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Is there a difference between critical thinking and information literacy? A systematic review 2000-2009

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Abstract

This paper investigates the similarities and differences between two important ideas in information processing and knowledge utilisation. Those ideas are [critical thinking] and [information literacy]. The two phrases are shown in brackets to indicate that the two words involved in each idea are not arbitrarily combined but have been coupled by authors to represent a single entity or a focus for development of concepts describing the characteristics involved. By exploring terms related to this couplet from the same sentence, the meaning of each of the central ideas can be expanded. The education, library science, and health science literature were used in this study, which analysed 8745 articles dealing with [critical thinking] and 8201 reports dealing with [information literacy] included in either ERIC or PubMed from 2000-2009. The findings showed that combinations of terms (i.e. ideas) such as [information & literacy & *related term]* or [critical & thinking & *related term]*, when organised based on Bloom's Taxonomy of Learning (Bloom 1956), clarified the similarities and differences between the two central ideas. [Information literacy] was involved in all of the cognitive functions suggested by Bloom. This finding is consistent with the definitions of [information literacy] that relate it to lifelong learning and effective decision-making. In addition, the ideas describing [information literacy] were consistent with actions and perceptions that were more public and standardised than those associated with [critical thinking].

This suggests that [information literacy] and its associated procedures could significantly augment current instruction in [critical thinking] and indeed, the possibility has been explored by some authors in the current literature. A merging of the two ideas would involve [information literacy] providing tools and techniques in the processing and utilisation of knowledge and [critical thinking] supplying the particulars and interpretations associated with a specific discipline. This type of integration could lead to instructional programs similar in concept and application to those in research methodology where methods from statistics are integrated with the techniques and skills associated with a specific discipline. The development of a curriculum of this type would change functions and perceptions from private, individualised mentation, now associated with [critical thinking], to a more easily learned and practiced process suitable across the breadth of disciplines.

Keywords

critical thinking; information literacy; idea analysis**;** US;

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1. Introduction

The intent of this paper was to explore the deeper meaning provided by education, library, and health specialists as they employed the ideas, [critical thinking] and [information literacy] in their discussions of research findings. There are two basic ways to determine the meaning of a term or phrase. The first is by using the dictionary. The second is to identify and organise terms that serve as attributes of the key word or phrase. The latter approach, representing a critical aspect of linguistics, offers the advantages of combining insights and observations from a large number

of subject specialists and does so in a traceable way. This form of objective analysis is used in this paper.
The terms linked with [information literacy] and [critical thinking] by authors of education, library science, and health science reports dealing with the two topics were identified and organised. For the purposes of this analysis, an idea is operationally defined as a combination of informative terms contained within the confines of a sentence. As already explained in the abstract, to denote the idea as an entity, the involved terms are enclosed in brackets. A total of 16,946 articles were identified in the ERIC and PubMed databases dealing with [information literacy] or [critical thinking] from 2000-2009.

Definitions: Existing definitions of [information literacy] are comparable to the ones given for [critical thinking]. This suggests that the two ideas may have much in common. Traditionally, [information literacy] has been a focus of research and instruction by academic librarians while [critical thinking] has been considered by faculty discipline specialists.

A definition of [critical thinking] was first introduced in 1906 (Sumner, 1906). A current dictionary definition is "the mental process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and evaluating information to reach an answer or conclusion"[1]. This process is said to enhance the individual's ability to effectively manage information in order to learn and use the facts, figures, and principles in a specific discipline. The expected outcomes are problem solving and innovation.

Several definitions of [information literacy] have been provided through time. Some were:

- *''Information literacy is a set of competencies that an informed citizen of an information society ought to possess to participate intelligently and actively in that society"* (AASL, 1998).

- *"To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information."* (ALA, 1989).

- *"A new liberal art that extends from knowing how to use computers and access information to critical reflection on the nature of information itself, its technical infrastructure and its social, cultural and philosophical context and impact."* (Shapiro and Hughes, 1996)

Text Processing: The challenge of rapidly and efficiently identifying, extracting, and organising the information that describes the large number of authors' uses, perceptions, and illustrations dealing with the central ideas, [critical thinking] and [information literacy], raised an additional consideration. Text processing has changed from a paper-oriented medium to a digital one in terms of access, retrieval and transmission. However, once the documents of interest are acquired, the subsequent processing tends to use long-standing manual methods. The text would be read and data of interest highlighted or extracted in the form of notes. The drawbacks associated with this approach are well known and include time spent in processing and the effort associated with clerical activities. In the present study, a manual analysis of the 16,946 articles dealing with the ideas, [critical thinking] and/or [information literacy], would require about 4,236 hours. In addition, the organisation of the extracted data would be awkward to manage using index cards or post-its. Highlighted text in documents would be repeatedly 'lost' in the maze.

Alternative approaches involve applications of computer technology. One such is popular in search engines and involves assigning lists of terms (subject headings, keywords, or metadata) to documents. This process has a long history (Stone, 1992). Retrieval based on this approach has been associated with dubious success (Blair 1986).

[1] www.dictionary.com 2010 [Accessed 24 November 2011]

A more recent approach involved text mining software that identified frequently occurring terms. The method also identified the frequency of combinations of the terms in the text. This frequency-linking offered a statistical approach to 'explaining' the contents of the document and had been used to combine documents into themes. (Dubais, 1996; Landauer, 1994, 1998) A variation of the text mining approach, Idea Analysis, was developed by the author of this paper, as a research tool, in 1979 (Weiner 1979).

This research software tested the basic concept inherent in a different approach to text processing. That concept was based on the premise that the author of the document was a specialist and as such, he/she selected terms representing the vocabulary used in that subject. In addition, this specialist was best suited in forming relationships among these terms in order to express thoughts. The software, Idea Analysis, was created to perform the following tasks:

1. **Segregation** of each of the authors' sentences.
2. **Identification** of informative terms (nouns, adjectives, or gerunds) within a sentence.
3. **Pairing** of the informative terms within each sentence and storage of these data records in a database. The restriction to the sentence ensured that the author meant to combine the terms. This is unlike traditional Boolean searching in which search terms may appear anywhere in a document, resulting in many "false hits".
4. **Analysis** of these idea records to look for clusters involving specific central terms (e.g., [information literacy] or [critical thinking].

Once this concept involving the importance of the ideas presented by the authors was accepted, a number of different approaches could be employed using existing software. As an example, the tasks identified above could be performed using Word and Excel. The 'Edit' function in Word could be used to highlight the informative terms. The pairs of terms could be copied into Excel as data records together with document identifiers. These records could be sorted using 'Edit' functions in Excel. The records containing [information literacy] or [critical thinking] with related third terms could be extracted and copied into a new Excel file for further processing. By including the document ID provided by ERIC or PubMed, that data item could be used to retrieve the precise document containing an author's idea of interest. This search process is based on *a priori* awareness of the contents of the document, a well recognised, effective retrieval approach.

In this paper, the analysis examines combinations of terms that are linked in sentences with [information literacy] or [critical thinking]. Sentences containing the central ideas, [critical thinking] or [information literacy], provide additional information in the form of larger combinations of terms. The following sentence illustrates the combinations possible. This sentence contained both central ideas and they are highlighted in **bold**.

> *PBL pedagogy developed **information literacy** skills, **critical thinking**, and evidence-based nursing skills, communication, co-operation and team working skills, problem solving and self-assessment skills*."

The authors linked additional informative terms in the same sentence to each of the central ideas. The triplets of terms from this sentence would be:

[Information Literacy] With	**[Critical Thinking] With**
Problem-Based Learning (PBL)	Problem-Based Learning (PBL)
Pedagogy	Pedagogy
Skill	Skill
Evidence	Evidence
Communication	Communication
Working	Working
Problem	Problem
Solving	Solving
Assessment	Assessment

Separation of Tasks: Each triplet (i.e. [information & literacy & PBL] or [critical & thinking & PBL] describes the meaning and/or perceptions associated with the central idea. For example, the triplet involving [information literacy] showed that the author considered PBL as a tool for learning. Similarly, the triplet involving PBL with [critical & thinking] offers the same impression.

The authors associated the terms by linking them within sentences. The individual studying the text determines the value and validity of each triplet. This results in a separation between the identification and organisation of the authors' ideas and subsequent interpretations and descriptions using them.
Applying Bloom's taxonomy of learning, (Bloom, 1956), the tasks associated with recall and analysis were essentially performed by the Idea Analysis software leaving the higher cognitive functions of synthesis, comparison, evaluation, judgment and application to be performed by the individual. The advantages to this separation are:

1. Savings in time and energy engaged in mechanical tasks.
2. Shift of professional's work from mechanical to intellectual tasks.
3. Institution of quality control procedures.

Describing Complex Problems: By breaking up a complex sentence, such as that shown above, into central ideas plus related terms, the description of [information literacy] and/or [critical thinking] can be simplified and organised. The ideas describing [information literacy] and [critical thinking] can be compared to determine similarities and differences in the way the authors used those two central ideas.

The ideas also can be organised depending on the theoretical structure adopted. The analyses shown in this report employed the major cognitive functions (Bloom, 1956; Weiner, 1979). Those were:

1. Recall – the process of retrieving information from some repository.
2 Analysis – the process of dividing information into primary data elements.
3. Synthesis – the process of constructing new concepts using the primary data elements.
4. Comparison – the process of determining attributes associated with each of the newly constructed concepts.
5. Evaluation – the process of developing measures and criteria used in ranking the new constructed syntheses.
6. Judgment – the process of prioritising the newly constructed syntheses.
7. Application – the process of transforming the selected synthesis into actions.

Objective: Using this idea identification approach, the terms linked with [information literacy] and/or [critical thinking] provide an opportunity to explore how authors actually use the central ideas.

2. Methods

The study included 8745 articles dealing with [critical thinking] and 8201 reports dealing with [information literacy] entered into the ERIC or PubMed databases from 2000-2009. The Idea Analysis software performs the following tasks:

1. Separates and isolates each sentence of the text of an abstract.
2. Identifies nouns, adjectives, and gerunds relevant to the topic. The terms, "information" and "literacy", are examples of informative nouns. The term, "critical" is an example of an informative adjective. The term, "thinking" is an example of an informative gerund.
3. Combines the informative terms and constructs data records containing the idea plus identifiers denoting the associated sentence and document.

The software prepares a repository of ideas that can be used to explore different questions. This repository approach is comparable to the well-recognised numeric databases that serve as resources for investigators interested in secondary data analysis. By extracting the ideas from documents, the repository provides the data required to perform primary and secondary analyses. The individual can then focus on what Bloom called the higher cognitive functions of synthesis, comparison, evaluation, judgment, and application. These functions have been associated with intellectual behaviour, although, the methods to accomplish them have required considerable time and effort in learning. The goals of both [critical thinking] and [information literacy] are to use these higher cognitive functions.

3. Results

Differences Between Central ideas: Table 1 summarises the differences between the two central ideas. The use of [critical thinking] is specific to individual disciplines. [Critical thinking] enhances the status of the individual by focusing on the results. The process is a mixture of private acts, learned by trial and error, observation and experience. The learning period is long. There is little opportunity for quality control of the process as [critical thinking] is performed mentally, using procedures known only by the individual.

[Information literacy] is a more public process involving techniques linking computer with human actions. A commonly held belief is that the primary emphasis in application of information literacy is identification and retrieval of relevant literature. The findings of this study showed that information literacy is applied in all of the cognitive functions. This finding is consistent with the definitions of that idea.

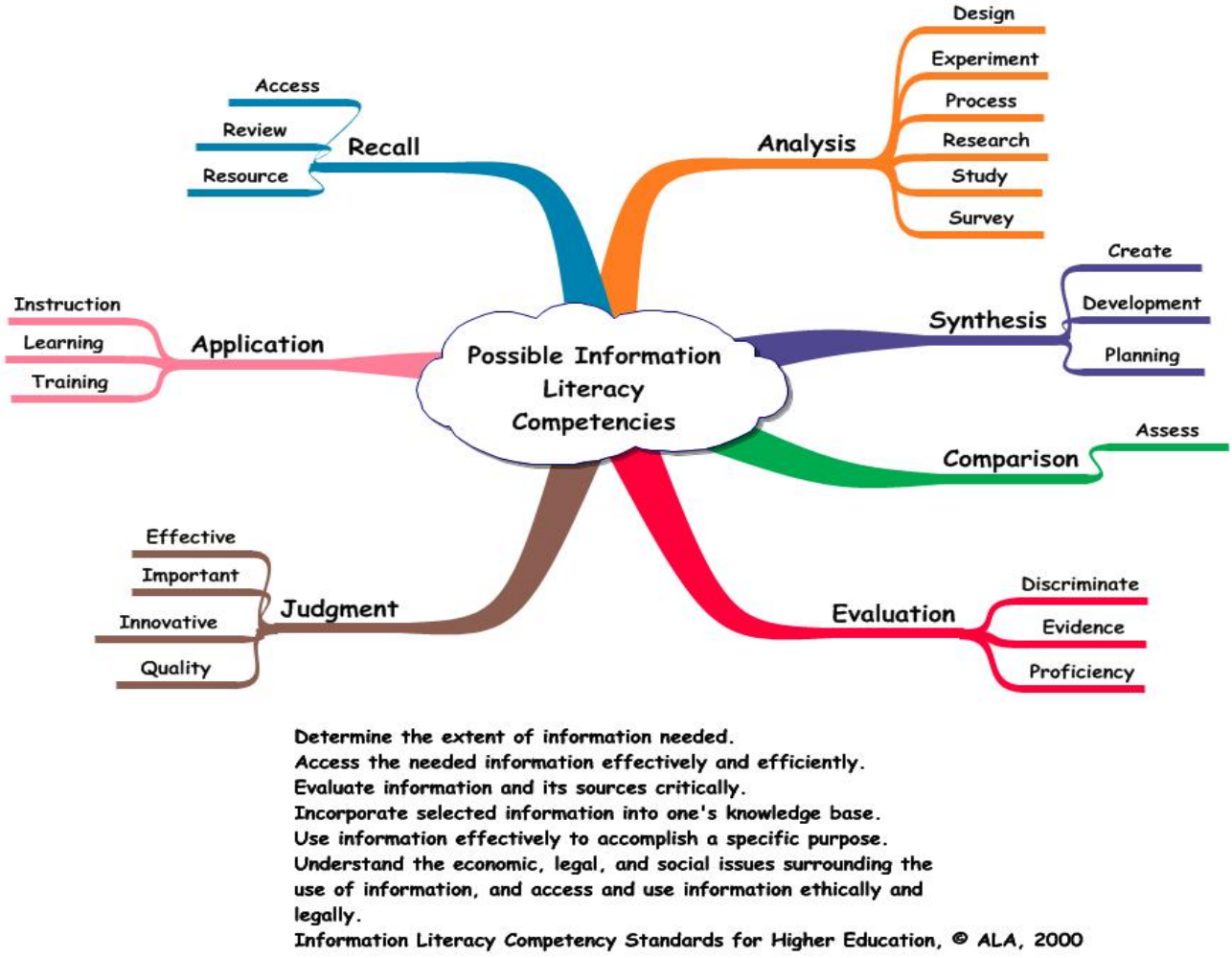
Table 1. Summary of Differences Between [Critical Thinking] and [Information Literacy]

Critical Thinking	Information Literacy
Individualised	Public
Discipline Specific	Across Disciplines
Solve Problem	Solve Problem
Learn New	Continuing Learning
Individual's Status	Decision-making

The differences between [Critical Thinking] and [Information Literacy] can be summarized using two dimensions. The first could be described as the ***degree of formalism***, associated with cognitive processing, ranging from private functions (i.e., [critical thinking] to public [information literacy]). The second could be described as the ***learning behavior employed***. Traditionally, teachers select, organize, and deliver information to achieve student learning. Textbooks provide a step-by-step, linear display of the information. These are commonly used in introducing [critical thinking].

Self-learning implies that the student assumes responsibility for the selection and study of information. The intent of [information literacy] is to make the individual self-sufficient in learning and is consistent with this discovery process.

Figure 1. Information Competences: Terms Linked with the Central Idea [Information Literacy]



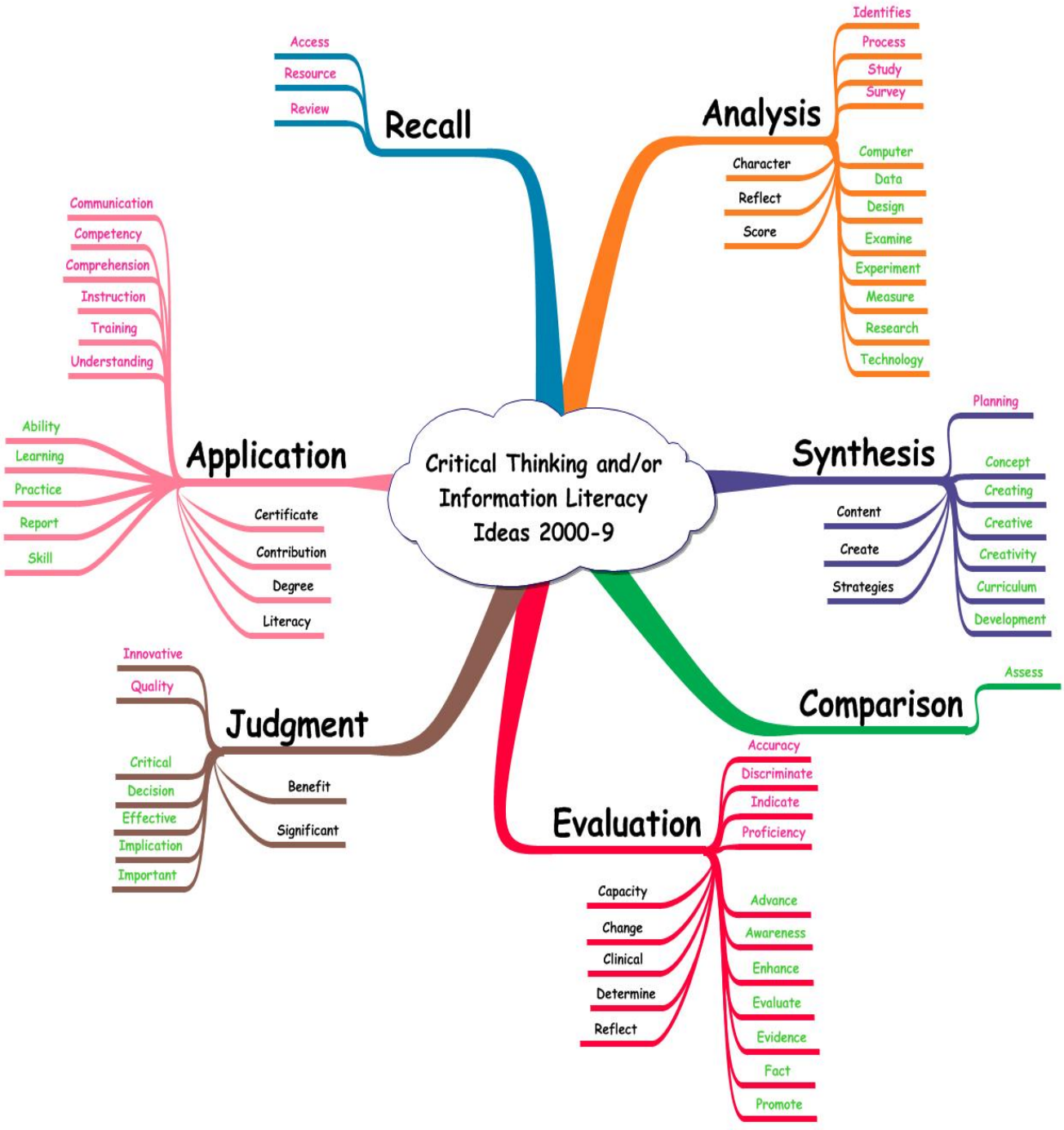
Information Literacy Competencies: Figure 1 shows the terms linked with [information literacy] that might represent the competencies suggested by the Association of College and Research Libraries (ACR, 2000). Classifying them using Bloom's cognitive functions translates these to learnable procedures. For example, the term, ***access*** (recall function), implies a process of identification and retrieval. The term, ***design*** (analysis function), implies a procedure to process essential informational elements in order to accomplish some objective. This translation from strictly mental functions to more public procedures suggests that [information literacy] could serve as a bridge between [critical thinking] as it is presently taught to a process involving more easily and rapidly learned techniques in the identification and management of knowledge.

With their expertise with text and in working with a large number of disciplines, information literacy librarians are positioned to teach the application of formal techniques.

It is possible that the two ideas, [critical thinking] and [information literacy], represent comparable intellectual and information utilisation functions. Figure 2 shows an easy way to explore this. The transitive law in mathematics, if A = B and B = C, then A = C, may apply. The same terms used by different specialists, to represent the two central ideas, may be interpreted as evidence that the two are equal. Terms representing only one of the central ideas may be evidence that the meaning and associated operations are separate.

Figure 2 shows the terms linked with the central ideas, [critical thinking] and [information literacy]. They are shown in the center of the graph. The third terms related to either central idea are shown on the periphery. Those terms were colour coded to represent their affiliation. Terms shown in black were linked with the central idea, [critical thinking]. Those shown in red were linked with the central idea, [information literacy]. Those in green were linked to both central ideas. In order to minimize spurious findings, only the ideas occurring with the highest frequency were included in the graphic. Selection of the higher frequency ideas implies a consensus agreement among specialists. Those ideas are most frequently employed by authors in describing either or both of the central ideas. The colour coding of the third term in each triplet facilitates comparison of the usage associated with the idea.

Figure 2. Terms Linked with Either [Critical Thinking] and/or [Information Literacy] in the Education, Library, and Health Science Literature (2000-2009). Black = [Critical Thinking], Red = [Information Literacy], Green = Both Central ideas.



A presumed major effort in [information literacy] involves identification and retrieval of relevant information. The role of [information literacy], however, is not restricted to the single component of Bloom's taxonomy. Ideas representing [information literacy] were seen in the analysis, synthesis, comparison, evaluation, judgment, and application functions.

Consider the analysis function. There were 15 terms linked with [information literacy] and/or [critical thinking] in this function. Of those, only three were uniquely linked with [critical thinking]. The remaining were linked with [information literacy]. Eight of those terms were linked to both central ideas. These findings support the possibility that authors using the central idea, [information literacy], considered more than recall as a major behaviour in processing of knowledge. The findings also raise the possibility that the two central ideas may have more in common.

The ten ideas, expanding the meaning of *synthesis,* emphasised the important mental processes involved in *concept development* and *creativity*. Six of the terms were linked with both central ideas, while three were linked with only [critical thinking] and one with [information literacy] alone. In terms of number of ideas, [information literacy] had a dominant role in describing the meaning of synthesis. However, those same terms were used in describing [critical thinking], again supporting the possibility that the two central ideas may represent common behaviours and perceptions.

The comparison function contained one idea. Comparison was defined, as "the function used to indicate degrees of superiority or inferiority in quality, quantity, or intensity"[2]. The term, assess, was linked with both [critical thinking] and [information literacy]. The definition of that term was "to estimate or judge the value or character"[3]. The implication suggested is the development of measures, criteria, and procedures designed to accomplish the recognition and ranking of the attributes compared. Traditionally, the comparison function was learned by example and exercise. The use of the same related term to describe the central ideas suggests that more formal techniques to characterise the comparison function could be developed or made more public. Since [information literacy] deals with processing of information and knowledge irrespective of individual disciplines, such methods might be forthcoming from that discipline.

The evaluation function illustrates the different emphasis employed in considering each central idea. [Critical thinking] involved ideas focused on private, mental activities such as ***determine*** and ***reflect***. The [information literacy] ideas included terms such as ***evidence*** and ***fact***. These are more public events. The evaluation function involved seven terms linked with both [critical thinking] and [information literacy]. The meaning of *evaluation* suggested by these ideas would be an *awareness* of the *facts* and *evidence* intended to *advance, enhance*, or *promote* decisions associated with the characteristics being compared.

The meaning of the term, *judgment,* could be expanded to, an *effective* and *important implication* leading to a *critical decision*. The judgment function has five terms involving both central ideas, two involving [information literacy] alone, and two involving [critical thinking] alone. The [information literacy] ideas describe quality and innovation. Both could be considered as more public events. The [critical thinking] ideas describe importance and benefit. These could be based on either private or public criteria.

The ideas in the *application* function suggest that the meaning is an *ability* or *skill* determined by *practice* and *learning* leading to a *report.* The application function has five terms involving both [critical thinking] and [information literacy]. There were four linked with only [critical thinking]. Six were linked with [information literacy] alone. Those included communication, instruction, and training. In contrast, the [critical thinking] only ideas included terms that dealt with results rather

[2] www.dictionary.com [Accessed 24 November 2011]
[3] www.dictionary.com [Accessed 24 November 2011]

than process. Five terms were linked with both central ideas. These were ***ability, learning, practice, report***, and ***skill***. These show the comparability between the two central ideas. ***Ability, learning***, and **skill** may be personal and private attributes but each can be measured using objective means. ***Practice*** is an observable behaviour while ***report*** is a learned procedure.

4. Summary

These findings support the assumption that attributes of a central characteristic do expand and clarify the meaning assigned to that characteristic. The cognitive functions enunciated by Bloom can be translated into tasks by using the attributes as portals to additional descriptors or actions. In addition to better understanding, however, is the enhanced capability for comparing characteristics that may or may not appear to be different. The two central ideas, [critical thinking] and [information literacy], do have a number of attributes in common suggesting that the strengths of each approach can be integrated to form a more effective curriculum and set of operations.

Central Ideas: An analysis of the education, library science, and health science literature focused on two important ideas in information and knowledge processing. Those ideas were [information literacy] and [critical thinking]. The two central ideas were selected for comparison because of the obvious similarity in the definitions of the two. This comparability was even more striking when the third terms, linked with each central idea, were examined.

Involvement in All Cognitive Functions: An important finding was the inclusion of [information literacy]-related ideas in the full range of cognitive functions of Bloom [Bloom 1956]. While current practices appear to be focused on identification and retrieval of relevant documents, researchers in education, library science, and health science have clearly expanded the [information literacy] idea to all of the cognitive functions. This finding would agree with the intent of the idea:

1. To provide the individual with the necessary tools and skills to accomplish lifelong learning.
2. To effectively manage knowledge in the personal and workplace environments.

Text Processing: The relatively large number of abstracts used in the analysis raised another consideration with respect to understanding the similarities and differences between the two central ideas. One way of managing the 16,946 abstracts was by employing a text mining approach [Weiner 1979]. This focused on the identification, extraction, and organisation of the authors' ideas. While the development and creation of an idea may be a personal form of intellectualism, once formed and presented within the context of a sentence, the idea can be identified and extracted. Operationally, this analysis identified combinations of informative terms contained within each sentence and constructed records for each identified combination (i.e., idea).

[Information Literacy] and Research: [information literacy], as a science, could play a role similar to that performed by statistics. Methods from that body of knowledge have been incorporated into essentially every scientific area of study. The specific methods (i.e., from [critical thinking]) in designing, capturing, processing, interpreting, and disseminating results of studies, unique to a discipline, have been combined with the numeric data analysis tools from statistics. That course of instruction is typically introduced to students as research methods. While this 'service-orientation' is important, it represents only a portion of the intent of statistics. There is a scientific component designed to further knowledge in the discipline. This 'pure' science aspect leads to new insights and understandings of the underlying structure and functions of the area of study. A third component, i.e., a 'practical application' approach involves the continued development of new methods to introduce into the research methods environment. These three aspects, taken together represent the realization of statistics.

A similar situation could be conceived for [information literacy]. That body of knowledge may represent a general any-information-set, formalised, quality-controlled process in acquisition and processing of information. The methodology would be available to everyone. The emphasis would be on methods and procedures appropriate and effective for any subject rather than those targeted to a subject.

Development of a New Instructional Program: By merging the information management techniques from [information literacy] with the interpretative experiences and skills (i.e., from [critical thinking]), instruction comparable to the research methods curriculum could be developed. The advantages associated with formalised information and knowledge processing go beyond savings in time and energy to encompass quality-monitored trails in intellectual creativity. These examples of 'creative paths' could be used to help students more rapidly acquire understanding of complex subjects. An example of that approach can be found in mathematics e.g., the proof of theorems.

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