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What to make, and why

PRINCIPLES
FOR THE
DESIGN AND DEVELOPMENT
OF
ONLINE CURRICULUM CONTENT

SUMMARY DOCUMENT

Prepared for
Curriculum Corporation

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We're online now …

We currently have two computers in the Year 4/5 classroom. The Internet has only just been installed this week (23.11.00).

Prior to this, the students were using the computer that was set up with Internet access in the library. Here, students had the opportunity to research HSIE topics and general topics of interest. Unfortunately there were considerable complications with this. There were times when there were technical difficulties which made access impossible, frustrating and time-consuming. It was also extremely difficult to supervise and monitor students' interaction with the Internet while teaching in another classroom. Inadequate supervision became an issue, so students' use of the Internet slowly diminished over the year.

As funding was made available, we decided to use it towards setting up the Internet in the classroom. The students and teachers were delighted with the idea. There have been various technical complications with the installation, but we are now finally 'online'!

— A primary teacher member of this Project's focus groups

The State of Play

(An expansion of this material will be found on pp. 34-46.)

How widespread is the use of ICTs in school education in Australia?

• The presence of computers for learning purposes in Australian schools is nearly ubiquitous.

• During the past four years government education systems in Australia have provided their schools with approximately $450m. for the purchase of computer hardware and information and communication technologies infrastructure. In the same schools this investment has been matched and exceeded by expenditure from various other sources. Thus more than $1b. has been spent for this purpose in government schools since 1996.

• This expenditure is ongoing. Most schools are presently giving a high budget priority to the provision of hardware and software for use by students and teachers. Nonetheless there is an evident and substantial divide between information technology 'haves' and 'have nots'.

• Secondary schools tend to have more sophisticated ICTs resources as do larger schools (which secondary schools frequently are).

• Nearly all teachers possess the basic range of skills required to use computers. A fairly high proportion has more advanced skills.

• Most students enjoy using computers, believe they will need to be good at using them to work in their chosen field and link ICTs skills with options for further study.

What are they being used for?

• We do not have a current, reliable and detailed account of the nature of use of ICTs in Australian schools. However word-processing appears to be the dominant use by far. Internet research, using drill-and-practice software (especially in primary schools) and other CD-ROM-stored educational software, e-mail communication and game playing are all reasonably widespread. Of these activities Internet research (used most extensively for Studies of Society and Environment) and e-mail communication are conducted online.

• The major pattern of difference occurs between primary and secondary classrooms. This partly relates to/is reflected in differences in the location of computers. Computers are more likely to be located in general use classrooms in primary schools and in laboratories in secondary schools. (In both sectors of schooling around 10% of computers are located in schools' libraries.)

• Students in primary schools are much more likely to use drill-and-practice software and to use digital tools *as a matter of course in the classroom* to process and present their work. They are about half as likely to use the Internet/Web as secondary students, less likely to use ICTs for graphs and diagrams and far less likely to use spreadsheets and databases. Primary student use of the Internet/Web is likely to be more guided and supervised than that of secondary students.

• A trend in schools in the USA and for which there is some evidence here is a decline in the use of drill-and-practice software.

What Australian education system-developed online material is available?

• An audit conducted by Curriculum Corporation in late 2000 contains 67 items. Ten are shells for collaborative projects; eight are resource banks; four (related to the Olympic and Arafura games) might be considered ephemeral; three are related to generalised student support; three are sites for annual competitions; two are displays of student (art) work; two are information-giving only; and one provides communication with an expert. Thus half are for on-going, topic-specific instructional purposes.

• A major emphasis on integrated or cross-curricular study is evident in these materials. Studies of Society and Environment is the Key Learning Area for which the most materials have been made. Material for use specifically in English, Mathematics, Health and Physical Education and Languages other than English is very limited.

What can be learned from the emerging models of successful use of ICTs in the classroom?

• Schools visited for this task where it was evident that both students and teachers were making widespread effective use of ICTs in all areas of the curriculum had a number of common infrastructural features. A very large investment in hardware and infrastructure had occurred; *computers were in all or most classrooms* and were serviced by a powerful Intranet; and Internet connection was available from all or most classrooms and many other active points were provided in the school buildings.

• A set of key learnings likely to be more broadly shared was described at one of these schools.

— Effective whole school planning is critical to the successful implementation of ICTs in all learning areas.
— Whole school change is required which is supportive of the changed role of the teacher.
— High speed multimedia networks are critical to allow the exchange of information, communication and collaboration.
— Educational network design and management are critical to success.
— High speed Internet access to all computers, links from home for staff and students and sophisticated Intranets are essential parts of a successful systems.
— The library is a key part of any successful ICTs strategy.
— Effective budgeting for capital and recurrent expenditure is essential.
— Formal and informal evaluation, research, benchmarks and feedback allow informed progress.
— High quality professional development is needed to support the pedagogical, technical and emotional needs of teachers. [Each of these schools had made very large investments in teacher professional development.]

• In the context of this project, it is wiser to focus on conventional circumstances than isolated cases of leading practice. However two consistent views might be borrowed for wider use.

— ICTs are to be of service to learning, not solely an object of learning in themselves.
— Their use must be embedded as conventional in teaching practice in order to enhance learning, and not be considered a substitute for teacher-student and student-student interaction.

Online Learning

A number of conclusions are drawn here from the section of the paper which discusses the distinctive qualities of and issues related to online learning. (See pp. 48-59.) This material relates to and has informed much of the paper.

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• In preparing online content it should never be forgotten that schooling serves important and pervasive social purposes which are met through personal and group face-to-face interaction.

• The quality of this work will improve as a result of remaining alert and open to the views of critics of digital learning.

• Some of the pertinent features of online learning include the following.

— Rather than anything inherent in the nature of the medium, productive learning engagement is likely to be a product of the degree of ongoing intellectual challenge embedded in the learning material and the consequent depth of intellectual processing.

— The capacity to vary pace and structure is inherent in the medium: it is one of its great strengths. However that capacity also exists in many other educational processes and experiences and it alone does not guarantee improvements in learning.

— The Web can provide access to a vast range of information: some which is absolutely current, expertly-generated and authoritative, and otherwise unavailable; other of which is hazardous, useless, out of date, wildly opinionated or wrong. Students must learn how to distinguish aspects of quality and the Web is a resource. Web research can, however, be very wasteful of time and energy and produce no learning at all.

— The communication functions present in online media have the potential to considerably enrich educational experience.

— Digital learning can make visual representations of knowledge (through static or moving images and animation) readily accessible. Through well-constructed simulations digital content can also provide an enhanced sense of place and/or circumstance and the range of variables which are in operation in

authentic situations. In that respect it *can* aid substantially in problematising and deepening the texture of learning. Online content can also provide access to processes which are otherwise unavailable to students in classrooms. This aspect of online content appears to provide the most potential for improving learning and understanding.

— Digital tools have revolutionised knowledge production. As other tools become more widespread and easy to learn and use they will become similarly embedded in learning processes.

• Learning through digital means has some specialised functional value. But the major value for educational purposes will be derived from the range and quality of opportunities for learning this medium provides.

Learning

The construction of public bodies of knowledge

A number of conclusions and relevant implications are drawn here from the section of the paper which uses incidents in the progressive development of the discipline of psychology, our understanding of minds and their workings, to describe more general features of the evolution of public knowledge. (See pp. 61-67.)

This material underlies the design principle: **The content must have integrity** (p. 97). It must be 'true', and true to its origins and relationships.

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• There *are* public bodies of knowledge which can and often need, for a wide variety of reasons, to be acquired by students. It is necessary to be both respectful of their depth, breadth and remarkable evolution and alert to their continued revision and growth.

• While knowledge, the content of learning, may always be provisional, subject to revision and influenced by context, knowledge in many areas evolves over time in terms of sophistication, depth of insight and reliability.

• The boundaries of areas of knowledge (or disciplines or key learning areas) tend to be somewhat arbitrary, and more so in some cases than others. However the process of grouping related ideas and methodological principles is useful to learners and especially less sophisticated learners.

• There is a strong and obvious match between the strategies used to advance public knowledge and many of those used by students to acquire personal knowledge in formal settings. These strategies include:

— establishing an understanding of the basic principles and internal topography of the field of knowledge and its relationships with other fields
— comparing, contrasting and connecting like and differing information and perspectives
— sorting, classifying and defining
— guessing and 'muddling along', pursuing and expanding insights
— learning how to apply principles to authentic situations
— hypothesising, testing, observing, concluding and sharing

— reviewing what other people engaged similar tasks are doing and learning from that process, and
— using technological tools to extend learning capabilities.

• Knowledge is embedded in and, to various degrees, shaped by its social context. It is often subject to misapprehension, distortion and caricature, and frequently has direct or applied political and social implications and consequences.

The chief implications for the development for online curriculum content are as follows.

• The development of online curriculum in terms of content and content areas is virtuous.

• Considerable effort should go into ensuring the reliability of that content.

• All the activities referred to in the second last point in the section above should feature in the formulation of learning activities contained in the online content.

• Attention should be paid in the materials to:
— placing the content into its social and historical context
— exploring evidence for its validity, drawing attention to and examining differing views and emphases, and
— where relevant, examining the social and political implications of the 'knowledge' itself from varying perspectives.

The construction of knowledge by individuals

A number of conclusions and relevant implications are drawn here from the section of the paper which outlines some key characteristics of the ways in which individuals learn. (See pp. 68-77.) These conclusions and implications respond to some fundamental questions and alternative propositions about how this process occurs.

This material underlies the design principle: **Objects should include learning tasks which require a range of types of intellectual processing. One or more of these should include products which have to be 'made up' by students.** (p. 99). The learning encouraged by the online material must be fertile, intellectually challenging and developmental. It also underlies the fifth condition for making the content usable **The materials must respect and reflect the actual cultural makeup of our country** (p. 96)**.**

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• The capacity to learn is embedded in human beings to the extent that it almost makes no sense to talk about a 'capacity'. Learning should be understood as an ongoing and constant process.

• Thinking is a physical process. The human brain and the rest of the body constitute a single indissociable organism. The organism interacts with, shapes and is shaped by the environment as an ensemble.

• All 'knowledge' input occurs through sensory processing, an extraordinarily complex neural process which does not reflect the way we consciously partition and describe the nature of experience.

• We have a working memory and a long term memory. The working memory, of which we are conscious, has a very limited capacity and is easily overloaded. The long term memory, of which we are largely unconscious, is the source of 'expert' performance generated by practice which can be, in a very crude distinction, automatic (eg walking) or rational (eg solving problems).

• The level of learner engagement with the 'task' (situation, event, etc.) coupled with the level of challenge it entails will generally relate to the pace of learning and the intensity of neural activity and processing.

• Behaviourist theories of learning do describe some of the ways in which we learn, but they are inadequate to the task of dealing with issues of agency and other causes and forms of development and growth.

• Cognitivist theories provide a more successful and complete account of learning. The view supported in the paper proposes a view of learning influenced in complex ways by a series of regulatory processes — genetic, genomic, epigenetic, cognitive and socio-cognitive — suggesting that genetic makeup, individual will and social and environmental factors all have important roles to play.

• From a genetic point of view the striking thing about all humans is the level of similarity in their makeup. From the point of view of individual development and function there is a substantial level of difference.

• There is no firm empirical evidence that a set of 'learning styles' or defined types of 'intelligence' exist. There is considerable evidence to suggest that there are patterns of behaviour and response which are common to all people, which are common to most people of particular broad cultural (including age) groups and which also vary in individual cases in unsystematic and often unpredictable ways.

The chief implications for the development for online curriculum content include the following.

• Quite literally, learning will occur only if connections are made with what is already 'known'. Materials need to provide 'scaffolding' (ie to show how previously acquired knowledge can be used to acquire new knowledge and skills) and to make appropriate connections with the cultural knowledge and experiences of the learner.

• Deep processing occurs through challenging and open-ended tasks. Behavourist learning activities do not provide these.

• The same knowledge and skills can be acquired in varying ways. This is one of the reasons why the development and use of the online content might contribute to more effective learning.

• Cognitive overload will produce limited or negative learning outcomes.

Learning at school

A number of conclusions and relevant implications are drawn here from the section of the paper which discusses the distinctive qualities of formal learning as it occurs at school. (See pp. 78-87.)

This material underlies the design principle: **The purpose and structure of the content must be readily apparent and model rational learning processes.** (p. 97). Online content should support the purposes and well-established practices of formal education. The former include the development of rationality and structured habits of mind.

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• The nature and purposes of schooling are socially-constructed artefacts. Simplification and selection of material to be learned on the basis of what is valued as 'good for young people' are two features of this construction.

• Formal learning differs from informal learning in many important ways. It is subject to a conscious process of design. It is intended to be purposeful and to achieve one or more defined purposes; it is structured to achieve this result; and it is intended, *inter alia*, to inculcate habits of rationality.

• Formal learning is subject to a range of theoretical positions. Of these 'Constructivism' is frequently linked at present to discussions of learning and online learning. Constructivism's implications in practice closely mirror current descriptions of good teaching practice.

• Through practice, a structure has evolved for the design of formal learning tasks. It is visible in Bloom's *Taxonomy of Educational Objectives*. Genuine alternatives are difficult to locate.

• This structure is logical — moving, broadly speaking, from more simple to more complex, easier to more difficult. It includes explanation and practice, application to new problems/contexts, the processing and generation of information, production of learning artefacts, review and revision. Thus the structure embodies various forms of intellectual processing. It resonates widely through the profession, although in practice the more complex elements of the structure are sometimes ignored.

The chief implications for the development for online curriculum content are as follows.

• Current descriptions of good (and conventional) teaching practice are an important reference point for designers of educational materials.

• Materials should be structured to support the development of rational processes in, for example, the visibility of the purpose, relationships and structure and the evident logic of those features.

• The range of types of learning activity referred to above (explanation and practice, application to new problems/contexts, the processing and generation of information, production of learning artefacts, review and revision) should be present in objects.

A Framework for Design

It should be noted that in an environment which is in such a formative state, where so much is to be learned and which is changing so rapidly, the proof of the quality of the materials will come largely from their use. In the end, *quality will only be assured through evaluation of whether nor not what is made is, firstly, taken up for use and, secondly, whether it actually does improve teaching practice and student learning*. However, it is recommended that …

Recommendations

1. The following framework be adopted to guide the development of online curriculum content.

2. Online content does not assume self-contained assessment processes. (See pp. 100-101.)

3. For the time being, online content should not be developed for use in the first two years of schooling, viz. Kindergarten/Reception/ Preparatory and Year 1.
(See pp. 114-116.)

THE FRAMEWORK
(This material is treated at greater length on pp. 89-109.)

1. General considerations about learning

It is taken as given that the primary purpose of online curriculum content should be to improve teaching practice and student learning. In which case the following considerations, drawn from the discussions of aspects of learning, must be respected during the development process and evident in the products.

Connection and engagement

- Related prior knowledge is the single most powerful influence in mediating subsequent learning. New knowledge becomes increasingly meaningful when integrated with existing knowledge. Knowledge is best integrated when unfamiliar concepts can be related to those which are familiar.
- Transfer improves when knowledge is situated in contexts which are intelligible (but not necessarily immediately familiar) to the learner.

Processing

- Learning improves as the amount of invested mental effort increases.
- Knowledge utility, the ability to apply new knowledge in varied and appropriate ways to new cases and in varied circumstances, improves as processing and understanding deepen. Processing and understanding also deepen as a result of those forms of learning experience.
- Feedback and various other forms of reinforcement increase the likelihood of effective learning.

Organisation

- Learning is influenced by the ways in which the concepts to be learned are organised.
- The organisation of what is to be learnt needs to take into account possible differences in learner familiarity with lesson content, the nature of the learning task, and assumptions about the structure of knowledge.
- Visual representations of lesson content and structure have the potential to improve the learner's understanding of the content and awareness of both the conceptual relationships and procedural requirements of a learning system.

System features

- Learning is facilitated when system features are functionally self-evident, logically organised, easily accessible and readily deployed.
- Learning improves as competition for similar cognitive resources decreases and declines as competition for the same resources increases.
- Shifts in attention improve the learning of related concepts. However, learners become confused and disoriented when procedures are complex, insufficient or inconsistent.
- Individuals vary widely in their learning processes. Learning systems are most efficient when they adapt readily to relevant individual differences.

2. Conditions which must be met

One theme proposed for the design for online curriculum content is that, in a number of ways: *It must be usable*. A set of conditions follow which must be met for successful take up of online curriculum content.

• Access to the materials through effective connectivity (also implying adequate hardware) must exist.

Lack of access, while still an issue, is one which must be declining given the massive scale of local investments in hardware and infrastructure. However, telling issues remain regarding levels of connectivity and the nature of access at any given site.

• Teachers must know how to use that connectivity.

Basic skill levels in using ICTs are well established in the teaching workforce but a 'second generation' of professional development related to the use of ICTs in the classroom is just beginning.

Using ICTs in the classroom is currently one of the three most common topics for teacher professional development activities. However it is suggested that one of the major difficulties encountered in this process is the absence of materials which seem comparatively familiar, easily accessible, 'teachable' and subject to teacher selection and organisation.

• The materials must reflect, and be responsive to, relevant current and ongoing conditions of teachers' work.

— The online curriculum content which is developed must reflect the requirements of the curricular descriptions and prescriptions which operate in various jurisdictions.

— The intensity of teachers' work and the nature of classroom interaction must be factored into considerations of what is to be made. The implications include the following.

— Online material must be ready when it is needed by teachers and, in technical terms, must work reliably. It must be simple and relatively quick to download; able to be selected and sequenced according to teachers' own requirements; and readily recognisable as teaching materials which can be incorporated immediately, with the appropriate degree of thought and planning, into teachers' work. (These are important justifications for the decision to adopt an object-based approach.)

— Management functions should be modelled on what teachers actually do in their administrative processes. (PRISM provides a very good example of this process.)

- **The materials must be created with the various needs of students with disabilities in mind.**

Digital media are malleable and can be adjusted for groups of learners with varying specific needs. It is desirable that this capability should be exploited in developing online curriculum content. It is also required legislatively. All developed materials should conform with the World Wide Web Consortium's Web Content Accessibility Guidelines.

- **The materials must respect and reflect the actual cultural makeup of our country.**

This is both a duty and a functional requirement for effective learning.

3. Essential principles of design

The first three of these principles are intended to be defining and fundamental aspects of quality. They must be met, and can be judged preliminary to any trialing. Their theme: *The content must be useful to teachers and students.*

- **The content must have integrity.**

The term 'integrity' encompasses

— *reliability*: the content should come as close as possible to reflecting the best of our current knowledge on any relevant issue. Contemporaneity should be a major concern and can be enhanced through links to other appropriate sites, but it should not be the over-riding concern. The fundamentals of the content should rest, where relevant, on well-established knowledge; and

— *thoroughness and balance*: the content should be distinguished by its
absence of bias and distortion and, where relevant, by the presentation of multiple perspectives relating to the same or similar issues.

- **The purpose and structure of the content must be readily apparent**

and model rational learning processes.

As well as providing a focus and reference point for design, clearly establishing the purpose for the learner is an important factor in motivation. It allows 'placement' ('Is this new, or like what we were doing before?'); it encourages connections with other related material which has been previously encountered; it can point directions to what is coming next; and it sets a target for students to aim at.

The structure of the learning process must also be made clear. Online material must foster and model rational and structured habits of thinking in its design and construction.

To this end, the products should always provide a map, readily accessible to the learner, which helps build understanding of context and item relationships; and navigation processes must be both simple and purposeful in terms of *what is to be learned*. (This relates to the need for design 'schemas', p. 106. See also discussion of the virtues of simplicity in design, p. 108)

• **Objects should include learning tasks which require a range of types of intellectual processing. One or more of these should include products which have to be 'made up' by students.**

The range of types of intellectual processing referred to include explanation and practice, application to new problems/contexts, the processing and generation of information, production of learning artefacts, review and revision.

The term 'made up', used here in the absence of a better alternative, means that students themselves are required to think, develop, construct and produce. The 'answer' is not directly available in the material they are looking at or working with.

The term 'products' is used in here to include designs, essays, plays, solved equations, musical compositions, theories, games, posters and any of the other student-created artefacts of learning. Some of these may be produced in digital form or through a digital medium; and many of them will not.

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The next three principles reflect both the uncertainty of our state of knowledge in this area and a necessary will to experiment.

The first two reflect an underlying need to make online content attractive and engaging for students: *to make online content interesting*. The third recognises the ongoing need for testing, refinement and acquiring additional knowledge about effectiveness.

- **Encourage creativity.**
- **Encourage diversity.**

Creativity is difficult to define. (Some of its relevant functional characteristics are suggested in the discussion of 'concept' p. 107.) It is also not something which can be mandated. But it can be encouraged through such simple measures as not working to a template, by using diverse sources of production, and simply by expecting, accommodating and approving diverse approaches, styles and signs of 'personality'.

It is wasteful not to have a centrally-organised production process. However over time in the course of the Online Curriculum Content Initiative, attention should be paid to ways of incorporating teacher-authored objects which satisfy the framework of design considerations outlined here to, inter alia, enhance the diversity and range of online content materials.

- **Regular testing and trialing must be a part of the development process and should occur, inter alia, through observation of classroom use.**

Features which must exist in online curriculum content can be defined, but it is still not possible to say with any certainty what will actually improve students' learning. There is a massive amount still to be learnt; and empirical contributions, testing in use, leading to modifications in practice, will be critical to that process.

It will be continuingly important to monitor and understand the level and type of takeup of the new online material as its components become available. But trialing and testing will also be a crucial part of the production process.

The major medium of trialing and testing should be the careful *observation* of student and teacher *classroom* use at a limited number of contextually-varied school sites.

4. Reference points for the design process

There is a very high level of agreement on many of the technical aspects of quality online design. In addition the following ideas regarding effective production procedures recurred consistently during consultations.

- **No team should make online curriculum content for use in schools which does not have one or more experienced and well-qualified educators in an authoritative role.**

The aggregation of the expertise and experience required to produce good quality digital educational materials in individuals is rare. Thus teams of people who can contribute one or more of the requisite skills — a deep knowledge of and (current or recent) immersion in school processes, highly developed capabilities in the design of learning materials and very high levels of technical skill in digital authoring — are required for effective design and production.

- **Construct the object in concept — schema — chunks**

The design of the content of online material should be configured around three components, termed here 'concept', 'schema' and 'chunks'.

A *concept* is something which is used, holistically or as an entry point to new learning, to generate interest and to frame the understanding of what is to be learnt. It provides insight into an area through the process of making connections with familiar experiences and giving an idea of shape, form and meaning.

The concepts and other aspects of the material must respect and reflect the actual cultural makeup of our country. This is both a duty and a functional requirement for effective learning.

Schema as used here means a rational structure with elements of hierarchical and/or other relationships. A schema should be, and readily display, a logical construction and ordering of knowledge. It should show how the parts relate to the whole and how subordinate purposes aggregate to serve overarching purposes. It should indicate what must be done for core understanding and where choices may be made.

Chunks are discrete portions of knowledge, the flesh attached to the skeleton of the schema. In this medium concision and thus clarity are of the utmost importance.

- **When in doubt, make it simpler.**

Cognitive overload, split attention and redundant information are problems which all education materials must avoid. The capacities provided by online multimedia provide considerable temptation to add features that are unnecessary, distract users and inhibit their effectiveness. Open or free navigation processes, in particular, appear to reduce educational effectiveness for all types of learners.

- **Make it modifiable.**

Digital material allows for the capacity to revise, develop and modify. This capacity accommodates the anticipation that objects made generally available should also be subject to regular review and, where required, progressive revision. This capacity should be exploited.