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New Roles for Education through the Internet

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1. Introduction

One of the paradoxes of human nature is that we frequently use new technologies to speed up old tasks rather than as tools to explore new possibilities. In education, for example, many see the Internet simply as a way of putting their traditional texts, lesson plans and courses on line. Others see it as a medium for children to share e-mail messages or to discuss each others' learning on-line.

This essay explores some of the new possibilities which are being developed as part of the author's System for Universal Media Searching (SUMS), a software for conceptual navigation on the Internet. General aspects of this system have been considered elsewhere. This paper outlines a vision, some aspects of which have been initiated on a local scale, other elements of which will require international co-operation. The first part of the paper explores how computers can provide a more systematic view of institutions, persons and peer review (who), curricula and equivalents, on-line reference sections and libraries (what). In our view, the challenge lies in integrating the needs of a particular course into a larger framework for learning where the end result is not defined a-priori, to make education truly an agency for open learning. The second part of the paper focusses on new methods for classing, searching, ordering materials on the Internet all of which are pre-requisites for systematic searching and meta-searching in order to make these resources more powerful tools for learning. To put it differently, part one explores the creation of new educational content, while part two focusses on new strategies for accessing that content.

2. Institutions, Persons and Peer Review

Lists of institutions and persons in education have traditionally been local. The world wide web has begun systematic lists of schools and other institutions (fig. 1). With respect to persons, a principal knows who are the best teachers and the lesser qualified teachers in their particular school. A schoolboard superintendent has some sense of exceptional teachers in their board. Needed is an on-line equivalent of a *Who's Who* for teachers, facilitators, consultants and other persons in education first on a local, then on a national and an international basis. This list will be correlated with both peer reviews not chosen by the person in question. It will include letters of recommendation from individuals chosen by the person themself, to serve as a safeguard for those whose qualities may not be appreciated by those in their immediate vicinity. In the SUMS framework such lists will come under the question *who*, while peer reviews are accessed via *Learning*, *Methods*, *Evaluate* and *Review* as outlined in Appendix 1.

http://www.csu.edu.au/education/resmenu.html
http://techfa.unige.ch/info-edu-comp.html
http://web66.coled.umn.edu/schools.html
www.ukshops.co.uk:8000/thedoor/subjects/Education/ghindex.html

Figure 1. List of some key international sites for education.

Each school will enter its own lists. The names of individuals in these lists will be forwarded to a centralized national list. Detailed information concerning the individuals in these lists will remain local. This detailed information will be confidential in principle and accessible only to the persons directly concerned, e.g. a principal, superintendent and supervisor. Others wishing to have detailed access must acquire permission from the principal plus the teacher in question. On the other hand the basic facts about any teacher such as their *curriculum vitae* would become public knowledge such that any parent wishing to be re-assured about the qualifications of their child's teacher could do so. This approach will apply equally to members of the school board and will thus provide basic community access to the educational structure.

In Canada, since education is a provincial matter, each provincial government will also enter the names of the individuals in their Ministry of Education as a part of the government on-line process. Connections between the Ministry of Education and school boards will be identified. This entails no threat to the provincial mandate for education but allows federal governments an integrating role for standards between different provinces and other countries, thus laying a framework for co-ordination with G7 pilot project 3 on education and training.

3. Curricula and Equivalents

Traditionally each province or state designed its own curriculum which was then interpreted by each local school board and in some cases by each local school. This arose partly of necessity. A curriculum tended to be a list of high-level goals such as “ability to analyse literary texts” or “transformation of three-dimensional space.” Precisely which literary texts or which mathematical problems were suited for these goals was left unanswered. Traditionally a Ministry of Education would generate the curriculum goals. Publishers working with designated teachers would then propose possible materials to cover these goals. The Ministry would vet these and some would be accepted as official textbooks approved for the curriculum.

In the case of the Metro Toronto Separate School Board (MTSSB), these abstract goals of the mathematics curriculum have been translated into corresponding lists of concrete mathematical problems. Such lists should be made public, giving school boards across the country a chance to provide additional, corresponding, concrete, mathematical problems. At the MTSSB, one of the mathematics teachers to (John MacDonald), has been given a year’s research leave to take this approach a step further, using this list of concrete mathematical problems and linking it with actual textbook examples.

This work can serve as a model for other school boards provincially and nationally, with those in other provinces adding links to their local textbooks. This should be made available on-line nationally. As a result a teacher or student in Ontario who is planning to move to British Columbia can check on the mathematical problems for their level and examine corresponding textbook examples in the new place. This approach will provide a new framework for establishing equivalents between education in different provinces and countries and help in the development of international standards such as those towards which the International Baccalaureate has been striving.

The above effectively contextualizes three levels of the learning process: the curriculum, courses and specific problems in individual texts. In the long term more is needed, namely, a full contextualization of knowledge which will in turn link all levels of learning as outlined below (fig. 2).

LEARNING CONTEXT

1. Corpus
2. Curriculum
3. Courses, Lesson Plans
4. Texts
5. Tests
6. Evaluations
7. Reviews

Figure 2. A list of seven levels which need to be co-related to provide a proper contextualization of the learning process.

Such a thoroughgoing contextualization is necessary in a highly mobile, multi-cultural environment, if teachers and school boards wish to have serious instruments for accountability. If this framework is made public it provides parents, students and teachers alike with a basis for explaining the links between exams, courses, curricula and the corpus of knowledge generally. This framework will provide a basis for assessing differences in education in other provinces and other countries.

A concrete example helps to explain this more clearly. On a given test or exam a student may receive a mark of 95%. This test may, however, represent only 10% of a given textbook and only 5% of the course to which that text belongs. The same test may represent only 1% of the actual curriculum pertaining to that subject and .001% of all knowledge in the field. Hence a student who receives 95% clearly needs to be given a sense of achievement: this mark is much better than a 75% or a 55%. Yet at the same time they need to be made aware of the relativity of their success, and recognize the enormity of that which still needs to be learned when one shifts focus from a particular test to the subject as a whole.

The system will begin by focussing on traditional lessons and courses in terms of individual learning. It will also encourage newsgroups, listserves and collaborative learning where appropriate.

4. On-Line Reference and Libraries

Traditionally each school had its own library and/or resource centre which provided students with some glimpse of materials beyond the boundaries of their everyday textbooks. It is an obvious next step to use the Internet for these purposes. The world wide web already has a Virtual Library site and the G7 has made its pilot project four a *Bibliotheca Universalis.*[1]

Libraries have a reference section consisting of classification systems, subject catalogues, dictionaries, encyclopaedias, bibliographies and abstracts, i.e. tools for finding other materials in this and other libraries. These correspond to the first five levels of knowledge in the SUMS approach. A priority should be to collect all Internet references to these reference materials and make them available on-line. Some of these materials such as the *Oxford English Dictionary* and the *Encyclopaedia Britannica* require subscriptions. These companies should be approached concerning board-, province-, or nation-wide site licenses for educational institutions. This will have the enormous advantage that students in a remote site will have access to the same educational resources that might be found in an affluent school in a major urban centre.

In keeping with the quest for contextualization outlined in the section above, a next step will be to make a list of all textbooks available on-line. Those not yet available should be put on-line. This will again ensure that persons in remote locations will have universal access to the same materials as persons in urban centres.

A next step will be to correlate the names and titles used in curricula, courses and textbooks with those in major libraries, galleries and museums. Hence, if Shakespeare is mentioned in an English course the system will automatically allow a user to check what copies of Shakespeare are available in the local, regional, national and eventually international libraries. Enterprising students can then explore to what extent the person or topic they are studying is a local phenomenon or international in scope. Such activities can begin as initiatives in given schools which are then co-ordinated by schoolboards, provincial ministries and national organizations such as Schoolnet in Canada.

Given the emerging Z39.50 protocols[2], aspects of such searches can increasingly be automated. Indeed some will argue that all of these exercises should be automated entirely and that knowbots acting as electronic butlers should replace entirely the students' and teachers' manual searching. In our view this is philosophically dangerous in that learning to search is a vitally important active exercise, which should not be replaced fully by a passive experience.

5. New Knowledge

Simply having access to the combined resources of libraries throughout the world will constitute one form of new knowledge in that it greatly increases the sample on which claims are based. Someone wishing to study Shakespeare will have access not only to titles in the local library but will be able to trace the spread of editions in different languages around the world. A student interested in a particular mathematical problem will potentially have access to examples from all over the world.

The integration of spreadsheet packages (such as Excel) with databases means that statistical views of data in various forms of charts will become increasingly easy in future. Such graphical visualizations of facts will help users to see new patterns.

The rapid development of Geographical Information Systems (GIS), combined with the evolution of Computer Aided Design (CAD) packages means that students will have access to dynamic maps such that they can trace historical changes in the boundaries of an empire, a country as well as a province, county, a town or an estate. They can connect these geographical sites with images of churches, historical buildings, and monuments, any of which can be reconstructed at various levels of complexity. These maps can be treated chronologically such that one can trace the development of Romanesque or Gothic churches as they spread across Europe. Or one will be able to trace the spread of a given motif or theme.

Companies such as Autodesk have extended the notion of object-oriented programming to the building blocks of the man-made world through what they term industry foundation classes. A door is now treated as a dynamic object which contains all the information pertaining to doors in different contexts. Hence if one chooses a door for a fifty storey skyscraper, the door object will automatically acquire certain characteristics which are very different from a door for a cottage or for a factory warehouse. This concept can readily be applied to local cultures both at present and historically, thus adding an enormous richness to our awareness of doors, such that the variety of the particular becomes an incentive for global variation.

In the past, knowledge was primarily about physical events and objects. When was the battle of Hastings? Where are the manuscripts of Euclid's *Optics*? What is written in Act 2, Scene III of Shakespeare's *Hamlet*? Such questions were also the focus of education. The advent of computers is increasing the definitions of what we know and thereby the horizons of education. As noted above we can now trace the development of a style geographically and chronologically, in space and time. We can trace the spread of religious movements such as Christianity and Islam. With statistics, knowledge becomes patterns as well as facts, tracing for example not only the publication of a given text, but the history of its publication in different cities and different languages.

In the past what if questions were vigourously opposed by most historians and scholars in general. This was in no small part because our tools for reconstruction and simulation were so limited that they precluded any serious models for imitating reality. The advent of advanced graphics packages, virtual reality, auto-stereoscopic displays and increasingly holography is changing all this. Those at the frontiers of the Italian National Research Council are exploring how fully realistic virtual reality models of ancient Pompeii could be used to test different theories concerning the economics of the time. Simulating storms is becoming a serious pre-occupation for scientists. Knowledge is not only about what is and was: knowledge extends to what could be and could have been. Knowing how to define a serious or a useful simulation will increasingly become one of the challenges of education.

6. International Developments

As a first step towards understanding these changes countries have begun making inventories and lists of available educational materials. In Canada, for example, Schoolnet is providing a national framework for access to educational sites. Other countries are developing their own versions of Schoolnet. With respect to the G7 countries, some of the key sites are listed below (fig. 3).

Britain	www.yahoo.com/Regional/Countries/United_Kingdom/Education /Elementary_Schools /High_Schools
Canada	www.schoolnet.com
France	www.edutel.fr www.worldwide.edu/ci/france/index.html
Germany	www.classroom.net/classweb/german_schools.html www.stran_ni.ac.uk/ed-structs/germ-struct.html
Italy	www.nettuno.it/demonapoli www.itdf.pa.cnr.it
Japan	www.csj.co.jp/R/vu/eng/jpnumi.html
U.S.	www.yahoo.com/Regional/Countries/United_States/Education /Elementary_Schools /Middle_Schools /High_Schools

Figure 3. List of G7 Countries and some of their chief educational sites.

In some cases, such as France, this is proceeding in a centralized manner at a national level. In other cases, such as Italy, there is a regional approach, with some regions much more advanced than others. Each region tends to have their own interface. Ideally a standard interface such as that provided by SUMS might be translated into the major languages and serve as a common interface for all these countries. More is needed than a common interface. We need new approaches to classing, ordering, searching and learning.

7. Classing

Most of the early search engines saw no need for classing objects. The assumption was that one merely typed in a random subject and found whatever happens to exist on the net concerning that subject. Once one found something of interest one could then make a bookmark. Per se this was a sensible strategy, except that, once one had a few hundred bookmarks, one tended to get lost.

Another solution is to shift attention from the results to the criteria for finding results, i.e. to create a list of terms in which one is particularly interested such that one has at the outset a set of cubbyholes to arrange the titles that one finds. These lists can be arranged both alphabetically (as a flat file) and hierarchically (as a tree file) which amounts to creating one's personal classification system.

In more complex cases, another solution is to use the fields in one's database as the basic set of terms with which to search the Internet. These then become a set of hooks for catching titles. A fourth alternative is to consult a subject list produced by librarians as a means of acquiring a set of terms one wishes to use in searches.

Librarians, who are experts in dealing with large amounts of information, have long recognized the need for classing in the sense of creating classification systems. At a very practical level classification schemes help determine where books appear on shelves. By consulting the classification number of a given book, we immediately have a bibliography of other books on that subject in this library. This classification number can then be applied to a series of libraries either randomly or networked in a system such as the Research Libraries Group (RLG) and the On-Line Computer Company (OCLC).

By consulting the terms clustered around this particular classification number, we have a bibliography of related books in the field. In a traditional library this process is termed browsing, that subtle art whereby we often discover that the book which truly interests us is lying on the shelf just a few books from the title with which we originally began. The advent of the Z39.50 protocol and networked library catalogues on the Internet means that we can now do electronic browsing: choose a topic with a given classification number and then study the titles pertaining to it. This is possible today in cases such as the National Library Catalogue of Norway which includes classification numbers as one of its search parameters. Libraries such as Göttingen have put their old and new systematic classifications on-line but have not yet linked these to their corresponding titles in the on-line version.

Electronic browsing allows other possibilities. A particular subject has its given number in one classification system. It will have different numbers in other classification schemes. Each classification scheme is like a method for creating mental cubbyholes.

These differ from culture to culture. So multiple classification schemes are ways into the mental cubbyholes of different cultures and in the case of a particular subject, they reveal the different contexts or constellations within which this book can be placed. Thus one subject leads to a series of related subjects.

Taken together these six approaches represent a spectrum of strategies from a completely random search to one using multiple classification systems (fig.4).

1) random search
2) personal classification
3) personal lists based on database fields
4) standard subjects
5) standard classification system
6) multiple classification systems

Figure 4. Six strategies for access to knowledge.

This spectrum is best seen as a set of complementary rather than competing strategies. In some cases a random search may be sufficient. In other cases, one may wish progressively to move from a personal classification to a combination of multiple formal classification systems. For this to be effective it is important to have a set of authority files such that the terms used in a personal system are effectively a subset of those used in major library classification systems such as Library of Congress and Dewey.

It is also essential that the items for which one is searching have been carefully classed ahead of time. In the case of libraries this is almost always true[3]. In the case of the Internet the converse is true. Almost everything has not yet been classed. It is true that Yahoo has created lists

In order that material can be searched it must be classed or tagged. This applies particularly to the addresses of materials on the Internet. A series of steps are required. Step one, which was the focus of a recent Schoolnet contract, identified some of the basic addresses using an object-oriented approach to classing. Step two will class all the main addresses for the Canadian context, using a template based software and put these titles on-line. Step three will license the software to schools across the country such that students and teachers can further class materials which they find within these general headings. Many of these references, once they have been checked by the teachers, can be added by students to the national database. In this way the educational system will become a co-operative process in building up its own cumulative list of references. This approach is extendible to all levels of education and training. Thus students training to become radio engineers will have as their assignments to find, class and add materials to the national database on radio-engineering.

At the higher levels of education students have always been doing something approximating this every time they created footnotes and bibliographies for their essays and term papers, the fundamental difference being that these efforts were inevitably non-cumulative. Now, every time a student finds a new reference they can add it to a cumulative list. This principle applies not only to Internet addresses but also to content. As the contents of major libraries become available on-line, the importance of this approach will become ever more fundamental. By building the classing process into the process of learning, students will contribute to the organization of new knowledge.

Of these the first two will be organized in schools. Such classing retains certain ambiguities. For instance, in a system such as the Library of Congress perspective occurs under architecture, art, mathematics and technology. In a simplified classification it is likely to occur only once, thus giving users titles concerning all of these meanings although one may well be interested in only one of them. If the terms developed in classing methods one and two are linked with the categories in classing methods three to five, produced by libraries and major institutions, much greater precision in search strategies can be attained. The challenge lies in linking these systematically. This should be done in conjunction with a research centre such as FIS.

8. Searching and Meta-Searching

Once the basic materials concerning the school system have been entered, the scope of the enterprise can be expanded to include a complete corpus of knowledge that can be accessed by searches and meta-searches. Existing search engines typically assume that a simple alphabetical search of all materials is sufficient. This results in too many hits most items of which are of no interest to the user. Some of the most popular lists of search engines are provided in figure 5. An analysis of their relative merits and the specific role of the SUMS engine has been made by Andrew McCutcheon.

International	www.chemie.fu.berlin.de/outerspace/meta-index.html
	www.unisa.edu.au/library/internet/engine.htm
France	www.ac_toulouse.fr/svt/2www.html.
Germany	www.uni_hamburg.de/World/Search/search_homepage.html
Japan	www.kanzaki.com/jinfo/jlink.html

Figure 5. List of some key international sites for search engines.

The user may be an elementary school teacher, a high school OAC level teacher, a university professor or a post-doctoral research scholar. All four may ask for mathematics, but they want something very different. For such a search engine to function, it is important to identify the level of education of the site in question. In this way, when the user identifies the level of education which interests them they will receive only the titles and materials pertinent for that level. The search engine must be distributed, it must use multiple protocols. It is not a simple hierarchy, but uses a multiple approach via meters. It assumes non-linear, multiple cataloging in order to provide an interface standard which is public. It must be HTML compliant, and work towards SGML, use the Z39.50 protocol and rely on SQL for its query interfaces. These protocols will change as software and hardware evolve.

Basic searching will entail only personal classification systems listed in figure 4. Meta-searching will entail standard subject lists and classification systems in isolation and in combination. Meta-searching will use these established systems to go from broader term to narrower terms and conversely. It will use the broader terms of universal systems such as Dewey (cf. http://www.oclc.org/oclc/fp/mrdui/mrdui.htm) or Library of Congress (cf. http://www.w3.org/vl/LibraryOfCongress.html), find the corresponding term in specialized bibliographies relating to a given field, e.g. the Mathematics Subject Classification of the American Mathematical Association. Such an approach will permit advanced browsing and triangulation of concepts. Meta-searching will also entail specific strategies for specialized fields. For instance, botany will involve classifications in the tradition of Linnaeus with different phyla, types of genus, speices etc, whereas chemistry will have periodic tables as entry points for searches.

Metadata entails a rapidly evolving field. A recent conference on the subject offers an important survey of some of the major players.[4] Their related site[5] offers a useful list of other projects in the U.S. Some of the key players are given below (Fig. 6). Such efforts are part of a much larger move towards international standards which are beyond the scope of this paper, but which include a whole spectrum of organizations form the International Standards Organization and national standards bodies to consortia, major companies and purely proprietary standards.

A. International		
International Standards Association	(ISO)	
B. Multi-National		
AEGIS for G7[6]		
C. National		
ARPA Knowledge Sharing Effort	(ARPA)	
Knowledge Query Manipulation Language		
Knowledge Interchange Format		
Biological Metadata		
Metadata Council		
Metadata Coalition		
World Wide Web (W3) Consortium		
American National Standards Institute	(ANSI)	X3L8
		X12
D. International Electrical Engineers	(IEEE)	
Scientific Metadata		
E. Major Companies		
Xerox		
Metaobject Protocols		

Figure 6. Some of the major organizations concerned with metadata and standardization.

9. Ordering

In addition to classing and searching for materials, a tool is needed for ordering what one has found. The same lists of choices used in SUMS for searching for new materials can be used to organize the materials one has found. In the ordering mode the choices lead to lists of what one has found on a given topic. Such an approach marks a quantum advance over the present use of bookmarks on the Internet. Bookmarks simply list everything one has found helter-skelter in a list, which soon becomes confusing if one is collecting a large number of references. The SUMS approach links these with basic topics and then with one's personal classification scheme such that one can readily find them again.

10. Learning

In the SUMS approach, each of the categories used for classing, searching and ordering knowledge can serve for learning. A student defines their level of education, decides on the topic that interests them and the system indicates what courses are available, locally, regionally, nationally and eventually internationally.

This approach may seem much more plodding than the present trend to give persons access to everything at once on the Internet, but it brings the enormous advantage of a framework for providing students and teachers with the materials appropriate to their level of education, while leaving entirely open to them the possibility of going to the next level if they are convinced that they have achieved everything at their present level. Because each level will be linked with specific tests, reviews and evaluations, students will have opportunities of establishing objectively what is involved at a given level of education and will not be able to blame their own performance or lack thereof on the standards of a given teacher. To achieve this will require help in co-ordinating the four requirements outlined above.

11. Conclusions

Education and training are crucial for all nations. A systematic, multi-functional software for classing, searching, ordering and learning will offer a common interface to disparately organized materials and offer new means of establishing common standards both nationally and internationally. This has major implications for the dissemination of educational materials across large geographical expanses in individual countries such as Canada and around the world. It will offer new points of entry into global information structures. SUMS offers a model for such an interface.

APPENDIX 1

The System for Universal Media Searching (SUMS, Copyright 1992-1996) approaches knowledge in terms of the questions *who, what, where, when, how, why* in combination with ten basic choices (fig. 1):

1. Access
2. Learning
3. Levels
4. Media
5. Quality
6. Quantity
7. Questions
8. Space
9. Time
10. Tools.

Figure 1. A list of ten basic choices used in SUMS.

These basic choices break down into hundreds of lists thus giving thousands of choices in combination with the questions. One of the rationales for these handy lists of choices was that they can be ported to a remote device. It is instructive to note that such an idea is being adopted by Schoolnet in its Media Awareness Project where there is a virtual site controller (http://www.screen.com/mnet/eng/). It is equally instructive to note that the basic questions in SUMS have their equivalents in the quickfind section of that same project: e.g. What (Topic, Keywords), Where (Country), How (Medium) as well as in various meters such Level of Education (Target, cf. http://199.126.5.105/qf_quickfind.db). This appendix provides a breakdown of only one of the ten basic choices, namely learning.

2. LEARNING

Learning is closely connected with formal education but is a more fundamental concept because it includes informal learning as well. It includes five basic elements:

LEARNING

1. Contexts
2. Goals
3. Methods
4. Kinds of Learner
5. Types of learning

LEARNING 1. CONTEXTS

When a student writes an exam they may obtain a mark of 95%. Yet this may represent only 40% of the text, 10% of the course, 2% of the curriculum and .002% of the corpus of knowledge in any field. One of the challenges of learning is to contextualize the achievements of students (and teachers) allowing them to understand these links in such a way that they are not discouraged. in concrete terms this requires a systematic linking of facts and modules in each level of the system as listed below:

LEARNING CONTEXT

1. Corpus
2. Curriculum
3. Courses
4. Texts
5. Tests
6. Evaluations
7. Reviews

LEARNING 2. GOALS

Goals list all the benchmarks, curriculum documents and equivalents in other provinces and other countries:

GOALS

1. Benchmarks
2. Curriculum
3. Equivalents

Curriculum entails the standard items one wishes to achieve in a given course. It includes information about standards, outcomes, leaning tasks, assessment samples, planners and resources.

CURRICULUM

1. Common Document
2. Standards
3. Outcomes
4. Learning Tasks
5. Assessment Samples
6. Planner
7. Resources

Curriculum outcomes can in turn be divided into essential and specific:

CURRICULUM OUTCOMES

1. Essential
2. Specific

LEARNING 3. METHODS

Learning methods include all the formal methods of learning:

LEARNING METHODS

1. Course
2. Collaborate
3. Demo
4. Simulate
5. Train
6. Test
7. Evaluate
8. Review
9. Tracking
10. Reports

Different kinds of courses are identified:

COURSES

1. Curriculum Course
2. Just In Time Learning
3. Lifelong Learning
4. Professional Development
5. Skills

At the university level a course will have a series of choices:

COURSE

1. Administration
2. Description
3. Lectures
4. Readings
5. Further Readings
6. Internet
7. Other Media (Films)

Courses are but one way of learning. A second method is collaborative learning, which leads to a series of further options. Very much needed are methods that will help us assess which kind of learning is more effective using collaboration and which kind of learning is better pursued on an individual basis.

LEARNING COLLABORATIVE

1. Encounter
2. Meeting
3. Comments
4. Thoughts
5. Reflections
6. References

Simulation and Training are other methods of learning applicable in some cases. Once the student has learned then they are tested in various ways:

TEST

1. Essay
2. Multiple Choice
3. Problem Solving

PROBLEM SOLVING

1. Correct Conceptions
2. Parallel Conceptions
3. Misconceptions
4. Incorrect Solutions
5. Irrelevant Responses
6. Not Understand the Question

As part of the greater move towards accountability, these learning methods include four stages for checking progress: evaluation, review, tracking and reports. Evaluation breaks down into at least three choices:

EVALUATE

1. People
2. Process
3. Product

Of these the first breaks down into at least another five categories:

EVALUATE PEOPLE

1. Directors
2. Supervisors
3. Principals
4. Teachers
5. Students

Access to this information will be limited to the appropriate level in each case. The same approach applies to reviews:

REVIEW

1. Teacher
2. Peer Review
3. Student

It also applies to reports.

REPORTS
1. Interim Reports
2. Report Cards

These interim and final reports will apply to the whole spectrum of the system:

REPORTS TO

1. Directors
2. Supervisors
3. Principals
4. Teachers
5. Students
6. Parents

These reports will be in the form of grades:

GRADE

1. Percent
2. Number
3. Letter
4. Word
5. Equivalents

LEARNING 4. KINDS OF LEARNER

At the level of theory a great deal of effort has been dedicated to identifying kinds of learning. Four basic kinds are generally agreed upon:

KINDS OF LEARNER

1. Cognitive
2. Affective
3. Perceptual
4. Psychomotor

Precisely what these mean and how these subdivide is a matter of debate. For example, the Ontario guidelines divide cognitive in one way, while theorists such as Bouchard do so differently:

COGNITIVE (Ontario)

1. Focus
2. Organize
3. Locate
4. Record
5. Assess/Evaluate
6. Synthesize and Conclude
7. Apply

8. Communicate

COGNITIVE (Bouchard)

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

SUMS is not concerned with taking sides or pretending to know which of these alternatives is best. If the province of Ontario uses one alternative and wishes to use that exclusively then the SUMS framework allows this. In time, an international version of SUMS will present users with a list of various versions such that scholars, educators and students can explore the ways in which they relate and the extent to which they are equivalent. This same principle applies to the other three kinds of learning:

AFFECTIVE

1. Receiving, Responding
2. Valueing
3. Organization
4. Characterization

PERCEPTUAL

1. Sensation
2. Figure Perceptual
3. Symbol Perception
4. Perception of Meaning
5. Perceptual Performance

PSYCHOMOTOR

1. Perception
2. Imitation
3. Manipulation
4. Precision
5. Articulation
6. Naturalization

At a future date these features of kinds of learning will be related directly back to the curriculum, courses, texts, exams etc. such that there is a greater contextualization of knowledge. It will then be possible for a teacher or student to start from some learning skill such as focus or perceptual performance, determine what things in the curriculum and the course are directed to those goals and see precisely which courses, texts, tests exist for those skills. Alternatively, a student or teacher could begin with some item in their course of study and trace back what skills this item or set of exercises is meant to develop, i.e. the reasons why it is being learned.

LEARNING 5. KINDS OF LEARNING

At present most schools give students some basic psychological tests the results of which are usually only consulted if the student become a so-called problem child, in which case the school psychologist uses the results in trying to help the child. There are various kinds of learner.

TYPES OF LEARNER

1. Basic
2. Myer-Briggs (Jung)
3. Sternberg

Each of these breaks down into further categories:

BASIC

1. Abstract
2. Sequential
3. Concrete
4. Random

In addition to the basic tests there are the others such as those of Jung which are the basis of the Myer-Briggs tests:

MYER-BRIGGS

1. Extraversion E
2. Sensing S
3. Thinking T
4. Judgment J
5. Introversion I
6. Intuition N
7. Feeling F
8. Perception P

These two sets of four combine to produce 16 categories which are not listed here. Other systems include the seven kinds of intelligence identified by Sternberg.

STERNBERG CATEGORIES

1. Anthropological
2. Biological

3. Computational
4. Epistemological
5. Geographic
6. Sociological
7. Systems

These too will become part of the system. In future there will be links between these categories and the different goals and contents of curricula such that these psychological types serve as filters of access to information. These filters can function in different ways. A person with, say a geographic intelligence, will be presented geographical materials as best suited to them. They will also be given a particular approach to materials entailing other kinds of intelligence. The precise details of this content are not the concern of SUMS, which focusses on a systematic framework for gaining access to the results.

Much of scholarship is about making links. Each new medium allows some of those links to be made more easily. At the same time each new medium poses the challenge of creating many new links which were previously impossible. Hence the advent of computers means there will be whole generations working to create systematic connections. SUMS offers a comprehensive framework for dealing with the results.

Some will object that all this is much too complex for the everyday needs of schools and that a much simpler approach would do fine. Here it bears remembering that there is a basic and intermediate level in addition to the complexities of advanced navigation just outlined. A simpler approach is given in the examples below.

EDUCATION

At a basic level a person begins from the list of SCOPE WHY (see p. 139 above) and chooses Education, Learning. They would then be led through the basic questions of why, how, when, where, what, who ?

EDUCATION WHY

GOALS

1. Individual
2. Class
3. School
4. Board
5. Province, State
6. National
7. International

If the user chooses 5 the list looks as follows:

EDUCATION WHY

GOALS PROVINCE

1. Common Curriculum
2. Benchmarks
3. Guidelines

The user is then asked to define how:

EDUCATION HOW

1. Alternative
2. Professional Development
3. Regular
4. Sources

If they choose 3, the following choices appear:

EDUCATION HOW

REGULAR

1. Methods
2. Kinds of Learner
3. Types of Learning

They are now asked to define what:

EDUCATION WHAT

1. Activities, Learning Tasks
2. Contexts
3. Courses
4. Equivalents
5. Instructions
6. Outcomes
7. Resources
8. Subjects
9. Themes

Sometimes the user wants to ask something directly. Having stated that the scope of their search is education they then press When Events at which time the system offers them a list of education related events:

EDUCATION WHEN

EVENTS

1. Conferences
2. Events

3. Exhibitions
4. Meetings
5. Plays

Having chosen one of these alternatives the user is given the appropriate information. Alternatively they may be concerned with finding information about individual persons. Hence they press Who and are given an appropriate list of categories:

EDUCATION WHO

1. Administration
2. Persons Studied
3. Students
4. Teachers

The first of these leads to a series of new choices:

EDUCATION WHO

ADMINISTRATION

1. Administrators
2. Contacts
3. Institutions
4. Organizations
5. Staff

The second of these in the previous list leads to a series of new choices:

EDUCATION WHO

PERSONS STUDIED

1. Artists
2. Explorers
3. Mathematicians
4. Poets
5. Scientists
6. Writers

The third of these leads to a series of new choices:

EDUCATION WHO

STUDENTS

1. Students
2. Peers

The fourth of these in the previous list leads to:

EDUCATION WHO

TEACHERS

1. Teachers
2. Experts
3. Facilitators
4. Innovators
5. Mentors

Some aspects of Learning also come under the scope of other basic choices. For instance, if one is interested in publications one goes to LEVELS Titles Books, which category then adjusts to one's educational scope and the level at which one is studying. An advanced list might, for instance, look as follows:

BOOKS

1. Books
2. Catalogues
3. Journals
4. Directives
5. Magazines
6. Manuals
7. Texts
8. Reports

If one chooses catalogues the results will adjust for the area in question. For example, if one is in Toronto and chooses regional catalogues then the list will be something akin to the following:

CATALOGUES

1. CCC
2. CESS
3. Curriculine
4. OCRMC
5. Smart Shop
6. TéLéPEC

Other materials pertinent to education and learning are to be found under MEDIA Internet WWW. In a national context in Canada, that list might include the following:

INTERNET WWW

1. ERIC
2. MET

3. OISE
4. Schoolnet

Under the heading MEDIA Television one will find other choices:

TELEVISION
1. Cable
2. PDTV
3. TFO
4. TVO

This approach presents the user with the relevant information based on their needs defined by the series of questions why, how etc. rather than simply trying to find all information on a given topic.

Appendix 2. Andrew McCutcheon, **Existing Search Engines and the Contribution of SUMS**

Introduction

SUMS began as a project at the University of Toronto developing conceptual navigation techniques. The most recent product has been the SUMS World Wide Web search engine. Traditional search engines are faced with a variety of problems. By combining the best elements of catalogues and indexing systems with the concepts of object oriented databases, SUMS hopes to eliminate these problems. The goal of SUMS is to create a search engine that uses a human approach to find information.

Catalogues

A catalogue consists of hierarchical categories into which documents are classified. Catalogue systems like *Yahoo!, Lycos A2Z,* and *The Whole Internet Catalog* narrow searches very quickly, and while most of the documents found are on topic, such catalogues are not without problems. *Yahoo!* employs twenty people to search for new documents, and then categorize them. These employees are not experts on all of the information they catalogue, and documents are sometimes placed in the wrong category. As the Internet continues to evolve, a wide variety of information will be available. The categories contained in the catalogue will have to be changed, and documents will have to be shuffled around. To add to the amount of maintenance a catalogue requires, web content is increasing almost exponentially. Eventually, twenty employees will be unable to keep up with the rate of content creation and more employees will have to be hired. When more employees are hired, the catalogue becomes less consistent, as each employee has a slightly different idea of where a document should be placed. In addition to dealing with new documents, catalogues must also deal with changed documents. Documents are constantly moving, and their contents are changing. Unless the catalogue is notified, these changes can go without being noticed. While a catalogue is a good interim solution, as the amount of content on the Web grows, a catalogue will fall short of being able to encompass the entire Web.

Indexing Systems

Indexing systems like *Inktomi, HotBot, Lycos, The OpenText Index, Webcrawler, Infoseek,* and *WWW Worm* store the addresses of World Wide Web documents, and a list of keywords that appear in those documents. The keywords are retrieved by programs that roam the web, jumping from site to site. When a keyword is searched for, a list of documents that contain that keyword is returned. Because no human work is required in the actual storing of the documents, an index doesn't have to deal with many of the problems faced by a catalogue. Growth is not a problem because an index only needs to purchase faster computers with more storage space to keep up. An index is also bias free, because an index works purely with facts - either a document contains a keyword or it does not. Despite these advantages, indexing systems tend to return many off-topic documents, because they blindly search for keywords. A keyword taken out of context could have several meanings on different documents. An indexing system tends to get out of date very quickly, referencing documents that no longer exist, or no longer contain the same information that they did when the document was added to the index. This is especially true when World Wide Web content grows and bandwidth does not grow with it, because the programs that build the index take more time to complete the job. In an attempt to make an index context sensitive, a technique called word proximity is used, where keywords are stored in the order that they appear on the document. The index is then storing almost exact copies other people's documents, which could lead to copyright problems.

Hybrid Systems

Hybrid systems such as *Excite* and *AltaVista* that combine the best elements of a catalogue and an index would theoretically solve the problems of both. Documents are stored in an index with similar documents being stored together. The goal is to create a kind of classification system that modifies itself as the type of content on the web changes. A group of keywords entered to the search is supposed to represent a concept, and groups of documents that match that concept are returned. *AltaVista* make assertions about documents based on the images used in them, their address, and links that they contain, and then catalogues them appropriately. In practice, these systems fall short of their lofty goals. The power of a catalogue is to allow people to narrow a search by walking through a tree of named categories. The idea of building a list of documents grouped by concept is less impressive than it seems because the concepts are not visible. The search engine is guessing at the concept that the user is trying to search for. The users cannot specify exactly what they are looking for in the same way they could if they were using a catalogue. Such a system still faces the problem of out of date documents, because they also use programs to compile their index. Irrelevant information is less of a problem in a hybrid system than in an index, but it remains a challenge.

The SUMS Solution

SUMS combines the best elements of a catalogue, an index, and an object-oriented database. Instead of entering keywords, a user performs *object* searches. An object is a group of data that represents a search concept more accurately than a keyword. In addition to containing data, objects are created and stored in *parent* / *child* relationships. An easy way to visualize this is to use a hierarchical list:

- Life
    - Plant
        - Bush
        - Tree
    - Animal
        - Fish
        - Dog

Each item in the hierarchical list is a child of the non-indented item directly above it. "Fish" and "Dog" are children of "Animal" which is in turn a child of "Life". "Bush" and "Tree" are children of "Plant" which is also a child of "Life".

Recall that objects are groups of data. The data associated with an object is called its *properties.* Children inherit the properties of their parents. Here are some sample properties for the objects defined in the above example.

Object Name	Properties

Life	Name
Plant	Name, Climate Preference
Bush	Name, Climate Preference
Tree	Name, Climate Preference, Type of Tree
Animal	Name, Food Preference
Fish	Name, Food Preference, Spawning Time
Dog	Name, Food Preference, Breed

Objects become increasingly specific as they reach a deeper level in the list. This property of the object list allows a user quickly to make a search very specific. Note that an object's properties do not necessarily become more specific. The "Bush" object has no different properties than its parent object, "Plant". It is in the list to be used as a category to differentiate between types of plants, and to narrow the scope of searches.

The SUMS object list is a hierarchical list of objects. To search for information using the SUMS search engine these steps are followed:

1. An object is selected. This immediately narrows the scope of the search to the level of that object: only objects of that type, and any children of that object will be searched.

   Example - If the object being searched for was a "Plant" object, only "Plant", "Tree" and "Bush" objects would be searched :

- Life
  - Plant
    - Bush
    - Tree
  - Animal
    - Fish
    - Dog

Values for the properties of that object are filled in. Documents that contain objects of that type with properties matching the values entered are returned.

The object list uses the broader / narrower terms property of a catalogue through the parent / child relationship system, but the object list has several advantages over a standard catalogue:

- The object list is *distributed.* What this means is that the classification of the documents resides on the content providers server. Each content provider maintains their own catalogue of documents. When the documents are created or updated, the content provider is responsible for updating their object catalogue. No programs or individuals are responsible for maintaining a catalogue of the entire Web. Using the SUMS search engine, content providers have full control over how their information is catalogued. This prevents out of date information from being found as well as insuring that all information is correctly classified. When a search is made, it is propagated throughout all content providers who have installed the SUMS software, instead of searching a single site.

- The object list is *flexible*. The parent / child relationship property of objects makes it very easy to modify the list. If a content provider should find the existing objects inadequate to catalogue their information, they can extend the object list as necessary. SUMS would give the content provider a base object somewhere in the object list, and all of that content providers objects would be children of it. Any objects that are created by content providers are their property, and reside entirely on their server.
- The object list can be modified to contain *aliases*. Standard catalogues provide one classification system. Many hierarchical classification systems exist. No two hierarchies are identical. Part of the subjectivity of catalogues stems from the fact that they only provide one classification system. An object list can easily be re-ordered to form a new hierarchy. The object list could be viewed as a Library of Congress hierarchy, a Dewey hierarchy, or even a custom hierarchy created by the user.

Because content providers catalogue their own information, and aliases allow multiple classification systems to be used, SUMS is almost as objective as an index while being more functional :

- By selecting an object type to search for, the quantity of data that must be searched has been considerably reduced; an indexing system must search all of the documents it contains while SUMS only needs to search the documents that fall into the subset that contain the object and its children.
- Unlike an indexing system, SUMS knows the context in which a search is performed because the object a user searches for is a node in a hierarchical list. SUMS understands that photographic film and the most recent Batman film are two different objects.
- Because SUMS does not mirror documents, SUMS avoids the copyright problems with which indexing systems are faced.
- Content providers are responsible for maintaining a catalogue of their objects on their server. Consequently, expansion is not a problem for SUMS - the computational power required to perform a search is provided by the servers that are being searched, not a central server.

By working hand in hand with content providers instead of assimilating their data, SUMS effectively solves the problems faced by indexing systems and catalogues.

Progress Report

In the last month, several features have been added:

- The object list has been expanded to make it more useable.
- Administrative tools have been added to automate the deletion and modification of records, and the modification of the object list.
- A “zoom” feature has been added to allow a user to view an object in its context.
- Multi-lingual support has been re-written to be modular. Adding a new language is even easier than it was before.

- A configuration file has been created, much like the preferences file supplied with Netscape navigator.

Plans for the Future

SUMS plans to take the following steps in the next 8 months:

Advanced object list manipulation tools will be developed to allow remote content providers easy object creation and painless content cataloguing.

A powerful database system will be written or adopted to allow fast searches to be performed by many users at once.

A query propagation protocol will be written to allow queries to travel to other servers.

As many content providers as possible covering as diverse a spectrum of topics as possible will be asked to test drive the SUMS software. The feedback received during the beta test period will be used to polish the search engine, and reveal any immediate flaws of the system.

Open the SUMS search engine to the general public.

Plans for School Net

Immediately, SUMS could be used to index and catalogue the School Net web site. This could be used to replace the existing search function. Following that, SUMS could be distributed to and used by School Net's partners, allowing the search function to extend beyond the School Net site to its partners' sites.

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[1] See http://culture.fr/culture/bibliuni/bliu-u.htm.

[2] See http://lcweb.loc.gov/z3950/gateway.html#other.

[3] One exception is in the case of major libraries with residual collections which somehow have never yet been catalogued.

[4] See http://llnl.gov/liv_comp/metadata/proceedings/author_index.html.

[5] See http://llnl.gov/liv_comp/metadata/other-efforts/other-metadata-efforts.html.

[6] See http://www.ewos.be/aegis/home.htm.