sound of the students at work) and a video splitter device that combined the video image with the output of the computer, producing a composite image that was recorded onto VHS tape (Figure 1) Students were always told when they were being recorded. The tapes were transcribed using common video notation style for coding and analysis (see below)

Figure 1: Output of the video observation system showing student at work, lower right.

(b) Student characteristics.
At the beginning of the data collection process and at various stages over the 18 months the team also collected information about individual students' knowledge of computers, approaches to study and conceptions of the process. The tools below provided particularly useful results:

(i) Study Process Questionnaire
Biggs developed this questionnaire in Australia and normalised it across Hong Kong university students during 1991-92 (Biggs, 1992). The questionnaire comprises 60 Likert scale questions (in English and Chinese) that provide numerical scores describing the student's approach to learning on six factors:

Surface motive and strategy
Deep motive and strategy, and
Achieving motive and strategy

Our students' raw scores were compared to Biggs' normalised scores for Hong Kong tertiary students and a graphical profile was developed showing each student in relationship to the wider population.[1]

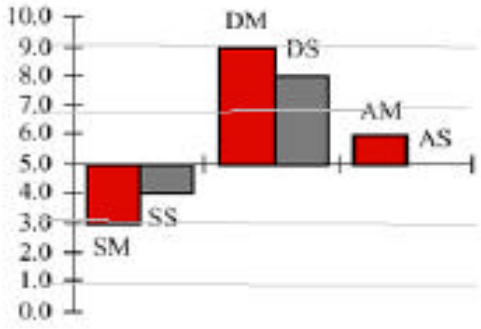

Figure 2: SPQ graph

Figure 2 illustrates the response of a student in our study who can be characterised as having a unusually high «deep-achieving» approach to learning. Surface motive and strategy are below average, whereas Deep motive and strategy are in the top 10-20%. The slightly above average Achieving motivation score suggests that the student is clearly focused on how to succeed in the course.

(ii) Mental models and concept maps
A number of approaches to concept mapping were employed in the study.

Buzan-style mind maps
In an early investigation, students were asked to demonstrate their knowledge and skill using the common 3D computer applications AutoCAD and 3D Studio. The demonstration was videotaped and then «mapped» using Buzan's (Buzan & Buzan, 1993) «mind mapping» techniques (Figure 3). These diagrams provided useful visual references for the research team.

[1] The «average response» in this exercise is by no means representative of the general population of Hong Kong: it has been normalised on an elite group of successful university students.

Figure 3: Buzan-style mind map of computer knowledge

Concept maps

Student reported that they often lost files that they had spent considerable time developing. The students were asked to draw a concept map of the laboratory network and to indicate where they thought their files were. The results were revealing: only about half the class drew a conventional branching structure beginning at the root, and many of these were inaccurate. The remainder of the students produced sketches ranging from architectural sketches of the laboratory to self portraits with the files in their frontal lobe! (Figure 4)

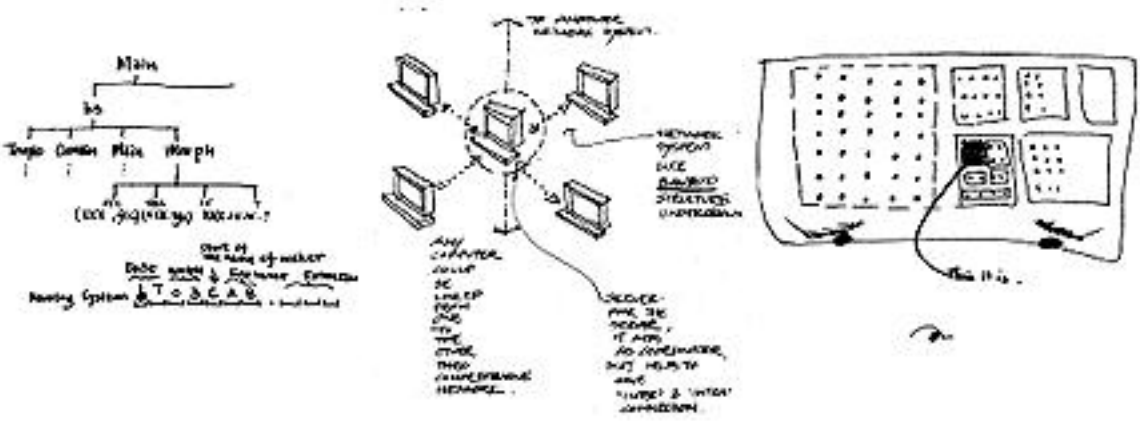

Figure 4: three student-drawn concept maps of the computer network

PFNets

The most interesting concept mapping exercise employed a software program called «Knot», one of a set of concept mapping tools developed at the University of new Mexico by Roger Schvaneveldt (Schvaneveldt, 1990). It produces multidimensional outputs known as «Pathfinder networks». The procedure is as follows:

a collection of concepts is distilled from the student interviews and presented as a list of words,

the students are required to rate each pair of words in terms of relatedness[2],
Knot calculates the relative similarity measures and presents the result in the form of a graph.

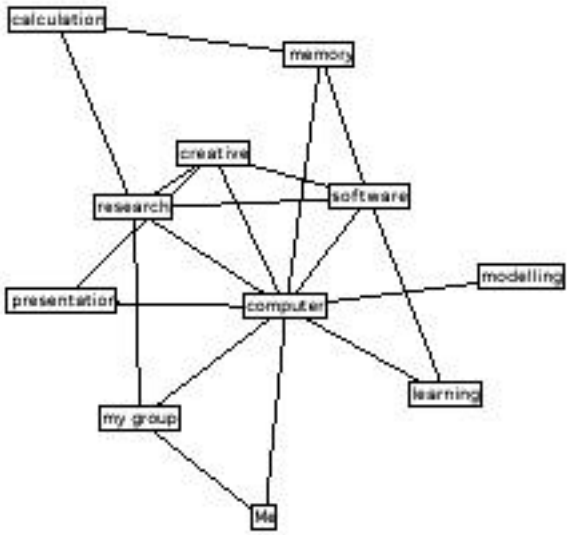

Figure 5: PFNet showing with «computing» at centre

The resulting PFNet provides a graphic illustration of the student's mental schema and, if the concepts (words) have been carefully chosen it can be used as a diagnostic tool. In this study it was employed as the starting point for a set of interviews aimed ad revealing metacognitive knowledge and skills.

(b) The data
Over the 18 month period a large collection of unstructured data was collected in the form of interviews, videotapes, photographs and sketches, concept maps, computer files, etc. The interview transcripts totalled more than 17,000 text units (60 character lines of text). About 50% of the interviews were conducted in Cantonese and these were translated into English by a research assistant.

(c) Analysis
The data were analysed using NUD.IST[3] , a software for qualitative research developed at LaTrobe University in Australia by Tom and Lyn Richard (Richards & Richards, 1991) and now in commercial distribution.

As its title suggests, the program enables a researcher to index and search unstructured data and to build and test theories. This is done using a «grounded theory» approach involving the development of increasingly refined categories described at nodes on a tree structure. The data is indexed at these nodes, then categories are brought together with text searches and can be further cross indexed in a recursive fashion.

A comparison of qualitative research methodologies and a detailed description of NUD.IST are outside the ambit of this paper, however I have provided a number of references on the topics and would be happy to correspond with interested qualitative researchers by e-mail.

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[2] Trial end error demonstrated that the maximum number of pairs that could be presented before a subject's response became automatic was about 50. The formula for calculating the total number of pairs is t=(n-1)+(n-2)+...1. Eleven words, producing 55 semantic comparisons, was considered to be an upper limit.

[3] Non-numeric, Unstructured Data - Indexing Searching Theory building, available from QSR (http://www.qsr.com) and Sage Publications.

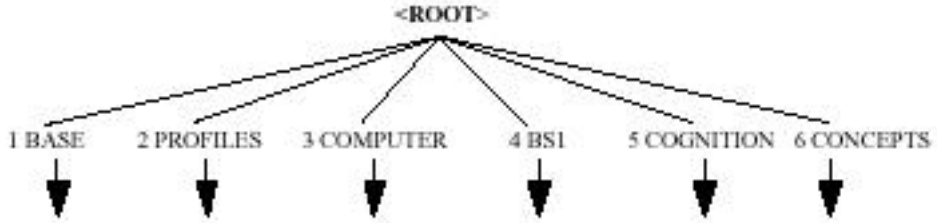

Figure 5: The NUD.IST tree at level one

4. Conclusions of the study

The outcomes of a qualitative study do not consist of the proof or disproof of hypotheses nor of tables of statistics and graphs, they are more likely to be descriptive narratives or of dialectical arguments. In this study, which sought to examine students' learning experiences in a constructivist environment, there were four main conclusions plus a number of noteworthy unanticipated outcomes.

Paradigms of learning

- The constructivist paradigm was appreciated by students (after some initial hostility) and produced scores on declarative knowledge comparable to traditional instruction.
- The constructivist paradigm appears to be most effective in the development of structural knowledge and deep approaches to learning
- The computer intensive learning environment (computers, software, network, working procedures, etc.) was an effective and efficient means of developing skills and knowledge in architecture

Student profiling

- The profiling tools developed for this study (SPQ, concept mapping, PFNets) provided useful feedback for teachers faced with students' conceptual difficulties (e.g.. of computer networks and complex software)

Metagognition

- The fundamental importance of metacognitive skills for learners at this level was strongly confirmed.

Successful learning requires

- Problem solving skills
- The development of a deep approach to learning
- The acquisition of procedural and structural knowledge (e.g.. in computing and research)
- The ability to work collaboratively, which includes group projects and peer teaching.

Unanticipated outcomes

- The «picture-in-picture» equipment developed for observing students at work on a computer has proved to be extremely effective and has been used several times since in observational studies of human-computer interaction.
- PFNets have been shown to provide accurate indications of a student's degree of structural knowledge and may be effective diagnostic tools for learning difficulties
- NUD.IST, originally developed as a research tool in Sociology, has proved to be very effective in the analysis of student interviews and observations related to learning

More detailed descriptions of this study and of qualitative research methods in general can be found in some of my earlier publications (Hart, 1996, 1999; Hart, Bradford, & Will, 1997)

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