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Creating a Comprehensive Search Strategy for Research on Learning Disabilities Using the Pearl Harvesting Information Retrieval Framework

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by

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Abstract

The migration of libraries to the digital realm has created new opportunities for information sharing; however, the abundance of available literature has made locating relevant research studies on specific learning disabilities a difficult task, one that existing search strategies have not adequately addressed. Moreover, definitions of specific learning disabilities have evolved and the nature of this field is interdisciplinary, creating a confusion of possible search terms for the topic. The present investigation used the Pearl Harvesting Information Retrieval Framework to create a comprehensive search strategy for locating research on learning disabilities. The analysis produced four groups of harvested search terms for the subtopics of general learning disabilities, reading disabilities, math disabilities, and nonverbal learning disabilities. The wide range of diverse search terms retrieved a greater number of relevant citations than other search strategies.

Dedication

To Haidar, my younger brother, who lit in me an indestructible spark for research and teaching – my love for you has allowed me to walk through fire.

Acknowledgements

All praise is due to Allah, Lord of the worlds. [1:2]

I would like to acknowledge and give gratitude to my supervisor, Dr. Robert Sandieson, for his continuous support, and for his inspiring strict adherence and advocacy for evidence-based practice and methodologically sound research.

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Chapter I

Introduction

The migration of libraries to the digital realm has made new opportunities for information sharing; however, it has also created an abundance of available literature. This abundance has made locating relevant research studies on learning disabilities an increasingly difficult task. Searching online databases is not as simple as it appears; it is in actuality incredibly complex, given the complicated organization and structure of most databases (Adrent, 2007). As well, scholars are often not trained to search effectively in research databases (Jankowska, 2004; Valentine, Cooper, Patall, Tyson, & Robinson, 2010). Conducting a comprehensive literature search is a key component of research and has tremendous implications in policy and practice. This is particularly true in education, where there has been a push towards evidence-informed decisions.

The aim of my research is to overcome past difficulties in searching and create a comprehensive and precise strategy for locating research about learning disabilities. Such a strategy can guide future researchers, practitioners, and policy makers in their investigations and decisions. To do so, I have focused on creating a validated set of search terms or search filters (i.e., a synonym cluster, synonym ring, or synset) pertaining to learning disabilities.

In the following section I will discuss how vast learning disabilities research is, and the prevalence and definition of specific learning disabilities.

Learning Disabilities Research

Learning disabilities research spans from the early years to postsecondary levels and adulthood. The prevalence of specific learning disabilities is higher than any other single group of exceptionalities, with approximately 8.6% of children being identified (Pastor & Reuben,

2008). However, the definition of learning disabilities is varied, and research in this area is markedly diverse and interdisciplinary. In addition to education, researchers from psychology, biology, medicine, law, economics, and various subfields are interested in studying learning disabilities (e.g., Barnes, 2011; Cirino, Fuchs, Elias, Powell, & Schumacher, 2015; Mascheretti, Facoetti, Giorda, Beri, Riva, Trezzi, Cellino, & Marino, 2015; McGee, 2011). The multiple disciplines that conduct research on learning disabilities results in different ways they may be denoted in an article, for example *learning difference* and *dyslexia*. This creates difficulties, therefore, in devising a search strategy for finding information on the topic since keywords or words used for subject headings are a major artery to locating research literature.

Conceptualizing Specific Learning Disabilities

Historically, specific learning disabilities have been defined in a variety of ways. More recent models of specific learning disabilities include the discrepancy model and response to intervention. Both of these models have been used to inform diagnosis and intervention.

Early labels of learning disabilities were highly medically oriented, though flawed, and included terms such as brain injured, perceptually impaired and neurologically impaired (Dombrowski et al., 2006). It wasn't until 1962 that the term learning disabilities was formally introduced in the literature.

> A learning disability refers to a retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, writing, arithmetic, or other school subjects resulting from a psychological handicap caused by a possible cerebral dysfunction and/or emotional or behavioral disturbances. It is not the result of mental retardation, sensory deprivation, or cultural and instructional factors. (Kirk, 1962, p. 263)

Though still medically oriented, Kirk's definition was a move toward a more comprehensive view of learning disabilities, referring to a delay in a certain area of learning that is not the result of another disorder. Bateman, a student of Kirk, was the first to suggest a definition that

resembled the discrepancy model (Bateman, 1965), referencing a discrepancy between ability and achievement. Rutter and Yule (1975, as cited in Dombrowski et al., 2006) later wrote about the model stating that an IQ-achievement discrepancy can be validly used for diagnosing learning disabilities.

The discrepancy model. The discrepancy model for conceptualizing and diagnosing learning disabilities is based on the premise that there is a significant discrepancy between achievement and level of intelligence for an individual with a learning disability. According to the discrepancy model, individuals with learning disabilities receive average to above average scores in intelligence tests while their level of achievement is significantly below average. Typically a variety of testing and statistical approaches are used to determine if the discrepancy is significant enough to qualify the individual as having a learning disability. In doing so, it is crucial to take into account various external variables, such as cultural background and lack of opportunity, and internal variables such as impaired vision and comorbidity.

Response to intervention. Researchers and professionals have called into question the procedures used to identify students with learning disabilities, particularly the use of intelligence testing and IQ-achievement discrepancies (Fletcher et al., 1994; Share, McGee, & Silva, 1989; Siegel, 1988; Speece & Case, 2001; Stanovich & Siegel, 1994; Stuebing et al., 2002). One of the responses to diagnosis issues has been an approach called Response to Intervention (RTI) (Fuchs & Fuchs, 1998; Vaughn & Fuchs, 2003).

The purpose of RTI is twofold: one, to provide intervention for students who are academically *at risk*, and two, to develop a more valid way of identifying students with reading disabilities. RTI allows teachers to play a key role in the diagnosis of learning disabilities and to identify students who have not been responding to high quality instruction and recommend their

placement in an intervention. Researchers have reported high validity in RTI as a prereferral system (e.g., Case, Speece & Molloy, 2003).

Diagnosis of learning disabilities. Prior to 1980, the Diagnostic and Statistical Manual of Mental Disorders (DSM) referred to a learning disability as *learning disturbance* (DSM-II, 1969) and it was subcategorized within Special Symptom Reactions. Subsequently, in the third edition as well as its revised counterpart, the name was changed to *academic skills disorder*, listed under the Specific Developmental Disorders section (DSM-III, 1980; DSM-III-R, 1987).

Since the release of the fourth edition, the official diagnostic term for learning disabilities has been specific learning disorders. However, while the fourth edition filed learning disorders under a heading titled Disorders Usually First Diagnosed in Infancy, Childhood, or Adolescence, the most current edition includes specific learning disorder under the umbrella category, Neurodevelopmental Disorders. The changes made to the DSM's section illustrate changes in classification, which might result in issues with definition, conceptualization, diagnosis, and consequently, terminology and research.

The fourth edition of the DSM as well as its later published revised version (DSM-IV; DSM-IV-TR, APA, 1994/2000) divided learning disorders into four categories: reading disorder, mathematics disorder, disorder of written expression, and learning disorder not otherwise specified (NOS) and outlined that a diagnosis of learning disorder can be given when the following criteria is met:

> (1) an individual's achievement in reading, mathematics, or written expression is substantially below that expected for age, schooling, and level of intelligence (e.g., ≥ 1½ SDs below the mean).
> (2) the learning problems significantly interfere with academic achievement or activities of daily living that require reading, math, or writing skills.
> (3) if a sensory deficit is present, the learning difficulties are in excess of those usually associated with it (DSM-IV; DSM-IV-TR, APA, 1994/2000)

The fourth edition outlined each of the four categories separately, though each category (that is, reading, math, written expression) must also follow the above guidelines. Generally, learning disorder NOS was diagnosed when the disability was not specific enough to qualify as one of the other three diagnoses.

Diagnosis of learning disabilities underwent dramatic changes with the release of the DSM 5, with the name being changed to Specific Learning Disorder. Its diagnostic criteria are now much more specific and detailed, even offering more consideration to nonpsychometric data sources, the lack of which was a criticism of previous editions (Wodrich, Pfeiffer, & Landau, 2008). However the three types of learning disorders now fall under one diagnosis. For example, a student may receive a diagnosis of Specific Learning Disorder with impairment in reading. The NOS category that was present in the previous editions is absent in the DSM 5.

The DSM is the main tool for diagnosis of learning disabilities in North America, and its evolution has brought about different ways of defining and categorizing learning disabilities. This in turn affects both research and practice in the area. Issues of diagnosis have resulted in a diversity of terminology in the area of learning disabilities that has complicated the use of terms for keyword searching.

Nonverbal learning disabilities. Though not mentioned in the DSM under the same category, researchers have consistently identified nonverbal learning disabilities as a subtype of specific learning disabilities. Researchers have found that individuals with nonverbal learning disabilities tend to have deficits in visual-spatial processing, motor-tactile performance, and nonverbal problem solving, along with strengths in rote language skills such as oral language mechanics and word reading (Fine, Semrud-Clikeman, Bledsoe, & Musielak, 2013; Rourke,

1995). Students with nonverbal learning disabilities tend to have academic achievement difficulties and social problems.

Learning disability terminology in the UK. Demonstrating the magnitude of terminology and information retrieval issues in the area of learning disabilities, one important note is that in the United Kingdom, the term "learning disability" is used to refer to what used to be described as "mental retardation" and is now referred to world wide as "intellectual disability". Outside of Great Britain, the term "learning disabilities" is used to refer to individual with average to above average intelligence while the term "intellectual disability" is used to refer to individuals with significantly below average intelligence". This substantial terminology difference furthers the complexities of searching for relevant literature.

Current Issues in Searching Online Databases

Researchers search in academic databases by entering search terms that relate, either directly or indirectly, to their topics. In turn, databases search engines retrieve articles which have these terms in the title, abstract, subject headings and identifiers or descriptors. However, there are two problematic issues in searching digital libraries. The first is the ways in which information is indexed in databases. The second is the search strategies researchers use to locate such information.

Database organization strategies. Pertaining to the first issue, there is inconsistency in the ways in which databases grapple with issues of diverse terminology. Online databases have taken over as the preferred source of information for scholars and students (Hemminger, Lu, Vaughan, & Adams, 2007; Nicholas, Williams, Rowlands, Hamid, & Jamali, 2010). Databases index information according to numerous fields including abstract, author(s), title, location, subject headings/descriptors/identifiers. An article's subject headings, also referred to as

descriptors and identifiers, usually make up a small list and may neglect important terms (Adrent, 2007). These articles come from a database thesaurus. Sandieson, Kirkpatrick, Sandieson and Zimmerman (2010) found that although *mental retardation* and *developmental disability* are each terms that denote *intellectual disability*, they separately retrieved unique citations on the same topic. The ways in which databases organize information are bound to produce varied search results.

Issues with common search strategies. White (1994, 2009) described common search strategies used by researchers: backward and forward citation tracking, keyword searching and browsing key relevant journals. Forward tracking involves investigating literature that cite an original or popular article. Conversely, backward tracking involves reviewing a pertinent article's references to locate relevant literature and continuing to review the located literature's references. The issue with citation tracking is that it relies on the assumption that articles in a given body of literature naturally connect through references. However, this assumption is questionable. Researchers may not cite certain articles that differ in theory, research paradigm, or methodology (Sandieson & McIsaac, 2013). That is, researchers often work in their own specific area, and may not even be aware that there are bodies of work dealing with the same topic they are. Thus citation tracking in itself is lacking as a tool for comprehensively searching the literature.

Another common search strategy is called keyword searching (White, 1994; 2009). Several researchers have indicated that keyword searching is becoming increasingly common among scholars in recent years (Holman, 2011; Nicholas et al., 2010; Vakkari & Talja, 2006). One approach to locating relevant keywords involves finding relevant articles and locating potential keywords in their bibliographic information. The newly found keywords initiate new

searches, further potential keywords are located, and the process is repeated until the researcher is convinced that no further keywords exist. This is referred to as pearl growing (White, 1994). Beall (2008, 2011) argued that keyword searching is incomplete, imprecise and unreliable. He explained that there are too many ways to linguistically represent a given topic and that many scholars do not recognize the complexities of terminology and synonym searching.

Browsing through the indexes of key relevant journals is the third common search strategy that scholars and researchers have used. This approach may seem strategic; however, it is problematic in that there is often no standard methodology for choosing which journals to use, making it possible to miss journals and thus relevant research. This may be particularly problematic when the research is cross-disciplinary (Sandieson & McIsaac, 2013).

Evans (2008) expressed concern that research about digital libraries has focused almost exclusively on the superiority of electronic research, emphasizing its universal availability and abundant knowledge. This selective attention has been at the expense of overlooking discussion on browsing and searching the web and the effect that that has on scholarship. Evans' research has indicated that even though digital libraries have made research more available, researchers are citing fewer articles and predominantly recent ones.

Issues in searching by educators. Educators and researchers in education have unique difficulties in navigating digital libraries. In a mixed-methodology study, Williams and Coles (2007a, b) found that teachers relied on a narrow range of information sources, most of which were informal (i.e., colleagues). Moreover, teachers expressed a lack of skill in using the Internet to find information. The authors suggested that a "targeted approach to the organization of research" (Williams & Coles, 2007a, p. 821) would be useful to teachers.

> A number of interviewees admitted to problems and lack of confidence in defining a search strategy or knowing where to start, and even those who took a more proactive

> approach to finding information admit to difficulties in the area. (Williams & Coles, 2007a, p. 824)

Given these findings, it is suggested that a comprehensive, easy to use search strategy for learning disabilities would benefit educators in their information seeking.

The Importance of Effective Searching in the Area of Learning Disabilities

The value of effective search strategies is connected to numerous matters, with three that stand out, namely, the push for evidenced-based policy and practice, the study of educational theory, and the inclusion of multiple viewpoints in educational literature.

Evidence-based policy and practice. The movement toward evidence-based decision making started in medicine and spread into many disciplines. The terms *evidence-based practice* and *empirically supported treatment* are the most widely used within literature. These terms also correspond with usage in the extensive literature on evidence-based practice in psychology (e.g., APA, 2005; Chambless & Ollendick, 2001). The term *treatment* in education usually refers to intervention, program, and curriculum, whether it be preventative, concurrent or remedial (Spencer, Detrich, & Slocum, 2012). In the past two decades, stakeholders in education have acknowledged the benefit of evidence in educational decision-making and have pushed for its inclusion.

In the United States, the introduction of the No Child Left Behind Act (NCLB, 2001) has brought an emphasis on instructional practices that are supported by research. Meanwhile, as with other education systems across Canada, the Ontario Ministry of Education (MOE) has had a strong focus on evidence in recent years, taking strong initiative to implement programming that is research-based. According to its website:

> The Ontario Ministry of Education is committed to developing and implementing policies, programs, and practices that are evidence-based, research-informed, and connected to provincial education goals. (Ontario Ministry of Education, 2012)

This is further evidenced by views expressed in the Ontario MOE's most recent revision of the *Achieving Excellence: A Renewed Vision for Education in Ontario*. The writers of this document explain, "policy decisions and the allocation of resources have to be guided by evidence and research … to guide us in the future as we develop more rigorous, relevant and innovative approaches to learning" (Ontario Ministry of Education, 2014, p. 3). It is evident that having evidence inform decision-making is a significant part of Ontario's goal for the future of education.

Educational theory and research. The second major reason it is important to be able to access all of the relevant literature concerns educational theory and research. In attempting to develop a theory and advance it, it is important to consider all work in the given area, as well as all scholars from around the world who have authored work in the area. This is particularly true in the area of learning disabilities, given their varied definition both within North America and beyond. Moreover, it is important to situate one's research within the existing literature and to provide guidance for future researchers connecting it to relevant information.

Understanding multiple viewpoints. To gain a comprehensive understanding of given issues in education it is important to consider multiple perspectives and contexts, and to do that one must have the tools to navigate the literature. Moreover, it is crucial to refrain from including only information that supports certain viewpoints and neglecting other sources.

Issues with existing meta-analyses. Without a detailed strategy for conducting a comprehensive literature search, there will be significant issues in the reliability of locating evidence and therefore the validity and generalizability of learning disabilities research, particularly highly regarded synthesis research. As described below, most systematic reviews examining issues related to learning disabilities are limited in their search strategies.

One example of a limited search strategy is that of Cornwall and Bawden (1992) who conducted a review of the literature on the relationship between specific learning disabilities and aggression. Since its publication, their article was cited 57 times in journals of psychology, education, economics, social work, psychiatry and law and in articles from multiple countries. This is evidence of the article's high value within the literature, and has likely influenced political, economic, and social decisions as a result. Unfortunately, the search strategies that Cornwall and Bawden (1992) used are suspect since they were only vaguely described, as follows:

> A computerized literature search was used to identify research and review papers examining the co-occurrence of learning disorders and externalizing behavior problems (aggressive, delinquent, and oppositional behaviors). Subsequent searches of the reference lists of relevant articles were carried out. More than 80 articles were obtained from sociology, psychology, medical, and justice journals. Most of these articles were published within the past 20 years (p. 281-282).

First, there is no mention of where they initially browsed for papers. Second, it is unknown which search terms were used and which ones where omitted.

A study that holds similar power is that of Cronin (1996), who examined the literature on life skills curricula for students with specific learning disabilities. It is apparent that Cronin worked to identify the diverse terminology used in life skills literature; however, this effort was not matched with learning disabilities. Although Cronin (1996) mentioned including only research that included individuals with learning disabilities as a target population, she did not mention any strategies used to search the literature in the area. This is problematic in that some articles may have been missed. Moreover, because life skills research is vast and interdisciplinary, the relevance of the articles retrieved might have been greatly increased if she had a strong strategy for searching the learning disabilities literature.

One recent meta-analysis (Solis, Ciullo, Vaughn, Pyle, Hassaram, & Leroux, 2012) only used combinations of the search terms LD, learning disab* and reading disab*, while omitting other terms. However, a search of the term dyslexia yielded thousands of unique articles, and this article as well as many other many meta-analyses (e.g., Ciullo & Reutebuch, 2013; Maccini, Mulcahy, & Wilson, 2007; Mull, Sitlington, & Alper, 2001) did not include dyslexia as a search term.

The evidence-based practice movement pushes for objective research procedures that have a high degree of validity and reliability. For this to be achieved it is important to have the tools to conduct comprehensive searches.

Chapter II

Methods

This investigation tested the hypothesis that there is a large and varied set of terms to denote learning disabilities, which if located and verified will serve as a comprehensive search strategy when the terms are used as search terms. It was also the aim of this work to identify terms that are not necessary for searching. I used the methodology of the Pearl Harvesting Information Retrieval Framework (Sandieson, 2006; Sandieson, Kirkpatrick, Sandieson & Zimmerman, 2010; Sandieson & McIsaac, 2013) to undertake my investigation and to further the development of the framework.

Pearl Harvesting has been used to create a comprehensive search strategy in the areas of intellectual disabilities, autism, and giftedness with success (Sandieson, 2006; Sandieson, Kirkpatrick, Sandieson & Zimmerman, 2010; Sandieson & McIsaac, 2013). The rationale for Pearl Harvesting is that scholars often use a variety of terms on a topic that result from factors such as time, culture, research methodology and paradigm. Using this framework, I aimed to collect all of the relevant search terms and using common database functions and verified their uniqueness and relevance.

Step 1: Choosing a Representative Sample of Articles

The initial step of Pearl Harvesting is finding a representative sample of articles, which serve as pearls (Sandieson, Kirkpatrick, Sandieson, & Zimmerman, 2010). Here, I gathered articles from across disciplines using articles used by meta-analyses and systematic reviews on learning disabilities. A broad, representative sample of articles includes a wide range of terminology in a given field.

To locate popular meta-analyses and systematic reviews in the field, I used the following search terms:

> "research synthesis" OR meta-analysis OR "meta analysis" OR "meta-analytic" OR "systematic review" OR "realist synthesis" OR "integrative review" OR "quantitative review" OR "quantitative synthesis" OR "qualitative review" OR "qualitative synthesis" OR "critical review" OR "literature review" OR "review of the literature" OR "selective review" OR "evidence-based review" OR meta-synthesis OR meta-ethnograph* OR "narrative review" OR "narrative synthesis" OR "narrative review" (Sandieson, 2014).

The above search terms were used in conjunction with “learning disab*”. I did not use any other search terms as my intention was not to locate all of the research syntheses, but the most prominent ones. I employed PsycINFO and ERIC as these databases were the most popular amongst researchers in psychology and education.

In the subsequent step I chose research syntheses that investigated different topics, looking particularly for those that looked into each subtype of learning disability (i.e., reading disabilities, math disabilities, nonverbal learning disabilities), downloaded all of the articles used in the syntheses, and these articles served as pearls. Then, each pearl was analyzed for its use of relevant terminology. The details of this will be discussed in the results section.

Step 2: Finding a Set of Search Terms for Learning Disabilities

Once the representative articles had been selected, I started analyzing for search terms. I analyzed the bibliographic information – title, abstract, descriptors and identifiers (i.e., subject headings), and references – of each of the articles. I reviewed the titles and journal names in each article’s references in order to gather terms that are representative of that article’s accompanying articles. This step allowed me to survey a wide number of articles written by different authors, coded by different indexers and in different databases, thus permitting me to gain insight into a range of possible keywords used to denote specific learning disabilities and therefore minimizing any bias in the final search strategy.

Step 3: Refining the List of Search Keywords

In the initial stage for refining the long list of search terms found in step two, I used the database truncation feature for similar terms. Secondly, I investigated their search precision. Here, I calculated each term's recall (number of articles retrieved) and precision (number of articles retrieved that were relevant to learning disabilities). In the third refinement stage, I considered whether or not to include a given search term in the synonym cluster based on its level of precision. Finally, I used a procedure for assessing essentiality of each search term to the synonym cluster for its category.

List refinement using truncation. The previous step yielded a long list of potential search terms, thus the asterisk (*) function of truncation was used to refine the list. This function allows for all words with the same root to be retrieved during a search. The term I used in step 1, "learning disab*", is an example of truncation and expands to include the terms learning disability, learning disabilities, and learning disabled all at once.

Assessing relevancy. To assess relevancy, I considered the definitional and diagnostic issues discussed in the introduction. To decide whether or not an article was relevant for the general learning disabilities category, I looked for indication of the discrepancy model of defining learning disabilities and/or reference to the RTI model of diagnosing learning disabilities. For example, some articles I found referenced low student achievement, however made no mention of intelligence levels, and were thus assessed as irrelevant to the topic of learning disabilities. Most articles that contained important information related to RTI were considered relevant. However, though rarely, some articles contained information on RTI but did not indicate a connection or make mention of students with learning disabilities; these articles were assessed as irrelevant.

To assess relevancy for the reading disabilities category, I used the same relevancy criteria as that for the general learning disabilities category, however I also looked for an additional indication of information regarding reading skills, for example phonemic awareness, decoding, and reading comprehension. To assess relevancy for the math disabilities category, I also looked for an additional indication of information regarding math abilities, for example number sense, performing calculations, and math reasoning. For the nonverbal learning disabilities, I used the definitional criteria outlined in the introduction, namely significant deficits in nonverbal processing accompanied by strengths in rote language skills.

Considering precision. Some terms may yield a large number of nonrelevant citations – this means that they have high recall but low precision. In this case I considered using more specific versions of the broader term. This is referred to as word sense disambiguation, for example, if one was searching articles on intellectual disabilities and searched the word disability, it would likely produce a high recall of articles though it would be too general to many different types of disabilities. In this case, you can disambiguate the word into multiple insinuations such as intellectual disability or developmental disability or severe disability.

Assessing essentiality. A further refinement is to determine and test the terms that are essential to the synonym cluster, which are those that retrieve specific articles that could not be found using any other descriptor in the synonym cluster. I did this using the Boolean subtraction procedure (Sandieson & McIsaac, 2013). Here, I used the Boolean NOT function provided by the database to determine if each term yields unique and relevant citations. For example, to determine if “learning deficien*” produces specific articles that could not be found using “learning disab*”, I would search (“learning deficien*” NOT all the other potential search terms)

This search would generate all of the articles that "learning deficien*" produces on its own, separate from those produced using all the other search terms.

Step 4: Validating the Search Keywords in the Synonym Cluster

After verifying the uniqueness and relevance of the list of search terms, I did a follow-up analysis to ensure that all relevant terms have been harvested. To do this, I compared my list of search terms to those used in the meta-analyses and systematics reviews found in step one. If more terms were located, then I verified them using the Boolean subtraction technique, and I added the verified terms to the synonym cluster for which they seemed most suitable.

Chapter III

Results

Choosing a Representative Sample of Articles

Step 1 involved finding a set of representative articles using meta-analyses, systematic reviews, and other types of research syntheses. To locate these articles, I typed in the research synthesis synonym cluster (Sandieson, 2014) in combination with "learning disab*" in both PsycINFO and ERIC. After putting aside research on learning disabilities from the UK that is actually on intellectual disabilities, my search led me to 23 relevant research syntheses, which are outlined in Table 1.

Initially, I intended to analyze each of the articles that made up each research synthesis, however that would have meant analyzing over 300 articles, which I found to be beyond the scope of this investigation. Thus, I chose four research syntheses that I judged to be most representative of the learning disabilities field and its prominent subtypes (denoted in Table 1 with a two asterisks). The resulting sample of representative articles was 105 studies, each of which were analyzed for learning disabilities terminology.

Table 1

Information Retrieval Search Terms Used by Systematic Reviews on Learning Disabilities

Author (date)	Article title	Journal	Search terms	Databases
Bal, A. & Perzigian, A.B.T. (2013)	Evidence-based interventions for immigrant students experiencing behavioral and academic problems: A systematic review of the literature	Education and Treatment of Children	learning disabilit*, LD, SLD, learning difficult*, learning problem*, reading disability*, writing disability*, math disability*	PsycINFO, ERIC, Education Full-Text, Family and Society, Google Scholar
Bender, W.N., & Wall, M.E. (1994)	Social-emotional development of students with learning disabilities	Learning Disability Quarterly	Not specified	Not specified
Ciullo, S.P., & Reutebuch, C. (2013)	Computer-based graphic organizers for students with LD: A systematic review of literature	Learning Disabilities Research & Practice	learning disab*, reading disab*	ERIC, PsycINFO
Collins, D.W., & Rourke, B.P. (2003)	Learning-disabled brains: A review of the literature	Journal of Clinical and Experimental Neuropsychology	Not specified	Not specified
Cornwall, A., & Bawden, H.N. (1992)	Reading disabilities and aggression: A critical review	Journal of Learning Disabilities	Not specified	Not specified

Author (date)	Article title	Journal	Search terms	Databases
Cronin, M.E. (1996)	Life skills curricula for students with learning disabilities: A review of the literature	Journal of Learning Disabilities	Not specified	Not specified
Dudley-Marling, C.C., & Edmiaston, R. (1985) **	Social status of learning disabled children and adolescents: A review	Learning Disability Quarterly	Not specified	Not specified
Fine, J.G., Semrud-Clikeman, M., Bledsoe, J.C., Musielak, K.A. (2013) **	A critical review of the literature on NLD as a developmental disorder	Child Neuropsychology	NLD, NVLD nonverbal learning disability, math disability	
Greenham, S.L. (1999)	Learning disabilities and psychosocial adjustment: A critical review	Child Neuropsychology	Not specified	Not specified
Little, S.S. (1993)	Nonverbal learning disabilities and socioemotional functioning: A review of recent literature	Journal of Learning Disabilities	Not specified	Not specified
Lyytinen, H., Guttorm, T.K., Huttunen, T., Hämäläinen, J., Leppänen, P.H.T., &Versterinen, M. (2005)	Psychophysiology of developmental dyslexia: A review of findings including studies of children at risk for dyslexia	Journal of Neurolinguistics	Not specified	Not specified

Author (date)	Article title	Journal	Search terms	Databases
Maccani, P., Mulcahy, C.A., & Wilson, M.G. (2007) **	A follow-up of mathematics interventions for secondary students with learning disabilities	Learning Disabilities Research & Practice	learning disabilities, high incidence disabilities, mild disabilities, learning difficulties, math disabilities, math difficulties, at-risk, mathematics, arithmetic, instruction, problem solving, computation, geometry, algebra, algorithms	PsycINFO, ERIC, Exceptional Child Education Resources
Mull, C., Sitlington, P.L., & Alper, S. (2001)	Postsecondary education for students with learning disabilities: A synthesis of the literature	Council for Exceptional Children	disabilities, support services, student development, special needs students	ERIC
Nelson, R., & Lignugaris-Kraft, B. (1989)	Postsecondary education for students with learning disabilities	Council for Exceptional Children	learning disabled, dyslexia, disabilities, academic failure, learning programs	Exceptional Child Education Resources Abstract, Dissertation Abstract
Orr, A.C., & Bachman Hammig, S. (2009)	Inclusive postsecondary strategies for teaching students with learning disabilities: A review of the literature	Learning Disability Quarterly	disabilities, learning disabilities	Education Abstracts, ERIC, GALE PowerSearch, Google Scholar, InfoTrac, JSTOR, PsycArticles, PsycINFO, Sage Journals Online, WilsonSelectPlus

Author (date)	Article title	Journal	Search terms	Databases
Solis, M., Ciullo, S., Vaughn, S., Pyle, N., Hassaram, B., & Leroux, A. (2012) **	Reading comprehension interventions for middle school students with learning disabilities: A synthesis of 30 years of research	Journal of Learning Disabilities	reading, reading comprehension, LD, learning disab*, reading strategies, reading disab*	PsycINFO, ERIC
Swanson, E.A. (2008)	Observing reading instruction for students with learning disabilities: A synthesis	Learning Disability Quarterly	reading, remedial reading, reading difficult*, disability, dyslexia, learning problems, minimal brain dysfunction, resource programs, resource teachers, special needs students, reading teachers, special education teachers	Not specified
Swanson, E., Hairrell, A., Kent, S., Ciullo, S., Wanzek, J.A., & Vaughn, S. (2014)	A synthesis and meta-analysis of reading interventions using social studies content for students with learning disabilities	Journal of Learning Disabilities	struggling readers, dyslex*, learning disab*	ERIC, PsycINFO
Swanson, H. L. (1999)	Instructional components that predict treatment outcomes for students with learning disabilities: Support for a combined strategy and direct instruction	Learning Disabilities: Research & Practice	"learning disabled (disabilities)", "reading disabled (disabilities)", dyslexic, "educationally handicapped", "slow learners"	PsycINFO, MEDline, ERIC

Author (date)	Article title	Journal	Search terms	Databases
Swanson, H. L. (2001)	Research on interventions for adolescents with learning disabilities: A meta-analysis of outcomes related to higher-order processing	The Elementary School Journal	"learning disabled (disabilities)", "reading disabled (disabilities)", dyslexic, "educationally handicapped", "slow learners"	PsycINFO, MEDline, ERIC
Swanson, H. L., & Hoskyn, M. (1998)	Experimental intervention research on students with learning disabilities: A meta-analysis of treatment outcomes	Review of Educational Research	"learning disabled (disabilities)", "reading disabled (disabilities)", dyslexic, "educationally handicapped", "slow learners"	PsycINFO, MEDline, ERIC
Swanson, L. H., & Hoskyn, M. (2001)	Instructing adolescents with learning disabilities: A component and composite analysis	Learning Disabilities: Research & Practice	"learning disabled (disabilities)", "reading disabled (disabilities)", dyslexic, "educationally handicapped", "slow learners"	PsycINFO, MEDline, ERIC
Vogel, S.A. (1990)	Gender differences in intelligence, language, visual-motor abilities, and academic achievement in students with learning disabilities: A review of the literature	Journal of Learning Disabilities	Not specified	Not specified

Note. Asterisk denotes truncation function. Double asterisk denotes that the synthesis was used to retrieve pearls for search term analysis.

Finding a Set of Search Terms for Learning Disabilities

Soon after I started analyzing each pearl or representative article for potential search terms, four categories emerged: general learning disabilities, nonverbal learning disabilities, reading learning disabilities, and math learning disabilities. Table 2 demonstrates all of the

search terms that I found in surveying the representative articles. I located 133 search terms altogether: 39 for general learning disabilities, 39 for nonverbal learning disabilities, 32 for reading learning disabilities, and 22 for math disabilities.

Table 2

Potential Search Terms Found in the Representative Articles

Learning disabilities, general (39)	Specific learning disability Specific learning disabilities Learning disability Learning disabilities Learning disabled LD Academic underachievement Developmental learning disability Learning disorder Specific learning disorder Neurodevelopmental disorders Academic skill deficit(s) Neurological dysfunction Learning deficit(s) Working memory deficit(s) Arithmetic-and-reading disability Specific learning disorders Verbal learning disability Verbal learning disabilities VLD Below-average achieving student(s) Basic phonological processing disabilities (BPPD) Low achievers Low achieving students High-risk learners Mildly handicapped Mild handicaps Learning problem(s) Educationally high-risk children Learning problems of underachievers Disadvantaged students Learning handicap(s) Educably mentally handicapped Educably mentally retarded Slow learning children Below-average achieving student(s) Below-average achieving child (children)

	Exceptional child Exceptionality
Nonverbal learning disabilities (39)	Nonverbal learning disability Nonverbal learning disabilities NVLD Visual-spatial deficits Visualspatial deficits Visual spatial deficits Visual spatial learning disability Visual spatial learning disabilities Auditory-perceptual Nonverbal reasoning abilities Verbal abilities Nonverbal communication Receptive nonverbal processing abilities Visuospatial learning disability Visuospatial learning disabilities Nonverbal learning disability syndrome Nonverbal learning disorder NLD syndrome Concept formation Nonverbal reasoning abilities Developmental right-hemisphere syndrome DRHS Developmental learning disabilities of the right hemisphere Tactile-perceptual disability Tactile-perceptual disabilities Nonverbal problem-solving skills Minimal brain dysfunction Nonverbal deficits Low visuospacial high verbal intelligence Right hemisphere deficit syndrome Nonverbal intelligence Low nonverbal/high verbal (LNV) Right hemispheric dysfunction Visuoperceptive disorder Visuoconstructive disorder Developmental dysgraphia Dysgraphic Developmental Gerstmann syndrome Developmental right-hemispheric dysgraphia
Reading learning disabilities (32)	Reading disability Reading disabilities Reading disabled Poor readers

	Reading disorder
	RD
	Retarded readers
	Reading retardation(s)
	Phonetically accurate
	Reading problems
	Developmental spelling retardation
	Basic phonological processing disabilities
	Developmental dyslexia
	Dyslexia
	Dyslexic
	Atypical reading-spelling pattern(s)
	Reading problem(s)
	Reading backward child
	Reading backward children
	Not yet reader
	Reading intervention(s)
	Language learning disability
	Language learning disabilities
	Word-reading difficulty
	Disabled readers
	Psycholinguistically impaired
	Deficient reader(s)
	Poor reader(s)
	Reading difficulty
	Reading difficulties
	Disabled reader(s)
	Phonemic awareness
Math learning disabilities (22)	Developmental dyscalculia
	Arithmetic disability
	Arithmetic disabilities
	Specific arithmetic disability
	Specific arithmetic disabilities
	Specific arithmetic impairment(s)
	Disabilities of arithmetic and mathematical reasoning
	Math disability
	Math disabilities
	Mathematical disabilities
	Mathematics disabilities
	Math difficulty
	Math difficulties
	Mathematics difficulties
	Mathematics disabilities
	Mechanical arithmetic competence
	Specific academic problem(s) with math
	Mathematic learning disabilities

	MLD Learning problems in math Learning difficulties in numeracy (math, mathematics) Students at high risk for math failure

Refining the List of Search Keywords

The truncation function reduced the list of search terms from 132 to 105, which then underwent the next refinement phases, assessing relevancy, precision and essentiality. Table 3, 4, 5, and 6 represent the refinement phases for the synonym clusters of general learning disabilities, reading disabilities, math disabilities and nonverbal learning disabilities, respectively. I used the Boolean NOT procedure in ERIC for each search term, assessing if it is essential to its synonym cluster and reported this information as the total number of unique citations produced by that search term. The number of citations retrieved column represents only scholarly articles; that is, all other sources, including theses, dissertations and news articles, were not represented in the numbers.

If a search term retrieved more than 40 articles, I assessed relevance of the first 40 and reported my results as a percentage and an estimation of the number of unique, relevant citations for that term. The rationale for choosing not to analyze more articles is that there was a large number of search terms at this step, and the relevancy check was more a matter of determining if the search term could make any contribution to a search.

Relevancy was determined by analyzing each article's title, abstract, journal of publication and indexed identifiers and descriptors. However, in some cases it was still unclear whether or not the article was relevant. Here, I quickly surveyed the introduction and methods section, looking for further indication of relevance to the subtopic. For example, in some cases the article investigated several types of disabilities, thus I looked into whether or not students with learning disabilities made up a group of the sample studied.

I found three more search terms in two different articles while analyzing for relevancy: *bright underachiever* (see table 3), *reading deficit** (see table 4), and *spelling disab**. I subsequently added them to their respective list of search terms and analyzed their uniqueness and relevance.

Table 3

Refining the List of Search Terms for General Learning Disabilities

Potential search terms	ERIC unique citations	ERIC unique, relevant citations (percent)	ERIC estimated total # of unique, relevant citations for synonym cluster terms
Arithmetic-and-reading disab*	1	100	1
Academic skill deficit*	4	100	4
Academic failure	925	3	23
Academic underachiev*	69	18	12
Below-average achieving student*	0	0	0
Basic phonological processing disab*	2	0	0
Below-average achieving child*	0	0	0
BPPD	0	0	0
Bright underachiever*	2	100	2
Developmental learning disab*	0	0	0
Disadvantaged student*	585	8	44
Educably mentally handicapped	0	0	0
Educably mentally retarded	8	0	0
Educationally high-risk child*	1	100	1
High-risk learner*	1	100	1
Learning difficult*	418	23	94
Learning disab*	10,951	100	10,951
LD	254	75	191
Learning disorder*	47	43	20
Learning deficit*	36	11	4
Learning handicap*	16	38	6
Learning problem*	1,759	46	792
Learning problems of underachiev*	0	0	0
Low achiever*	258	15	39
Low achieving student*	228	8	17
Mild disab*	407	45	183
Mild handicap*	103	50	52
Neurodevelopmental disorder*	107	0	0
Neurological dysfunction	15	13	2
Slow learning child*	5	40	2
Specific learning disab*	0	0	0
Specific learning disorder*	0	0	0
Verbal learning disab*	0	0	0
VLD	1	0	0
Working memory deficit*	54	13	7
Exceptional child*	4903	15	735
Exceptional student*	122	33	40
Exceptionality	494	23	111

Note. Pink denotes that the search term was found and added during the refinement stage. Green denotes that the search term was added in the validation stage. Asterisk denotes truncation function.

Table 4

Refining the List of Search Terms for Reading Disabilities

Potential search terms	ERIC unique citations	ERIC unique, relevant citations (percent)	ERIC estimated total # of unique, relevant citations for synonym cluster terms
Atypical reading-spelling pattern*	0	0	0
Basic phonological processing disab*	0	0	0
Deficient reader*	2	50	1
Developmental spelling retardation	0	0	0
Disabled reader*	47	100	47
Dyslexi*	1145	95	1088
Language learning disab*	114	15	17
Reading disab*	84	98	82
Phonemic awareness	427	23	96
Poor decoder	8	13	1
Poor reader*	256	15	38
Psycholinguistically impaired	0	0	0
Reading deficit*	10	80	8
Reading difficult*	2066	38	775
Reading disorder*	12	58	7
Reading retardation	0	0	0
Reading intervention*	218	45	98
RD	1088	5	54
Retarded reader*	1	100	1
Reading problem*	85	33	28
Reading backward child*	0	0	0
Not yet reader*	1	0	0
Spelling disab*	9	100	9
Struggling reader*	147	8	11
Writing disab*	26	77	20

Note. Pink denotes that the search term was found and added during the refinement stage. Green denotes that the search term was added in the validation stage. Asterisk denotes truncation function.

Table 5

Refining the List of Search Terms for Math Learning Disabilities

Potential search terms	ERIC unique citations	ERIC unique, relevant citations (percent)	ERIC estimated total # of unique, relevant citations for synonym cluster terms
Arithmetic disab*	16	100	16
Arithmetic learning disab*	4	100	4
Developmental dyscalculia	0	0	0
Disabilities of arithmetic and mathematical reasoning	0	0	0
Dyscalculia	49	100	49
Learning difficult* in numeracy	1	100	1
Learning difficult* in math*	7	71	5
Learning problem* in math*	176	3	4
Math* disab*	26	100	26
Math* difficult*	106	100	106
Mathematic learning disabilit*	7	100	7
Mechanical arithmetic competence	0	0	0
MLD	31	13	4
Specific academic problems with math*	0	0	0
Specific arithmetic disab*	0	0	0
Specific arithmetic impairment	0	0	0
Students at high risk for math* failure	0	0	0

Note. Asterisk denotes truncation function.

Interestingly, the majority of the search terms that were found for the nonverbal learning disabilities subtopic were found to be not essential, or unique, to the synonym cluster. As a result, the refined list was much smaller than the initial one.

Table 6

Refining the List of Search Terms for Nonverbal Learning Disabilities

Potential search terms	ERIC unique citations	ERIC unique, relevant citations (percent)	ERIC estimated total # of unique, relevant citations for synonym cluster terms
Auditory-perceptual	67	43	28
Concept formation	5356	0	0
Developmental right-hemisphere syndrome	0	0	0
DRHS	0	0	0
Developmental learning disabilities of the right hemisphere	0	0	0
Low nonverbal/high verbal (LNV)	0	0	0
Low visuospacial high verbal intelligence	63	0	0
Minimal brain dysfunction	2624	0	0
Nonverbal communication	2	100	2
Nonverbal deficit*	127	8	10
Nonverbal intelligence	23	100	23
Nonverbal learning disab*	4	100	4
Nonverbal learning disorder*	0	0	0
Nonverbal problem-solving skill*	0	0	0
Nonverbal reasoning abilit*	0	0	0
NVLD	0	0	0
Receptive nonverbal processing abilities	1	100	1
Right hemisphere deficit syndrome	0	0	0
Right hemispheric dysfunction	0	0	0
Visual-spatial deficit*	0	0	0
Visualspatial deficit*	0	0	0
Visual spatial deficit*	0	0	0
Visual spatial learning disab*	1	100	1
Visuospatial learning disab*	0	0	0
NLD syndrome	0	0	0
Nonverbal reasoning abilit*	0	0	0
Tactile-perceptual disab*	0	0	0
Visuoperceptive disorder*	0	0	0
Visuoconstructive disorder*	3	100	3
Developmental dysgraphia	1	100	1
Developmental gerstmann syndrome	0	0	0
Developmental right-hemispheric dysgraphia	0	0	0

Note. Asterisk denotes truncation function.

All search terms that produced unique, relevant citations in relation to the other search terms for their subtopic were included in the final synonym clusters. Some search terms produced a low percentage of unique, relevant citations and therefore had low precision, however they were still considered essential.

Validating the Search Keywords in the Synonym Cluster

Table 1 includes all of the search terms used by the meta-analyses and research syntheses I found in the initial step of my investigation. To validate my refined list, I compared it to the search terms used in these research syntheses. I found four additional search terms in the syntheses, analyzed their uniqueness and relevance in comparison to the list for which they seemed suitable, and added those that were found to be unique and relevant to that list. *Academic failure* and *learning difficult** were added to the general learning disabilities synonym cluster, while *struggling reader** and *writing disab** were added to the reading disabilities synonym cluster.

Final Synonym Clusters

After the phases of refinement and validation, 61 search terms remained: 25 for general learning disabilities, 18 for reading disabilities, 10 for math disabilities and 9 for nonverbal learning disabilities. The final pearl-harvested synonym cluster for each determined subtopic of learning disabilities are presented below in a format that could be copied and pasted into a bibliographic database search field.

Table 7

Pearl Harvested Synonym Clusters

Learning disabilities subtopic	Synonym Cluster
General learning disabilities	"arithmetic-and-reading disab*"OR "academic failure" OR "academic skill deficit*" OR "academic underachiev*" OR "bright underachiever*" OR "disadvantaged student*" OR "educationally high-risk child*" OR "learning disab*" OR "high-risk learner*" OR LD OR "learning difficult*" OR "learning disorder*" OR "learning deficit*" OR "learning handicap*" OR "learning problem*" OR "low achiever*" OR "low achieving student*" OR "mild disab*" OR "mild handicap*" OR "neurological dysfunction" OR "slow learning child*" OR "working memory deficit*" OR "exceptional child*" OR "exceptional student*" OR exceptionality
Reading disabilities	"deficient reader*" OR "disabled reader*" OR "dyslexi*" OR "language learning disab*" OR "reading disab*" OR "phonemic awareness" OR "poor decoder" OR "poor reader*" OR "reading deficit*" OR "reading difficult*" OR "reading disorder*" OR "reading intervention*" OR RD OR "retarded reader*" OR "reading problem*" OR "struggling reader*" OR "writing disab*"
Math disabilities	"arithmetic disab*" OR "arithmetic learning disab*" OR dyscalculia OR "learning difficult* in numeracy" OR "learning difficult* in math*" OR "learning problem* in math*" OR "math* disab*" OR "math* difficult*" OR "mathematic learning disabilit*" OR MLD
Nonverbal learning disabilities	"auditory-perceptual" OR "nonverbal deficit*" OR "nonverbal intelligence" OR "nonverbal learning disab*" OR "nonverbal learning disorder*" OR "right hemisphere deficit syndrome" OR "visuospatial learning disab*" OR "developmental dysgraphia" OR "developmental gerstmann syndrome"

Note. Asterisk denotes truncation function.

To further demonstrate the power of the pearl harvested synonym clusters, I conducted a follow-up analysis.

Follow-up Analyses

The final analyses were meant to demonstrate how the extra search terms produce better searches than are typically used in current research syntheses. Here, I compared the search outcomes of the pearl harvested synonym clusters to the search outcomes of the common search

terms (see Table 1) for each subtopic. Table 8 represents the citations retrieved for each search, the percentage of relevant citations, and the estimated total number of relevant citations.

Table 8

Comparison of the Number of Citations Retrieved by the Pearl Harvested Synonym Clusters and the Often Used Search Terms

Learning disabilities subtopic	**Search terms**	**Citations retrieved**	**ERIC percentage of relevant citations**	**ERIC estimated total # of relevant citations**
General learning disabilities	"learning disab*" OR "learning disorder*"	10,998	98	10,723
	Pearl harvested synonym cluster	21,776	61	13,334
Reading disabilities	"reading disab*" OR "reading disorder*" OR dyslexi*	1,241	100	1,241
	Pearl harvested synonym cluster	6,825	35	2,372
Math disabilities	" math disab*" OR dyscalculia	107	100	107
	Pearl harvested synonym cluster	403	41	222
Nonverbal learning disabilities	"nonverbal learning disab*" OR "nonverbal learning disorder*"	36	100	36
	Pearl harvested synonym cluster	292	25	73

Note. Asterisk denotes truncation function.

It was evident that the pearl harvested synonym clusters produced considerably more relevant citations than the commonly used search terms (see Table 8). Also, it can be seen that the search terms used the research syntheses in Table 1 provide only a subset of the possible

terms that can be used to search the topic of learning disabilities. It is beyond the scope of this research to audit those reviews, but considering the findings here the comprehensiveness of those reviews can be questioned.

It is also worthwhile to note that each of these clusters will produce unique citations in comparison to the other clusters (see Table 9). Therefore, if the intent was to search the complete literature on learning disabilities each of these clusters could be combined in a single search through the Boolean OR command. The search of the combined synonym clusters produced 28,898 citations, a number that is much larger than what typically used search terms produce.

Table 9

Number of Unique Citations for Each Synonym Cluster

Learning disabilities subtopic	**Number of unique citations for cluster**
General learning disabilities	20,731
Reading disabilities	241
Math disabilities	7,974
Nonverbal learning disabilities	531

Chapter IV

Discussion

The main purpose of this investigation was to create a strategy to comprehensively and effectively search the literature on specific learning disabilities using sets of terms (i.e., synonym clusters). The pearl harvested synonym clusters are a modular way of creating a search strategy such that they can be used separately or in conjunction with one or more other synonym clusters, depending on researchers' investigating needs.

After employing each of the extensive steps of the Pearl Harvesting Information Retrieval Framework, I reported the results as a set of synonym clusters that will serve as a strategy for searching the ERIC digital library for information on learning disabilities. During the initial steps of the Pearl Harvesting Information Retrieval Framework process I kept in mind each of the specific learning disabilities, namely dyslexia, dyscalculia, dysgraphia and nonverbal learning disabilities, and created a separate search strategy for anyone who wishes to gain an understanding of specific areas. Four subtopics emerged from the analysis: general learning disabilities, reading disabilities (dyslexia), math disabilities (dyscalculia) and nonverbal learning disabilities. Additionally, these clusters could be combined to develop a complete search of the field of learning disabilities that might provide interesting insights at a global level.

Contribution of the Pearl Harvesting Information Retrieval Framework

Using the Pearl Harvesting Information Retrieval Framework to create a comprehensive search strategy for research on specific learning disabilities was a unique task, given the definitional, diagnostic and interdisciplinary nature of the field. Creating four synonym clusters for four subtopics was strategic in that it will allow researchers the freedom to use the synonym cluster that will best suit their searching needs.

Perhaps one of the most significant contributions here is the reusability of the synonym cluster. That is, once developed it can be used by anyone. This is in contrast to current search methods where a specific strategy is disposable. That is, strategies used on the same topic are not utilized to any great extent in further studies' searches. Having an explicit, transparent set of terms that can be reused, and adapted as the language of the field evolves provides researchers with a considerable saving in effort.

Limitations and Future Research

Although the present investigation systematically addressed the issue of navigating databases for research on learning disabilities, it is only a starting point and further investigation is required.

One potential limitation to my findings is that the number of articles that were analyzed (105) was nearly a third of the total number of articles that emerged (over 300) out of the meta-analyses reviewed (displayed in Table 1). Investigating the remaining articles for more terms may produce a greater variety of search terms, which may in turn retrieve relevant, unique citations when added to the synonym clusters.

The representative articles that were used did not seem to locate a variety of terms on dysgraphia, a significant subfield of specific learning disabilities. However, *developmental dysgraphia* was included in the nonverbal learning disabilities synonym cluster as the term was found in an article that addressed nonverbal learning disabilities. Future researchers should consider investigating the literature for a greater diversity of terms on dysgraphia and perhaps producing a separate synonym cluster for the topic.

A third potential limitation is the size of the sample of articles that were used to assess relevance for each search term. Since only 40 articles were reviewed for relevancy for each

search term, the estimated number of relevant articles for a given term is likely to have been different from the actual number of relevant articles. The number 40 was chosen only because it was thought to be large enough given the task of validating a great amount of search terms. Further research needs to be done using a more systematic approach to determining sample size of citations to use. Perhaps a way of doing so might be to use a probabilistic sample size calculation, which would give a more efficient way of determining how many citations to sample. However, since all terms that produced relevant citations were included in the final synonym clusters, in terms of comprehensiveness, it wasn't as problematic that only 40 articles were assessed for relevance.

Future researchers should also investigate handbooks on learning disabilities to better address definitional issues. Here, a sample of representative articles used in a given handbook can be used to locate diverse terms, which can then be refined, verified and added to the synonym clusters developed in the current investigation.

This research focused on the ERIC database to ensure comprehensiveness; however, information is spread out across databases. Additionally, databases tend to have different collections of journals, thus my findings may not be completely transferable to other databases. Further research needs to be done to explore the commonalities and differences of the synonym clusters in other databases. Moreover, the synonym clusters validated in this study using the ERIC database should also be validated across multiple databases. Future researchers may also need to determine which databases should be used with intent to locate research on learning disabilities.

The field of learning disabilities can greatly benefit from a comprehensive strategy to navigating the research literature. The task of comprehensively searching the literature has

become more difficult given that learning disabilities research is vast and interdisciplinary and online database searching is increasingly complex. The aim of this research was create such a strategy, which can now serve as a guide for future researchers, educators and other practitioners and policy makers to locating a large variety of relevant research on learning disabilities.

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Curriculum Vitae

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EDUCATIONAL STUDIES
Concentration: *Educational Psychology and Special Education*
Thesis: *Creating a Comprehensive Search Strategy for Research on Learning Disabilities Using the Pearl Harvesting Information Retrieval Framework*
Supervisor: *Dr. Robert Sandieson*

Bachelor of Education, University of Windsor (Windsor, ON) **2013 – 2014**
PRIMARY/JUNIOR QUALIFICATIONS

Bachelor of Arts, University of Windsor (Windsor, ON) **2008 – 2012**
HONOURS PSYCHOLOGY WITH THESIS
Thesis: *Academic Entitlement in Upper Year Undergraduate Students: A Qualitative Exploration*
Supervisor: *Dr. Dennis Jackson & Dr. Dusty Johnstone*

PROFESSIONAL EXPERIENCE

VIP Program Facilitator, *Student Success Centre* **2014 – Present**
University of Windsor (Windsor, ON)

Camp Supervisor **2013 – 2014**
Windsor Homes Coalition (Windsor, ON)

Research Assistant **2013**
Dr. Betty Barrett and Dr. Dana Levin, University of Windsor (Windsor, ON)

CONFERENCE PRESENTATIONS

Almanssori, S. (2014). *Creating a Comprehensive Search Strategy for Learning Disabilities Using the Pearl Harvesting Information Retrieval Framework.* Poster presented at the Ontario Council for Exceptional Children Conference, Niagara Falls, ON (November, 2014).

Almanssori, S. (2013). *Hijab in Educational Discourse: A Disruptive Narrative.* Poster presented at Engaging with the Critical Edge: Rethinking Pedagogy Conference, Windsor, ON (November, 2013).

Almanssori, S. (2012). *Academic Entitlement in Upper Year Undergraduate Students.* Paper presented at the Ontario Undergraduate Thesis Conference, Toronto, ON (April, 2012).

PROFESSIONAL AFFILIATIONS

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