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Using a Pearl Harvested Synonym Ring for the Creation of a Digital Index on Giftedness

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Abstract

This thesis examined the use of a pearl harvested synonym ring in the creation of a digital index on the subject of giftedness, with the goal of better defining the available information in the field and facilitating information retrieval. The pearl harvested synonym ring was used in the retrieval of citations relating to giftedness in the ERIC database. A content analysis of these citations provided the list of topics that would form the basis of a digital index. When the topics retrieved using the pearl harvested synonym ring were compared to the indices of two textbooks on gifted education, they were found to be more comprehensive and better representative of the field. The results of this study have potential implications in the improvement of digital indexing techniques, better understanding of academic fields of study, and creating a standard procedure for scoping reviews.

Keywords**:** pearl-harvested synonym ring, pearl-harvesting information retrieval, information retrieval, topic maps, database indexing, indexing, giftedness, gifted education, scoping reviews, search techniques, digital index

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Introduction

This thesis explored whether a digital index could be created in the field of gifted education from a content analysis of citations found by using a synonym ring on giftedness. The long-term goal is to better define the information that is available in this field, facilitating easier and more precise information retrieval, creating the opportunity for better informed decision making in the field. The following paragraph will give a brief overview of the background for this thesis, which will be described in more detail below.

There is a growing need for precision in information retrieval both for researchers attempting to navigate the vast amounts of data available and for educational practitioners who are expected to make use of evidence informed practice in the classroom. These problems are compounded by information overload and information anxiety, two issues of the digital age that stem from the overwhelming amount of resources that are available to searchers. These issues are not helped by database designs that are not intuitive to users of other digital technologies and that require searchers to be experts in their fields. One solution to searching is the use of pearl-harvested synonym rings. A pearl-harvested synonym ring is a list of search terms that aims to denote all the ways in which a subject is linguistically recorded in the research literature (Sandieson, 2006; Sandieson, Kirkpatrick, Sandieson, & Zimmerman, 2010; Sandieson & McIsaac, 2013). Once the pearl-harvested synonym ring has been developed, it can then be used by searchers to ensure they are covering the various iterations of terminology that exist within the research literature and not missing relevant citations that cannot be found using the more obvious search terms of the subject at hand. Another possible solution to modern search

problems is that of topic maps. Topic maps are an electronic, subject-based data classification technique that originated with endeavors to merge indices (Garshol, 2004; Northedge, 2008). They contain many useful features and have been shown in the research literature to have a number of benefits over more traditional forms of indexing. Unfortunately, there is currently no standard method for the creation of topic maps, which means that there is no guarantee that a particular topic map is a comprehensive representation of the research literature. The present project explored the possibility of using a pearl-harvested synonym ring as a systematic method for the production of topic maps or other e-indexes, particularly where data collection and ontology development are concerned.

Importance of Effective Search Techniques

The ability to find research information is critically important for a number of reasons. One is that there is a growing focus in education on evidence-informed practice, which emphasizes the use of educational programs and practices that have been proven effective by scientific research (Smith, 2003). Where special education programs such as gifted education are concerned, the use of evidence-informed practice is critical to assuring that time and money are well spent, and that the programs in place are truly helping students with exceptionalities. In the United States, evidence-informed practice is legislated as part of the No Child Left Behind Act of 2002. The American government released guidelines as to which kinds of studies are to be used, particularly those with randomized trial designs, and established the Institute of Education Sciences to aid in the research process. In Ontario, the Ministry of Education (2010) released a research and evaluation strategy that promotes evidence-informed and research-informed policy and

programming. Although this approach has not been legislated, it is clear that teachers are expected to use programs and methods that have been proven effective by research.

Effective literature searching is essential to the successful implementation of evidence-informed policy and practice. Incomplete searching can result in the impression that an educational program or intervention is more or less effective than it truly is, which in turn could lead to the use of programs that are unsuitable or the discarding of those that may be useful (Schlosser, Wendt, Bhavnani, & Nail-Chiwetalu, 2006). One way that evidence finding is made simpler for educational professionals is through the use of systematic reviews and meta-analyses. These studies are intended to be less biased than an individual study, and show broad trends rather than focusing on the results of a single study (Valentine, Cooper, Patall, Tyson, & Robinson, 2010). The use of these sources allows a professional to save valuable search time and identify high-quality studies that may otherwise be difficult for them to find (Schlosser et al.). If systematic reviews and meta-analyses are to be relied upon however, it is imperative that they consider the entire body of literature, as missed articles can potentially alter the conclusions reached (Arendt, 2007). Studies undertaken by Valentine et al. (2010) and Arendt (2007) both examined the search terms used by authors of research syntheses and meta-analyses, and found a surprising lack of consistency and comprehensiveness in the search techniques used in these types of studies. The results of these studies indicate that the present state of information retrieval using research databases is less than adequate, making it difficult for educators to access evidence useful for the practice of education.

Pertinent to evidence-informed policy and practice are scoping reviews. That is, at the initial point of investigation research there might not be a clear idea of what research

is available to the decision maker. In this case a scoping review needs to be done in order to get a sense of what might be available to find either existing systematic reviews or to identify where the literature is lacking such that a systematic review needs to be done (or that there are enough primary studies to actually do a systematic review). The Canadian Institutes of Health Research (CIHR) defines scoping reviews as "exploratory projects that systematically map the literature available on a topic, identifying the key concepts, theories, sources of evidence, and gaps in the research" (CIHR, 2014). In contrast to systematic reviews, scoping reviews do not assess the quality of the included studies. They simply provide an overview of the available literature on a topic (Levac, Colquhoun, & O'Brien, 2010). Scoping studies may be undertaken for a number of different purposes, such as "to examine the extent, range and nature of research activity...to determine the value of undertaking a full systematic review... to summarize and disseminate research findings...to identify research gaps in the existing literature" (Arksey & O'Malley, 2005, p. 21). Scoping reviews can be an essential tool towards defining and mapping a large and ill-defined field, such as giftedness.

Another reason for being able to effectively search the research literature is to become knowledgeable of the various viewpoints on a topic. Giftedness is a good example of the need for this due to the wide number of views on what constitutes giftedness. In an educational setting, giftedness has been defined as high achievement or ability in one or more areas including academic pursuits, creativity, athletics, and leadership (McClain & Pfeiffer, 2012). In practice, however, students are most often assessed for giftedness using achievement and intelligence tests (McClain & Pfeiffer). Even when these tests are used, there is little consensus regarding the appropriate cut-off

for gifted identification. Various educational bodies report cut-offs as low as the top 1 percent, or as high as 20 percent (Bélanger & Gagné, 2006). Theories of giftedness are equally disparate. Some require the presence of multiple traits simultaneously; others, such as Gardner's multiple intelligences and Sternberg's theory of successful intelligence, hypothesize that there are different forms of giftedness (Bélanger & Gagné; Grigorenko & Sternberg, 2002). There are also theories that attempt to answer the question of whether children are born gifted, such as the g-based theory that posits a general intellectual ability or the differentiated model of giftedness and talent that distinguishes between natural abilities (gifts) and developed skills (talents) (Grigorenko & Sternberg). In order to effectively find and understand information on giftedness, it is essential to be able to find literature pertaining to all theories, including those that use a different term.

Information Overload

Information overload is a phenomenon that is worthy of our attention in that it is a problem for which effective database organization and searching strategies provide remediation. At its most basic, the term information overload refers to a situation in which there is simply too much information available, making it very difficult for an individual to sort through to find what is relevant (Bawden & Robinson, 2009; Reichardt, 2006). Information overload can lead to information anxiety in which stress affects an individual's ability to access, understand or use necessary information (Bawden & Robinson). One coping method that has been identified is "satisficing". Satisficing occurs when an individual takes only as much information as they need to complete a task, rather than searching through all of the information to find the best and most relevant

(Bawden & Robinson). This means that students, and perhaps even professionals, may be relying on lower quality sources simply because they are the most easily accessible. The amount of information itself is likely not the only culprit here. It has been theorized that databases and catalogues that are more user-friendly and better organized may make it easier to hone in on the most relevant information (Bawden & Robinson). Good database organization might mean straightforward and consistent indexing in order to make searching more intuitive and easier for the user. It could also manifest itself in the use of more keywords attached to each entry, so that they are more likely to be called up during a keyword search. Likewise, better search strategies and information literacy, especially better education of researchers in search strategies and how databases are organized, may increase the likelihood of finding the most relevant materials (Bawden & Robinson; Sandieson, 2006). Information overload combined with poor search strategies make for an even bigger problem for searchers trying to find relevant citations. Due to the amount of information available, good search strategies and an intuitive search framework are essential for refining the available information and finding the most relevant citations.

Database Organization

In order to better understand how research databases (e.g., ERIC, PsycINFO) differ from traditional print sources, it is vital to know how they are structured. Databases are typically organized using subject headings, which are the access point for finding information on specific topics. These subject headings make up a predefined vocabulary of terms used by database indexers, which is referred to as the database thesaurus. The collection of subject heading terms is located in the thesaurus along with their related terms, and is unique to that database. Higher order headings, under which more specific

topics may be found, are used for the sake of efficiency (Barlow, 2009). Subject-based indexing is widely used because it is a straightforward and cost-effective method of organizing information (Cournington, 2010). The thesaurus system allows for multiple indexers to catalogue database entries, which is particularly important given the constant uploading of articles from journals comprising most databases (Barlow).

Unfortunately, there are some disadvantages to the subject-based system. One major problem is that each author or journal may use a different set of terminology, which must then be reconciled by an indexer to match the standard terms used by the particular database they are working on (Barlow, 2009). Indexing is done manually, and individual indexers may index an entry in different ways, which can lead to inconsistencies and therefore difficulties finding entries or related information (Cournington, 2010). There are no published statistics by the database providers as to the accuracy and reliability of indexing.

Search Strategies in the Digital Domain

Electronic and print resources require different strategies for a successful search. Many books contain an index printed at the back of the book, which includes a list of all the topics covered in the work and page numbers for where each topic can be found. These print indices are often arranged in a hierarchical manner, with more specific topics being arranged under more generalized ones. In contrast, database indices contain far fewer topics, due to their broader subject areas and the volume of information that they contain (Barlow, 2009). For example, the PsycINFO thesaurus lists four related topics under the topic “gifted” (creativity, ability, savants, intelligence) and four other topics that are included under “gifted” (exceptional children, talented, intellectually gifted,

geniuses). This does not compare well with the large number of topics that could be found in the index at the back of any textbook on giftedness.

A study undertaken by Berg, Hoffmann, and Dawson (2010) demonstrated the value of indexes and the problems students have using electronic resources even when indexes are available. They compared undergraduate students' search techniques in print books and e-books, to see how the digital format altered their search strategies. Using books that were available in print and e-book format, students completed a series of search tasks in each format. They found distinct differences between search patterns in each format. Students used the index and table of contents in print books effectively, but did not refer to these same resources in the e-books. Instead, participants expected the e-books to contain many of the same functionalities as websites, including full-text searching, advanced search capabilities, and hyperlinks between terms and related content. Many of the participants expected the e-books to be more interactive, with titles, tables of contents, and subheadings that could be clicked and used for navigation. In reality, an e-book is more like a picture of the original text, similar to the way that many journal articles are available to searchers on a database. Additionally, the students were frustrated when the search function in the e-book did not work the same way as the keyword search in a search engine.

The results of this study indicate that search strategies successfully used in print books cannot be automatically transferred to digital sources. The students expected the digital source to mirror other digital technologies, and became lost and overwhelmed when this wasn't the case (Berg, Hoffmann, & Dawson, 2010). It is reasonable then to think that similar problems would be encountered by those searching online databases.

Two major issues with digital sources emerge from this study; the students were unaware that the e-book would have an index, and they expected the search function to work like a web search engine (Berg, Hoffmann, & Dawson). Both of these issues have implications for other digital sources, particularly digital databases. If the students did not think an e-book would have an index, even though the e-book is simply a digital copy of a print book, it is likely that they may also be unaware of the thesaurus found in digital databases. Additionally, if students are attempting to search a database the same way they would a search engine, they will encounter problems such as having difficulty finding relevant citations and potentially missing important information. Search engines are meant to search the full text of a website, whereas database searches are often limited to keywords, or words and phrases found in titles or abstracts, so different search techniques are necessary to most effectively use each technology.

Further evidence of the general lack of understanding in regards to database searching can be found in the use of Boolean operators (AND, OR, NOT, etc.) to aid search precision. In an analysis of 1,000 database searches, Wilson (2006) found that only 12% of searches used Boolean operators, and that an average search contained 2.11 words and 1.13 concepts. Searchers then, seem to prefer searching for a single keyword, rather than trying a number of terms or combinations in the hopes of finding the most relevant information. These difficulties with search strategy are important when we take into account that both students and faculty have been found to prefer digital journals over print journals, and that the main reasons for this preference seem to be searching capability and ease of searching (Liu, 2006).

The type of searchers identified in these studies would likely benefit from a database search system that functioned more like a book index and a traditional search engine. An e-index of a database could fulfill both of these requirements by providing a visual hierarchy like that of a print index, as well as interconnecting keywords in order to increase the number of relevant citations retrieved in a basic keyword search.

Terminology Issues Pertaining to Database Organization

The problems identified with information overload are further compounded in the field of gifted education by the use of a myriad of terms for giftedness, as well as the fact that definitions of giftedness differ between provinces and states, and even between school boards in the same political territory (Dai, Swanson, & Cheng, 2011). Of the 48 US states that have an official definition for giftedness, most use the term *gifted and talented* while others use either the terms *gifted* or *high-ability student* (McClain & Pfeiffer, 2012). If one goes back as far as 1990 a number of other terms appear in state definitions including *extraordinary learning ability*, *talented children, exceptional children/student, outstanding talent, highly capable student,* and *learner with high ability* as well as variants such as *intellectually gifted, creatively gifted, mentally gifted,* and *artistically gifted* (Stephens & Karnes, 2000). This mixture of terms being used in the field of education leads to the same issue cropping up within academic work on the subject, as researchers are influenced by the terminology of their region. This lack of consensus makes it difficult for indexers to ensure that articles are organized to account for these terminological variations, and has led to a body of research that can be a challenge to navigate for students or even academics not intensely familiar with the subject area.

Closely related to the terminological variance within the field of gifted education is an issue of particular importance to the field of education; that of changes in preferred terminology over time. Even though a particular term may no longer be the most acceptable either in academia or society in general, if it was previously the standard term for a particular journal or database, it may still continue to be used there for the sake of consistency (Barlow, 2009). A poignant example of this is the term *mental retardation* in databases such as ERIC. This term still retrieves the highest number of citations, although its use in public is actively discouraged. This is the case even though terms such as *intellectual disability* and *developmental disability* have been around for some time, and since 2005 have become the predominant terms used by authors (Sandieson et al., 2010). This large number of terms within one field of education only compounds the difficulties with database searching previously discussed. Organizing and connecting all of these terms and their related information in a way that is easy for searchers to view and understand may help them to better navigate the field and make searching for information on the topic easier and more precise.

Pearl-Harvested Synonym Rings

The use of pearl-harvested synonym rings are one possible solution to the problem currently affecting searching in digital formats. A pearl-harvested synonym ring offers an efficient and comprehensive method of searching the literature (Sandieson, 2006; Sandieson, Kirkpatrick, Sandieson, & Zimmerman, 2010; Sandieson & McIsaac, 2013). Pearl-harvesting involves the creation of a comprehensive set of keywords, emphasizing recall but considers precision in order to effectively retrieve the most relevant citations. The process for creating this set of keywords, as proposed by

Sandieson (2006) and Sandieson, Kirkpatrick, Sandieson, and Zimmerman (2010), involves first selecting a large, representative sample of articles from the domain. The sample can come from a number of sources, such as meta-analyses and literature reviews, subject area textbooks, and journals focusing on the subject at hand. This sample of articles is then manually analysed within a particular database(s) in order to extract possible keywords. These keywords can be taken from the title and abstract, the language used by the authors, and from the descriptors, identifiers, or subject headings used by the database indexers. These keywords are then compared to the terms listed in the database thesaurus on the topic to ensure no major terms were missed by the process. The keyword list generated in this manner will be a larger and more exhaustive keyword list than that included in the database thesaurus, and represent the language that is used in the research literature. The second step in the process of generating a pearl-harvested synonym ring is to test the precision of the keywords found from the initial search. This is done by individually inputting each keyword into one or more databases relevant to the subject area, and generating a citation list for each one (as well as noting the number of citations per database for each term). The relevancy of each citation is then evaluated, by ensuring that each article included content relating to the desired subject area. This step also yields important information about the precision of each keyword, defined as the percentage of generated citations for the term that were determined to be relevant. The next step involves refining the list of keywords through the use of truncation symbols, quotation marks, and the elimination of redundancies. Truncation symbols are symbols that can be used in a database search in order to retrieve all of the citations for words with the same stem in a single search. For example, using gifted* (where * is the truncation symbol)

will retrieve citations for ‘gifted’ and ‘giftedness’ in a single search. These can be utilized to refine the list of search terms and cut down on the overall number of searches necessary to retrieve all relevant citations. Quotation marks are another useful search tool that can be used to group two or more words together as a single search term and thus increase precision for terms that retrieve a large number of citations. For this reason, the pearl-harvested synonym ring uses the term “high achieve*” rather than the more general term ‘achieve*’. ‘Achieve*’ searched on its own would retrieve citations relating to achieve of all types, including low achievement and achievement in fields unrelated to gifted education. In the ERIC database, ‘achieve*’ retrieved 66,997 citations from scholarly journals, whereas “high achieve*” retrieved a much more manageable 1377 citations. Finally, the keyword list needs to be validated, either by comparing the list to the list of words used in meta-analyses or systematic reviews to see if “expert searchers” used any other relevant terms, or by comparing the list to another list of keywords for the field, such as a database thesaurus. A comparison with a meta-analysis or systematic review would involve using the pearl-harvested keywords to recreate the search conducted in the comparison study, following the same search criteria and tests for relevancy as the study author (such as date restrictions and databases used). The set of citations generated by this search is then compared to the list of citations found by in the study to determine if the pearl-harvested keywords were able to find all of the same citations, as well as other relevant citations that were missed by the study author’s search. This process allows for the testing of the comprehensiveness of the pearl-harvested keyword list (referred to as the pearl-harvested synonym ring) compared to traditional “expert” searches, and to what extent it is an improvement over these more standard

search methods. The pearl-harvested synonym ring for giftedness includes the following 53 keywords, which together are able to retrieve a comprehensive list of relevant citations in a database search (Sandieson & McIsaac, 2013):

> gifted* OR "high achieve*" OR "high abilit*" OR talented OR eminent OR genius OR "able student*" OR "precocious child*" OR "precocious read*" OR "math* precocious" OR "precocious kid*" OR "precocious learner*" OR "precocious music" OR "precocious talk*" OR "linguistically precocious" OR "intellectually precocious" OR "high IQ" OR "high* intelligen*" OR "advanced placement course*" OR "more able student*" OR "superior student*" OR "bright student*" OR "enrichment course*" OR "high aptitude" OR prodigy OR "accelerated student*" OR "superior abilit*" OR "elite student*" OR "superior academic" OR "high academic abilit*" OR "high cognitive abilit*" OR "advanced abilit*" OR "highly able" OR "bright child*" OR "superior intelligen*" OR "academically advanced" OR "academically superior" OR Mensa OR "intellectually superior" OR "able learner*" OR "superior IQ" OR "superior cognitive abilit*" OR "intellectually advanced" OR "high potential student*" OR "high potential learner*" OR "superior thinking" OR "accelerated learner*" OR "superior learner*" OR "advanced learner*" OR "advanced student*" OR "elite child*" OR "advanced placement program*"

I investigated whether the use of these keywords might serve as the basis for ontology development of the domain of giftedness. Each of the 53 keywords above found unique citations (those not found by any of the other keywords in the synonym ring) in the field of giftedness (Sandieson & McIsaac, 2013). Therefore, the investigation here was whether the collection of these terms might represent the field of giftedness, and each of these terms find unique citations. It is reasonable to presume that these unique citations may also retrieve ALL the unique topics for inclusion in the e-index on giftedness. It follows then, that by doing a content analysis of the topics retrieved by these terms and organizing the retrieved topics by the keyword(s) that retrieved them, a complete index of topics on giftedness might be found. As such, this would be a powerful, systematic (i.e. replicable) method for creating digital indexes in general.

Topic Maps

Another possible solution to the problems at hand are topic maps. Topic maps build on the framework of a book index but have many unique and useful features made possible by their web-based format, and are perhaps better suited than a traditional index to indexing the digital realm. Topic maps allow the searcher to retrieve information not only on the topic searched, but also on related topics. Since the citations are not retrieved by keyword occurrences, but rather by the main ideas in the citations (referred to as topics), topic maps retrieve fewer, but more relevant, citations (Venkatesh et al., 2007). Like an e-index to be developed here, topic maps aim to build on and improve searching and data retrieval, but where topic maps are based on print indices, our e-index seeks to apply some of the same principals to the indexing of databases. Although the e-index will not contain all of the functionalities of a topic map due to time and technological constraints, it will be developed with a focus on topics, and how these topics are related to one another and to the keywords found in the pearl-harvested synonym ring. The basis for topic maps are the topics themselves. Topics represent the main ideas or concepts in whatever medium the topic map is being created from, and are similar to the terms used in a database thesaurus (Pepper, 2002). Each topic has four attributes: name(s), type, relationships, and occurrences. In order to fully appreciate how topic maps are developed, it is crucial to understand how these attributes are used within a topic map, and how they interact with one another.

In a topic map, each item (called a topic) must be assigned one or more names (Pepper, 2002). Assigning multiple attributes to a single topic ensures that it can be retrieved using a number of relevant search terms; thus making the data more accessible.

These different names can be synonyms, historical terms, or even the same term in another language (Northedge, 2008). For example, a topic map dedicated to opera would likely have many topics named in both English and other languages such as German and Italian. Unlike other forms of indexes, topic maps may have more than one topic of the same name, which will be differentiated by their type (Garshol, 2004). For example, "Rome" could be included twice as a topic, once as the city and once as the ancient civilization. The use of different names for the same topic would make searching a topic map similar to searching a web search engine, in that it is not always necessary to input an exact keyword in order to retrieve relevant data, because the search engine is able to understand that two keywords might mean the same thing.

In order to categorize and identify the topics in a map, it is necessary to divide them into a number of types (Pepper, 2002). These types help to identify the type of data that is represented by a specific topic, for example person, place, or book (Northedge, 2008). Types become particularly useful when a map includes two topics of the same name, for example the entry "Emma" could refer either to a person or to the Jane Austen book of the same name. Additionally, all types must be included in the map as topics and properly defined (Northedge). In a traditional index, types are sometimes identified using different formatting such as bold or italic font, but this convention is not easily translated into a searchable online format (Northedge; Pepper). Types can also allow the searcher the option of searching only for topics of a particular type, thus excluding irrelevant data and making their search results more relevant and manageable (Garshol, 2004; Pepper).

Perhaps the most important and useful aspect of topic maps over other forms of information management is the use of relationships (also sometimes referred to as

associations). The relationships feature allows an indexer to program in a link between two topics, and define this link within the map (Northedge, 2008; Pepper, 2002). A topic map on literary classics would likely contain entries for Jane Austen and Pride and Prejudice. These entries would then be connected in the map, with a relationship added showing that Pride and Prejudice was written by Jane Austen. In this example, "written by" is the relationship, as it would appear in the topic map. The relationship function facilitates searching as it allows a search query to bring up not only the topic requested but also suggestions for related topics that might also be of interest (Cournington, 2010). In this way, searchers are able to find more relevant results much more quickly than in a traditional database that relies on keyword indexing. Likewise, having access to a topic map on a subject could allow a searcher to explore relationships between topics and possibly discover related areas that they may not have thought to include in their search. This extra thoroughness could ensure that the searcher finds more relevant citations, without much extra searching.

Finally, a topic map requires that all occurrences of a particular topic be attached to it in the map (Pepper, 2002). Often, this is done by way of URL links (Northedge, 2008). In a topic map of an academic journal, this would mean that each article would be attached to any topics with which it is associated. Rather than assigning keywords to each article, as a traditional system would do, in a topic map the articles would be assigned to the topics (Garshol, 2004). Although this is similar to the keyword system used by databases, the use of multiple names for a topic and additional connections forged by defining the relationships between topics mean that an article in a topic map is searchable by a broader array of terms than in a database. An article could be retrieved not only by

an exact keyword, but could be found by searching the topic itself, another of the names associated with that topic, or possibly even by searching for a closely related topic. These additional ways of retrieving an article make it more similar to both a book index and a web search engine, and thus more user-friendly.

Topic Map Development

The basis of topic map creation is the development of an ontology for the domain at hand. In an information technology context, an ontology can be defined as a method of organizing data in a way that describes reality, and which can be communicated to and understood by other people and computers (Venkatesh et al., 2007). This thesis aims to develop a domain ontology in the field of giftedness and gifted education, like what would be required as the first step for the creation of a topic map. The first step in this process is to select the content for the topic map, whether this is a single book, or an entire database. The second, and most essential, step in topic map creation is the development of an ontology based on the chosen content (Venkatesh et al.). There is no standard method of ontology creation, with common methods ranging from fully computerized to completely manual and combinations of the two (Pattuelli, 2011; Venkatesh et al.). The topics chosen for inclusion in an ontology can be gathered from a variety of sources that will vary depending on the purpose of the topic map, such as text analysis of the materials to be included in the topic map, thesauri of subject specific databases or dictionaries, indexes of relevant books, journals, or encyclopedia, or expert knowledge of the domain (Pattuelli). For example, if one were creating a topic map for use by high school students they would likely consult curriculum documents and textbooks for key terms in addition to using other sources relevant to the subject. The

next stage in ontology development is the organization of the identified topics into a conceptual framework. This process involves analyzing and identifying the relationships between topics and organizing them in such a way that these relationships are evident, be that through the use of a concept map or a digital system such as a topic map platform (Pattuelli). Once an ontology has been developed, the creation of a topic map is fairly straightforward, and involves the insertion of the topics and associations identified in the creation of the ontology into a topic map platform. Once this basic data has been entered, the topic map author can then add specific occurrences of the topics, details about the nature of the associations between topics, and any other relevant information, such as alternative names for a topic (Venkatesh et al.). What is most significant here as it pertains to this thesis is the lack of a comprehensive, standardized framework of topic map creation. This means that there is also no standard when it comes to the quality and comprehensiveness of a topic map itself. If topic maps/eindexes are ever to become a useful tool to facilitate the discovery of research database information, we first need to ensure that topic maps are created using an efficient, standard methodology, in order to ensure their reliability and ease of use.

The Efficacy of e-Index Structures

A recent study conducted by Yi (2008) compared a topic map based system to a more traditional thesaurus based system in terms of information retrieval. The participants, all undergraduate students, answered both fact-based and relationship-based queries in two search systems developed for the study. One system was thesaurus based and the other used a topic maps based ontology. Participant success was determined based on recall (the percentage of relevant documents retrieved) and search time. The

study found that when it comes to straight fact-based searches, the two systems were roughly equal. When it comes to searches focused on the relationship(s) between two topics however, the topic maps based system was much more effective, with a 76% success rate on recall compared to an only 43% success rate for the thesaurus based system. Likewise, the search time for the topic maps based system (89.6 seconds) was less than half that of the thesaurus based system (191.8 seconds) when used for relationship-based queries. Relationship-based queries are defined in this study as those involving two or more concepts, such as "security system engineer who specializes in network security". In this example, security system engineer would be one concept, and network security would be another.

A similar study compared topic map based search and retrieval to a standard keyword system (Venkatesh et al., 2007). Participants had 30 minutes to answer two questions. Half used a keyword based search engine and the others used a topic map of the subject area. Participants were given two questions and asked to identify themes related to these questions. Although the number of themes identified was similar for both groups, those who used the topic map identified more relevant themes in their answers to the questions. After the experimental portion of the study was completed participants were given an opportunity to try the other information retrieval system, in order that the researchers could compare user perceptions of both systems. All participants preferred the topic map over the traditional search engine.

A study conducted by Pattuelli (2011) involved a survey of six middle and high school social studies teachers regarding their use of and search for digital reference materials, particularly digital primary source material. Each teacher was interviewed and

asked a series of ten open-ended questions regarding the teaching of history and their use of and searches for primary source materials. These questions informed the researchers about the types of materials the teachers prefer, how they use them in the classroom, and their search strategies for finding these materials. The survey found that teachers valued efficiency in their searching and were often overwhelmed by the number of search results returned by search engines and the difficulty they had in narrowing these down to relevant items. The information gathered from these interviews was then used to inform the process of creating an ontology representing a selection of digital primary source materials from a museum collection. This ontology took the form of five topic maps, each covering a curriculum expectation relating to the Great Depression. A concept map is a visual representation of a subject, and shows the main topics associated with that subject and the relationships between those topics. Concept maps are arranged in a tree-like structure, with the main concept at the top and related topics branching off from one another. They can contain short descriptions about the relationship between two topics ("Wife" is a member of "Family") and will sometimes use arrows to portray a directional relationship between two topics. A concept map differs from a topic map in that a concept map is only a visual representation and does not include the depth of data available in a topic map. A concept map would not include important attributes of a topic map such as multiple names for a topic, the nature of the relationships between topics, or links to occurrences of those topics in the database on which the map is being based. However, advantages found in a concept-map model may also translate to a topic map model, and be further enhanced by the additional features found in a topic map. The keywords chosen for inclusion in the concept map were determined manually, due to the

small size of the collection being studied. The researchers analyzed the documents and texts included in the primary source database in order to extract concepts and used a variety of reference materials to ensure the accuracy of the terms that they chose to use to describe those concepts. Curriculum expectations were used as the basis for the structure and division of the concept maps, since the primary goal was to develop an ontology that would be useful to history teachers searching for this material. The final stage of the study was to evaluate the utility of the ontology by comparing it to a keyword-based search system, in this case Google. The participants first given two questions to be answered using Google, then given two different questions to answer using the primary source database. After completing both searches, the participants were given a paper search interface developed from the five concept maps and asked to redo their searches of the primary source database using the interface to inform their search terms. The results of Pattuelli's study showed that teachers used a very limited set of keywords when searching in Google, almost exclusively terms used in the question they were working from. Participants had difficulty obtaining resources that were as specific as they wanted. In contrast to this, the paper based interface made a noticeable difference in the searches performed in the primary source database. In addition to using a higher number of relevant keywords in their searches, teachers using this model commented that it helped them to choose the right variants of certain keywords and prompted them to use keywords that they may not have thought of on their own. In their first question searched in the primary source database, use of the paper based interface led to an increase in the total number of search terms used (28, compared to 13 before the introduction of the interface) and a decrease in the number of search terms derived directly from the

question. Similar results were obtained from the second question searched using the same procedure. Overall, the participants found the paper based interface and concepts maps to be useful search tools, stating that having access to the keywords and hierarchies used in the database enabled them use the correct keywords and inspired them to use keywords they otherwise may not have utilized. This study shows the advantages of highlighting the relationships between topics (as the concept maps and paper based interface did) and the benefits that this type of system can have for searchers.

The results of these three studies highlight the potential advantages of topic maps. For anyone searching for information on a topic, overwhelmed by the quantity of data available, the limited evidence that is available indicates that the relationships between topics that are highlighted in this system can make information retrieval more comprehensive, accurate, and less time consuming. The process of creating a topic map would yield a product quite similar to the concept map used by Pattuelli (2011). Although a topic map would take this to another level by adding links and references to specific articles and resources, it is based on the idea of interconnected and related subjects similar to a concept map. Indeed, one of the key steps in the creation of a topic map is the identification of subjects (known as topics in the topic map literature) and the associations between them. By identifying as many relevant topics as possible and highlighting the relationships between them, it may be possible to build upon the currently identified keywords to ensure a more complete and efficient search strategy, particularly when looking for information in more specific areas of the field. Additionally, the process of creating a topic map on giftedness may allow for the development of a more thorough understanding of what information is available on the

subject. Also, it may evidence where deficiencies exist in the database system, and in their thesauri, that make some information difficult to find. This knowledge can then enhance the indexing process in creating more user-friendly databases.

Methodology

The present investigated whether the creation of a digital index can be devised using a pearl-harvested synonym ring. In this study, the pearl-harvested synonym ring was used as a means of generating the list of topics that form the basis of a digital index.

The first step was the use of the pearl-harvested synonym ring developed by Sandieson and McIsaac (2013) as representing the 53 unique and relevant terms for expressing giftedness. This served as the basis for the searches conducted in the ERIC database. ERIC was chosen over other databases such as PsycINFO because of its primary focus on education, and the fact that it contains articles from a large number of peer-reviewed journals. The citations located by a single search term were found by conducting a search by entering a single keyword/key phrase of the synonym ring into the first line of the search, then entering all remaining keywords into the second line of the search, connected by the Boolean NOT. This ensured that the citations found were ones generated by the first keyword independent of the other keywords. The search was also restricted to include only peer-reviewed journal articles, in order to control the quality of the citations, and to be able to properly compare and contrast the citations and topics generated from them.

The number of citations produced on the subject of giftedness was extremely large. Indeed, at the time of writing, a search in the ERIC database using the keyword

"gifted" retrieved 15,622 citations. Rather than attempt to review the entire data set in gifted education, this thesis used a random sample of these citations to review. A sample size calculation was done based on the total number of citations retrieved, at the 95% confidence interval, when a keyword retrieved more than 200 unique and relevant citations. When a keyword retrieved less than 200 citations, all citations were reviewed. The sample size calculated was then input into a random number generator in order to determine which of the retrieved citations should be used, in order to have as random a sample as possible.

Then a detailed content analysis of the topics of the retrieved citations was completed in order to see what topics related to giftedness were uncovered. This process was then repeated with each keyword in the list, and a comprehensive list of topics representing that area emerged. The content analysis involved reviewing the titles, abstracts, and keywords of each citation in order to determine the key topics represented by the article. Tables were created for each keyword, showing the citation information and the topics generated. An example of the table created for the keyword "enrichment course" is shown in Table 1.

Table 1: "enrichment course*"

Citation Information				
A Basic Microbiology Course for High School Students *Yip, Cheng-Wai*	Secondary school	Science Education; microbiology	Hands-on learning	
An Introduction to the Developmental Student and Antisocial Behaviors on the College and University Campus. *Bennett-Johnson, Earnestine*	Post Secondary	Violence	Developmental students, honours students	Crime, vandalism
Foxfire in American History: An Experiment. *Wilder, Jenny*.	Secondary Education	History Education; American history	History Project	Primary Source Materials

Once the searches were completed using each keyword in the pearl-harvested synonym ring, the topics generated were entered into a table (see Appendix 2) showing which keywords retrieved which topics and the frequency of each. During this step some refinement of the topic names was done in order that each topic could be represented in the data using a single term, with the most common terminology among the citations being chosen for inclusion, with an external evaluator checking for consistency. In many cases this simply involved very specific terms being grouped together under a more common, overarching term such as the topic "mathematics education" being used for

citations about arithmetic and calculus. This was done in order to more accurately show the relationships between topics and keywords, since having a topic split into two or more different terms could make it appear less prevalent than it really is, and artificially inflate the total number of topics found. This table demonstrates how likely a particular search term was to retrieve citations related to a specific topic, which in turn shows where important relationships occur.

Next, validation of the index was done by comparing it to the indexes of two textbooks on the subject of giftedness. The two textbooks that were used are *Education of the Gifted and Talented, 6th ed.* (Davis, Rimm, & Siegle, 2011), and *Growing Up Gifted: Developing the Potential of Children at Home and at School, 8th ed.* (Clark, 2013). These textbooks were chosen because they were recommended by an expert in the field of giftedness as being comprehensive and representative of the field, and they have both had multiple editions, attesting to their popularity. The textbook comparison tested if there were any topics missed by this methodology, and how comprehensive the textbooks and their indices are by comparison. A data extraction table was created to record the topics found by the content analysis and how they compare to the topics contained in the textbooks (see Appendix 1). In order to make the comparison easier to carry out, the topics from the content analysis were divided into categories. This allowed the textbook topics to be more easily compared to the extensive topic list from the content analysis, rather than relying on them using the same terminology. The table shows the topics generated from the content analysis, the topics found in the textbooks, topics unique to the content analysis, and topics unique to the textbooks.

In order to determine the relevancy of the topics unique to the textbook, they were each searched in ERIC along with the entire pearl-harvested synonym ring. They were searched with the pearl-harvested synonym ring in order to limit the results to those pertaining to giftedness, while still ensuring that as many citations as possible were retrieved. The search was limited to only peer-reviewed journal articles, in order to mirror the search conditions of the original searches. Each of the citations retrieved in this manner was then reviewed in order to determine if it was relevant to the study (related to both the topic being searched and to giftedness). This involved reviewing the title, abstract, and keywords, and in some cases the full text of the article if relevancy could not otherwise be determined or an abstract was not available.

Results

First, this chapter will report the topics discovered by searching the ERIC database using the pearl-harvested synonym ring. Next, the relationships of the topics to the search terms in the synonym ring and to one another will be reported. The frequency with which the topics occur in relation to specific search terms will be examined, in order to expose patterns in the data. This chapter will also compare the topic list generated using the pearl-harvested synonym ring to the topics found in the indices of two textbooks on gifted education. Finally, this chapter will discuss how effectively this process could be used towards the creation of an e-index in the field of gifted education, and the implications this has for indexing and database creation.

A total of 461 unique topics in the ERIC database were discovered using the pearl-harvested synonym ring developed by Sandieson and McIsaac (2013); see Appendix 1.

The search process highlighted a number of patterns between search terms from the synonym ring and the topics they retrieved. The strongest of these relationships was exhibited with topics related to level of education, such as elementary school, secondary school, post secondary, and adult education. There are a number of search terms that primarily retrieved results related to only one of these topics. For instance, the search terms "advanced placement program*" and "advanced placement course*" both retrieved results mostly related to secondary school, and more specifically to the AP (advanced placement) Programs in high schools in the United States. Another striking difference is that the term "gifted" seems to be most closely related to elementary school, while citations on the topic of post secondary were more likely to use the term "talented". The term "high abilit*" was equally related to both elementary school and secondary school. These relationships are exhibited most clearly in Appendix 2.

In addition to the relationships between search terms and different levels of education, there exist a number of relationships between search terms and other topics. For example, the terms "high cognitive abilit*" and "high IQ" were both associated with topics such as IQ and WISC. The term "talented" was strongly related to science education, with a high proportion of those citations referring more generally to STEM (Science, Technology, Engineering, and Mathematics) fields. "Talented" was also associated with citations on the topic of minority students, especially where identification of talented minority students was concerned.

Textbook Index Comparison

The comparison of the topic list generated using the pearl-harvested synonym ring to the indices of two textbooks on gifted education resulted in a combined total of 171 topics unique to the textbooks and not retrieved using the pearl-harvested synonym ring (see Appendix 1). *Growing Up Gifted : Developing the Potential of Children at School and at Home, 8th Ed.* (Clark, 2013) contained 108 unique topics, while *Education of the Gifted and Talented, 6th Ed.* (Davis, Rimm, & Siegle, 2011) contained 105. Four of the topics were found in both textbooks. When these 209 topics were searched in the ERIC database along with the entire synonym ring, which on its own generates more than 12,000 citations, only 16 of them yielded 10 or more relevant results. 8 topics yielded 20 or more results, and "community" was the only keyword to yield more than 100 relevant results. 129 of the keywords yielded no relevant results when searched with the synonym ring, meaning that rather than being "missed" in the research process they are simply unique to those textbooks and are not present in the literature on gifted education that exists within the ERIC database. This includes topics such as "houndstooth pattern", "McTalent burger", "unschooling", and "Word-Search Puzzles". They were often keywords relating to specific interventions, teaching strategies, or people, and not ones that would be expected to be commonly found in the research literature. Appendix 3 shows the list of topics unique to the textbooks and the number of relevant results found in ERIC for each one.

Discussion

The results of this study demonstrate the unique benefits of using a pearl-harvested synonym ring as the basis for the e-index development process. It is a simple and straightforward method for creating a comprehensive list of topics in a particular subject area, and for discovering the relationships between topics and keywords.

The pearl-harvested synonym ring allows the user to retrieve more relevant citations than a regular keyword search, thus producing a more comprehensive and representative picture of the field of study. Using only common search terms would not only miss a large number of relevant citations, as demonstrated by Sandieson, Kirkpatrick, Sandieson, and Zimmerman (2010), but would also cause the searcher to miss a majority of the relevant citations on specific topics that are strongly related to less common search terms. The results above and the data in Appendix 2 demonstrate how topics in the literature can be closely related to specific search terms. For example, not including the search term "advanced placement program*" in this study would cause one to overlook almost all of the citations related to the International Baccalaureate degree program, and many of the citations related to Advanced Placement courses in the American high school system. Both of these topics are significant to the field of gifted education, and missing them would provide an incomplete and inaccurate picture. Thus, the use of the pearl-harvested synonym ring can play an important role in ensuring that a complete and representative picture of the research literature is formed.

The relatively small number of relevant topics missed by this process shows the benefits of using a pearl-harvested synonym ring as a basis for database searching and

topic generation. The textbook comparison is also a key step in ensuring that any topics missed due to sample error can be found and included. There are a number of reasons why topics may have been missed by the search process, including sample error, limitations within the search capabilities of the database, and coding errors. Analyzing the list of missed topics allows for refinements to be made to the search and coding process, in order to minimize the number of topics missed by the synonym ring and ensure that the topics generated by the process are as representative of the field as possible.

The comparison between the topics retrieved by the pearl-harvested synonym ring and those in the textbooks highlights the efficacy of this method for the purpose of indexing large amounts of data, such as would be found in a database. Current database systems rely on subject based indexing through the use of database thesauri (Barlow, 2009). An e-index system based on a pearl-harvested synonym ring could provide a more complete list of topics in each area, as well as additional data about the ways those topics are related to each other and common search terms. The textbook comparison also showed that topics relevant to a textbook will not necessarily also be relevant to the citations retrieved from a database. The different nature of the material contained in the two formats requires that different strategies be used to appropriately index them.

A potential use of the process developed in this thesis is for scoping reviews. The primary goal of a scoping review is to provide an overview of the literature on a topic (Levac, Colquhoun, & O'Brien, 2010). As this study demonstrated, the use of a pearl-harvested synonym ring to facilitate database searching is a systematic method for generating topics and creating a complete picture of a field. At present, there is no

standard systematic method for the completion of a scoping review, meaning that they will vary in content and quality depending on the search process used by the researcher. An efficient, systematic method is vital to ensuring that scoping reviews can be trusted to contain a comprehensive overview of a topic, and are not missing relevant subtopics that simply aren't generated by the most common keywords. The method presented in this study ensures the comprehensiveness of such a study, and is also able to be implemented in a straightforward and timely manner.

A second common use of scoping reviews is to find gaps in the research literature (Arksey & O'Malley, 2005). The process used in this study of executing searches based on the pearl-harvested synonym ring, coding the citations, and then comparing them to another source (in this case subject-specific textbooks) could be used in the context of a scoping review to identify unexpected gaps in the research literature. The textbook comparison identified a number of topics which, based on their inclusion in the textbook indices, were clearly of interest to the field of gifted education, but which were lacking from the research available in the ERIC database. This information could be used to inform researchers of areas in need of future study or systematic reviews.

The process for creating an e-index used in this study has potential uses far beyond that of database indexing. With refinement and future research it has the potential to streamline a search process, improve database and other digital forms of indexing, provide a systematic method for conducting scoping reviews, and better define broad fields of study. The pearl-harvested synonym ring has proven to be a valuable tool for information retrieval, and its ability to find the most possible relevant citations indicates it can be an important tool for indexing and navigating databases.

Appendix 1.

Category	Topics	Textbook Comparison	Topics not found in Textbooks	Topics unique to textbooks
Age/Grade Level	Post Secondary			
	Secondary Schools	Secondary Schools (G)		
	Elementary Schools	Elementary Schools (G)		
	Early Childhood Adult Education	Early Childhood (G)	Adult Education	
	Graduate Studies		Graduate Studies	
	Post Graduate		Post Graduate	
	Continuing Education		Continuing Education	
	Adults	Adults (G)		
				Babies/Infants
Subject Learning	Mathematics Education	Mathematics Education (G)		
	Science Education		Science Education	
	Teacher Education	Teacher Training (G)		
	Nursing Education		Nursing Education	
	Social Studies Education		Social Studies Education	
	English Education		English Education	
	Literature		Literature	
	Journalism		Journalism	
	Computer Science Education		Computer Science Education	
	Spelling		Spelling	
	Geography Education		Geography Education	
	History Education		History Education	
	Language Learning	Language Learning (G)		
	Liberal Arts		Liberal Arts	
	Art Education	Art Education (G)		
	Reading	Reading (G)		
	Writing	Writing (G)		

	Dance /Drama Education Philosophy Education Medical School Engineering Education Food and Agricultural Sciences Paramedic Education Psychiatry Education Business Education Humanities Education Library Education Environmental Science Education Spanish Language Education Psychology Education Architecture Education French Language Education Archaeology Education Second Language Learning Music Education African American Studies Poetry Economics Education Peace Education Latin Education Vocational Studies International Education College Preparation Interdisciplinary Studies Communications Education	Drama Education (E) Music Education G) 	 Philosophy Education Medical School Food and Agricultural Sciences Paramedic Education Psychiatry Education Business Education Humanities Education Library Education Environmental Sciences Education Spanish Language Education Psychology Education Architecture Education French Language Education Archaeology Education Second Language Learning African American Studies Poetry Economics Education Peace Education Latin Education Vocational Studies International Education College Preparation Interdisciplinary Studies Communications Education	Character Education

People	John Baer Lauretta Bender Charles Dickens Albert Einstein Michael Faraday Judy Lupert Mara Sapon Shevin Robert Sternberg Luis Alvarez Neil Slater Benjamin Bloom Leta Hollingworth Roberto Assagioli	Robert Sternberg (G) Benjamin Bloom (G)	John Baer Lauretta Bender Charles Dickens Albert Einstein Michael Faraday Judy Lupert Mara Sapon Shevin Luis Alvarez Neil Slater Leta Hollingworth Roberto Assagioli	Historically Eminent Persons
Exceptionalities / Students with Special Needs	Language Disorders Learning Disabilities Multiple Exceptionalities Developmental Students Deaf/Hearing Impaired Students Attention Deficit Hyperactivity Disorder Autism Spectrum Disorder Intellectual Disabilities Verbal Precocity Speech Impairment Savants Blind Students Cerebral Palsy	Learning Disabilities (E) Twice Exceptional Students (G,E) Hearing Impairments (G) Attention Deficit Hyperactivity Disorder (G,E) Speech Impairments (G) Savants (E) Blindness (G)	Language Disorders Developmental Students Autism Spectrum Disorder Intellectual disabilities Verbal Precocity Cerebral Palsy	

	Asperger's Syndrome Disabilities Hearing Underachiement Dropouts	Asperger's Syndrome (G,E) Disabilities (G) Underachievement (E,G) Dropouts (G)	 Hearing	 Highly Gifted Children
Programs and Placement	"Star" Schools Advanced Placement Open Enrollment Acceleration International Baccalaureate Programs International Schools Early Entrance Bridge Programs Dual Enrollment Honours Programs Private Schooling Summer Programs Programming Pullout Programs Homogenous Grouping Inclusion Heterogeneous Grouping Residential Programs Enrichment Homeschooling Apprenticeship Urban Schools International Exchange	 Advanced Placement (E) Acceleration (E,G) International Baccalaureate Programs (G,E) Early Entrance (G) Honours Classes (G) Summer Programs (E) Gifted and Talented Programs (G,E) Pullout Programs (E, G) Homogenous Grouping (E) Inclusion (G) Heterogeneous Grouping (E) Residential Programs (E) Enrichment (G,E) Homeschooling (G)	"Star" Schools Open Enrollment International Schools Bridge Programs Dual Enrollment Private Schooling Apprenticeship Urban Schools International Exchange	

	Public Education Jewish Schools Special Schools Catholic Schools Montessori Bilingual Schools Elite Schools Training Schools Community College Placement Cooperative Education Rural Communities Workplace Inner City Schools Distance Learning Internship Course Enrollment Program Planning Transition Early Intervention College Credit	Special Schools (G) Placement (G) Rural Communities (G) Distance Learning (E) Program Planning (E) College Credit(E)	Public Education Jewish Schools Catholic Schools Montessori Bilingual Schools Elite Schools Training Schools Community College Cooperative Education Workplace Inner City Schools Internship Course Enrollment Transition Early Intervention	Team Teaching
Social/ Cultural Factors	Black Schools Gender Minority Students African Americans Hispanic Students Nationality Multiculturalism International Students Ethnicity	Gender (G,E) Minority Students (E) African Americans (G) Hispanic Students (G) Multiculturalism (G) Ethnicity (G)	Black Schools Nationality International Students	

	Socioeconomic Status Immigrants Asian Students First Generation Students Racism Age Religion Culture Aboriginal Students Opportunity Gap Intercultural Understanding Sexuality International Mobility Violence Labelling Discrimination Stereotypes Crime Society	Socioeconomic Status (G) Asian Students (G) Age (G) Culture (G) Aboriginal Students (G) Sexuality (G) Labelling (G) Discrimination (G) Society (G)	 Immigrants First Generation Students Racism Religion Opportunity Gap Intercultural Understanding International Mobility Violence Stereotypes Crime	 Underrepresentation

Teaching Methods	Learning Strategies	Learning Strategies (E)		
	Problem Solving	Problem Solving (G)		
	Teaching Style	Teaching Style (E)		
	Inquiry		Inquiry	
	Scientific Method		Scientific Method	
	Math Problems		Math Problems	
	Ability Grouping	Ability Grouping (G,E)		
	Differentiation	Differentiation (E)		
	Discussion	Discussion (G)		
	Scaffolding	Scaffolding (E)		
	Learning Support		Learning Support	
	Curriculum	Curriculum (G,E)		
	Block Scheduling		Block Scheduling	
	Counseling	Counseling (E)		
	Laboratory Learning		Laboratory Learning	
	Textbooks		Textbooks	
	Mentors	Mentors (G,E)		
	Self Regulation	Self Regulation (G)		
	Concept Learning		Concept Learning	
	Levels		Levels	
	Hands on Learning		Hands on Learning	
	Primary Source Materials		Primary Source Materials	
	Independent Study Projects	Independent Study Projects (E)		
	Special Education	Special Education (G)		
	Accommodation		Accommodation	
	Problem Based Learning	Problem-Based Learning (E)		
	Streaming	Streaming (G)		
	Instructional Time		Instructional Time	
	Projects	Projects (E)		
	Interventions		Interventions	

	Incentives Individualized Instruction Talent Development Parent Education Early Exposure Student Centered Teaching Modeling Portfolios Blended Learning Outcomes Based Education Group Work Self Directed Learning Difficulty Level Advisors Tutors Service Learning Learning Style Best Practice Discipline Specific Content Technology Higher Order Thinking Skills Public Service	Incentives (G) Individualized Instruction (G) Talent Development (G) Portfolios (G) Group Work (G,E) Advisors (G) Tutors (G) Learning Style (E) Technology (G,E) Higher Order Thinking Skills (E)	 Parent Education Early Exposure Student Centered Teaching Modeling Blended Learning Outcomes Bases Education Self Directed Learning Difficulty Level Service Learning Best Practice Discipline Specific Content Public Service	Individualized Education Plan (IEP) Play Resources Field Trips
Career	Teaching Profession Teacher Recruitment Career	Career (G)	Teaching Profession Teacher Recruitment	

	Staffing Professional Development Brain Drain Career Choice Employee Recruitment Teacher Retention Wages Career Plan Career Expectations Compensation Job Search Career Recruitment Career Education Teaching Career Performance Evaluation Academia Employee Retention Job Market Entrepreneurship Vocational Knowledge Gifted Teachers Teacher Burnout Teacher Quality Teachers	 Professional Development (G) Career Education (G) Gifted Teachers (G) Teachers (E,G)	Staffing Brain Drain Career Choice Employee Recruitment Teacher Retention Wages Career Plan Career Expectations Compensation Job Search Career Recruitment Teaching Career Performance Evaluation Academia Employee Retention Job Market Entrepreneurship Vocational Knowledge Teacher Burnout Teacher Quality	
Relationships	Role Models Social Relationships Home Environment Socialization Parental Involvement Parent-Child Relationship	Role Models (G) Social Relationships (G) Parental Involvement (G)	 Home Environment Socialization Parent-Child Relationship	

	Student Teacher Relationship Parenting Relationships Siblings Peers Friendship Twins Families Social Skills Peer Pressure Peer Effects Bullying	 Parenting (E) Siblings (G) Families (G) Peer Pressure (G) Bullying (E)	Student Teacher Relationship Relationships Peers Friendship Twins Social Skills Peer Effects	 Community Affection
Assessment	Ability Tracking Test Performance Standardized Testing GPA Achievement Gap Assessment SATs Grade Inflation Grades Entrance Exams Test Preparation Cheating Student Outcomes Test Construction Test Scores Class Ranking	 Achievement Gap (G) Assessment (G) SATs (E,G) Grades (G) Test Construction	Ability Tracking Test Performance Standardized Testing GPA Grade Inflation Entrance Exams Test Preparation Cheating Student Outcomes Test Scores Class Ranking	

Identification	Test Validity Identification Intelligence WISC/WAIS Intelligence Tests Gifted and Talented, Definition Aptitude Multiple Intelligences Intelligence Quotient Screening Achievement	Test Validity (E,G) Identification (G) Intelligence (G) WISC (G, E) Intelligence Tests (E,G) Gifted and Talented, Definition (G,E) Multiple Intelligences (G,E) Intelligence Quotient (G) Screening (G) Achievement (E)	Aptitude	Talent Search Programs
Politics	History Administration No Child Left Behind Resource Allocation School Characteristics Policy Politics Economics Social Justice Political Science Advocacy Ethics International Cooperation Bush Administration Economy International Affairs Affirmative Action	Administration (G) No Child Left Behind (G) Policy (G) Politics (G) Advocacy (E)	History Resource Allocation School Characteristics Economics Social Justice Political Science Ethics International Cooperation Bush Administration Economy International Affairs Affirmative Action	

	Globalization Industrialization International Rankings Court Cases Equity Funding Developing Nations Teacher Deficits School Rankings History of Education School Improvement	Globalization (G) Equity (E, G) Funding (G)	 Industrialization International Rankings Court Cases Developing Nations Teacher Deficits School Rankings History of Education School Improvement	 Standards
Theory	Learning Theory Educational Discourse Successful Intelligence Epistemiology Educational Philosophy Educational Psychology Item Response Theory Neuroscience Delay of Gratification Eugenics Emotional Intelligence Theory Child Development Ethnography Locus of Control Big Fish Little Pond Effect Law of Diminishing Returns	Learning Theory (G) Epistemiology (E) Neuroscience (G) Emotional Intelligence (E,G) Child Development (E) Locus of Control (G)	 Educational Discourse Successful Intelligence Educational Philosophy Educational Psychology Item Response Theory Delay of Gratification Eugenics Theory Ethnography Big Fish Little Pond Effect Law of Diminishing Returns	
Personal Characteristics	Attitude Motivation	Attitude (G) Motivation (G)		Social and Emotional Maturity

	Self concept	Self-concept (G,E)		
	Student Variance		Student Variance	
	Memory	Memory (G)		
	Diversity	Diversity (G)		
	Leadership	Leadership (E,G)		
	Creativity	Creativity (E,G)		
	Versatility		Versatility	
	Eccentricity		Eccentricity	
	Genetics	Genetics (G)		
	Perfectionism	Perfectionism (E,G)		
	Behaviour	Behaviour (G)		
	Emotions	Emotions (G)		
	Perception		Perception	
	Spatial Ability		Spatial Ability	
	Life Purpose		Life Purpose	
	Reasoning	Reasoning (E)		
	Potential		Potential	
	Health	Health (E)		
	Stress		Stress	
	Study Habits		Study Habits	
	Anxiety	Anxiety (G)		
	Motor Skills	Motor Skills (G)		
	Cognitive Development	Cognitive Development (G)		
	Persistence		Persistence	
	Personality	Personality (E)		
	Impulsivity		Impulsivity	
	Common Sense		Common Sense	
	Cognitive Ability		Cognitive Ability	
	Artistic Talent		Learning Ability	
	Learning Ability		Learning Ability	
	Self Confidence	Self-Confidence (E)		

	Mental Health	Mental Health (E, G)		
	Self Worth	Self Worth (G)		
	Musical Talent	Musical Talent (G)		
	Self Fulfillment		Self Fulfillment	
	Self Perception		Self Perception	
	Elitism		Elitism	
	Empathy		Empathy	
	Perspective		Perspective	
	Values		Values	
	Coping Strategies		Coping Strategies	
	Bilingualism		Bilingualism	
	Knowledge		Knowledge	
	Popularity		Popularity	
	Personal Identity		Personal Identity	
	Masculinity		Masculinity	
	Self Improvement	Self Improvement (E)		
	Resilience	Resilience (G)		
	Sensitivity		Sensitivity	
	Over Excitability		Over Excitability	
	Morality	Morality (G)		
	Self Actualization	Self Actualization (G,E)		
	Personal Expression	Personal Expression (E)		
	Goal Setting	Goal Setting (G)		
	Decision Making		Decision Making	
	Engagement		Engagement	
	Active Listening		Active Listening	
	Metacognition	Metacognition (E)		
	Logic	Logic (E)		
	Strategy		Strategy	
	Recall		Recall	
	Novelty	Novelty (G)		

	Learning Process Communication Vocabulary Questioning Innovation	Learning Process (G) Communication (G)	 Vocabulary Questioning Innovation	 Intellectual Traits Wisdom Intuition Humour Curiosity Boredom
Post Secondary Education	College Admissions Research Financial Aid Teaching Assistants Admission Interviews College Advisors College Recruitment College Choice Student Teaching Fundraising Alumni Graduates Research Grants College Enrollment	College Admissions (G) Research (E) College Choice(G) College Enrollment (G)	 Financial Aid Teaching Assistants Admission Interviews College Advisors College Recruitment Student Teaching Fundraising Alumni Graduates Research Grants	 Response to Intervention
Other	Competition Interschool Cooperation Energy Conservation Thinking	Competition (E) Thinking (E)	 Interschool Cooperation Energy Conservation	

	Critical Thinking	Critical Thinking (E,G)		
	Problematicity		Problematicity	
	Valedictorian		Valedictorian	
	Libraries		Libraries	
	Attendance		Attendance	
	Literacy		Literacy	
	Class Size		Class Size	
	Expectations	Expectations (G)		
	Nobel Prize		Nobel Prize	
	Television		Television	
	Non-Verbal Communication		Non-Verbal Communication	
	Teacher Bias		Teacher Bias	
	Participation	Participation (G)		
	Extracurricular Activities		Extracurricular Activities	
	Location		Location	
	Dogmatism		Dogmatism	
	Sleep		Sleep	
	Climate		Climate	
	Adolescence	Adolescence (G)		
	Delinquency		Delinquency	
	Student Needs		Student Neeeds	
	Phonological Awareness		Phonological Awareness	
	Pre-Readers		Pre-Readers	
	Calculation		Calculation	
	Drug Use	Drug Use (E)		
	School History		School History	
	Design		Design	
	Scientists		Scientists	
	Graduation Rate		Graduation Rate	
	Athletes		Athletes	
	Lifelong Learning		Lifelong Learning	

	Suicide Flow of Talent Entertainment Merit Equality Student Interest Choice Making Student Retention Feedback Awards Environmental Factors Student Experience	Suicide (G) Equality (G) Choice Making (G) Feedback (G) Environmental Factors (G) Student Experience (G)	 Flow of Talent Entertainment Merit Student Interest Student Retention Awards	 Discipline Support Affective Learning Business

Appendix 2.

Keyword	Topics Retrieved
able student*	Post Secondary (3) Mathematics Education (3) College Admissions (3) Elementary School (2) Secondary School (2) Teaching profession (2) New Teacher recruitment (2) Teacher education (1) Science Education (1) Learning Strategies (1) Mathematics Competition (1) Interschool cooperation (1) Nursing education (1) Traditional achievement measures (1) Energy conservation (1) Problem solving (1) thinking (1) teaching methods (1) Teaching thinking (1) John Baer (1) Individualized Inquiry (1) Social Studies Education (1) Scientific method (1) Math problems (1) teaching styles (1) "star" schools (1) SAT scores (1) Underachievers (1) Attitude (1)

	Motivation (1) Self Perception (1) history of Education (1) Segragation/black schools (1) Principals (1) Girls Education (1) Career Paths
academically advanced	advanced courses (1) open enrollment policy (1) secondary school (1) english education (1) science education (1) college preparation (1)
academically superior	Secondary School (3) Post Secondary (1) College Preparation (1) english education (2) Literature (1) Literary Analysis (1) Young Adult Literature (1) Journalism (1) American College Testing Program (1) Ability Grouping (1)
accelerated student*	Secondary School (1) Mathematics education (1) Longitudinal study of American Youth (1) Grade Acceleration (2) Elementary school (1) Post Secondary (1) Calculus (1) factors associated with acceleration (1)

	NELS, ELS (1) No Child Left Behind (1) School Resource Allocation (1) Watson Glaser Critical Thinking Appraisal (1) Critical thinking (1) test validation (1)
advanced abilit*	test performance (1) gender (1) secondary school (1) test results (1)
advanced learner*	post secondary (1) differentiation (2) classroom discussion (1) discipline specific content (1) learning theory (1) computer learning (1) problematicity theory (1) ability grouping (1) student varience (1) scaffolding (1) spelling (1) adult learners (1) spelling strategies (1) sequential verbal memory ability (1) diversity (1) underachieving gifted (1) standardized tests (1) computer software (1) problem solving (1) learning support (1) real world learning applications (1)

advanced placement course*	Advanced placement courses (AP) (10) Secondary School (9) post secondary (3) College admissions (2) Course enrollment (3) school characteristics (1) minority students (2) black students (2) latino students (1) School counseling (1) opportunity gap (1) college preparation (1) english education (1) journalism (1) geography education (1) curriculum (1) college completion (1) block scheduling (1) rural schools (1) distance learning (1) science education (1) chemistry (1) vocational studies (1) history education (1) assessment (1)
advanced placement program*	International Baccalaureate degree (52) Secondary School (97) International Schools/education (23) Advanced Placement Courses (AP) (92) Post Secondary (22) Assessment (44)

	Curriculum (27) College Admissions (3) History Education (12) Science Education (15) English Education (8) Geography Education (9) Mathematics Education (6) Teacher work conditions (1) GPA (2) Policy (3) Valedictorian (1) Leadership (3) Early College Entrance (1) Libraries (1) Standards and Practices (1) Pedagogic Identity (1) Educational discourse (1) United world College Education System (1) Autoethnography (1) National Identity (1) National Education Program (1) Developing Nations (1) Ability Tracking (1) Achievement Gap (3) Minority Students (10) Black Students (3) latino Students (4) International Mobility (1) Multiculturalism (3) Successful Intelligence (2) Technology (6)

	Population Mobility (1) International Students (1) Bridge Programs (3) Intercultural Understanding (1) Language Education (5) Staff (2) Cultural Literacy (1) Course Selection (1) Role models (1) Government and Politics (9) Inner City Schools (1) Dual enrollment (10) College Preparation (13) Textbooks (1) Distance Education (2) Liberal Arts (1) social relationships (1) mentoring (1) extracurricular activities (1) advanced placement incentive grants (1) teaching methods (7) globalization (5) catholic schools (2) religion (1) environmental science education (1) independent study projects (1) research (3) merit (1) achievement (6) motivation (2) elementary school (4)

	student outcomes (1) identification (1) course enrollment (8) history of education (2) program planning (1) gender (5) ethnicity (3) university of cambridge international exams (1) empathy (1) perspective (1) social studies education (2) IB program growth (1) public education (7) montessori (1) theory of knowledge (1) values (1) bilingual schools (1) spanish education (3) enrichment program (1) ethnography (1) teacher values (1) levels (1) test construction (1) economics education (2) critical thinking (1) transition programs (1) college credit (5) private schools (2) incentives (2) participation (1) equality (1)

	SES (3) student perceptions (1) SAT (2) Art education (2) portfolios (1) coping strategies (1) anviety (1) peace education (1) cultural diversity (1) drop outs (2) educational philosophy (1) epistemology (1) acceleration (2) vocational knowledge (1) administration (1) professional development (1) bilingualism (1) knowledge (1) academic ability (1) underachievers (1) school rankings (2) test scores (1) school improvement (1) culture (2) hands on learning (1) geographical differences (1) urban schools (1) rural schools (1) AP abroad (1) interventions (1) class rank (1)

	elite schools (1) agriculture (1) teacher challenges (1) industrialization (1) student perspective (2) journalism (5) computer science education (2) honours programs (2) teacher perspective (2) skill development (1) writing (3) training schools (1) teacher education (2) grading (2) latin education (1) vocational education (1) reading (1)
advanced student*	Secondary School (19) Mathematics education (11) post secondary (8) science education (6) advanced placement courses (AP) (5) achievement (4) technology (3) assessment (2) laboratory learning (2) dual enrollment (2) economics (2) art education (2) curriculum (2) elementary school (2)

	english education (2) counseling psychology (1) mentoring (1) career development (1) course completion (1) social stratification (1) distance education (1) differentiation (1) epistemiology (1) self-regulated learning (1) honours programmes (1) research training (1) Higher Order Thinking Skills (1) attendance (1) social justice (1) concept learning (1) fast tracking (1) problem solving (1) learning needs (1) teacher profile (1) self-directed learning (1) early college entrance (1) private schooling (1) acceleration (1) academic competitions (1) ability grouping (1) reading (1) writing strategies (1) academic levels (1) gender (1) locus of control (1)

	political science (1) summer school programs (1) instructional methods (1) history education (1) gifted identification (1)
bright child*	Definitions of intelligence (1) Intelligence (1) language disorders (1) learning disorders (1) gifted learning disabled (1) Lauretta Bender (1)
bright student*	ESL learning (1) literacy (1) Content area learning (1) Professional Development (1) Post Secondary (2) class size (1) brain drain (1) honours colleges (1) mathematics education (1) international students (1) enrollment (1)
elite student*	secondary school (2) stratified education systems (1) politics (1) expectations of gifted students (1) post secondary (1) adult education (1) language learning (2) foreign language instruction (1) teaching styles (1)

	motivation (1) mathematics education (1) achievement (1) drop outs (1)
eminent	Gender (2) nobel prize (2) Post Secondary (2) Science Education (2) Creativity (2) History (2) economics (1) Careers (1) Women in Science (1) Versatility (1) Writing (1) Childhood Environment (1) Achievement (1)
enrichment course	secondary school (2) Post Secondary (1) science education (1) violence (1) hands on learning (1) history education (1) primary source materials (1) developmental students (1) honours students (1)
genius	science education (2) charles dickens (1) Albert Einstein (1) Michael Faraday (1) Victorian Age (1)

	attitudes about intelligence (1) mindsets (1) teaching methods (1) learning strategies (1) history (1) eccentricity (1) Grade Point Averages (1) SAT (1) grade inflation (1) genetics (1)
gifted*	Elementary School (13) Gifted Identification (10) Multiple Exceptionalities (9) Secondary School (8) Minority Education (8) Gifted Programming (7) Black Students (5) Self Concept (4) Gender (4) Ethnicity (3) Socio-Economic Status (3) Politics (3) Post Secondary (3) Curriculum (3) Labelling (3) Perfectionism (2) Pullout Programs (2) Social Studies Education (2) Creativity (2) Best Practice (2) Peer Relationships (2)

	Segregated classrooms (2) Differentiation (2) Independent Study Projects (2) Advocacy (2) Gifted Teachers (2) Ethics (1) Goal Setting (1) Inclusive Education (1) Special Education (1) Educational Philosophy (1) Attitudes (1) History Education (1) Socialization (1) Judy Lupert (1) Grade Level Differences (1) School Psychology (1) Behaviour (1) Emotional Problems (1) Accomodations (1) Parental Involvement (1) Achievement Gaps (1) College Preparation (1) Career Counselling (1) Decision Making (1) College Recruiting (1) Black colleges (1) Mara Sapon-Shevin (1) Heterogeneous Classrooms (1) Television (1) Parent-Child Relationship (1) Critical Thinking (1)

	Epistemiology (1) Problem-based learning (1) Discrimination (1) Assessment (1) Summer Programs (1) Residential Programs (1) Bridge Programs (1) Problem Solving (1) Council for Exceptional Children (1) Teacher Education (1) International cooperation (1) International Schools (1) Student Engagement (1) WISC III (1) Intelligence Testing (1) Test Validity (1) Dance and Drama Education (1) Active Listening (1) Student-teacher relationship (1) Acceleration (1) Motivation (1) Definition of giftedness (1) English Education (1) Reading (1) Critical Thinking (1) Higher Order Thinking Skills (1) Deaf/Hearing Impaired (1) Early Childhood Education (1) Rural Students (1) Perceptions (2) School experiences (1)

	Non-Verbal Communication (1) Attention Deficit Disorder (1) Teacher Recruitment (1) Philosophy Education (1) Teaching Strategies (1) Enrichment Programs (1) Talent Development (1) Academic Expectations (1) Parenting Styles (1) Achievement (1) Teacher Bias (1) Spatial Ability (1) Art Education (1) Mathematically Gifted (1) Home Schooling (1)
high abilit*	secondary school (14) Elementary School (13) ability grouping (12) assessment (11) post secondary (9) English education (9) reading (8) gender (6) science education (5) self concept (5) Mathematics Education (4) Technology (4) Big Fish Little Pond effect (2) Class size (2) Motivation (2) Participation (2)

	Achievement (2) Learning Strategies (2) Streaming (2) Aptitude (2) Ability Levels (2) Medical School (1) College Recruitment (1) Instructional Time (1) English as a Second Language (1) Adult Education (1) Life purpose (1) College Admissions (1) Creativity (1) Teachers (1) Second Language Learning (1) Writing (1) Problem Solving (1) Multiple Intelligences (1) Classroom Discussion (1) Research (1) Robert Sternberg (1) Educational Psychology (1) Theories of Intelligence (1) Law of Diminishing Returns (1) Reasoning ability (1) SAT (1) Counseling (1) Social Interaction (1) Curriculum (1) Potential (1) Black Students (1)

	Standardized Testing (1) Ethnicity (1) Stereotypes (1) Socio-Economic Status (1) Peer Effects (1) Metacognition (1) Careers (1) Deaf/Hard of Hearing (1) Teacher-student relationship (1) immigrants (1) Extracurricular Activities (1) Dropouts (1)
high academic abilit*	Secondary school (1) Post Secondary (2) Teachers (1) Assessment (2) Socio-economic status (1) stuent health (1) Stress (1)
high achieve*	Achievement (19) Elementary school (14) Secondary school (12) Post secondary (11) Minority education (9) Mathematics Education (8) Black students (7) Self Concept (6) Gender (5) English Education (5) Learning Strategies (5) Reading (4)

	Technology (4) Science Education (4) Teaching Methods (3) Ethnicity (3) Motivation (3) hispanic Students (3) Social Relationships (3) Study Habits (3) Socio-economic status (2) Student-teacher relationship (2) Writing (2) Anxiety (2) Attitude (2) Project based learning (2) student-parent relationship (2) Logic (2) Medical School (2) Personal Goals (2) Ability Grouping (2) Assessment (1) Engineering Education (1) Engagement (1) Honours Programs (1) Interventions (1) Language Learning (1) English as a Second Language (1) Distance Education (1) Location (1) Reasoning Ability (1) Incentive Programs (1) Grades (1)

	Problem Solving (1) Intuition (1) Home Environment (1) Politics (1) College Preparation (1) College Recruitment (1) Careers (1) Academic Gap (1) motor Skills (1) Cognitive Development (1) Dual Enrollment (1) Early Admission (1) Art Education (1)
high aptitude	Achievement (2) Elementary School (2) Post Secondary (2) mathematics education (1) diversity (1) ability grouping (1) Streaming (1) Classroom discussion (1) Logic (1) Science education (1) teacher education (1) Careers (1) Self-concept (1) Persistence (1)
high cognitive abilit*	IQ (2) Personality (2) Item Response Theory (1) Workplace (1)

	Bullying (1) Age (1) Dogmatism (1) Education Level (1)
high intelligen*	Brain Studies (4) Elementary School (3) IQ (3) Assessment (2) WISC (2) Neural Efficiency (2) Student Health (1) Behaviour (1) Sceondary School (1) Strategy (1) Achievment (1) Delay of Gratification (1) Motivation (1) Self Regulation (1) Learning Strategies (1) Post Secondary (1) Sleep (1) Ethnicity (1) Climate (1) Socio-Economic Status (1) working Memory (1) Creativity (1) Mathematics Education (1) Problem Solving (1)
high IQ	Adults (5) IQ (4) WISC/WAIS (3)

	Elementary School (3) Adolescence (2) Autism Spectrum Disorder (2) Brain studies (2) Age (2) Achievement (2) Ethnicity (2) Impulsivity (1) Crime (1) Perception (1) Assessment (1) Problem Solving (1) Recall (1) Common Sense (1) Social Relationships (1) non verbal communication (1) ADHD (1) Cognitive ability (1) Technology (1) Creativity (1) Differentiation (1) Genetics (1) Novelty (1) Delinquency (1) Secondary School (1) Multiple Exceptionalities (1) Self Concept (1) Black Students (1) Gender (1)
high potential student*	post secondary (1) assessment (1)

	class size (1)
highly able	Secondary School (2) Learning strategies (1) Achievment (1) Science Education (1) Summer Programs (1)
intellectually advanced	Elementary School (1) Early Admission (1) Society (1) Student needs (1)
intellectually superior	assessment (2) WISC (1) IQ (1) memory (1) Age (1) achievement (1) Mathematics education (1)
math* precocious	Mathematics education (2) secondary school (1) Gender (1) Reasoning (1)
Mensa	Eugenics (1) Mental Retardation (1) Mensa (1) Genetics (1)
precocious read*	language learning (5) Reading (5) Phonological Awareness (5) Elementary school (3) Spelling (2) Pre-readers (2)

	Early Childhood Education (2) Verbal Precocity (1)
precocious talk*	Autism Spectrum Disorders (1) Speech Impairment (1) Language Learning (1)
prodigy	Mathematics education (2) memory (2) calculation (2)
superior abilit*	Art education (1) IQ (1) Artistic Talent (1)
superior academic*	achievement (2) mathematics education (1) Asian students (1) Drug use (1) Secondary School (1) Elementary school (1) Engagement (1)
superior intelligen*	multiple exceptionalities (1) Elementary school (1) secondary school (1) school history (1) WISC/WAIS (1) assessment (1) IQ (1) motor skills (1) age (1)
superior IQ	Aptitude (1) Individualized instruction (1) Research (1) assessment (1)

	Post secondary (1) personality (1) learning ability (1)
superior student*	Secondary School (4) Teaching Profession (2) Assessment (1) Competition (1) Valedictorians (1) Post Secondary (1) College Recruitment (1) Administration (1) Teaching Practices (1) Curriculum (1)
talented	Post Secondary (86) Secondary School (37) Science Education (40) Minority Education (34) Careers (15) Teacher Recruitment (26) Financial Aid (16) mathematics Education (19) Teacher Education (14) Art Education (18) Research (14) College Recruitment (11) College Preparation (9) Gender (20) Attitude (2) Talent Development (10) Elementary School (16) Technology (10)

	Differentiation (3) Writing (5) Black Students (9) Apprenticeship (2) Food and Agricultural Sciences (3) Competitions (2) Mentoring (6) Hispanic Students (3) Ethnicity (6) Engineering Education (5) Motivation (3) Teaching Assisstants (1) Nature of Talent (1) Perfectionism (2) Personality (2) Student-parent relationship (1) Advanced Placement Courses (AP) (1) Student-teacher relationship (1) Honours Programs (4) Rural Schools (2) Personal Expression (1) Teacher Deficits (1) Bush Administration (1) Distance Education (1) Economy (3) English Education (5) Summer programs (11) Liberal Arts Colleges (1) Leadership (8) School Staffing (3) Admission Interviews (1)

	Post Graduate (3) Administration (8) Language Learning (4) Aptitude (1) College Advisors (1) Computer Science Education (1) Urban Schools (4) Drop Outs (3) Immigration (1) Behaviour (2) Identification (3) Creativity (7) Design (1) Brain Drain (1) International Exchange (1) Internship (4) Political Science Education (2) Nobel prize (1) Luis Alvarez (1) Albert Einstein (1) Scientists (1) Adolescents (2) Career Choice (5) public education (3) socio economic status (9) self confidence (1) learning process (1) intelligence testing (1) school rankings (2) paramedic education (1) employee recruitment (2)

	teacher burnout (2) workplace (4) teaching methods (17) music education (6) advocacy (1) entrance exams (1) parent education level (1) autism spectrum (1) savants (1) early exposure (1) teacher retention (6) jewish schools (1) standardized testing (3) history of education (5) diversity (3) reading (1) curriculum (10) test preparation (1) cheating (1) wages (2) career plan (1) educational psychology (3) college admissions (6) competition (1) bridge programs (3) dance education (2) career expectations (1) achievement (2) acceleration (4) verbal talent (1) policy (5)

	graduate studies (6) interdisciplinary studies (1) college choice (1) graduation rate (1) international affairs (1) assessment (3) foreign students (1) student teaching (2) compensation (4) athletes (3) first generation students (1) role models (1) communication (1) mental health (3) adult education (3) parent-child relationship (2) self worth (1) neil slater (1) fundraising (3) alumni (2) neuroscience (2) musical talent (1) inclusion (1) learning disabilties (2) job search (1) graduates (1) career recriutment (3) social standing (1) politics (4) student centered teaching (1) modeling (1)

	test validity (1) enrichment (1) career preparation (2) programming (5) engagement(1) african american studies (1) television (1) incentives (3) teaching career (3) performance evaluation (1) communications education (1) psychiatry education (1) research grants (1) academia (2) lifelong learning (1) self fulfillment (1) business education (2) problem solving (2) suicide (1) racism (2) learning strategies (2) flow of talent (1) international students (2) sexuality (1) teacher quality (1) achievement gap (1) affirmative action (1) employee retention (1) continuing education (1) alternative schools (1) entertainment (1)

	public service (1) educational philosophy (2) job market (1) entrepreneurship (1) poetry (1) drug use (1) age (1) siblings (1) counselling (1) resource allocation (1) vocational education (1) student needs (1) second language (2) underachievers (1) benjamin bloom (1) nationality (1) professional development (1) self perception (1) elitism (1) humanities education (1) library education (1)

Appendix 3.

Growing up Gifted		**Education of the Gifted and Talented**	
Topic	**# relevant results**	**Topic**	**# relevant results**
"I" Messages	0	"Love-Hate" relationship with gifted education	0
Abraham Maslow	1	academically gifted project	1
acknowledgement	2	acceptance finding	0
adjunct program	0	active ignoring	0
advisory committee	1	adaptive thinking	1
affection	0	adderall drugs	0
Alfred Binet	1	adrenogenital syndrome	0
American association for the study of the gifted	0	affective learning	2
anglo test	0	after-the-fact definitions	0
Anglo-american students	2	alphasmarts	0
Arnold Gesell	0	America Competes Act	1
Babies/Infants	8	American Association of University Women	0
Belva Lockwood	0	American College Testing Program	2
cartesian split	0	analytic giftedness	0
Charles Darwin	2	ancient sparta and military skills	0
columbus group	4	apathy	2
community	160	Ascending Intellectual Demand	0
Council for Exceptional Children	4	assimilationist position	0
Curiosity	6	Athens, social position and	0

		gender based opportunities	
D. J. Seigel	0	attribute listing	0
D. Krech	0	Autonomous Learner Model	3
David Wechsler	0	avoidance behaviours	0
Declaration of the Educational Rights of the Gifted Child	0	Baldwin Identification Matrix	0
Discipline	6	bell curve	0
E.R. Kandel	0	biography and autobiography	4
Elizabeth Blackwell	0	Boredom	8
Ellen Swallow Richards	0	brainstorming	0
Entelechy	2	broad-based advisory groups	0
Excellence	36	calming techniques	0
Exercises	5	Cattell-Horn-Carroll theory of intelligence	0
Exploration	8	Centre for Academically Talented Youth	0
Fetal interaction with environment	0	character education	2
Field Trips	6	comprehensiveness	0
Foresight	1	conformity	1
Francis Galton	1	cornucopia kids	0
Good Child Syndrome	0	crossword puzzles	0
Hand Models	0	deductive reasoning	1
Heirarchy of Human Needs	0	defensibility	1
Howard Gardner	5	Duke University's Talent Identification Program	2
Humor	14	Elementary talent search programs	0
Idealism	1	estrangement	0
Imagery	16	field trips	6
Imagination	13	grade equivalent scores	1

Intuition	10	great books foundation	0
J. Bruner	3	growth mindset	1
J. Hawkins	0	HALT phenomena	0
J. Kagen	0	highly gifted children	9
J. LeDoux	0	historically eminent persons	0
J. McV. Hunt	0	home-career conflict for women	0
J.C. Gowan	1	houndstooth pattern	0
J.P. Guilford	0	housewife syndrome	0
Jean Piaget	1	idea finding	0
Job Shadowing	1	individualized education plan	0
Joseph Renzuilli	0	Intel Science Talent Search Competitions	0
Julia Link Roberts	0	intellectual traits	0
Julian Stanley	1	Junior Great Books	4
K.K. Urban	0	learned helplessness	2
Lawrence Kohlberg	0	McTalent Burger	0
Leo Vygotsky	1	Mental Age	6
Lewis Terman	2	mental chronometry	0
M. C. Diamond	1	mental experiments	0
M. Rosenzweig	0	mess finding	0
magnet school	11	Moderately Gifted Students	0
Maria Montessori	1	Morphological Synthesis Technique	0
maturation	0	movement exercises	0
mini course	2	Odyssey of mind and Destination imagination	1
Mission of Gifted Education and Talent Development	0	orientation in space problem	0
mistakes	4	ovation	0
multitasking	0	pantomime	1

outdoor activities	0	Parent Questionnaire	2
Perinatal Interaction	0	personalized learning plans	0
physical encoding	0	pluralism	4
play	11	processing speed	2
positive statements	1	Queen bee syndrome	0
praise	1	Quiet crisis	1
Prenatal Interaction	0	reliability	30
publicity	1	response-to-intervention	21
punishment	1	ritalin drugs	0
quotas	4	ropes challenge course	0
reflection, on gifted program	0	Saturday Programs	3
relaxation	3	Sensory and body awareness	0
Response to Intervention	21	Skillfulness	0
Responsive learning environment	1	Social and Emotional Maturity	0
Risk Taking	3	Sounds of Silence	0
search committee	0	Speyer project	0
self fulfilling prophecies	1	Statements of philosophy, rationale, and objectives	0
Self Talk	2	Structured Observation Form	0
sense of belonging	3	Study of Mathematically Precocious Youth	42
Sensory Input	0	Superior Humour	0
Sidney Marland	1	Synthetic giftedness	0
social conscience	0	Talent Pool	4
Stanley G. Hall	0	Talent Search Programs	10
states (politics)	0	Telescoped Programs	0
stimulating environment	1	Termites	0
success	19	Thinking Styles Preferences	1
support	27	Threshold Concept	0

T. Simon	0	Tiering Strategy	0
Team Teaching	9	Tomboyism	0
telescoped learning	0	United Auto Workers	0
Thematic connections	0	Verbal Comprehension	0
timelines	2	Weirdness	0
touch, and infant development	0	William and Mary Eclectic Model of Gifted Program Evaluation	0
underrepresentation	41	Wisdom	3
unschooling	0	Word-Search Puzzles	0
visual complexity	0	Young Child Program	0
visualization	5		
Wilhelm Stern	0		
wisdom	3		
Total # of Topics	108		105

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