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Abstract

The article investigates the interdisciplinary nature of research in adult education and suggests interactive research guides and other interactive resources for fostering collaboration and interdisciplinary inquiry. The purpose is to foster the development of a more functional literacy for information seeking as expressed across disciplines and the thoughtful integration of such information into academic and practical research projects within the field of adult education. Studies of researcher behavior are utilized to suggest some techniques and resources that could be employed more widely in conducting literature searches, including the creation and use of interactive resource guides. Some trends in libraries that offer promise for knowledge discovery and sharing, such as federated searching, customizable workspaces, and user-generated content, are also explored. Finally, tools and resources currently available to promote collaboration and interdisciplinary research are also noted.

Keywords

interdisciplinary research, adult education, interactive research guide, social media

Introduction

This article investigates the interdisciplinary nature of collaboration within education research and suggests interactive research resources, and particularly the creation of online resource guides, as means for fostering interdisciplinary research in and across education-related fields. We aim to address three questions: (a) How can we overcome differences in language and terminology for describing similar research interests across fields to foster collaborative research in education? (b) What are some of the tools and resources currently available in assisting and promoting collaborative and interdisciplinary research? and (c) What is meant by an interactive resource guide and how can similar tools be utilized as valuable strategies for managing interdisciplinary necessities of cross-discipline collaboration? In examining information-science trends, how expertise is translated between disciplines, and nascent social media applications, we hope to provide a viable framework for cultivating spaces and means for interdisciplinary innovation in adult-education research.

Education has always been a strategically collaborative endeavor, in both research and practice. Similar to the cross-curricular movements in the fields of writing and communication (Dannels & Housley Gaffney, 2009), education has also developed collaborative and interdisciplinary initiatives, and rightly so. The field of education has historically

drawn on a number of different fields in the generation, elaboration, and application of theory and practice, and the field of adult and continuing education is no exception. Adult and continuing education is an interdisciplinary field where students examine human learning and development from the biosocial, cognitive, and psychosocial perspectives with special emphasis on the adult years. Indeed, adult educators come from a grand diversity of backgrounds and bring expertise and knowledge from a multitude of disciplines. Closson's (2010) recent article on critical race theory in adult education highlighted the interdisciplinary nature of research in the field, emphasizing the need to "draw from a cross-section of sociology, psychology, economics, and anthropology as well as the arts to understand and enhance our practice" (p. 273). This is no small undertaking, and information science, communication technologies, and social media now offer a vast range of possibilities in pursuing this challenge.

Unfortunately, collaboration and interdisciplinary work are not as heavily advocated in higher education as one might

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think and in some instances are discouraged in favor of purely disciplinary work. The traditional tools for discovery of relevant research, abstracting and indexing (A&I) services, focus on literature published in closely related disciplines. Knowledge itself has been rigidly categorized and compartmentalized in libraries and repositories. Opportunities do exist for fostering interdisciplinary research and knowledge creation. Not only should we become more familiar with the many (ever changing) resources available in the facilitation of our research processes, practice, and partnerships, but we should also find and promote new and imaginative ways of using, sharing, and improving these resources to help us overcome the challenges of our collaborative and interdisciplinary work. We hope to foster the development of a more functional literacy for information seeking as expressed across disciplines and the thoughtful integration of such information into academic and practical research projects within the field of adult education.

Research Approach

Our work examines some of the obstacles in conducting collaborative and interdisciplinary research and describes research tools and interactive, technology-driven strategies for overcoming some of these obstacles to add depth to theoretical and conceptual development. First, we will briefly address the complicated nature of performing interdisciplinary research, including inconsistencies in terminology employed in interdisciplinary research and their impact on research and professional practice. Next, we will utilize studies of researcher behavior to suggest some techniques and resources that could be employed more widely in conducting literature searches, including the creation and use of interactive resource guides, patterned after selective bibliographies offered by academic libraries (Vileno, 2007). We will also explore some trends in libraries that offer promise for knowledge discovery and sharing, such as federated searching, customizable workspaces, and user-generated content. Finally, we will present some online and interactive resource guides, pathfinders, wikis, and collaboration via social media among others.

Literature Review

In adult education, collaborative practice is a core facet of professional life for both researchers and practitioners (Tartas & Mirza, 2007). However, interdisciplinary synthesis is a distinct mode of knowledge production that is not as well understood or practiced as disciplinary research (Brew, 2008; Woods, 2007). Indeed, the use of the term *interdisciplinary* is inconsistent in higher education (Manning et al., 2008). Three influences have shaped the promotion of interdisciplinary research in higher education: (a) the recognition of complexity of nature and society, (b) the need to solve problems not confined to one discipline, and (c) the capacity

of new technologies to enable discovery (National Academy of Sciences, 2010). The definition of interdisciplinary research that we employ in this project is individual research or collaboration that reaches across disciplinary lines and draws on different bodies of knowledge, integrating them in an attempt to address problems, topics, or issues of a complex nature.

Gardner (2007) explains that within an information society where the production and growth of information is exponential, one of our most important tasks as scholars is that of synthesizing information from disparate sources and generating new knowledge to find solutions to problems that are increasing in complexity. The shifting boundaries of knowledge production complicate the nature of research. We need to become better able to address questions and dilemmas that operate outside of our disciplinary categorizations of knowledge, and we are often required to operate in a more complex cognitive environment (Feller, 2007; Hegarty, 2009; Lubet, 2009; Oksen, Magid, & De Neergaard, 2009). Interdisciplinary research allows us to generate new theoretical understandings, communicate across curriculum, and foster critical, reflective, and problem-solving skills in the face of complex social problems.

First and foremost, maintaining distinct territories of knowledge (Becher & Trowler, 2001; Stein, Connell, & Gardner, 2008; Woods, 2007) is the embedded disciplinary norm in higher education. These boundaries are entrenched in the American education system and have been historically reflected in academic research functions (Holley, 2009). Indeed, specialization is the institutional norm and requirement, and professional legitimacy is bound to the notion of disciplinary specialization (J. Parker, 2008). "Distinctive disciplinary perspectives are attached to epistemological components that shape knowledge production . . . The disciplinary mastery inherent in the act of research restricts participation in interdisciplinary endeavors" (Holley, 2009, p. 62). Though this kind of focus may allow for great progress within a particular field, it also isolates researchers from interaction with potential collaborators who may share common purposes, goals, or ideas. No single approach can provide a complete picture or understanding of a phenomenon or of the world (Winberg, 2008). Other barriers include institutional structures and organization, funding, lack of interaction between disciplines, contradictory expectations related to research and job performance, issues related to validity and quality control, and so on (Holley, 2009).

Written texts serve a vital role in our intellectual system, legitimizing and archiving scholarship for a disciplinary audience. These artifacts exist within a highly disciplinary context, offering unique perspectives, often seemingly inaccessible to *outsiders*. One of the main challenges in interdisciplinary research is locating specific data and inquiring into bodies of knowledge that may be relevant to one's research, but they are outside of one's field of expertise.

Disciplines have developed their own languages, norms, and cultures over the years, and communicating across these is the primary challenge of conducting interdisciplinary research. The process of learning a specific discipline is a lot like how one learns another language (Peterson, 2008). An individual researcher's ability to acquire disciplinary knowledge in a number of fields is limited, at least at the sophisticated level needed for complex problem solving.

Collaborative work across disciplines also presents challenges, as access to different fields and communities of knowledge requires engagement in a *process of translation*, which not only includes consuming knowledge from other fields but also interacting with the other disciplinary cultures and understandings that provide the context for that knowledge. McWilliam, Hearn, and Haseman (2008) explain that the *innovation space* needed for interdisciplinary work is most often comprised of three elements: (a) the expertise or content component that is blended into emerging knowledge in the form of new languages, symbols, narratives, characters, genres, products, entire fields of inquiry, and so on; (b) a social and human component that includes the interaction of people, engagement strategies and goals, and institutional and regulatory environments; and (c) a technology component that usually consists of new devices, software, and connecting media. The three components that constitute an *innovation space* will provide a rough theoretical framework for our discussion that follows:

Holley (2009) asserts that informal communication between researchers from different disciplines is what facilitates knowledge transfer and the process of generating new interdisciplinary knowledge. This is the process we are specifically interested in, and our focus is on two issues in particular. First, we are interested in finding or building on resources that can aid the *translation* process to further facilitate curiosity, knowledge seeking, and interaction across disciplines. Second, we are interested in technology-driven spaces and places that may contribute to the kind of contact and socialization across disciplines that could help the necessary acculturation to language, behaviors, and norms prevalent in other fields of study.

Research Activities and Interdisciplinarity

As educators and practitioners, we spend a great deal of time talking about employing informed strategies in the facilitation of learning in all environments; so too should we be more calculated and reasoned in the approaches we employ for our research endeavors. Information-science research has much to offer in terms of developing strategies for discovering knowledge across disciplines, creating a foundation for the first element of innovation spaces: the content component.

A number of studies have examined the research practices of scholars, particularly within the context of a shift from print to digital information environments (Evans, 2008;

Ollé & Borrego, 2010; Palmer, 2005; Palmer, Tefteau, & Pirmann, 2009; Schonfeld & Housewright, 2010; Tenopir & King, 2008). Additional studies have focused on research behaviors typified within or across disciplines (Meho & Tibbo, 2003; University of Minnesota Libraries, 2006) or among interdisciplinary scholars (Palmer, 1999; Palmer, Cragin, & Hogan, 2007; Palmer & Neumann, 2002; Spanner, 2001). These and other studies of researcher behavior and scholarly communication patterns inform libraries' decisions regarding collections, services, and interfaces for finding aids. As the following discussion will show, these studies also suggest approaches that researchers might employ to foster discovery and understanding of written texts beyond familiar domains.

Palmer and her colleagues (2009) analyzed literature on researcher behavior and identified five core activities common across disciplines: searching, collecting, reading, writing, and collaborating. Cutting across activities are *primitives* (Palmer et al., 2009; Unsworth, 2000) or primary functions that contribute to the larger activity. Our inquiry focuses primarily on searching and collaborating activities and the primitives of direct searching, browsing, monitoring, chaining, probing, and translating.

Searching entails where and how to look for information. *Discovery* is a broader term for searching, encompassing all kinds of purposeful and serendipitous search activities (University of Minnesota Libraries, 2006; Unsworth, 2000). *Direct searching* is purposeful discovery, where the researcher seeks information to address a specific need, whether verifying a fact or comprehensively answering a research question.

Browsing is a more open-ended activity than direct searching and of importance especially to interdisciplinary scholars (Palmer et al., 2009). Libraries facilitate browsing of physical collections by arranging materials by subject, but browsing can also be accomplished electronically. Journal databases usually offer browsing by subject, volume, issue, and table of contents. Library catalogs permit browsing by author, title, or subject. Browsing by call number is the virtual equivalent of the "three-foot rule" of looking on the shelves in a library within the radius of a book that one has already selected to find similar and useful material.

Monitoring publications or topics of interests helps scholars stay current. Researchers can track what is being published in a wide range of journals by subscribing to table of contents alerts via email or Really Simple Syndication (RSS) feeds from journal databases. Researchers may also automate database searches to alert them when articles meeting certain criteria have been published, including articles that cite a given article. Palmer and Neumann (2002) found that "push" sources—subscriptions, electronic mailing lists, and other information sent directly to individuals—were particularly valued by interdisciplinary humanities scholars (p. 102). Chaining—tracking down references in texts or recommended by colleagues—is another primitive common across

disciplines (Palmer et al., 2009). Forward chaining to find articles that have cited a specific document can lead researchers to discover other scholars working on similar areas of study. Citation databases like the Social Sciences Citation Index in Web of Science (<http://wokinfo.com/>) facilitate forward and backward chaining.

Probing and translating are primitives of particular importance to interdisciplinary scholars. *Probing* may be opened or directed at answering a specific question, but it is defined as exploring unknown information in unfamiliar areas of knowledge within or outside one's own domain (Palmer, 1999). Scholars who venture into unknown disciplines may have to adjust to new vocabularies and theoretical assumptions as they confront new literature, then turn around and formulate writing appropriate for a new audience (Palmer et al., 2009). Assistant professors in Spanner's study (2001) talked about the difficulties of conducting literature searches not knowing the language of a discipline, whereas more experienced professors had mastered these barriers. Palmer and Neumann (2002) found that accomplished interdisciplinary humanities scholars relied on disciplinary textbooks, handbooks, reference sources, core journals, and basic texts for this process of translation.

The *where* of scholarly searching can include print and online journals and books, reference sources, search engines, websites, databases, media, digital repositories, specialized collections, personal collections of materials, and colleagues. The *how* relates to terminology or techniques employed for searching. Creating a personal research log can help researchers reflect on and improve strategies for the *where* and *how* of searching literature. We propose that researchers take the research log a step further and create online, interactive guides to share strategies with other researchers for the purpose of fostering collaborative and interdisciplinary scholarship. We propose that resource guides serve as a means of engaging researchers across disciplines, the second component of innovation spaces.

Resource Guides for Interdisciplinary Inquiry

Libraries have long created local finding aids for researchers, either as reading lists of books or more structured guides to the literature of a discipline (Dunsmore, 2002; Vileno, 2007). Stevens and his colleagues at MIT (Stevens, Canfield, & Gardner, 1973) introduced a type of resource guide called a pathfinder and prescribed its contents. Pathfinders were neither to be exhaustive nor simply bibliographies, but to assist researchers in "gathering the fundamental literature of a field new to them in every respect" (p. 41). Each pathfinder began with a brief description of the topic covered. The first reference on the pathfinder would point to a good introductory source, like an encyclopedia. Sections on books, journals, and articles would list not only the discovery

tools for finding literature but also useful subject headings, call-number ranges, and the most-used journals related to a topic to facilitate searching or browsing. Titles of classic texts and existing bibliographies might be included, plus specific citations to relevant entries in encyclopedias, handbooks, or other specialized reference sources. Finally, the pathfinder would include lists of other sources important to individual disciplines—conference proceedings, government documents, newspaper indexes, regular columns, relevant organizations, and so forth (Warner, 1983). Libraries are demonstrating a renewed interest in subject or course guides with the development of content-management systems that simplify creation of online guides and incorporation of Web 2.0 features (Smith, 2008).

We were introduced to another structure for creating resource guides in an adult-education course taught by Dr. Robert Swisher (2008). The content for the guides was similar to pathfinders, but Swisher based his model on Freides's (1973) overview of scholarly literature in the social sciences. Freides described scientific communication as a system of ongoing discussion among scholars. New ideas enter the discussion as reports of research in articles, dissertations, technical reports, or journal articles. As ideas are tested, synthesized, and expanded, they are included in books, reviews of the literature, and essay collections. They then become part of the cumulative, established knowledge of the field and are summarized in textbooks and reference works. Freides described a parallel structure of finding aids for each type of literature. Swisher updated the model to include electronic tools for searching information and asked students in the course to create such guides on topics of interest.

Resource guides used in conjunction with social media could foster interdisciplinary and collaborative research. Guides could potentially combine disciplinary knowledge, more purposeful information-seeking methods, and the participatory norms found in social media. Combining the structure of resource guides, with their already almost wiki-like nature, and harnessing the potentials of social media could enable researchers to translate knowledge across disciplines and form the necessary links and social interactions necessary for the cross-pollination of ideas.

In our roles as teacher, researcher, and librarian, we have observed that fellow scholars and students overlook—or may be unaware of—resources included in Freides's (1973) and Swisher's (2008) models that could facilitate searches of literature, especially encyclopedias, textbooks, and handbooks that summarize and put into context theories and research in an area of study. Such cumulating sources are particularly useful in guiding readers to additional resources that support probing and translating in unfamiliar or interdisciplinary research. The proposed guides would be more specialized than what libraries typically post as general overviews of broad subject areas like education or adult education. The guides would focus on materials used by individuals or groups

of scholars to support ongoing research and would include keywords or controlled vocabulary, call-number ranges, or other strategies for using tools and resources effectively. We propose the following structure for the guide:

Resource Guide Template

Brief introduction.

- I. Cumulative sources and strategies for locating
 - A. encyclopedias and dictionaries
 - B. textbooks, histories, essays, and handbooks
 - C. research reviews and annotated bibliographies
- II. Current information and strategies for locating
 - A. books
 - B. scholarly journals
 - C. journal articles
 - D. reports, articles, dissertations, organizations, and other information
 - E. informal conversations (blogs, websites, and social networking sites)

Creating an online resource guide as a wiki, shared document, or customized page on a social networking site would make it easily shared, updated, and posted for other researchers' and students' use. The format is simple and adaptable enough to facilitate the creation of topic-specific, expanded, online social media tools, like wikis and other collaborative endeavors. Researchers and scholars could share their expertise and techniques in probing and translating their interdisciplinary research. Placing guides online would help researchers with similar purposes and interests find one another—regardless of their discipline or field—and potentially become collaborators in interdisciplinary work. The idea is, by becoming more purposeful in how we look for information in interdisciplinary research, making notation of our information-seeking processes and discoveries (for ourselves and others), sharing some of those findings (especially regarding the translation of terms and knowledge across disciplines), and taking the initiative to make connections with others of similar interests through interactive and social media, we may be able to create innovation spaces and new learning communities.

Populating the Resource Guide

The proposed guide moves from sources that summarize information to sources of new information, but the guide developer may prefer to start in the middle or bottom of the guide—or move back and forth as helpful resources are discovered. The following discussion suggests tools for locating resources to include in a guide.

Cumulating sources like encyclopedias, textbooks, handbooks, and research reviews are valuable for probing,

translating, and identifying avenues for further exploration. Translating goes beyond navigating differences in terminology; it includes gaining perspective of concepts, theories, and methods in a discipline (Palmer et al., 2009). Encyclopedias can be comprehensive and focused on a limited subject area, like the *International Encyclopedia of Adult Education* (English, 2005), or interdisciplinary like the *International Encyclopedia of the Social and Behavioral Sciences* (Smelser & Baltes, 2001). Textbooks, histories, essays, handbooks, and research reviews are important summarizing sources because they are authored and edited by scholars, who tend to be more evaluative and selective than institutionally produced encyclopedias or article databases (Palmer, 2005).

A library catalog is a good starting point to locate encyclopedias and other summarizing sources, but today's libraries offer additional options. Libraries purchase online encyclopedias, dictionaries, handbooks, histories, and other reference books through searchable platforms like Gale Virtual Reference Library (<http://www.gale.cengage.com/gvrl/>). Reference Universe (http://www.paratext.com/reference_universe.html) goes a step further to index both print and electronic reference books from a multitude of publishers. Searching a library catalog for textbooks, histories, essays, or reference books can be somewhat tricky, so enlisting the help of a librarian can save the researcher's time. Subject-specific databases, discussed below, may also index select books of essays, histories of ideas, disciplinary handbooks, or reviews of research.

Many avenues exist for discovering recent or new literature added to a field. Internet search engines, journal databases, and bibliographic databases are common tools for direct searching. Scholars use search engines like Google (<http://www.google.com>) or Google Scholar (<http://scholar.google.com>) to find books, articles, and papers on the open web or even as a substitute for the search capabilities of journal or bibliographic databases (Schonfeld & Housewright, 2010). Informaworld (<http://www.informaworld.com>) is an example of a publisher-hosted journal database, providing subscribers with full-text access to Taylor and Francis journals. A second type of journal database is an aggregator (K. Parker & Dollar, 2005). Aggregators acquire licenses to provide access to journal articles from numerous publishers. Examples of aggregators are EBSCO (<http://www.ebsco.com>) and Gale (<http://www.gale.cengage.com/>). These companies sell subscriptions for multidisciplinary databases like Academic Search Premier, but they also offer subsets of their journal content in discipline-specific or interdisciplinary collections. Some of Gale's offerings include collections in education, gay and lesbian studies, and popular culture. JSTOR (<http://www.jstor.org/>) is an aggregator that archives older journals across disciplines.

A bibliographic database comprises standardized descriptions of articles, books, or other items; library catalogs and article indexes are examples. Bibliographic databases differ

from journal databases and search engines in that the more detailed item descriptions—or metadata—can help researchers make preliminary judgments about the usefulness of materials and show connections to other resources. Bibliographic records have traditionally been created by human indexers or catalogers.

Discipline-specific bibliographic databases, also known as A&I services, track the literature of a given field. Two longstanding A&I services for education are H. W. Wilson, producer of the Education Index since 1929 (<http://www.hwwilson.com/>), and the Education Resources Information Center (ERIC), originally a decentralized system of information clearinghouses and now an online database maintained by a contractor for the U.S. Department of Education (<http://eric.ed.gov>). An interdisciplinary A&I service is Dissertation Abstracts International, with web-based access via ProQuest (<http://proquest.com>).

A&I databases often provide only citations or abstracts of articles, pointing to the existence of literature but not necessarily including full text. However, libraries utilize linking technology to connect citations to full-text resources, making the activities of searching and accessing literature nearly seamless (Lagace & Chisman, 2007).

Why do distinctions in databases matter? The features of each type of database may make one more suitable for the interdisciplinary researcher than another. Journal databases, aggregators, and search engines tend to cover a wide range of disciplines. Searching a journal or aggregator database or the web can lead a researcher to relevant articles or papers in domains not even considered as potential sources for discovery. Journal databases can also point to new journals in emerging interdisciplinary fields and to possible opportunities for publication.

However, bibliographic databases—and especially discipline-specific A&I services—have features that can guide researchers to terminology appropriate within an unfamiliar discipline and to resources that provide the additional context needed for a research topic. One such feature is controlled vocabulary. Controlled vocabulary standardizes terminology used to describe the content of materials in the database, regardless of diverse terminology used by authors. The indexer charged with identifying the subject(s) of an article selects subject headings or descriptors from a hierarchical, structured list or thesaurus. Two articles discussing the same topic but using different terminology—say numeracy versus quantitative literacy—will have the same subject headings or descriptors. The researcher can take advantage of the database's subject list or thesaurus to find broader, narrower, preferred, or related terms. This is helpful in locating relevant information in an unfamiliar field and can provide additional meaningful and more precise search terms.

Web search engines and journal databases lack controlled vocabulary capabilities. The researcher constructs searches using familiar terminology or keywords. The database looks

for the keywords anywhere in the citation or abstract of the article—possibly even the full text. Keyword searching does not discriminate between homographs—take the word “cell” for example—so searching the web or a multidisciplinary database may result in the researcher having to sift through irrelevant articles. A keyword search may also miss articles where the searcher and author use different terminology to describe the same topic. One strategy is to search a disciplinary database with known terminology or keywords, find some relevant articles, and then examine the database's subject headings that are used to describe those articles. The researcher can then note the preferred descriptors or explore the database's thesaurus to find related terms for constructing new searches. Search engines and journal databases can be useful in initial and serendipitous searching, but switching between search types and databases helps develop and translate terminology in the cross-disciplinary research process. Adding productive subject headings or descriptors to a resource guide makes it less static and helps readers with the translation process. Users of the guide can take advantage of known descriptors to recreate searches for new publications or set up automated alerts to monitor literature.

Other features of bibliographic databases include the ability to restrict searches to specific document types, research methodology, populations, or other characteristics of literature important to a discipline. Library of Congress Subject Headings (<http://authorities.loc.gov/>) include subdivisions for publication types in library catalogs, like “handbooks, manuals, and so on.” Searching ERIC with the descriptors or document types “literature reviews,” “annotated bibliographies,” or “meta-analysis” can help identify summarizing sources.

Another type of database focuses on primary or specialized sources, like photographs, manuscripts, correspondence, maps, or locally produced research. These specialized collections and digital repositories have varying levels of bibliographic information, disciplinary focus, and search capabilities. The American West (<http://www.amdigital.co.uk/collections/American-West/>) is an example of a database that pulls primary sources from a wide range of disciplines while focusing on a more specific topic.

Academic library websites typically offer listings of their databases categorized by subject areas. The impetus is on the researcher to consider which disciplines might have an interest in a particular topic when selecting databases for searching. A librarian can help researchers identify locally available databases appropriate for a research topic or direct researchers to special collections or resources at other institutions.

One trend in libraries is to offer one-stop searching across catalogs and databases, helping the researcher who is uncertain about database selection. From a single search box, a researcher can simultaneously search catalogs and databases preselected by the library (Gibson, Goddard, & Gordon, 2009). Federated search engines have had a mixed reception because of their slow pace in returning search results, their

confusing result displays, and their lack of advanced search options expected by experienced researchers (Korah & Cassidy, 2010). Examples of federated search products are 360 Search (<http://www.serialssolutions.com/360-search/>) and MetaLib (<http://www.exlibrisgroup.com/category/MetaLibOverview>), though libraries may call the single-box search by something other than its commercial name.

A second type of federated search harvests and preprocesses metadata for storage in a large index (Gibson et al., 2009; Stern, 2009). Searching the index instead of numerous individual databases delivers a Google-like response time, and Stern suggests that preprocessing offers opportunities for building connections between diverse domains of knowledge. Preprocessing, or automated analysis of data, can find associations and create links between seemingly unrelated subject headings, keywords, authors, citations, or other content from a wide variety of journals, indexing services, repositories, or open web sources. Summon and EBSCO Discovery Service are commercial examples of this newer type of federated search, both released in 2009 (Rowe, 2010).

Another trend among libraries and database providers is to simplify or enhance search interfaces for databases. Libraries can add commercial or open-source software overlays for library catalogs (Webb & Nero, 2009). The overlay may provide a single search box, but its real value is in how it displays search results. The researcher sees lists of categories to narrow the search by subject, author, publication date, genre, or a number of other facets, depending on the software and how the library has customized it. Article databases from aggregators and indexing services are also adding faceted results, allowing researchers to see which journals or authors show up most frequently in searches or suggesting alternative or additional subject headings. Some overlays provide visual cues like word clouds. Overlays may also offer interactive and social media-type features for users, like the ability to write reviews, save and share lists of titles, or create and share meaningful and searchable tags for items. Databases are increasingly including options for uploading article links to social networking sites like Delicious, Twitter, Facebook, or Wordpress (see Table 1).

Interdisciplinary researchers can take advantage of the discovery services used to enhance databases, even if they prefer the advanced features of traditional bibliographic databases. When researchers use federated library search tools, they see how many results appear in each database searched. This feature can guide the researcher in selecting databases to explore further. Faceted search results can point researchers to new terminology, authors, or journals outside familiar boundaries. An expert who tags documents with language more familiar to colleagues makes those items more findable to interested scholars. Federated searching and discovery layers are in their early stages, but they show potential for guiding direct searching or for identifying cumulative and new literature.

Table 1. Common Social Media Tools

Social media tools	Common examples
Social tagging/bookmarking	Delicious, Diigo, Xmarks, StumbleUpon
Social presence	Skype, Adobe Connect
Image/video sharing	Flickr, Picasa, YouTube
Email	Gmail, Yahoo, etc.
E-Portfolio	Mahara
Microblogging	Twitter, Plurk, Tumblr
Blogging	Wordpress, Blogger
Collaborative writing	Wikispaces, Google Docs, PBworks
Task-management tool	Remember the Milk, Ubiquity, Evernote
Search engine	Google, Yahoo, Bing
Social network	Facebook, LinkedIn, Ning
Organizational tool	Feedly, Friendfeed, Netvibes, aggregators
Virtual worlds	iGoogle Second Life

Note: Adapted from O'Dell's (2010) listed resources starting p. 242.

Collaboration via Social Media

The third necessary component for interdisciplinary research and the creation of innovation spaces is the technology component, which consists of the new devices, software, and connecting media. Social media have revolutionized how we work, communicate, and seek information. The elementary sense of *media* is that it performs as the middle layer in any communication (Shirky, 2010). Social media and Web 2.0 imply user participation in the creation of information: online applications that are interactive and allow users to post, edit, contribute, share, and create their own content. This is different from the professionally created media that we have been accustomed to consuming in the past in that we can now participate and communicate with others in the creation and distribution of media in real time. The implications of the aggregation of these communities of knowledge combined with our increased connectivity in a shared media landscape are enormous.

In traditional curriculum and research, experts are the arbiters of established knowledge and the *canon* of a particular discipline. Experts serve as the translators of data and verified disciplinary knowledge, and play the primary role in the development of curriculum and research agendas. Proponents of rhizomatic (Cormier, 2008) and connected learning argue that social learning and technological trends have been transforming this process, and social networking tools are facilitating the evolution of knowledge communities.

We should examine these processes not only in the learning environments in which we participate but also in our undertakings as researchers within our defined fields of expertise. Interdisciplinary and collaborative research occur naturally as social learning processes that are bound to impact the negotiation of disciplinary knowledge and how we conduct research. It is essential that we understand these learning

Table 2. Social Media Tools Tailored to Researchers

Research and education social media tools	Purpose
AcaWiki (http://acawiki.org)	Intended to be the “Wikipedia” for academics
Epernicus (http://www.epernicus.com)	A professional networking platform for research scientists
Laliso (http://www.laliso.com)	Aims to empower students, scholars, and professionals in intelligent knowledge networks to share knowledge and make it globally visible, accessible, and expanding
myExperiment (http://www.myexperiment.org)	This is a product that makes it easy to find, use, and share scientific workflows and other research objects and to build communities
Mendeley (http://www.mendeley.com/)	Mendeley is a free reference manager and academic social network that can help you organize your research, collaborate online, and discover the latest research
Classroom 2.0 (http://www.classroom20.com)	This is a networking page for those who are interested in social media in education
Vyew (http://vyew.com/site/)	This is a free platform for synchronous and asynchronous collaboration, which is good for authoring, reviewing, managing, publishing, and supporting broad file types
Wiggio (http://education.ning.com)	This is a platform and free application for group communication and collaboration
Sloodle (http://www.sloodle.org/moodle/)	Free and open-source project, which integrates the multiuser virtual environment of Second Life® with the Moodle® system
LibraryThing (http://www.librarything.com/)	This social site allows participants to catalog their personal book collections online and share their favorite titles
PennTags (http://tags.library.upenn.edu/)	The University of Pennsylvania was an early adopter of user-created tags for their library catalog; tags are searchable
Zotero (http://www.zotero.org/)	Zotero is a FireFox extension that allows users to collect, organize, and share citations to articles, books, websites, and other documents

processes, how they are supported by emerging technologies, and how these relate to the collaboration of researchers and the creation and dissemination of new knowledge.

O’Dell (2010) examines a number of social media tools and how they might be used to find colleagues, identify project partners, follow emerging online discussions, share research information, visualize data, schedule meeting times, and facilitate communication. These tools have become mainstream and are expected by scholars and researchers.

The internal barriers to open collaboration are weakening; that the academic research culture is shifting cannot be denied . . . Scholars have always depended on a social network of colleagues in addition to using awareness tools to keep up with developments in their field. Web 2.0 allows social and professional networks to extend beyond geography or acquaintances. (O’Dell, 2010, p. 240)

Below, we list some applications that are becoming more common for collaboration.

Many researchers are using blogging and a number of other social media tools to communicate, share, and discuss research with colleagues within and across disciplines. No single tool fits all needs and purposes, but it is fair to say that the success of such tools hinges on their utility—if the tools improve output, researchers will need to adopt and adapt or fall behind the times (O’Dell, 2010). As Shirky (2010) points out, it is often serendipitous which tools become more commonly and widely used, and tools are often used in ways that were never imagined or intended by their inventors, but we “hire them out” to perform varying functions and meet

diverse needs. These tools are increasing connectedness for sharing and creating knowledge across disciplines.

The driving idea behind *connectivism* as a learning theory is that we derive our competence through forming connections (Siemens, 2004). Networks are entities connected to create an integrated whole. Like an organism, changes to one part of the network affect the whole. Nodes become centers that compete for connections because links determine survival in an interconnected world. Nodes (disciplines, ideas, and learning communities) that gain recognition become better able to form new links, and are thus better able to connect to other learning communities. These become the bridges between disciplines and formerly disparate ideas and can create new knowledge and innovations. Social media contribute to the final critical element of innovation spaces: tools and a place where researchers can create social contacts, share knowledge, and form links and connections that aid in the social process of translating knowledge and ideas between experts.

The tools we use define and shape our thinking. Through social media, we are increasingly becoming one another’s infrastructure, and who you know and are connected to may be as valuable as what you know. Social media are becoming critical tools that help us stay abreast in our new information ecology and can help make us better researchers. In Table 2, we note a few services that are growing in popularity.

Conclusion

Interdisciplinary research is necessary for elevating practice in the field of education and for solving broader problems in society. Conventional disciplinary scholarship has provided

abundant intellectual artifacts essential for interdisciplinary study, yet at the same time has reinforced boundaries between disciplinary communities that hamper cross-disciplinary inquiry and collaboration. Although we have little influence in changing a culture that discourages interdisciplinary scholarship, we can suggest practices for researchers who are willing to venture outside familiar disciplinary territory into new spaces for innovation.

We examined the challenge of overcoming terminology differences across disciplines. We found that studies in information science point to interdisciplinary scholars using traditional sources like textbooks, encyclopedias, and research handbooks to not only understand discrete terms but also to grasp concepts, theories, and significant research to build context in a field. Controlled vocabulary is another traditional tool we identified to guide researchers to unfamiliar terminology. Recent enhancements to library databases and catalogs offer faceted search results that suggest alternative vocabulary or even permit researchers to tag information with their own terminology that might be more meaningful to colleagues. Even the traditional tools have been transported to the web, allowing numerous multidisciplinary and subject-specific encyclopedias and handbooks to be searched simultaneously.

Our work addressed tools and resources currently available to promote collaboration and interdisciplinary research. We identified social media websites that offer free spaces for document sharing, communication, and project management, and we have highlighted social media tailored specifically to meeting the needs of researchers. Technology has also enhanced retrieval of traditional artifacts for research. A researcher can have immediate access to literature from a wide range of disciplines through library-subscribed journal databases. These resources typically offer RSS or email alerts to help an interdisciplinary researcher stay abreast of literature from diverse fields. Library discovery tools are becoming better at searching across multiple databases for the interdisciplinary researcher who is uncertain where to start, offering simplicity and speed while limiting results to the quality resources demanded of scholarly research.

We proposed adapting the traditional library pathfinder as a vehicle for fostering collaborative research. Scholars would themselves create research guides outlining useful resources, terminology, and search strategies, and then share them with collaborators via social media websites. We found Swisher's (2008) pathfinder model, which mirrors the scholarly information cycle, to be particularly promising for incorporating and summarizing current information resources necessary to the processes of translating, searching, and monitoring interdisciplinary research.

We recognize the continued need for experts in information science as well as expert knowledge within fields but suggest that collaborations, synergies, the creation of knowledge clusters, the generation of new perspectives, and promoting

challenging critical reflections across disciplines may not only facilitate and expand theoretical developments but also increase their impact and relevance across the field of adult-educational research. Hopefully, in exploring information-science trends, how expertise is translated between disciplines, and nascent social media applications, we have articulated some viable strategies for cultivating spaces and means for interdisciplinary innovation in adult-education research.

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