Signal and Noise: n-Dimensional Query and Experiential Learning

Jonathan Cornwell
The Center for Internet Research
jrc@tcfir.org

W. Reid Cornwell
The Center for Internet Research
wrc@tcfir.org

Abstract: This paper argues that act of searching the Internet is both an important "enabling" skill and act of experiential learning per Kolb's model. The necessity to conceive of an "enhanced enabling core" (EEC) of knowledge and skills evaluated against a standard of a "self-education threshold" is presented. Searching as both skill and experience is contextualized as a component of an EEC. The deficiencies of keyword searches are presented as reducing the educational value of Internet searches. Correlation-based n-dimensional search technology is offered as an important advance over keyword searches.

Let us briefly, and in broad descriptive brushstrokes, juxtapose two things: the Internet and education.

The Internet is our modern-day "Library of Alexandria". Let us set aside for a moment our doubts about the varied quality of content available on the Internet, and suspend our questions about the lack of structures in its contents, the kinds of structures to which we are both accustomed and expect in education as manifested in textbooks and curricula. To the issue of quality, we note that the "objective", "factual" "authority" of specific instances of information and knowledge have been debated in the Western tradition in various forms from the philosophies of Plato, Hume, Kant, and Nietzsche to the creation of categories such as "folklore", critiques of modern mass media, and the relatively recent emphasis on the need to cultivate "critical thinking" in education. Issues both philosophical and practical confound us here. Setting these issues aside, the contents of the Internet represent the single greatest collection of human expression to have ever been created. "It" is all there: the sacred and the profane, the profound and the trivial, the objective and subjective, the scholarly-scientific and the folk. And in this pile of representations of the human experience is the ability flit almost unfettered like bees from one flower to the next, whether that flower is like the Titan arum ("corpse flower") or a rose.

There is the problem of education, i.e. the (re)transmission of cultural knowledge from one generation to the next coupled with intent of creating "well-acculturated" members of a society. "Education" in some form is present in all human cultures but varies widely in content, methods, and goals (Ferraro, 2001). In pre-literate cultures, and in non-literate segments of literate cultures, such (re)transmission takes the form of oral tradition and customary example; that is, what is labeled by scholars as "folklore" (Georges & Jones, 1995) (but which may also be seen as a category of experiential learning). In contrast, our modern predisposition, when we encounter the word "education", is to conjure images of teachers, textbooks, and students sitting in ranks and rows of desks in a classroom. For the anthropologist, the tendency to think of education in this way is an example of our own enculturation and "ethnocentrism", i.e. the "isn't this the way things ought and should be" cognitive/emotive patterns that are a product of growing up and living in the normative-contextual matrix of a particular culture. This culture-bound idea of "education" is, in fact, an example of education in its broadest sense.

In principle, the Internet and education have a natural affinity. The former is a conduit and repository of knowledge; the latter denotes the methods, contents, and goals of purposive (re)transmission of knowledge. However, in practice, joining the Internet with education remains a vexing problem. For example, unstructured "flitting among the flowers" of Internet content does not appear to constitute the kind of rigor and standards-driven academic achievement which form the paradigmatic core of our ideas about what education should be. In addition, the "para-crystalline" (i.e. exhibiting short-range structure with no large-scale organization) macro-structure of Internet content does not easily yield to the pre-structured forms to which we expect curricular units to assume and against which we measure achievement. From this perspective, the Internet appears to be more like a landfill than a library relative to the needs of mass education. But, it may also be argued that the Internet-as-landfill represents a

laboratory – or, perhaps better yet, a window into the world itself – for cultivating the very kinds of knowledge and skills which we expect will result in well-adapted and well-acculturated adults in the present era, knowledge and skills which some categorized as "21st Century Skills" (e.g. Partnership for 21st Century Skills, 2004; Metiri Group, 2003).

Elsewhere (e.g. Cornwell & Cornwell, 2008a; Cornwell & Cornwell, 2008b), we have discussed various aspects of the problems and deficiencies of the Internet as it relates to intentionality, knowledge representations, and knowledge structures relevant to education and research. This paper and other papers on these topics are part of an ongoing collaborative research project between The Center for Internet Research and Correlation Concepts, Inc., developers of an "n-dimensional query" technology. In this paper, our focus is on the affordances offered by the act of searching the Internet-as-it-is, the nature of searching as experiential learning, and of the additional opportunities afforded by the use of n-dimensional (correlations-based) queries as a counter to the deficiencies of the keyword search paradigm.

Finite Intellectual Capacities and an Enhanced Enabling Core

What is meant by the phrase"21st Century Skills"? The relevance of this question is not so much in the particular answers which might, and have been, given but in the way that the phrase connotes a worry or anticipation that these times require a different kind of educated person than times past. The kinds of answers that have been offered strike squarely into the cultural heart of the problem of education – of attempting to make explicit the cultural ideals underlying the goals of education – but are also set against a background of nearly constant education reform throughout the 20th century which, concomitantly, has been strongly influenced by technological, and global political and economic change. Thus, a concept like "21st Century Skills" represents an arrow fired at an apparently moving target. But how novel is this 21st century milieu in which adults, educated in the current education system, perform and succeed? In the framework of the language of evolution, are the knowledge/skill traits that we cultivate in our children adaptive or maladaptive to the current and near-future ecology. Has the social/cultural/economic ecology truly changed so fundamentally that we must reform the traits we wish to develop in our children?

There are points of reference which help us to orient on a domain of possible answers. One such point of reference is the relative fixity of organic human intellectual capability coupled with individual variation in any trait which we might observe. Across historical timescales, there is no evidence of any substantive change in human intellectual traits beyond the phenotypic effects of better diets, sanitation, medicine, etc. Genetically, at practicable human timescales and at the scale of the total set of variation, we are a "fixed quantity" or, more accurately, a bounded (finite) set of variation. This observation, in part, refines the question of education-produced "traits" to one of ranges – of minimums and maximums – which might be cultivated in learners individually and collectively based on the biological capacities of the human organism. There are, of course, the innumerable environmental influences on the actual expression of genetic potential but the theoretical set of maximum organic capability represents the "superset" of potential. On this point hangs a premise central to both education and this paper: the scale, scope, and complexity of our knowledge are greater than the maximum organic capacity of the human organism to apprehend. Therefore, what we may teach and expect to be learned is something less than the total of human knowledge. Furthermore, as the scale, scope, and complexity of our knowledge increases, the proportion of the total of human knowledge any one individual may fully assimilate becomes smaller. Thus, what we (re)transmit to our children via formal education is inextricably and inevitably rooted in choice: which parts of the whole to teach within the framework of cultural ideals – and predictions/estimates – about what it means to be a well-adapted, well-acculturated adult. Therefore, a categorical phrase such as "21st Century Skills" is perhaps more accurately appreciated as an answer to problems which arise in the nexus between human limitations and estimates about what knowledge and skills are adaptive in the current and near-future "ecology".

With the advent of the Internet, we are not only more connected to our knowledge, but also even more keenly aware of its scale, scope and complexity. It is trivially easy for even the most educated of us to browse randomly to some fact or domain of knowledge of which we were previously unaware, and equally easy to become overloaded with the tsunami of information that might be generated in even a single day. However, this was true as well for Vannevar Bush when he wrote in the article "As We May Think" (Bush, 1945):

> "There is a growing mountain of research. But there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers—conclusions which he cannot find time to grasp, much less to remember,

> as they appear. Yet specialization becomes increasingly necessary for progress, and the effort to bridge between disciplines is correspondingly superficial."

Long ago, we crossed the threshold of the individual of being able to know even a statistically significant proportion all that human beings know. This, then, raises the question of just how new these times are relative to the goals of education. Perhaps all that has changed is the inability to maintain certain illusions about the universal, persistent, and valuable quality of certain kinds of content in education, and even the tendency to value content over process.

It would seem, given these arguments, that what we are seeking when we invoke phrases such as "education reform" or "21st Century Skills" is both an acknowledgement of the deficiencies in what we currently teach and desire to identify some subset of human knowledge that is more "enabling" in particular, if undefined, ways; a core set of knowledge and skills that is not only adaptive within the currently understood milieu but that also cultivates adaptivity. For the sake of discussion, let us call this an "enhanced enabling core" (EEC) of knowledge and skills. Let us not forget that the pre-structured forms and contents of primary, secondary, and higher education only represent a fraction of the learning that an individual experiences in every moment of every day, and the time spent in formal education is only a brief era in the span of a human life. Certainly, achievement during the time the individual spends within formal education is important but the real test and measure of formal education is in all that happens outside the context of formal education, particularly all that occurs subsequently in the lifetime of the individual. Of course, we recognize what we have just offered is a "statement of the obvious" to educators and those who have given some thought to what education represents but it is an idea of such fundamental importance that it may also be easily overlooked in the ebb and flow of debates about education and education reform. It is also crucial to the next premise: if the expanding universe of our knowledge is greater than any individual's capacity to apprehend it in total, then cultivating the knowledge and skills to effectively find, understand, relate, assess, and use knowledge is critical component of an true EEC. In other words, the knowledge to use Knowledge is primary.

Why do we append word "enhanced" to the phrase "enabling core"? Because the multitude and scale of education reforms in the U.S. and beyond demonstrates that we are not yet satisfied that we know what an "enabling core" of education content and process is. We know – or, perhaps more accurately, believe – that there is an ideal core curriculum. From the "Committee of Ten" (Sperling & Bergstrom, 2008) to "No Child Left Behind", we have attempted to create explicit "enabling cores" without yet reaching the goal. We have appended the word "enhanced" to denote the work that remains to be done to create a truly enabling core.

If the full measure of the success of formal education is in life beyond formal education, then the standard by which the effectiveness of an EEC is assessed is what we term the "self-education threshold". The self-education threshold is that point at which the mastery of an EEC enables an individual to effectively engage any other new knowledge on his or her own. At this point, both the ECC and the self-education threshold are merely general ideas and placeholders for further work; of metaphorical and qualitative, rather than quantitative, value. To continue, the importance of self-education (or "life-long learning" in other contexts) is elevated beyond the level of a character-based ideal to that of an assessment benchmark for formal education and as an adaptive trait of vital importance in the modern context of rapid technological, social, political, and economic change. And within these currently-amorphous ideas of self-education and an EEC is the foundational element of effectively finding particular, relevant objects or domains of knowledge.

Learning to Search and Searching to Learn

The act of searching is an intentional act rich with learning opportunity. Using the framework of Kolb's model of experiential learning (Kolb & Fry, 1975; Coffield, Moseley, & Ecclestone, 2004), experience is both the source (as the basis for the formation of intent) and the product of search (as concrete experience; as an act of observation and opportunity for reflection; and as a context for forming abstract concepts and testing new situations). Furthermore, every search is also an act of prediction, a notion which merits further examination. The intentionality and behavior of searching does not arise from nothing; preceding concrete experience, observed and reflected upon, results in a psychological state in the individual requiring resolution. This state requiring resolution constitutes the first point in a "prediction vector". The search itself is the next point in the prediction vector, both in the expectation that a search might be the source of resolution and in the judgment that specific formulations of search term(s) are likely to produce the desired results. Thus, a point of origin and a second point are established in a prediction vector that the individual hopes /predicts points to a specific, relevant object or domain of knowledge within a knowledge "space" such as the Internet. Since we common use concrete volume/spatial terms to refer to collections of knowledge, i.e. a "body", "corpus", "domain", "area", conceiving more explicitly of knowledge

"spaces" and "vectors" is not unreasonable or unprecedented. For example, such vector-based relationships have been reconstructed by mapping citations in scholarly-scientific literature (e.g. Rosvall & Bergstrom, 2008). Table 1 demonstrates the spatial qualities of knowledge spaces but also compellingly illustrates the complex structures and relationships between domains of knowledge, structures not revealed or preserved by current search technologies.

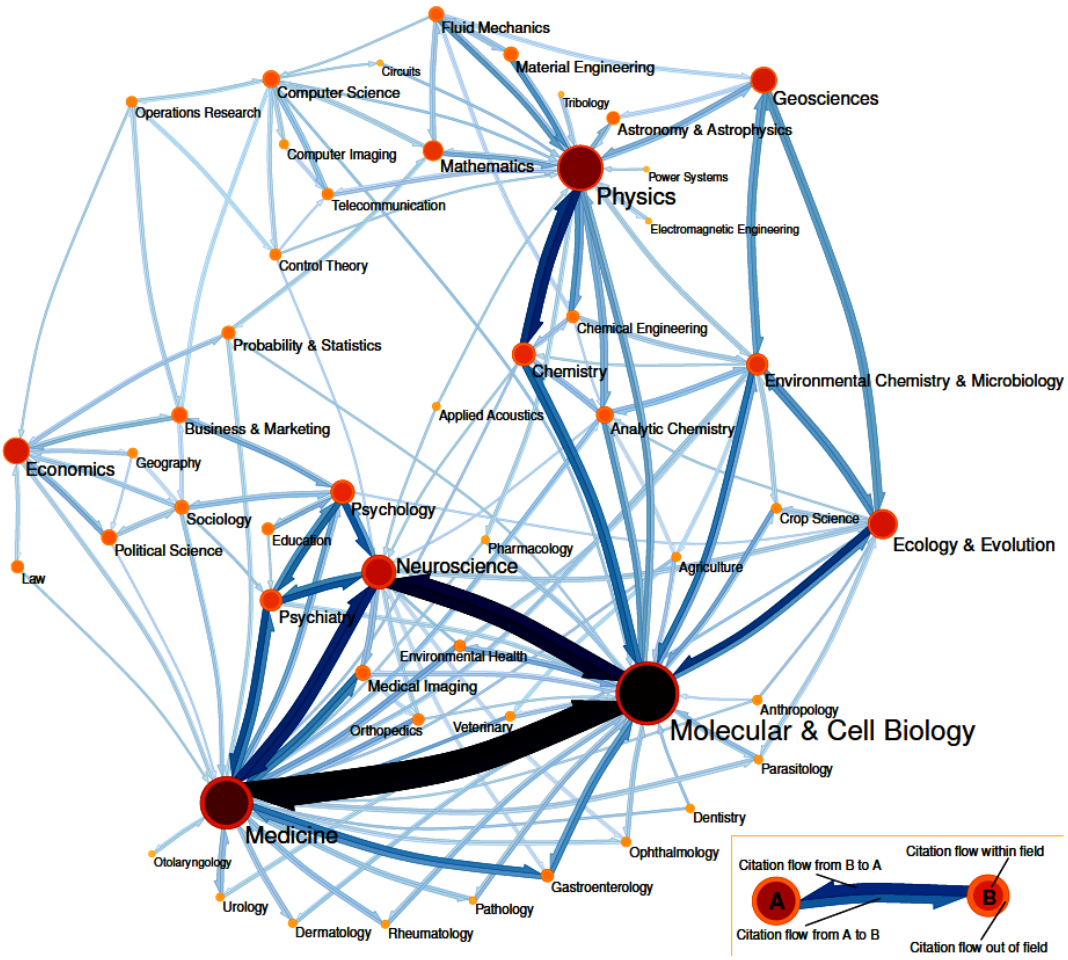

Table 1: A visualization of the relationships between academic disciplines created based on an analysis of journal article citations.

A prediction may also be thought of as a test or hypothesis thus casting search results in the role of "sense experience" and of "data from observation" in an empirical model. In this context, one may appreciate the act of search at the micro-scale as an opportunity for learners to explore the scientific method in a concrete manner, from the learning/observation that precedes hypothesis formulation to the analytic and critical processes subsequent to data acquisition. Our survey of the literature and our contacts among educators suggests that this observation is not entirely novel (e.g. Edward, 2008) but also not widely known and appreciated.

Returning to the theme developed in the previous section, we argue that the cultivation in learners of the knowledge and skills to effectively search constitutes a primary element of an EEC because 1) it is a necessity driven by the capacity of the human organism relative to the scale, scope, and complexity of human knowledge, 2) is an adaptive skill/knowledge set in the current era, and 3) is a context/milieu for learners to actively interact with knowledge and concretely experience the exigencies of knowledge discovery and utilization that they will encounter within formal education and beyond, when self-education, rather than directed and pre-structured education, becomes the norm for the individual.

Use of the Internet as a primary search/research tool in education has been strong (e.g. Becker, 1999) and continues to grow (e.g. Gunn, 2005). Use of commercial search servers, such as Google, has significantly displaced library catalog searches (electronic or otherwise) as a starting point for information consumers (e.g. De Rosa et al., 2005; Awre et al., 2005; Griffiths and Brophy, 2005). Among the reasons cited for this shift from the authoritative domain of library services to the authoritative "wilderness" of the Internet are deficiencies in library catalog services, especially the underlying technological bases of Boolean algorithms and keyword (index) organizational structures (Markey, 2007). Informally stated, Google and others simply do a better job of searching than library systems. However, the ease-of-use comes with the price of unknown authority of sources in search results, result sets that are impracticably large, and results sets that are minimally relevant to a searcher's intent. We have also argued elsewhere (Cornwell & Cornwell, 2008a; Cornwell & Cornwell, 2008b) that the nature of knowledge presentations in general, and as specifically manifested within the technological boundaries of information technology specifically, present even deeper and less tractable impediments to realizing the full benefit the universe of human knowledge.

However, we are arguing here that these deficiencies, in theory and practice, of knowledge on the Internet also afford experiential learning opportunities *par excellence* for the reasons given above but most especially for the development of critical thinking, a skill required regardless of whether knowledge is actively sought or passively acquired, and regardless of source quality and authority. But we are also arguing that the inherent "noisiness" of the Internet-as-landfill and the dominant methods of structuring and finding knowledge are beyond the organic threshold of human capacity to manage, regardless of expertise. Better technology is needed to improve the signal-to-noise ratio of Internet searches.

N-dimensional Query

One of the most fundamental knowledge structures is the correlation. In this case, we are emphasizing correlation's meaning as a (statistically significant) association of one thing with another rather than the more narrow meaning in the field of statistics of the degree with which two or more things are related or change together, although these two definitions are interdependent rather than exclusive. "Statistically significant" is parenthetically inserted because we are generally not interested in non-significant associations; these we include in the categories of "coincidence" or "noise" even in common experience. Correlation can also be viewed as one of the most fundamental structures of learning, e.g. the probability-based associations formed between unconditioned stimulus and conditioned stimulus, and the importance of the strength of correlation for determining excitation verses inhibition in the Rescorla-Wagner Model (Rescorla & Wagner, 1972). Correlation may also been seen as the basis for much of scientific investigation; the pattern or anomaly in a pattern which inspires formal research. The importance here is that correlation appears to be a basic trait of human cognition and is therefore an excellent candidate for finding and structuring knowledge in "natural" ways. In addition, correlations are a beginning to structure, a "likely to be disconfirmed" (Kuhn, 1996) sort of structure and, thus, a natural laboratory for learners to engage higher-order critical thinking. Correlations are also ontological in nature; that is, a correlation pops into being as objects-phenomena relationship that must be at least temporarily reified to be investigated. The boogeyman of correlation is coincidence but, in ideal terms, even potential coincidence must be treated as if it is real for it to be falsified.

Searches based on correlations differ from keyword searches on a number of highly significant points. First is the requisite nature of the form of a correlation search: the need for two or more search terms rather than one. This is due to the nature of correlation itself – that is, the relationships between two things rather than set membership based on (at minimum) a single thing held in common. Correlation searches benefit from, but do not require, knowledge of specific jargon, a point we will elaborate upon more in a moment. Correlation search results are based upon analysis of "massive networks of associated 'knowledge fragments' to 'connect the dots' and establish relationships between terms, phrases, concepts, or topic" (Bobick & Cornwell, 2008) rather than index or index-like set association. Knowledge objects that make the most "valuable" connections to the network of correlations are considered to be the most relevant. Correlation searches are non-semantic – that is, correlation searches to not require the algorithmic determination of "meaning" in the search terms or the "corpus" (i.e. the knowledge based being searched) – but produce results which appear "intuitive" in quality. For example, a set of search terms such as "green tea", "life quality", "metastasize" can recover relevant documents related to cancer and polyphenols (a class of compounds that may help to combat cancer that are present in green tea). As this example, suggests, correlation searches can also reveal non-user-supplied (algorithmically determined) terms upon which the correlation results are based and thus become a resource to the searcher for specific jargon in a domain of knowledge. Correlation searches

do not employ popularity or similarity metrics, binary logic, or link analysis. The import of this is that relationships revealed between knowledge objects are not necessarily predetermined by authors but, instead, are based on "native" or "organic" structure. While this feature of correlation searches risks decontextualizing knowledge objects in similar ways to keyword searches, the risk is at least partially offset by the ability to recover/discover previously unknown relationships between knowledge objects, and thus making correlation searches a potentially valuable tool for original research against the contents of the Internet or smaller, more focused knowledge bases. We refer to correlation-based searches as "n-dimensional" because each search term constitutes a dimension in an "answer space". The precision of correlation searches increased substantially with the number of search terms, thus leading to smaller, more relevant – and more practicable – results sets.

Explore Correlations Starting with *green tea - contains - chemicals*

(Destination terms are ordered alphabetically)

green tea - contains - chemicals	**benefits - need - quality**
green tea - contains - chemicals	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
chemicals - known - polyphenols	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
polyphenols - have - benefit	http://www.nlm.nih.gov/medlineplus/druginfo/natural/patient-green_tea.html
benefits - need - quality	http://www.o-cha.com/
green tea - contains - chemicals	**cells - for - proliferation**
green tea - contains - chemicals	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
chemicals - known - polyphenols	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
polyphenols - help - cells	http://www.umm.edu/altmed/articles/green-tea-000255.htm
cells - for - proliferation	http://en.wikipedia.org/wiki/Brain_tumor
green tea - contains - chemicals	**cells - for - proliferation**
green tea - contains - chemicals	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
chemicals - known - polyphenols	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
polyphenols - kill - cells	http://www.umm.edu/altmed/articles/green-tea-000255.htm
cells - for - proliferation	http://en.wikipedia.org/wiki/Brain_tumor
green tea - contains - chemicals	**tea - depending - quality**
green tea - contains - chemicals	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
chemicals - is - tea	http://coffeetea.about.com/cs/typesoftea/a/greentea.htm
tea - depending - quality	http://en.wikipedia.org/wiki/Green_tea
green tea - contains - chemicals	**tea - depending - quality**
green tea - contains - chemicals	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
chemical - found - tea	http://en.wikipedia.org/wiki/Green_tea
tea - depending - quality	http://en.wikipedia.org/wiki/Green_tea
green tea - contains - chemicals	**tea - depending - quality**
green tea - contains - chemicals	http://www.cancer.org/docroot/ETO/content/ETO_5_3x_Green_Tea.asp
chemical - in - tea	http://en.wikipedia.org/wiki/Green_tea
tea - depending - quality	http://en.wikipedia.org/wiki/Green_tea

Table 2: Example of an n-dimension search result based on the search terms "green tea" and "chemicals".

To be clear, we do not believe that correlation-based searches will replace keyword searches but will represent a significant and complementary advance over keyword searches. Nor do correlation-based searches represent the last word in search technology. What correlation-based searches do offer is the ability to at last employ a fundamental structure and method of knowledge against the burgeoning universe of human knowledge represented on the Internet.

In addition to the benefits given above, we believe that correlation-based searches will afford learners an opportunity to explore the nature of correlations in concrete experience rather than in the abstract. Furthermore, correlation-based searches – in the context of the nature of searches to parallel in the micro-scale the methods of science and scholarship – also afford opportunities to compare and contrast correlative verse causative research. However, we anticipate that the chief and most readily apparent benefits of n-dimensional queries will be in smaller and more relevant result sets.

Conclusion

The premises and observations offered above constitute some of the principles and delimiters that are currently guiding us in an ambitious program of research and development whose goal is the harnessing of the full potential of the Internet for all users but especially education. The idea of an EEC, and of the standard of self-education, has relevance in this context because the potential of the Internet is not limited to education or scholarly-scientific research; the need to make use of knowledge for which we never received formal education is likely for everyone. Acknowledging the ability to search as a keystone skill in a body of related skills and knowledge about how to make effective use of any knowledge one might encounter cannot be overstated. Furthermore, the ability to search the expanding universe of human knowledge is not something easily accomplished in the abstract but a matter of experience augmented by theory and principle thus making "experiential" models of learning particularly relevant.

N-dimensional query, by itself, is only the beginning, albeit an important one. It has been said that advancements in the ability to observe precede leaps in our scientific knowledge and technology. N-dimensional technology may well represent such advancement in the form of our ability to "observe" what is already in the record of human knowledge. The problem of managing the scale, scope, and complexity of human knowledge is not a new one, as Bush's (1945) observations illustrate, nor is it one that any of us is presently unaware if only at the level of common experience we receive 300 million results on a query. We have made great progress, as the very nature and existence of the Internet demonstrates, but many of our most pressing problems originate, or are confounded by, problems so fundamental as to be easily overlooked or intractable in the extreme. The technological affordances to find specific objects or bodies of relevant knowledge represent one such problem but one that we can begin to address with n-dimensional queries and a renewed effort to cultivate "knowledge skills".

References

Awre, C., Hanganu, G., Ingram, C., Brett, T., & Dolphin, I. (2005). The CREE Project: Investigating User Requirements for Searching within Institutional Environments. D-Lib Magazine 11, 10 (October). Retrieved September 9, 2008, at http://dx.doi.org/10.1045/october2005-awre.

Becker, H. J. (1999). Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use. *Teaching, Learning, and Computing: 1998 National Survey, Report #1, Center for Research on Information Technology and Organizations, The University of California, Irvine and The University of Minnesota*. Retrieved November 11, 2008, at http://www.vermontinstitutes.org/tech/research/i-use-teach.pdf.

Bobick, M. & Cornwell, W. R. (2008). A Knowledge Correlation Search Engine: Technical White Paper. The Center for Internet Research. Retrieved December 9, 2008, from http://tcfir.org/whitepapers/A%20Knowledge%20Correlation%20Search%20Engine.pdf.

Bush, V. (1945). As we may think. *Atlantic Monthly*. Retrieved August 15, 2008, from http://www.theatlantic.com/doc/194507/bush.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning styles and pedagogy in post-16 learning: A systematic and critical review. www.LSRC.ac.uk: Learning and Skills Research Centre. Retrieved October 11, 2008: http://www.lsda.org.uk/files/PDF/1543.pdf

Cornwell, J. R. & Cornwell, W. R. (2008a). *Signal and noise: Correlation searches as a means for addressing the failures of the keyword search paradigm on the Internet*. Presented to the Department of Communication, University of Illinois-Chicago on October 1, 2008.

Cornwell, J. R. & Cornwell, W. R. (2008b). Signal and noise: The power of n-dimensional query and education. (In publication review).

De Rosa, C., Cantrell, J, Cellentani, D., Hawk, J., Jenkins, L., & Wilson, A. (2005). *Perceptions of Libraries and Information Resources: A Report to the OCLC Membership*. Dublin, Ohio: OCLC. Retrieved September 9, 2008, at http://www.oclc.org/reports/2005perceptions.htm.

Edmund, N. W. (2008). The scientific method today. Retrieved November 20, 2008, at http://www.scientificmethod.com/.

Ferraro, G. P. (2001). *Cultural Anthropology: an applied perspective* (4th ed.). Australia; Belmont, CA: Wadsworth Thomson Learning.

Georges, R. A., & Jones, M. O. (1995). *Folkloristics: an introduction*. Bloomington: Indiana University Press.

Griffiths, J., & Brophy, P. (2005). Student Searching Behavior and the Web: Use of Academic Resources and Google. *Library Trends* 53, 4 (Spring), pg. 539-554.

Gunn, H. (2005). Become a Google power user. *Teacher Librarian*, 32(5), 14-21.

Kolb. D. A. & Fry, R. (1975) 'Toward an applied theory of experiential learning;, in C. Cooper (ed.) Theories of Group Process, London: John Wiley.

Kuhn, T. S. (1996). The structure of scientific revolutions (3rd ed.). Chicago, IL: University of Chicago Press.

Markey, K. (2007). The online library catalog: Paradise lost and paradise regained? *D-Lib Magazine*, 13(1/2), available at http://www.dlib.org/dlib/january07/markey/01markey.html. Retrieved on November 16, 2008.

Metiri Group (2003). *enGauge 21st century skills for 21st century learners*. Retrieved March 21, 2008, from http://www.metiri.com/21/Metiri-NCREL21stSkills.pdf

Partnership for 21st Century Skills (2004). Framework for 21st century skills. Retrieved March 27, 2008, from http://www.21stcenturyskills.org/index.php?option=com_content&task=view&id=254&Itemid=120.

Rosvall, M., & Bergstrom, C. T. (2008). Maps of random walks on complex networks reveal community structure. *PNAS, 105*, 1118.

Sperling, M., and DiPardo, A. (2008). English Education Research and Classroom Practice: New Directions for New Times. *Review of Research in Education*, 32, pp. 62-108.