The Intellectual Characteristics of the Information Field: Evidence from Heritages and Substances

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Abstract

As the information field (iField) becomes more recognized by different constituencies for education and research, the need to better understand its intellectual characteristics becomes more salient. Although there are various conceptualizations of the iField, to date, in depth studies based on empirical evidence are scarce. This paper reports a study that fills this gap. We focus on the first five iSchools in the iCaucus as a proxy to represent the iField. The intellectual characteristics are depicted by two independent sets of data of tenure track faculty as knowledge contributors: their intellectual heritages and the intellectual substances in their journal publications. We use a critical analysis method to examine doctoral training areas and three years of journal publications. Our results indicate that (1) the iField can be better conceptualized with empirical support by a four-component model that includes People, Information, Technology, and Management, as predicted by the I-Model (Zhang & Benjamin, 2007); (2) the iSchools' faculty are diverse, interdisciplinary and multidisciplinary as shown by their intellectual heritages, by their research foci, by journals where they publish, by the contexts within which they conduct research, and by the levels of analysis in research investigations; (3) the five iSchools share similarities while evincing differences in both faculty heritages and intellectual substances; (4) iSchool tenure track faculty members do not collaborate much with each other within or across schools although there is great potential; and (5) intellectual heritages are not good predictions of scholars' intellectual substances. We conclude by discussing the implications of the findings on iField identity, iField development, new iSchool formation and existing iSchool evolution, faculty career development, and collaboration within the iField.

Keywords: scientific discipline, information field, iField, iSchools, intellectual heritage, Intellectual substance, I-Model

Introduction

The recent information movement (Liddy, 2012) or I-School movement (King, 2006) has formally established the information field as a scientific field. Such a scientific field is evidenced by typical measures (Webber, 2003) such as the existence of academic units within universities (commonly known as the iSchools in many universities), offering some academic degrees and graduating students, having an international community formally gathered at annual international conferences (the i-conferences), having professional associations (the iCaucus), and having its own identify (the iField).

Although the word "information" started to appear in the names of the academic schools in the 1960s (Olson & Grudin, 2009), it is currently accepted that the origins of the iSchools can be traced back to 1988, when three schools (Pittsburgh, Syracuse, and Drexel) formed the "Gang of Three" (http://ischools.org/history/origins/). In 2001, the "Gang of Five" was formed with the addition of Michigan and Washington. As more schools continued to join force, in 2005, the organizational entity, the iCaucus (http://ischools.org/), was officially formed to represent the iField. With a clear community identity, the iCaucus organizes annual international conferences: the first one was in 2005 with 265 registered attendees and the most recent one, the 7th, was in February 2012 with 476 registered attendees (Liddy, 2012). The iCaucus also continues to attract and accept members. At the time of its 7th annual conference, the iCaucus had 36 members from eleven countries in four continents (Liddy, 2012).

The fast progress of the information field has gained tremendous attention from other disciplines, funding agencies, recruiters, and scholars. For example, Grudin states that "we may be witnessing the birth of a new star in the academic firmament - its growth, so far only a little slower than a supernova, may be tested by the economic collapse, but could accelerate with a recovery" (Olson & Grudin, 2009, p. 15). Consequently, interest in a better understanding of the iField within as well as outside the community has grown over the recent years. Given the diversity of research topics and contexts pursued by iSchool scholars, how can we better communicate a congruent picture of the research we pursue in the iField to those outside the academy? To ensure that this "supernova" does not fade and disappear in a short period of time, it is crucial to establish a framework that would allow us to extend the empirical understanding of the iField's central research foci. Thus, one goal of this study is to lay out the ground work for a framework to study the iField's intellectual characteristics that bind us together as a disciplinary community and differentiate us from scholars in other disciplines.

There are several formal and informal conceptualizations of the iField. Despite some differences, many of these conceptualizations agree that the iField is built on and related to many other disciplines, and thus is interdisciplinary and multidisciplinary by nature. One type of conceptualization considers the fundamental components of the field and their relationships. A component is the object of scientific inquiry, and a fundamental component is essential, exists independent of other components thus is concerned with the core of the field (Zhang & Benjamin, 2007). For example, several leaders of the iField suggest a three-component conceptualization of the information field: Information, People, and Technology (per Zhang & Benjamin, 2007: Dan Atkins, John M. Carroll, Ray von Dran). The iCaucus website builds on this notion and states that the study of information focuses on the intersection of information, technology and people (http://ischools.org/site/about/). A variation of this three-component conceptualization treats Information not as a distinct component but rather as an object that moves within and between People and Technology (Wobbrock, Ko, & Kientz, 2009). Ron Larsen presents another three-component model that includes Information, Technology, and Society (Larsen, 2004, 2005). Zhang

and Benjamin (2007) present a four-component model, named the I-Model, that consists of People, Information, Technology and Organization/Society. Other conceptualizations exist to provide additional understanding of the iSchools and the iField. For example, Bureau considers the technical focus (offering IT courses) and institutional constraints (whether staying close to old and traditional institutions) as two dimensions to classify the iSchools into three types: library-education, computer science, and information (Bureau, 2008).

There are a few studies that use empirical evidence to depict the characteristics of the iSchools. Using 21 iSchools' full time faculty's doctoral degrees as a proxy of a holder's research training and intellectual community, Wiggins and Sawyer (2011) characterize the iSchools as being in different clusters of compositions: computational science, sociotechnical, library and information, and niche compositions. Although doctoral training areas are interesting to reflect the diversity and intellectual roots of iSchools' research, it is unclear if doctoral training areas or intellectual heritages can be a good predictor of research foci and intellectual characteristics.

Wu and colleagues address the state of research and graduate education of 25 iSchools based on the publically available data of these schools (Wu, He, Jiang, Dong, & Vo, 2011). On the research side, source data and analyses include faculty doctoral degrees (classified into 13 categories), research interests (faculty's own descriptions from their webpages are classified into 46 areas), funded projects and funding agencies (faculty's own description of funded projects during 2005 and 2010), research productivity (number of articles in SCI and SSCI indexed journals published during January 2005 and June 2010), and research collaborations (co-authorships in journal articles and funded research projects). They conclude that iSchools share the same vision and mission of exploring and supporting relationships between information, people and technology as indicated at the iCaucus website. Although the study involves a large amount of diverse data, the research method (there was no inter-coder reliability check as all important facets were coded by only one coder) raises questions about the validity of the findings.

Chen (2008) uses thematic maps to illustrate scholarly communication patterns and specialties associated with individual iSchools. Sample schools were chosen to represent diversity based on a factor analysis of word distributions that mapped the interrelationships between all (at the time of publication, 19) iSchools. Author concept maps of each of the six sample schools were produced, highlighting the most prolific authors and connections, bursts in publication production, and areas of research foci. Additional analysis at the institutional level identified collaboration between the six schools. One final analysis identified highly cited literature and research areas representing what Chen refers to as the 'intellectual base' of all 19 iSchools. One critique of Chen's work is the accuracy of coverage of the raw data used in the analysis. Many important works were not included, making the findings less convincing.

Ba-Ilan (2010) focuses on the impact of individual iSchools on the research subject area of "information and library science." The impact was determined by citation measures including the h-index and g-index of publications, publication type and publication frequency. The University of Illinois was found to be the top producing and the University of Maryland to have publications receiving the most citations of all of the 27 iSchools at the time. Lists of the most highly cited articles, and most productive authors and journals were also provided. Analyzing only articles under the subject area 'information and library science' is a limitation of this project for illustrating the iSchools or iField's overall intellectual characteristics.

To date, existing empirical studies of iSchools' research have focused on simple counting of articles for productivity, citation analysis, classification of doctoral degrees, and classification of authors' keywords which are uncontrolled vocabulary. To our best knowledge, there is no study that examines the intellectual substances at a detailed level to understand the intellectual characteristics of the iSchools. Such an understanding is timely and will be important for new scholars to find appropriate academic homes, for administrators to make strategic decisions on schools' directions, development and priorities, and for other disciplines to better understand and collaborate with scholars in the iField.

In this study, we consider the intellectual characteristics of the iField by focusing on two aspects of iSchool faculty: intellectual heritages and intellectual substances. Intellectual heritages are represented by iSchool faculty's doctoral training. Intellectual substances are indicated by the specific research facets covered in faculty's academic journal publications. To make the task manageable, we consider tenure track faculty members from the original "Gang of Five" members of the iCaucus and their journal publications within the period of 2008-2010. Given the diverse historical development of these five iSchools, we are interested in the collective patterns of these five iSchools as a surrogate for the iField, the individual school's intellectual characteristics, and some individual faculty members' intellectual characteristics. In particular, we hope to gain insight on the following questions:

(1) What would be appropriate conceptualizations of the iField and iSchools?
(2) To what extent are scholars in iSchools multi- and inter-disciplinary?
(3) To what extent are iSchools similar to or different from each other?
(4) To what extent do scholars in iSchools collaborate with each other now and to what extent might they potentially? And
(5) What trends might the intellectual characteristics of the iSchools reveal in faculty hiring and development?

Conceptual Frameworks

Intellectual Heritages

Intellectual heritages represent the characteristics of academic training. Educational background, especially the terminal doctoral degree that prepares academic scholarship, has been a popular measure of intellectual heritages. In particular, it is believed that the academic discipline that a scholar received the doctoral degree from greatly influences the scholar's intellectual orientation toward knowledge domains, epistemology, research methods, among several other important research characteristics.

There are several classifications of scientific disciplines for various purposes. Some are relatively generic such as those used by funding agencies. For example, the Australian Research Council develops the research fields, courses, and disciplines classification (RFCD) for funding purposes. Some other classifications are developed by scholars for specific research purposes. For example, Wu et al. (2011) use bottom up approach to identify the 13 disciplinary areas of iSchool faculty's educational background. Wiggins and Sawyer (2011) develop a slightly different classification of nine disciplinary areas for iSchool faculty members' doctoral training.

Given the scarcity of empirical evidence on iSchools, it would be interesting to build on some existing empirical studies on doctoral training areas. It would also be interesting to test the adopted classification

and do some comparisons with existing findings. Therefore, we decided to adopt Wiggin and Sawyer's classification.

Intellectual Substances

Intellectual substances are the specific facets that are being investigated by scholars in their research efforts. Such specifics include topics, methods, contexts, and levels of analysis (Zhang & Li, 2005). Academic publications provide representations of a scholar's research interests, expertise, efforts, and results. Thus they are a significant indication of a scholar's intellectual profile in terms of intellectual substances.

Existing conceptualizations of the iSchools primarily touch upon the topical coverage of the iSchool research. Although the three-component models of the iField are popular and supported by some empirical evidence, different conceptualizations such as the four-component I-Model (Zhang & Benjamin, 2007) have not received much attention. Such models cannot be tested if authors do not consider all components during research conduct including collecting and analyzing data. For example, without having the fourth component in the data analysis of Wu et al.'s work, one cannot say whether the four-component model can be supported or not. In this paper, we utilize the more comprehensive four-component I- Model by Zhang & Benjamin (2007) to investigate the intellectual characteristics of the iField. Using the I-Model does not exclude the verification of any three-component models as these models are subsets of the four-component model. In addition to the four components, the I-Model also contains another facet, the context of studies, which is a part of the intellectual substances. So far, the I-Model has been used to reexamine historical Information Systems development cases (Liu, Benjamin, & Zhang, 2007) and to depict the evolution of social commerce (Wang & Zhang, 2012), demonstrating its explanatory and predictive power as a tool of analyzing intellectual substances.

The four fundamental components in the I-Model are People, Information, Technology and Organization/Society. People are the ultimate receivers of inventions and innovations in information, technology and other areas. They play important roles in the history of many iSchools' research efforts. Information with a social purpose has a life cycle of acquisition/creation, processing, dissemination, and use. It is the foundation of information science and library science that are parts of many iSchools. Technology is about any technological inventions and innovations that extend human mental or physical capabilities. In the context of the iField, technology may include computer and communication technologies such as hardware, software, infrastructure, platforms, applications, resources, services and the like. Technology-based information processing, communication, learning and education, and information services are commonly studied by scholars in iSchools. The Organization/Society component is concerned with policies, business strategies and models, management practices and operations, and processes, structures, and cultures that are essential to the effectiveness and efficiency of any human organizations such as for-profit or non-for-profit firms, communities and societies. These are normally managerial issues that are better captured under the notion of "Management." To avoid potential confusion with organization/society as contexts or levels of analysis of studies, in this paper, we use Management to represent this Organization/Society component.

One additional important facet in the I-Model is Context. Contexts are "specific settings, circumstances, or conditions in which studies are conducted or practices are carried out" (Zhang & Benjamin, 2007, p. 1939). Contexts play an important role in research because they impose certain constraints and conditions

for the studies. Thus the findings are bound by these conditions, and any generalizations of the findings have to be carefully applied. In addition, conducting research in a particular context requires the scholars to be knowledgeable about the context, as well as other potentially related studies in that context. Thus, understanding the contexts of iSchool scholars' research helps us understand their expertise as well.

For research methods, we consider the broadly accepted classification of empirical and non-empirical methods, although each class can have several more specific types (Zhang & Li, 2005). Empirical studies rely on observations and facts that are carefully collected. Non-empirical studies are based on ideas, frameworks, opinions and speculations.

Level of analysis "refers to the level at which data are collected and analyzed, or main issues and discussions are addressed" (Zhang & Li, 2005, p. 238). In the context of analyzing research articles in the Information Systems field, Zhang and Li provides a classification that include individual, group, organizational, and inter-organizational (societal). It would be interesting to see if such a classification can still be applied to the iField publications.

Methodology

This section describes in detail the selection of evidence, the development of classification schemes, the coding procedure and reliability control. We utilized a content analysis method with classification schemes on the evidence data.

Selection of iSchools, Faculty, and Research Publications

The iSchools listed in the iSchools Caucus (http://www.ischools.org/) are recognized for their active engagement in research, and commitment in advancing the information field. Using a purposive sampling strategy to make this investigation feasible, we selected the original "Gang of Five," the first five iCaucus members as our sample. These five iSchools are: Drexel University, University of Michigan, University of Pittsburgh, Syracuse University, and University of Washington.

Different iSchools have different types of faculty members. For example, the following titles appear in some but not all iSchools: "Professor of Practice," "Clinical Professor," "Research Professor," "Lecturer," "Adjunct," among others in addition to "(Full) Professor," "Associate Professor," and "Assistant Professor." Not all faculty members carry research responsibilities, nor are they full time or on tenure track. In this study, we considered only tenure track faculty members who are full time employees and usually have official titles as Full Professor, Associate Professor or Assistant Professor. Tenure track faculty members are expected to provide intellectual contributions evidenced by academic publications. Therefore academic publications are one of the several important factors to be considered for tenure and promotion evaluations. We drew our faculty sample from faculty listings on the five studied iSchools' websites, incorporating only faculty listed as tenure track as of January 2012.

Faculty members publish a variety of scholarly works. However, peer reviewed academic journal publications are most widely accepted as a demonstration of intellectual contributions during tenure and promotion evaluations at prestigious research universities. We do acknowledge that some schools consider conference proceedings almost equally as journal publications in tenure or promotion evaluations and some scholars publish in conferences primarily. In this study, we limit our analysis to the journal literature as an expedient measure, anticipating that the results will be indicative of the broader

trends and relationship. Future research can be expanded to included peer reviewed conference proceedings. Specifically, our article sample consists of peer reviewed academic journal articles published during the years 2008-2010. We include any journals iSchool faculty published in to ensure a comprehensive coverage, not just those indexed by Thomson Reuters because many journals, including computational and managerial journals, are not covered in Thomson Reuter's indices. We searched the website and/or curriculum vitae (CV) of each member in our faculty sample for publication information. When neither the website nor the CV was available, a Google search was conducted with the faculty member's name in possible variations. Only articles in English were considered. Each found article was further examined to make sure it is on research, rather than other issues (teaching, practice, personal reflections, pop education on some topics, editorial notes, special issue introduction, etc.). For articles in magazine type outlets that might not publish full length research articles (e.g., CACM, D-Lib Magazine, and GIM International), we examined the research content, and included only articles with research focus even if the length of these articles are short. Through various bibliography databases and by contacting the authors directly, we were able to obtain a digital copy (PDF, Word) of all but four identified articles. The final analysis did not include these four unavailable articles.

The Intellectual Heritage Coding Scheme

Wiggins & Sawyer's (2011) classification of intellectual heritage fits our data relatively well with some minor exceptions. We revised the classification slightly to make the conceptual distinctions among the areas clearer. The resulting coding scheme is shown in Table 1. This classification is used to code both the doctoral training areas, as well as the disciplinary areas of the journals where the selected articles appeared.

Table 1. Classification of Disciplinary Areas (Adapted from Wiggins and Sawyer, 2011)

Area	Component Areas
Communication	Media and Mass Communication, Journalism
Computing	Computer Science, Electrical Engineering, Mathematics, Computer Engineering
Education	Education
Humanities	History, Philosophy, Literature, Multi & Interdisciplinary Studies, Music, Geography
Information	Information Science, Information Studies, Information Transfer, Informatics
Library	Library Science
Management & Policy	Business Administration, Management, Policy, Economics, City & Regional Planning, Public Administration
Science & Engineering	Life Sciences, Physical Sciences, Statistics, Engineering (not Electrical)
Social & Behavioral	Psychology, Sociology, Social Sciences, Linguistics

The PITM Coding Scheme

The People-Information-Technology-Management (PITM) coding scheme was developed using a combination of pre-determined components (top-down) and emerging themes (bottom-up). Initial examination of a small set of articles indicates that some studies have a strong emphasis on certain PITM components as the core of the studies. These components are investigated explicitly with research models,

methods, or instruments for data collection in the case of empirical studies. Yet some studies consider one or more PITM components as either motivation for studies or implications of the studies. These components are not the core of the studies but play some peripheral roles in the studies. And some other studies do not consider a particular component at all. To differentiate the intensity of research emphasis of each article on any one of the four PITM component, we assigned the following values: a value of 2 to a component of PITM if the paper considers the component as the core of the study, value 1 if it is peripheral and discussed as motivation or implications for the study only, and value 0 if the component is absent and is not considered at all in the study. When examining each article, we focused on the primacy of each of the PITM components being investigated within the research study, not the inter-relationships among these components.

The Context Coding Scheme

The context classification was developed both deductively and inductively based on a previous classification for the Information Systems literature (Zhang & Li, 2005) and the article sample in this study. After several rounds of revisions, the final coding scheme consists of nine broad categories as shown in Table 2.

Table 2. Classification of Contexts

Context	Description
Academia	Article contains individual or comparative focus on discipline(s) or academic field(s). Examples include but not are limited to: disciplinary co-citation analyses, methodological recommendation that advances the field, overview of research strategies, and academic participation or behaviors (e.g. publishing) of participants within the field.
Education	Article focuses specifically on research in formal educational institutional settings (e.g. schools, universities, colleges). Empirical articles collecting data from college students, even if used as convenience sample were coded as Education context. Articles focusing on education or learning outside of educational institutional settings (e.g. informal learning, organizational learning) were not included in this category.
Industry/Government	Article focuses on either a particular form or branch of economic or commercial activity (Industry), or on government activities (e.g. governmental authority behavior, information/data use within branches of government).
Library	Article focuses on and collects data from various types of libraries such as school, academic, public, special, and digital libraries. Articles coded with this category include those that focus on professional activities, library services, unique collections, and patron use and interaction as examples.
Marketplace	Article focuses on competitive and/or commercial markets and trade. Examples include specific markets (e.g., Ebay transactions and user feedback) as well as general online marketplace practices.
NationalCulture/Global	Article focuses broadly on separate and comparative national, international and global culture or practices.
Organization	Article focuses specifically on workplace settings, often with formal organizational boundaries.
Society	Article focuses on social environments and social contexts. Examples include any range of formal and informal social groups, such as: online communities, open source software developers, medical support groups, and general software users.
Context Free	Article does not focus on or direct their conclusions toward any specific context. Thus these studies are context free or independent of any context. Examples of articles include but are not limited to technical articles testing generic models, interfaces, or algorithms.

The Levels of Analysis Coding Scheme

Similar to the context classification, the levels of analysis classification was also developed both deductively and inductively based on a previous classification for Information Systems literature (Zhang & Li, 2005) and the article sample in this study. One particularly interesting discovery from our sample is that many articles focus on some type of artifact (rather than people, organization, etc.). A further examination of these artifacts indicates that there are two types of artifacts: computational artifacts that are algorithms or technical solution based, and social artifacts that are objects with some form of social meaning. In fact, the social artifact concept is brought up by Babbie (Babbie, 2010) as any product of social beings or their behavior. Babbie further describes the class of artifacts to include concrete objects such as books, poems, paintings, automobiles. In our collection of papers, a social article can be an archival object, a book, a reference or citation, a teaching plan, or a computer application being evaluated in its use context. It is worth noting that social artifacts can also be abstract and conceptual in nature. For example, we consider some conceptions or theories as social artifacts in our study.

After several rounds of revisions, the final coding scheme is shown in Table 3. Unless an article clearly emphasizes multiple levels of analysis, we only assigned one code to each article based on its primary focus. For example, if an article examines the effectiveness of a learning management system using students as subjects but with the primary focus on the learning management system (rather than students), then its level of analysis was coded as social artifact. If its primary focus is on individual students' learning experience or outcomes, then its level of analysis was coded as individual.

Table 3. Classification of Levels of Analysis

Level of Analysis	Description
Computational Artifact	Algorithms, simulations, mathematical models, computer programs, computational models, computer systems in a technical sense
Social Artifact	Books, documents, lesson plans, how-to-do guidelines for practice, computer systems in social setting/situation or social side of computer systems, abstract objects/concepts
Individual	At the individual level, such as people's perceptions, beliefs, behaviors
Group	Focus on group performance, collaboration, etc. although collected data might be at individual level. The meanings of findings apply to groups.
Organization	Firm or organization level.
Industry/Government	Industry or government level, although collected data might be at firm or individual level.
Community/Society	A broad community or society level that analyzes communities.
Global/Cultural	At the national culture level.

Coding Procedure and Reliability Validation

For doctoral training areas, we went through several rounds to achieve conceptual clarity and consistency. We compared our sample to that of Wiggins & Sawyer's (2011). For those faculty members who are in both samples, we reexamined and reused the Wiggins & Sawyer's codes as much as possible. New faculty members not included in Wiggins & Sawyer's data collection were coded based on our

classification. Through the coding process, we took measures to ensure the overall conceptual clarity and consistency. For example, people who graduated from the same school with similar research interests were coded with the same component area. At times of potential doubts due to insufficient raw data, we visited the faculty members' CVs or homepages to check their early publications or research interests to determine their doctoral training areas.

For journal's disciplinary areas, two coders coded each journal separately based on the descriptions of the journal and sample articles in the journal. The coding agreement of all journals was 74%. A third researcher examined all the codes, discussed with the other two coders and finalized the coding.

Coding of articles for PITM, context, method and level of analysis was conducted in two phases. The first phase was done in an exploratory fashion with the goal to test and refine the coding schemes. A small set of papers was coded by two researchers and discussed with the third researcher to verify and refine the coding schemes. Then another small set of papers were coded and discussed to further verify and refine the schemes. Once the researchers achieved mutual understanding with at least 70% coding agreement on each of the seven facets, the two researchers started the second phase to code the rest of the articles. Raw agreement on all facets was above 70% before the discussions involving the third researcher and 100% after the discussions.

Findings

In this section, we report the findings from the three sets of evidence: (1) intellectual heritage (doctoral degree areas), (2) the disciplinary areas of the journals where the analyzed papers were published, and (3) the intellectual substances of the articles analyzed along PITM, contexts, methods, and levels of analysis. Where possible and appropriate, we follow the general reporting structure of collective (all five iSchools together to represent the iField), individual iSchools, groups of scholars, and individual scholars.

Faculty Composition and Intellectual Heritages

In this subsection, we first report the composition of the faculties in the five schools. Then we summarize their doctoral training areas as the intellectual heritage, followed by several observations.

Faculty Composition

Table 4 summarizes the five iSchools' tenure track faculty ranks, numbers and percentage within the respective school. The five iSchools have comparable total number of faculty members, although the distributions among the three ranks are different. Drexel has more assistant professors (36% of the 33 members) than any of the other four schools (ranging from 13% to 28%). Michigan has more full professors (56%) than the other four, and Pittsburgh and Syracuse have more associate professors (50%) than the other three.

Table 4: Faculty Numbers with Ranks

	Assistant Professor	Associate Professor	Full Professor	Total
Drexel	12 (37%)	11 (33%)	10 (30%)	33
Michigan	9 (28%)	5 (16%)	18 (56%)	32
Pittsburgh	6 (21%)	14 (50%)	8 (29%)	28
Syracuse	4 (13%)	14 (47%)	12 (40%)	30
Washington	6 (22%)	12 (45%)	9 (33%)	27
Total	37	56	57	150

Intellectual Heritages

Using a similar method as Wiggins & Sawyer did, we depict the doctoral degree areas of the faculty members in the five iSchools in Table 5. To ensure comparisons with Wiggins & Sawyer's findings based on their 2009 data, Table 5 provides information on three sets of data: 2009 tenure track faculty members who were also on faculty in January 2012 (column In2009&2012), newly hired tenure track members since 2009 (NewIn2012), and all tenure track faculty members at the time of 2012 (2012Total). It is worth noting that Wiggins & Sawyer considered full time faculty in their study, while we considered tenure track faculty, which is a sub-set of full time faculty. There are a total of 35 members who were in Wiggins & Sawyer's sample but not in ours. Among these 35 members, 4 were in Drexel, 15 in Michigan, 5 in Pittsburgh, 5 in Syracuse, and 6 in Washington. These 35 members could have been retired/left since 2009, or were non-tenure track faculty (e.g. research professors, clinic professors, professors in practice, etc.) at the time of January 2012. Given that these 35 faculty members were not part of our targeted faculty sample, we did not consider them further. We compared only the tenure track members in 2009 and in 2012.

To depict the intellectual heritages, we examined the two columns for 2012Total (both N and %) in Table 5 with a graphical display in Figure 1. It shows that the five iSchools collectively are largely composed of faculty with doctoral training in four dominant areas: Information (27%), Computing (23%), Management & Policy (17%) and Library (10%).

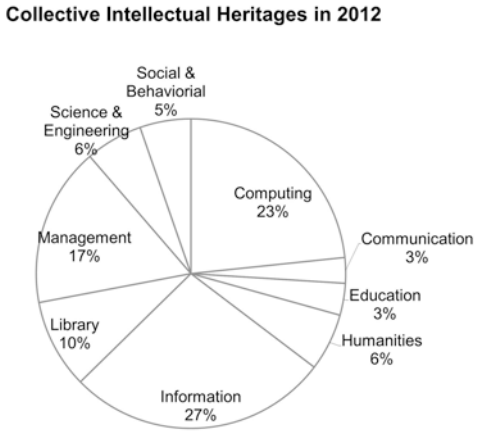

Figure 1. Collective Intellectual Heritages of the Five iSchool in 2012

Table 5 shows the five iSchools' respective intellectual heritages. In particular, 60% of Drexel's faculty members are from Information and Computing disciplines and the remaining 40% of the faculty represent diverse disciplines. Michigan has faculty representing five dominant disciplinary areas and has more faculty members with Humanities intellectual heritages than the other schools. The majority of Pittsburgh's faculty is from Computing and Information disciplines, but the remaining faculty members are from a diverse set of disciplines. Overall, Pittsburgh has more faculty members with Science & Engineering backgrounds than other iSchools. Of all the schools, Syracuse has the fewest faculty members with Computing backgrounds, while the majority of their faculty have Management & Policy or Information disciplinary backgrounds. Washington faculty represents three main disciplinary areas: Computing, Information, and Library.

Table 5: iSchool Faculty Intellectual Heritages in 2009 and 2012

							Drexel			Michigan			Pittsburgh			Syracuse			Washington		
Discipline Areas	In2009&2012 Total N	In2009&2012 Overall %	NewIn2012 Total N	NewIn2012 Overall %	2012 Total N	2012Overall %	In2009&2012	NewIn2012	2012Total	In2009&2012	NewIn2012	2012Total	In2009&2012	NewIn2012	2012Total	In2009&2012	NewIn2012	2012Total	In2009&2012	NewIn2012	2012Total
Computing	29	24%	6	21%	35	23%	30%	20%	27%	30%	22%	28%	33%	25%	32%	4%		3%	24%	50%	26%
Communication	4	3%	0		4	3%	4%		3%							7%		7%	4%		4%
Education	4	3%	1	4%	5	3%	4%		3%		11%	3%	4%		4%	4%		3%	4%		4%
Humanities	7	6%	2	7%	9	6%	4%	10%	6%	13%	11%	13%	8%		7%				4%		4%
Information	28	23%	13	46%	41	27%	22%	60%	33%	17%	22%	19%	21%	50%	25%	30%	67%	33%	24%	50%	26%
Library	12	10%	2	7%	14	9%	9%	10%	9%	4%		3%	4%	25%	7%	4%		3%	28%		26%
Management & Policy	21	17%	4	14%	25	17%	9%		6%	17%	33%	22%				48%	33%	47%	8%		7%
Science & Engineering	9	7%	0		9	6%	9%		6%	4%		3%	21%		18%				4%		4%
Social & Behavioral	8	7%	0		8	5%	9%		6%	13%		9%	8%	0%	7%	4%		3%			0%
Total	122	100%	28	100%	150	100%	23	10	33	23	9	32	24	4	28	27	3	30	25	2	27

Shifting of the Intellectual Heritages

As shown in Table 5, there has been some shift on intellectual heritages in some of the iSchools since 2009. The most noticeable shifts are in Drexel and Michigan, due to their large number of new hires since 2009. In 2009, Drexel was heavy on Computing (30%) then Information (22%). By 2012, it was heavy on Information (33%) then Computing (27%). This shift is resulted from hiring six new faculty members with Information and two with Computing degrees. Michigan shifted from being Computing dominant (30%) in 2009 to a slightly more balanced faculty of Computing (28%), Management & Policy (22%), and Information (19%). The nine new hires in Michigan are across five areas with emphases on Management & Policy (3), Computing (2), Information (2), Education (1) and Humanities (1). The other three schools are relatively stable due to small number of new hires.

New Hires and their Intellectual Heritages

It would be interesting to examine the new hires to gain some insight into the recent placement of people with various intellectual heritages. It is worth noting that the new hires were derived as the difference between our 2012 sample and Wiggins & Sawyer's 2009 sample. Therefore, we do acknowledge the possibility of sampling errors that would affect our claim of someone being a new hire. In fact, there are three faculty members who we wonder if they should have been in the 2009 sample: two from Drexel (one with degree in Computing in 2002 and one with degree in Information in 1995), and one from Washing (degree in Computing in 1975). Nevertheless, our analysis here may still shed some light on the hiring pattern over the three years in the five schools.

Among the 28 new hires in the five schools since 2009, the majority of them are in the Information area (13 people, or 46%). Among these 13 people, one received the doctoral degree in 1995, two in 2006, and the remaining between 2008 and 2010. This means that the majority of newly hired faculty members are recent graduates of the iSchools. Such job placement is encouraging news for the doctoral students in the iSchools who are looking for jobs in other iSchools. Among the six new hires (21%) in the Computing area, one received the doctoral degree in 1975, one in 2002 (see last paragraph on this), and the remaining in 2009 and 2010. All five schools except Syracuse hired one or two new members in the Computing area. The four new hires (14%) in Management & Policy all graduated in or after 2005. Three of them went to Michigan and one to Syracuse.

Among the 28 new hires, only three (11%) received doctoral degrees from outside the US: one from Scotland, and two from Canada. The universities that produced more than one of these 28 new hires are UIUC (3), UNC-Chapel Hill (3), Washington (3), Pittsburgh (2), and UC Irvine (2). Only two new hires were not recent graduates: one earned an Education doctoral degree in 1977, and another received a Geography (Humanities) doctoral degree in 2001.

Journal Publications and Disciplinary Areas

Publications and Co-Authorship

Table 6 summarizes the publications and collaborations in the five iSchools. The five schools have relatively comparable number of publications, although Drexel has more publications than the other four schools, accounting for 24% out of the 372 total publications. Collectively, the total numbers of publications are evenly spread out across the three years with a slightly upward trend.

At the school level, Drexel, Michigan and Pittsburgh all showed an increase in number of publications from 2008 to 2010 while Syracuse had a slightly downward trend. The publication pattern for Washington remained relatively stable compared to the other iSchools. Table 6 also shows co-authorship and single-authorship data. Although there are many co-authored articles (372-67=305 or 82%), collaboration among tenure track faculty members within a school is not very common: ranging from 3% to 15% out of each school's total papers. Much less common is co-authorship among tenure track faculty members across different schools: only one paper involved authors from two iSchools (Drexel and Michigan). An examination of the co-authored articles indicates that many co-authors are either people outside the tenure track faculty pool (other types of faculty or students) or outside the iSchools. The average number of authors per articles varies greatly across the five schools, averaging from 2.2 in Syracuse to 4.7 in Michigan.

Table 6. Publications and Collaborations

	2008 Pubs	2009 Pubs	2010 Pubs	Total Pubs	Avg. # Authors Per Article Mean (SD)	# Co-Authored within same School # (%)	Total Single Authored # (%)
Drexel	22	30	39	*91*	3.1 (1.4)	12 (13%)	9 (10%)
Michigan	16	19	31	*66*	4.7 (4.8)	10 (15%)	8 (12%)
Pittsburgh	23	23	30	*76*	2.9 (1.6)	4 (5%)	12 (16%)
Syracuse	26	25	22	*73*	2.2 (1.3)	2 (3%)	22 (30%)
Washington	21	23	22	*66*	2.9 (2.2)	3 (5%)	16 (24%)
Total	*108*	*120*	*144*	372	*3.1 (2.6)*	*29 (8%)*	*67 (18%)*

Journal Characteristics and Disciplinary Areas

The 372 papers were published in a total of 242 distinctive journals, and only 43 out of 372 articles shared journals. There is an increase in the number of distinctive journals over the three years: 85 different journals for 108 articles in 2008, 97 journals for 120 articles in 2009 and 115 journals for 144 articles in 2010. Table 7 lists the distinctive journals and their disciplinary areas that have four or more articles across the five schools over the three years.

Table 8 summarizes the 372 articles by journal disciplinary areas. Figure 2 depicts the total number of articles by journal disciplines, which shows that there are four dominant disciplines: Information, Computing, Library, and Management & Policy. These four dominant areas are the same as those of the intellectual heritages. As shown in Table 8, although different schools have slightly different coverage on journal areas, all schools have a diverse coverage of journal areas.

Such diversity on journals is an indication of several possible situations. First, the authors from these iSchools conduct research on diverse topics and have diverse audiences. Second, these schools do not seem to have restrictions or designated outlets as where their faculty can or should publish. Third, there is not a single journal that can be considered a journal for the iField. Even though JASIST has the highest number of publications from all five schools, less than 8% (28 out of 372) of the articles were published in it. The diversity of publication outlets may also indicate that it is not feasible or practical to establish a new journal for the iField, an idea discussed among several scholars since the first iConference.

Examining the publications from the disciplinary areas of the journals reveals that there are four rather than three distinctive disciplines that have significantly more publications. This further can be an evidence for a four-component model rather than a three-component model of the iSchools and iField.

Table 7. Journals with the Highest Number of Articles

Journal / School	Area	Drexel	Michigan	Pittsburgh	Syracuse	Washington	Total
# of Different Journals		57	47	64	60	57	242
J American Society for Info Science & Tech	Information	13	5	2	4	4	28
Information Processing & Management	Information	2	3	3			8
J Education for Library & Info Science	Library	6		1	1		8
American Archivist	Library	1	5	1			7
Journal of Documentation	Information	2	2		2		6
Cataloging & Classification Quarterly	Library	4				1	5
First Monday	Information		2		1	1	4
IEEE Computer	Computing		2	1		1	4
IEEE Trans on Info Tech in Biomedicine	Computing	4					4
Intl J of Human-Computer Studies	Computing	1				3	4
Journal of Information Science	Information	4					4
Library & Information Science Research	Library	1		2		1	4
School Library Media Research	Library				4		4
Telematics and Informatics	Information			3	1		4

Table 8. Journal Disciplinary Areas

Disciplinary Area of Journal	Drexel	Michigan	Pittsburgh	Syracuse	Washington	Total
Communication	1	1	1	3	0	6
Computing	25	12	28	4	11	80
Education	3	0	6	2	0	11
Humanities	1	1	0	1	3	6
Information	31	17	21	11	21	101
Library	17	16	9	20	8	70
Management & Policy	10	9	5	29	11	64
Science & Engineering	2	7	4	2	5	20
Social & Behavioral	1	3	2	1	7	14
Total	91	66	76	73	66	372

Figure 2. Distribution of Disciplinary Areas of Journals that Published the 372 Articles

Faculty Publishing Outside their Intellectual Heritages

To indicate whether faculty members publish outside their doctoral training areas, we calculated the collective summary of faculty members' doctoral degree areas and the disciplinary areas of the journals their papers appeared, as shown in Table 9. The diagonal cells (shaded) are the number of papers published in the same areas as the authors' doctoral degree areas. The total of these cells is 154, which is 37% of the total 414 author-article pairs (there are co-authored articles by members from the faculty sample). This means that the majority of the papers (63%) were published outside the authors' intellectual heritage areas.

A further examination by faculty ranks shows that there are 63 author-article pair at the assistant professor level, 164 at the associate professor level and 187 at the full professor level. The percentages of articles that remain in the same intellectual heritage areas are 46%, 42% and 30 % respectively for Assistant, Associate and Full Professors. This indicates that scholars at early career stages stay closer to their intellectual heritages and scholars at later career stages become more diverse and extend away from their intellectual heritages.

Intellectual Substances at the Collective and School Levels

Among all 372 articles, 19 (5%) articles emphasize on only one dimension of PITM; 119 (32%) on two dimensions; 170 (46%) on three dimensions and 64 (17%) on all four dimensions. All papers are found to emphasize at least one of the four dimensions. There is no paper that does not focus on any of the four dimensions of PITM.

The PITM Coverage

Figure 3 provides a view to understand the PITM emphasis patterns using Excel's radar charts. It shows the overall pattern by all papers in the five schools. In Figure 5, the line representing value=2 for intensive focus indicates that there is a strong and almost equal emphasis on Information, Technology and People and a much smaller emphasis on Management. The line representing value=0 for no focus shows the lack of coverage on PITM; it indicates that except Management, the number of papers with a lack of any coverage on PIT is small and that Management received the least amount of attention. The line representing value=1 for peripheral focus is the smallest among the three boxes and indicates that only a small portion of papers make implications on PITM. Overall, the articles from the five iSchools collectively have intensive

or some focus of all four dimensions of PITM, although people, information, and technology are emphasized by more articles than is management.

Table 9. Relationship between Doctoral Degree Areas and Journal Disciplinary Areas

Doctoral Area \ Journal Area	Communication	Computing	Education	Humanities	Information	Library	Management & Policy	Science & Engineering	Social & Behavioral	Total
Communication	1				5		5		1	12
Computing	1	62	6		31	2	12	6	3	123
Education		5	1			5	1		4	16
Humanities				1		3	1		2	7
Information	1	6	4	2	31	47	5	3	1	100
Library		1	1	2	7	20	2	2		35
Management & Policy	4	6			12	2	30	1	3	58
Science & Engineering		6			10	1	4	8		29
Social & Behavioral		2		1	9	9	11	2		34
Total	7	88	12	6	105	89	71	22	14	414

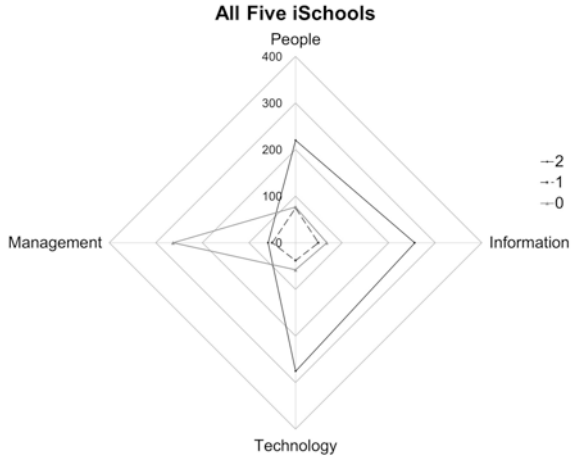

Figure 3. PITM Emphasis Pattern by Five iSchools

Figure 4 (sharing the same legend with Figure 5) shows each school's PITM emphasis pattern. On a macro level, all five exhibit a high presence (i.e. PITM value of at least 1 for some levels of emphasis) for People, Information, Technology but a relatively lower presence for Management. In particular, more than half of the articles from all but Pittsburgh have substantial emphasis (value = 2) on People. More than half of the articles from all five schools have substantial emphasis on Information and Technology. And all five schools have some articles that emphasize Management.

A glance at the blue lines indicates that Syracuse and Washington are more similar to each other and represent a more balanced coverage than the other three schools, although Syracuse is more evenly balanced than Washington. Drexel and Pittsburgh are similar to each other for having more concentrated

emphasis on Information and Technology. Regarding the lack of coverage depicted by the green boxes, Drexel and Pittsburgh are again similar to each other; while Michigan, Syracuse and Washington are similar to each other. All five schools have similar red lines that represent implications on PITM.

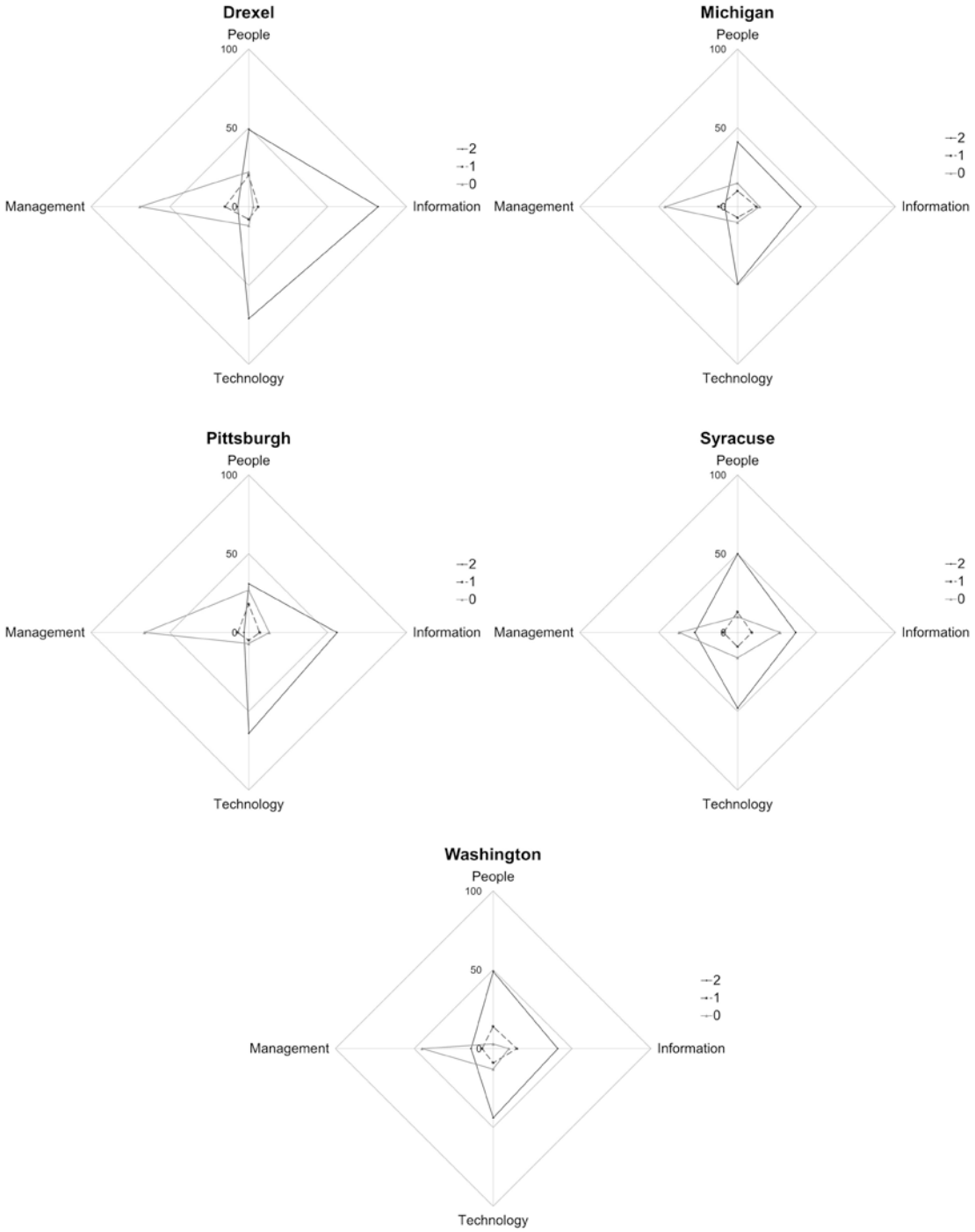

Figure 4. PITM Emphasis Pattern for each of the Five iSchools

Figure 4 can also demonstrate some differences on research foci among the five schools. The differences are observed as the following.

Drexel. Out of the 91 articles, Drexel skews toward Information (90%, 7%, and 3% for values 2, 1, and 0 respectively) and Technology (78%, 9%, 13%). There is a relatively lesser emphasis on People (54%, 22%, 24%) and lightest emphasis on Management (8%, 16%, 76%).

Michigan. Out of the 66 articles, Michigan articles heavily focus on Technology (74%, 11%, 15%), followed by People (62%, 15%, 23%) and Information (61%, 18%, 21%). Similar to Drexel, Michigan has a light emphasis on Management (14%, 18%, 68%).

Pittsburgh. Out of 76 articles, Pittsburgh is skewed toward Technology (84%, 7%, 9%), followed by Information (74%, 17%, 9%), and People (41%, 24%, 36%). The emphasis on Management (5%, 8%, 87%) is very light.

Syracuse. Out of the 73 articles, Syracuse has a relatively even emphasis on People (68%, 18%, 14%), Technology (66%, 12%, 22%), and Information (51%, 12%, 37%). Its coverage on Management (36%, 12%, 52%) is the highest among all five schools. Syracuse seems to be the most diversified in its research foci with a relatively balanced concentration on People, Information, Technology, and Management.

Washington. Out of the 66 articles, Washington also has a relatively even emphasis on People (74%, 21%, 5%), Technology (65%, 15%, 20%) and Information (62%, 23%, 15%). Its coverage on Management (21%, 11%, 68%) is the second highest among all five schools. Washington seems also diversified yet relatively balanced in its research foci on People, Information, Technology and Management.

The Contexts

Examining the contexts where studies were conducted is another way of depicting the intellectual substances. Table 10 shows the summary of the coding results on contexts. Figure 5 shows the composition of all contexts of the 372 papers. There are several interesting observations on Context at the collective level. As shown in Figure 7, the iSchool scholars cover a variety of contexts in a relatively balanced way. Table 10 and Figure 5 jointly show that the most prevalent context is Education, among which both Pittsburgh and Syracuse contribute more papers (32% and 28% respectively out of 82 papers) than other schools. The next most prevalent contexts are Industry/Government and Society. Interestingly, all five schools have a good coverage on Industry/Government while Washington and Drexel have slightly more coverage on Society than the other three schools. Academia and Context Free (independent of context, no context) are the next most prevalent contexts, while Drexel has the most articles in Academia (41% out of 41 articles) and Pittsburgh has the most articles with no context (46% of the 39 papers). Organization is mostly covered by articles from Syracuse (36% out of the 33 articles) and Library is by Drexel (37% out of the 35 papers). The least prevalent are National-Culture/Global and Marketplace. National-Culture/Global is mostly covered by Washington (75% out of the 12 papers). Marketplace is mostly covered by Michigan (67% out of the 9 papers).

Contexts can also be examined in conjunction with the PITM emphasis. Figure 6 shows the PITM intensity values for each context. The figure shows to what extent the PITM components are emphasized in each context.

The Methods

Among the 372 articles, 286 or 77% use empirical methods. There is a significant difference on method used among ranked scholars, as seen in Table 11. Assistant Professors tend to use empirical methods more than non-empirical; Full Professors tend to use non-empirical method more than empirical, and Associate Professors are in between.

Table 10. Contexts of the Studies in the 372 Articles

Context	Drexel	Michigan	Pittsburgh	Syracuse	Washington	Total
Academia	17	7	4	4	9	41
Context Free	11	9	18		1	39
Education	13	13	26	23	7	82
Industry/Government	12	9	17	15	7	60
Library	13	8	2	8	4	35
Marketplace	2	6	1			9
NationalCulture/Global		1		2	9	12
Organization	8	2	4	12	7	33
Society	15	11	4	9	22	61
Grand Total	91	66	76	73	66	372

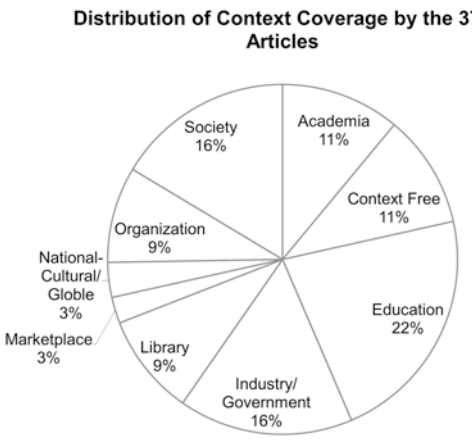

Figure 5. Distribution of Context Coverage by all 372 Articles

To examine whether journal areas may co-occur with certain research methods, Figure 7 shows the numbers of empirical and non-empirical articles within each journal area. The two areas that have 50% or more articles for non-empirical studies are Communication and Humanities, although each has only six articles. For the rest of the seven areas, there are more empirical studies than non-empirical: the percentage of non-empirical articles ranges from 15% to 30% with Library being the highest at 30%.

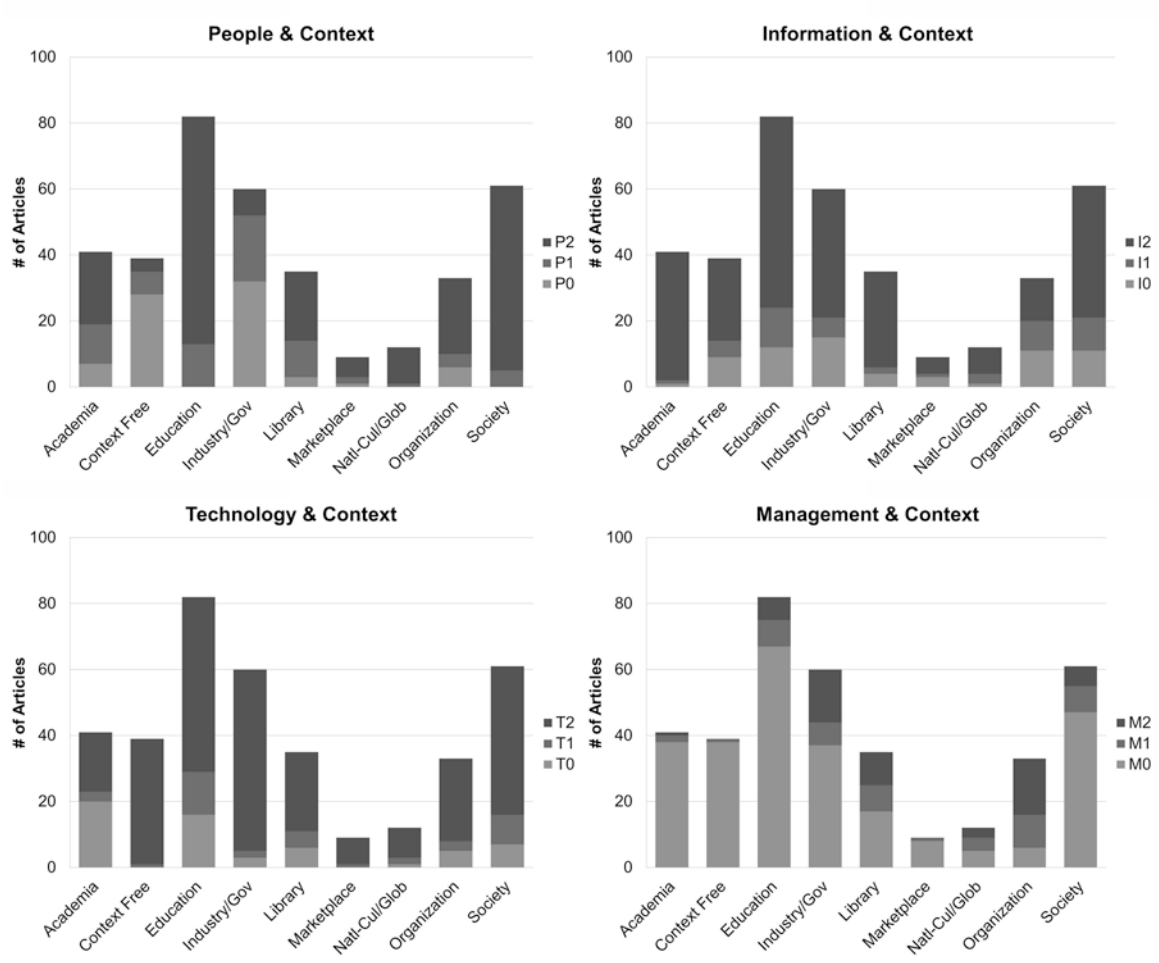

Figure 6. PITM Emphasis in Contexts

Table 11. Faculty Rank and Research Methods Used in the 372 Articles

Rank	Emp	Non-Emp	Total
Assistant	16%	14%	15%
Associate	42%	32%	40%
Full Professor	42%	54%	45%
Total	100%	100%	100%

To examine research methods in conjunction with contexts, Figure 8 shows the numbers of empirical and non-empirical articles within the total number of articles for each context.

Finally, we examined the methods along with the PITM emphasis. Since studies usually use particular methods to investigate core issues, here we only depict those papers with the PITM values of 2 (intensive focus), as shown in Figure 9. The majority of studies (roughly 75% or more) that have intensive emphasis on each of PITM are empirical studies.

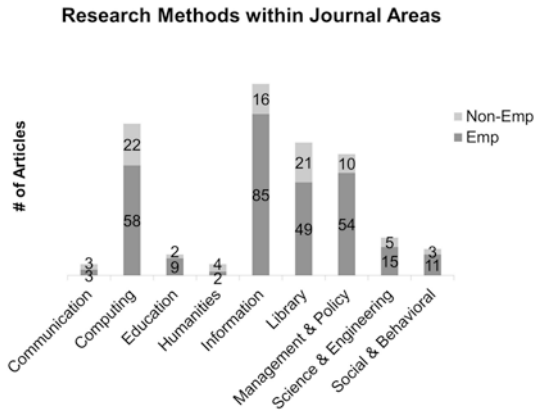

Figure 7. Research Methods and Journal Areas

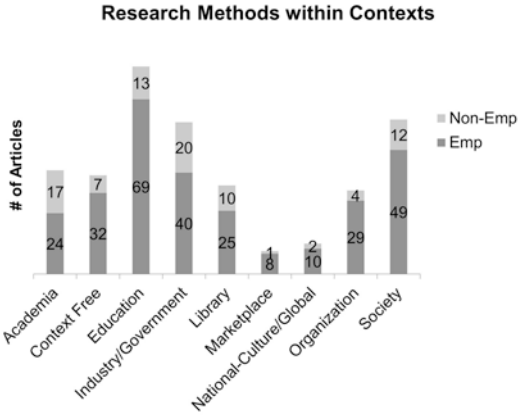

Figure 8. Research Methods and Contexts

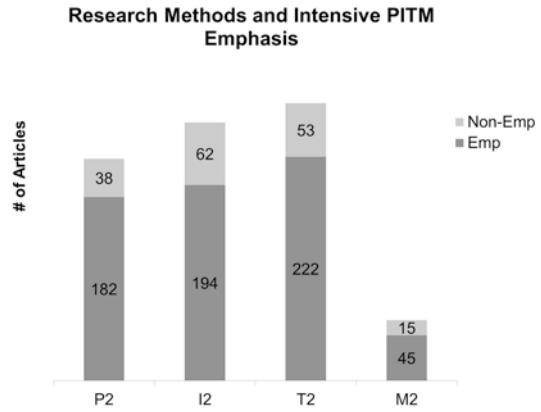

Figure 9. Research Methods with Intensive PITM Emphasis (value=2)

The Levels of Analysis

Table 12 summarizes the findings on levels of analysis (LOA). Among the 372 papers, three papers purposely emphasize multi-levels of analysis. All three are non-empirical survey papers that provide an overview of diverse research on a particular topic. Figure 10 shows the distribution of levels of analysis by the 369 papers (372 minus the three multi-level papers). There are four dominant levels: Social Artifact, Computational Artifact, Individual and Industry/Government.

Table 12. Levels of Analysis in the 372 Articles

Level of Analysis	Drexel	Michigan	Pittsburgh	Syracuse	Washington	Total
Computational Artifact	40	21	33		5	99
Social Artifact	26	21	17	29	23	116
Individual	11	15	14	13	21	74
Group	3	1		4	1	9
Organization		1		3	1	5
Industry/Government	8	4	12	21	6	51
Community/Society	2	2		2	3	9
Global/Cultural				1	4	5
Computation Artifact + Individual + Community/Society	1					1
Individual + Group + Community/Society					1	1
Individual + Group + Organizational + Community/Society					1	1
Grand Total	91	66	76	73	66	372

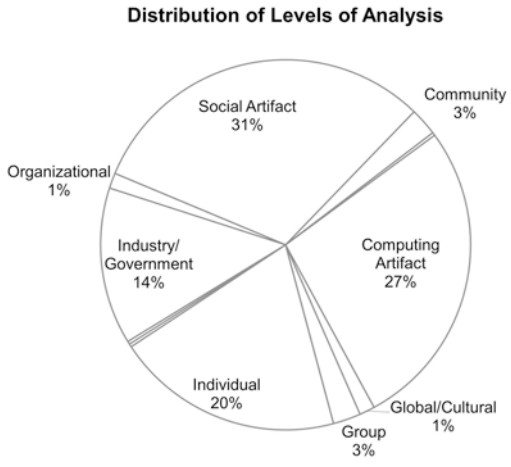

Figure 10. Distribution of Levels of Analysis by 369 Articles

It is worth noting that a study's level of analysis is different from its context, as indicated by their definitions and classification schemes in the Methodology Section. Table 13 demonstrates the differences by showing the levels of analysis and contexts of the 372 papers.

Table 13. Levels of Analysis Compared to Contexts

Level Of Analysis \ Context	Academia	Context Free	Education	Industry/ Government	Library	Marketplace	National-Culture/ Global	Organization	Society	Grand Total
Computational Artifact	7	38	10	26		6		5	9	101
Social Artifact	27		30	9	23	2	2	5	17	115
Individual		1	30		3	1	3	14	22	74
Group			3					3	3	9
Organizational			1	1	1			2		5
Industry/Government	4		7	24	8		1	4	3	51
Community/Society			1				2		6	9
Global/Cultural							4		1	5
Computation Artifact + Individual + Community/Society	1									1
Individual + Group + Community/Society	1									1
Individual + Group + Organizational + Community/Society	1									1
Grand Total	41	39	82	60	35	9	12	33	61	372

To gain more insight into the co-occurrences between levels of analysis and the PITM emphasis, Figure 11 outlines levels of analysis in conjunction with each of the PITM dimensions of the 369 papers (only papers with non-multiple levels). The two coding schemes also function as a cross validation. For example, none of the studies at individual, group, community, and global levels have People's value as 0 or 1 (none to peripheral emphasis); among all papers at the computational artifact level, none has Technology value as 0 or 1; and all papers at the organizational level has Management value of 2 (intensive emphasis).

Intellectual Substances at the Group and Individual Levels

To demonstrate the PITM coverage at the author level, we used Google's radar chart that can shed insight into a collection of articles by each author. Figures 12a, 12b and 12c demonstrate one author's papers in terms of their PITM emphasis. In the Google radar chart, the maximum value along each of the four axes (PITM dimensions) is 2. The points at the axes would represent the values of the PITM emphasis. Figures 12a and 12b show that the two papers have the following values for PITM respectively: (2, 1, 1, 1) for Paper 1 in Figure 12a and (2, 2, 2, 0) for Paper 2 in Figure 12b. The links or arcs are not significant in their own sake but connect the axes' values to indicate they are from the same paper. The shaded background area provides the maximum boundary of any author's work. While using Google radar charts, each paper is individually plotted to the chart (as shown in Figures 12a and 12b for two different papers by the same author), and multiple papers of the same author can be imposed together to the final chart (see Figure 12c for all six papers by the same author). If a line/arc is thicker in Figure 12c, it means more than one paper share the same line/arc. For example, among the 6 papers by Abels from Drexel, three share the same values on PITM as those for Paper 2 in Figure 12b: (2, 2, 2, 0). The thicker the line, the more papers there are that share the same values. These characteristics of the Google radar show clearly the PITM coverage

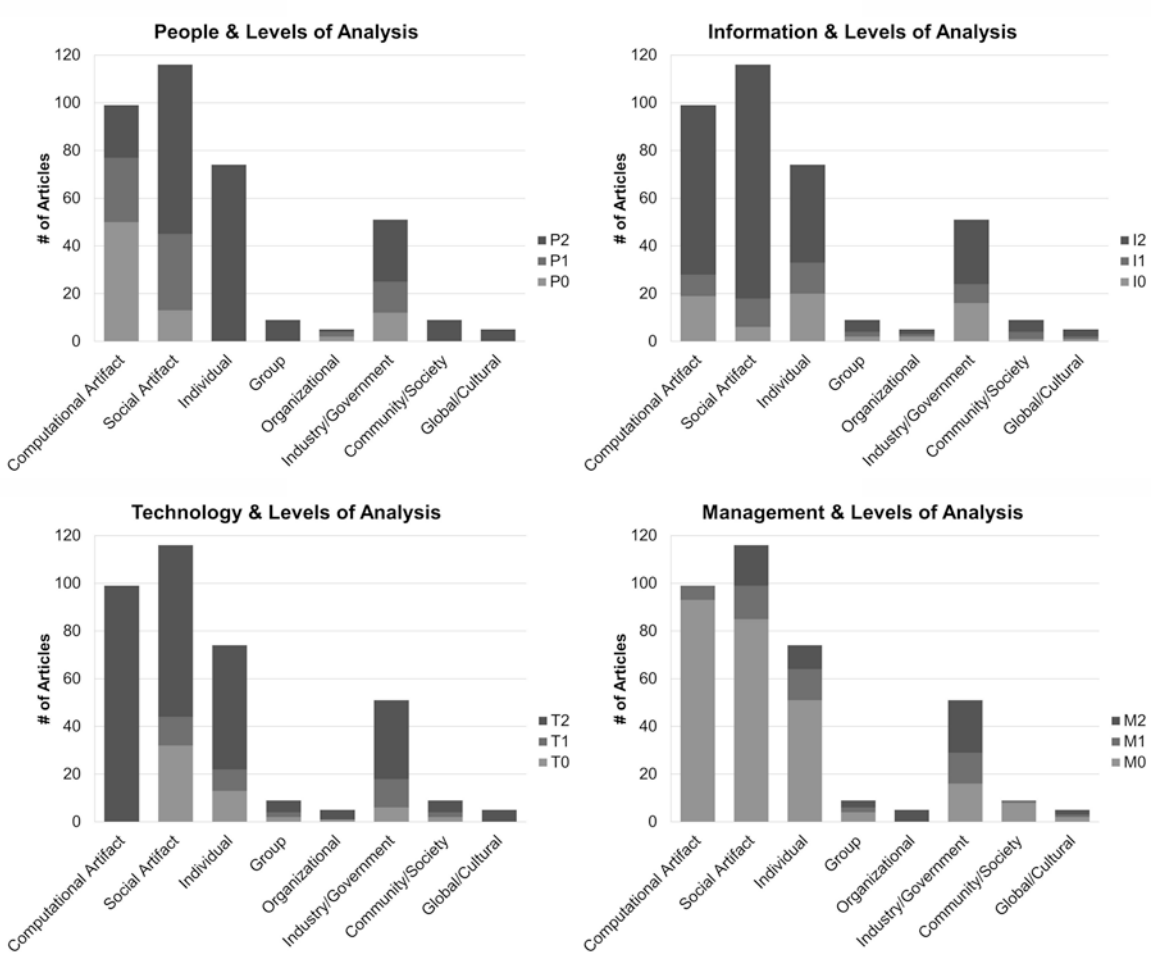

Figure 11. PITM and Levels of Analysis

patterns and make comparison possible. When the outside line is present, it may or may not mean that the author has a paper with PITM values of (2, 2, 2, 2). It could be that the author pays attention to all four dimensions although not necessarily simultaneously in a single paper. For example, in Figure 12d, Chen from Michigan has five papers with the PITM values as (2, 0, 2, 2), (2, 2, 2, 0), (2, 2, 1, 0), (2, 0, 2, 0) and (2, 0, 0, 1). For the rest of PITM analysis at the individual level, we used one chart for each author by imposing all his/her articles together.

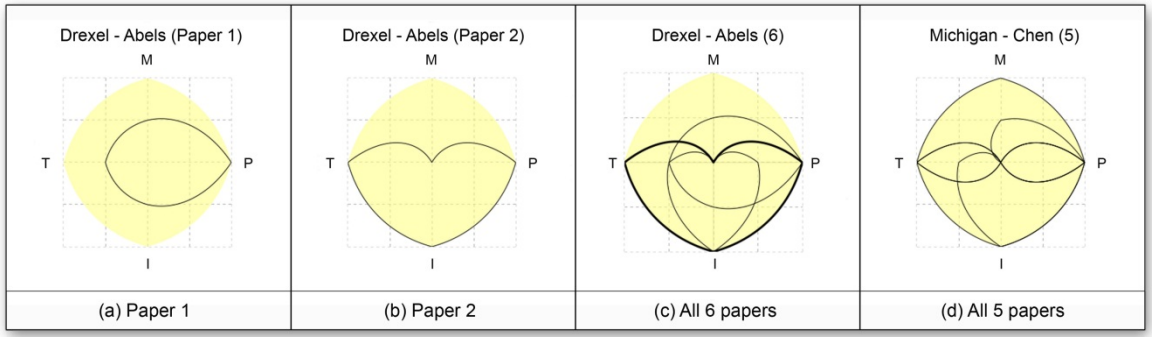

Figure 12. Google Radar to Depict PITM Emphasis in Articles by the Same Author

The PITM Emphasis by Doctoral Areas

In this section, we depict the PITM coverage patterns of individual authors to illustrate the diversity and similarity of their intellectual characteristics. To make the presentation manageable and at the same time representative, we depict only those prolific authors who have five or more publications in our pool of 372 papers from 150 faculty members.

Figures 13-20 depict the PITM profiles of prolific authors by their doctoral areas. Only areas with at least two prolific authors are shown. Within the same area, authors in the same iSchool are grouped together.

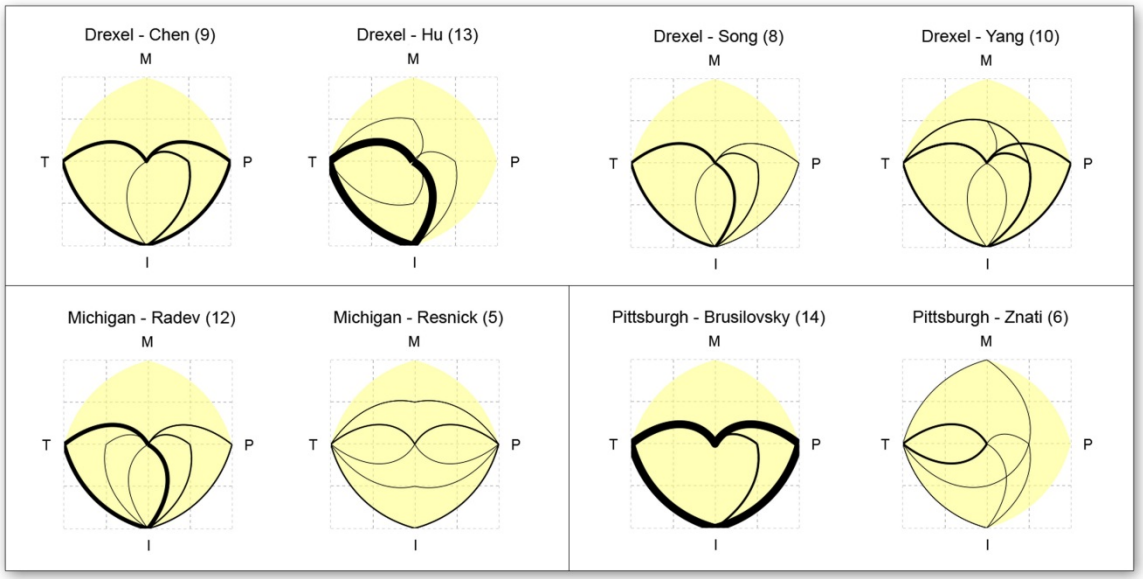

Figure 13. PITM Profiles of Prolific Authors with PhD Area in Computing

These figures show that some authors have more consistent PITM emphasis than others. The radar charts with very thick lines indicate that the corresponding authors produced somewhat homogeneous articles in terms of PITM emphasis. Two of them particularly stand out to be among the top prolific authors. A further examination of their articles indicates that these two authors vary by the contexts they considered for their studies. For example, Hu from Drexel conducted research with the following contexts: Library (1 paper), Industry/Government (7), Organization (1), and Context Free (4). Brusilovsky from Pittsburgh covered only two contexts: Education (13) and Context Free (1). In addition, Hu used empirical methods in all but one article, while all of Brusilovsky's articles used empirical methods.

It is obvious that intellectual heritages (doctoral training areas) are not good predictions of research foci in terms of PITM emphasis. This is consistently demonstrated by Figures 13-20. This finding is also consistent with findings in Table 9: doctoral areas do not predict which disciplinary areas authors will publish in.

Academic Twins and Triplets

Our data analysis discloses that there can be academic "twins" or "triplets" (i.e., similar PITM profiles) separated at "birth" (i.e. different doctoral areas) and also currently in different schools. These people can be examined by their PITM coverage, contexts, methods, and levels of analysis. Figure 21 depicts just

some of them. These academic twins or triplets might be potential collaborators who already share a lot of common ground. If not collaborators, they may want to know each other's work to benefit their own.

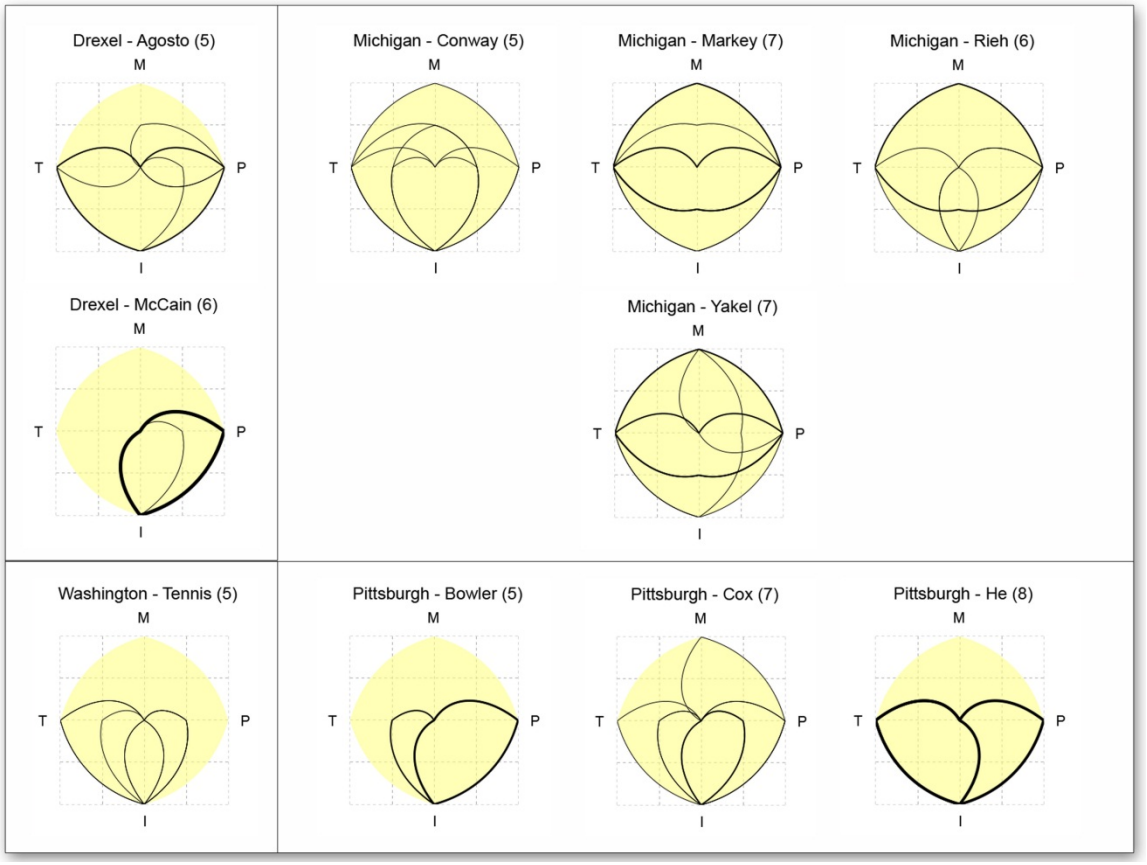

Figure 14. PITM Profiles of Prolific Authors with PhD Area in Information

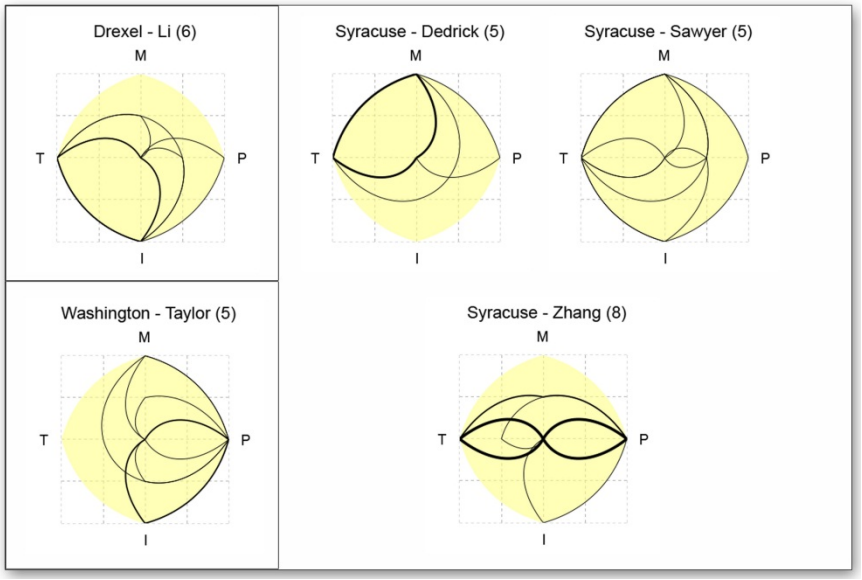

Figure 15. PITM Profiles by Prolific Authors with PhD Area in Management & Policy

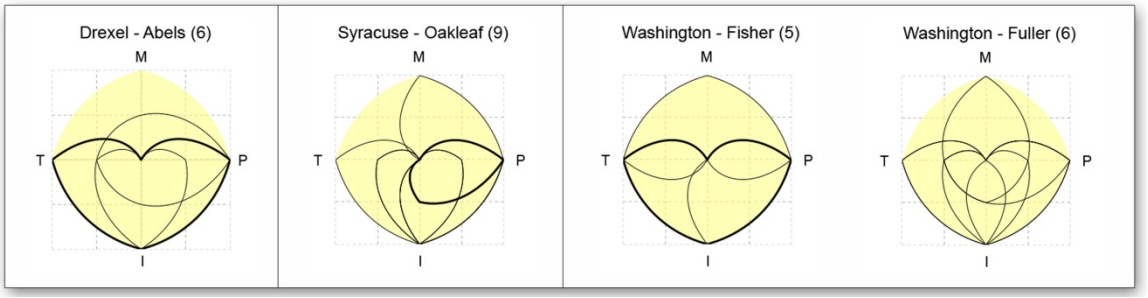

Figure 16. PITM Profiles of Prolific Authors with PhD Area in Library

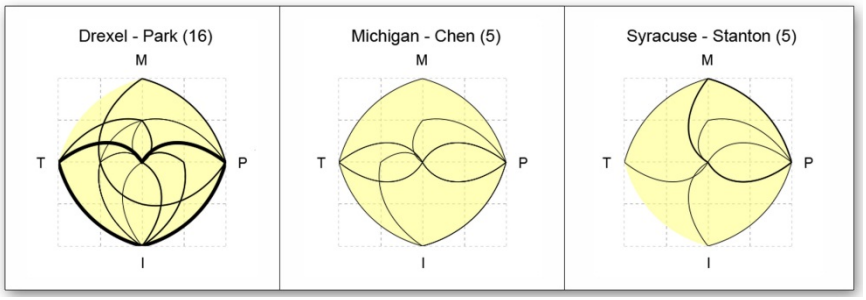

Figure 17. PITM Profiles of Prolific Authors with PhD Area in Social and Behavioral Sciences

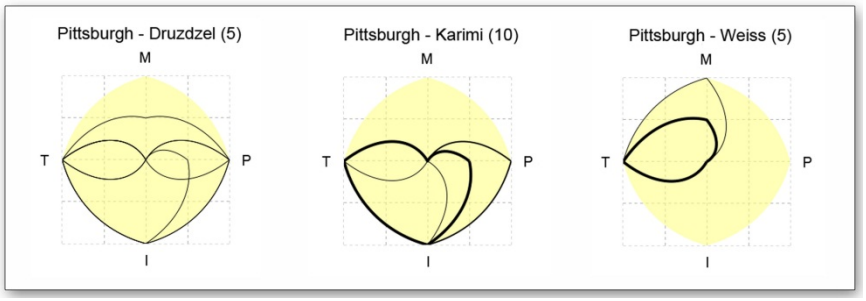

Figure 18. PITM Profiles of Prolific Authors with PhD Area in Science & Engineering

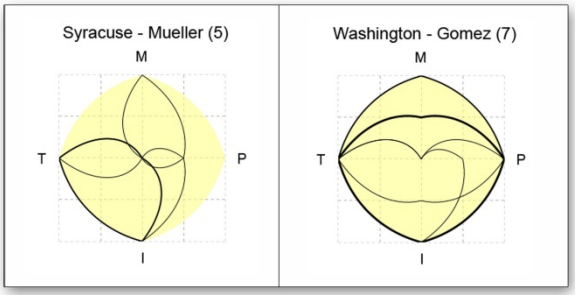

Figure 19. PITM Profiles of Prolific Authors with PhD Area in Communication

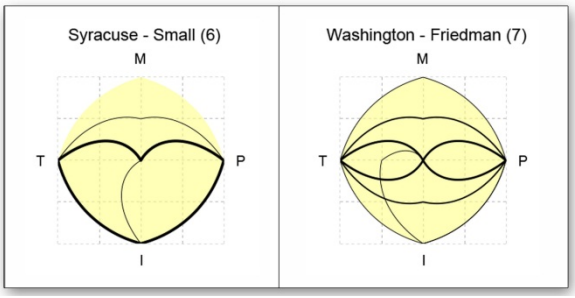

Figure 20. PITM Profiles of Prolific Authors with PhD Area in Education

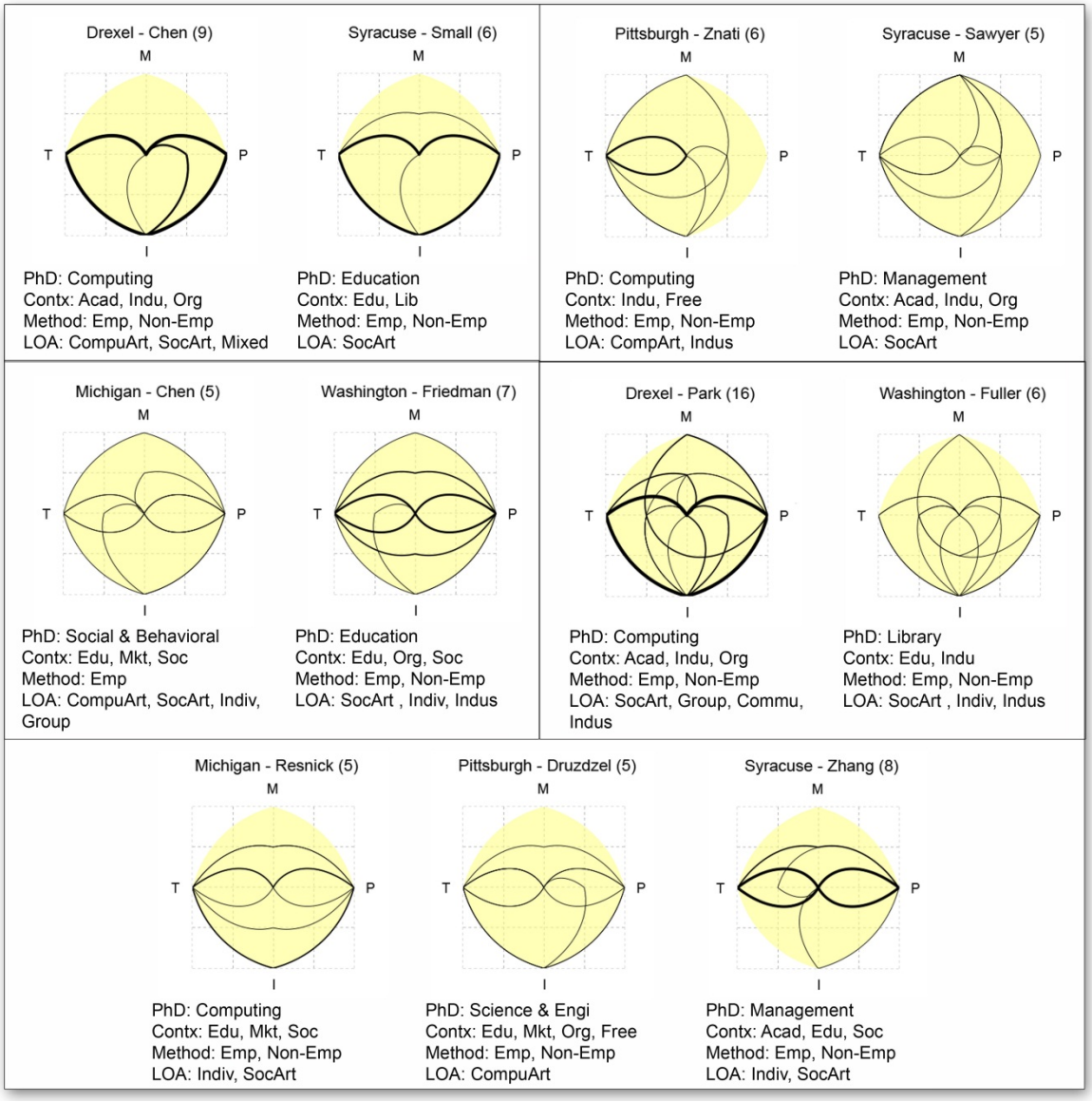

Figure 21. Academic Twins/Triplets with PhD Areas and Other Facets of Studies

Discussions

Before we discuss the significance and implications of the findings, we need to acknowledge some limitations of this study so that findings can be interpreted and applied with care. The first limitation has to do with the selection and sampling of the iSchools (the first five iSchools members of the iCaucus), faculty (only tenure track faculty), and research representations (only journal publications and only from 2008 to 2010). With a larger selection on all these aspects (more iSchools, more faculty types, broader period of publication time and greater variety of publications), the findings might be different. The second limitation has to do with the conceptual frameworks used to analyze the data. For intellectual heritage, we only considered doctoral training. We acknowledge that one's training or experience outside the doctoral program can be influential for one's research as well. For the doctoral training areas, we adopted Wiggins and Sawyer's (2011) classification of disciplinary areas. For intellectual substances, we adopted Zhang & Benjamin's (2007) I-Model. If different frameworks were used, different aspects might be included or omitted and the findings might be different. The third limitation has to do with the granularity of analysis on some of the aspects. For example, research methods can be examined in more details to demonstrate iSchool scholars' use of various types of empirical methods, such as surveys, lab experiments, case studies, among others.

Next, we discuss the findings to address the questions raised in the introduction section.

Conceptualizations of the iField

King states that "the most remarkable thing about the iSchools is the variety of their origins and the broad embrace of their intellectual interests" (King, 2006, p. 14). Our findings support King's statements. The findings of the tenure track faculty's intellectual heritages can be a testimony for the origins, and the findings on the intellectual substances (research foci on PTIM, contexts, methods, and levels of analysis) can be the testimony for the intellectual interests.

Our findings on faculty intellectual heritages (see Figure 1), journal disciplinary areas (Figure 2) and intellectual substances (Figure 3) can shed light on the appropriateness of various component based conceptualizations of the iSchools. For intellectual heritages and journal disciplinary areas, it is worth noting that there is no single discipline that focuses on People, yet the emphasis on People might be reflected in a number of disciplines. For example, there can be strong emphasis on People in Social & Behavioral, Communication, Education, and Humanities areas, and yet these areas do not exclusively cover People issues. Another interesting discipline is Library, which focuses on a good number of issues almost evenly including People, Technology as well as Management and Information. In addition, the Science & Engineering area may contribute to the Technology area too, thus only considering Computing as Technology is an underestimate or a conservative count. Nevertheless, for heritages, Figure 1 indicates that information (27%), Technology (those mainly in the Computing areas, 23%) and Management (17%) are more dominant disciplines than others. This seems to favor the Information-Technology-Society model. However, by combining Social & Behavioral (5%), Communication (3%), Education (3%) and Humanities (6%), which is 17% altogether, we may argue that there is a strong People emphasis as well in the intellectual heritages of iSchool faculty.

On the journal disciplinary areas, Figure 2 indicates a similar dominance of disciplinary areas of Information (27%), Technology (21%) and Management (17%). The combined Social & Behavioral (4%),

Communication (2%), Education (3%) and Humanities (2%) are 11% altogether, which can be a significant representation of the People component.

The research foci of the intellectual substances (Figure 3) demonstrate that Technology, Information and People are more dominant than Management. This provides support to the popular three-component model of Information-People-Technology for iSchools. On the other hand, Figure 3 also shows that a good portion of the papers cover the Management component (roughly 30% at intense levels 1 and 2 combined). Omitting the Management dimension, thus, can be misleading and may overlook great opportunities for the iSchools to conduct more interesting and innovative research that can have both academic and practical impacts. Overall, we believe that collectively the iSchools or iField is better conceptualized by the four-component model of People-Information-Technology-Management, as indicated by the I-Model.

Similarities and Differences among the iSchools

In their historical overview of iSchools, Olson and Grudin (2009) note that Syracuse, Michigan, and Pittsburgh iSchools evolved from previously extant Library Science programs. Based on the schools' histories presented on their websites, we also know that Drexel and Washington evolved in a similar manner. Like many of the iCaucus members, the five iSchools included in our sample have historical roots in Library Science. And although each of the five schools has evolved differently and have their own intellectual identities, both the similarities and the differences among these schools are worth noting. Here we discuss the similarities and differences based on comparison of the key components in intellectual heritages (see Table 5), journal publication areas (Table 8), and research foci (Figure 4). Table 14 summarizes the key components of each of the three measures where the components are listed in order of most dominant.

True to the name of Information School, all five iSchools have a strong intellectual root in Information, as evidenced in all three measures of heritage, publications, and research foci. To a slightly less extent, Computing or Technology is another common intellectual root among all five iSchools: all five have Technology as main research foci, although Syracuse is the only one that has no dominant Computing heritage or journal publications. All five schools maintain intellectual roots in Library science discipline as evidenced in intellectual heritages and/or journal publication areas. All five have research foci on People. All but Pittsburgh have intellectual root on Management as evidenced in all three measures.

Despite all the similarities summarized above, the five schools can still be roughly classified into two categories based on the dominance of their research foci: schools that emphasize on Technology-Information-People (Drexel, Michigan and Pittsburgh), and schools that emphasize on People-Technology-Information-Management (Syracuse & Washington). Overall, Management is the least covered research foci component across the five studies schools.

Regardless of the similarities or differences, it is safe to say that the iField is indeed a multi- and inter-disciplinary field where faculty members originate from a diverse set of disciplines, publish in a diverse set of disciplines and demonstrate diverse research interests.

Current and Potential Collaborations

The current collaboration among tenure track faculty members either within or across iSchools, as evidenced by co-authorship in journal publications, is not high. As shown in Table 6, despite that about 82% papers are co-authored (18% are single authored), only 8% of the articles have co-authors within the same

school, and only one paper across different schools. There can be different reasons for this low level of collaboration, which are beyond the scope of this study. If collaboration among tenure track faculty members (either within or across schools) is desired, there might be a need for some incentives from the administration to encourage such practice.

From a practical perspective, there is a great potential to have more collaboration among iSchool faculty members. The demonstration of the academic twins/triplets indicates that based on doctoral areas, currently published journal areas, research contexts, methods, and foci, many scholars share some common ground already.

Table 14. Similarities and Differences among the five iSchools

Source of Evidence	Drexel	Michigan	Pittsburgh	Syracuse	Washington	Total
Heritages	Information Computing Library	Computing Management Information Humanities	Computing Information Science&Engineering	Management Information	Computing Information Library	Information Computing Management Library
Journal Areas	Information Computing Library Management	Information Library Computing Management	Computing Information Library	Management Library Information	Information Computing Management	Information Computing Library Management
Research Foci	Technology Information People	Technology Information People	Technology Information People	People Technology Information Management	People Information Technology Management	Technology Information People Management

Implications for iSchool Planning and Faculty Development

This study has several practical implications for administration considerations. Given that each iSchool has its own intellectual characteristics, the administration of a particular iSchool, whether a newly planned one or an existing one seeking to evolve, should be aware of where it is and where it wants to be from the faculty composition and intellectual substances perspectives. For example, a particular iSchool may want to maintain their strength along certain PITM dimensions, or consider the lack of strength in certain dimensions a weakness, thus seeking new hires to compensate. Understanding the connection between intellectual heritages and intellectual substances would allow development of better strategic directions from the present to the future.

From the faculty hiring perspective, it is interesting to note that doctoral training areas are not accurate predictors of scholars' research foci or disciplinary areas they publish in. This, however, might be an artifact of new hires (especially fresh PhD graduates) being intellectually influenced and incentivized by the particular iSchool atmosphere. A personal observation from one of the authors of this article is that the majority of the faculty members changed or expanded their research areas, foci, contexts, etc. after they were hired. Doctoral training areas do provide a starting point for one's research career, and our finding shows the assistant professors tend to stay close to their intellectual heritage areas. As a scholar becomes more senior, she or he may depart further from her/his intellectual roots.

Related to hiring are faculty development, evaluation and promotion. One positive aspect of the iSchools is that there are no required journal outlets that faculty must publish in. On the other hand, promotion evaluations often require outside reviewers to provide judgment on intellectual contributions and such

external evaluations are considered heavily in promotion evaluations. This may impose potential conflicts in that either qualified external reviewers may be hard to find, or they may have a hard time trying to fully understand and appreciate a candidate's intellectual contribution. In some iSchools, new hires are recommended to maintain ties with their academic homes, often the disciplines they are either trained or published in. As iSchools and the iField continue to grow and expand, it may help with faculty evaluation and promotion matters in that external reviewers are from other iSchools who may share some intellectual substances with the candidates, such as the academic twins or triplets.

Implications for Young Scholars' Career Development

Young scholars in the iField face many challenges similar to those faced by scholars in other fields. In addition, they are constantly challenged by the uncertainty of which intellectual home they should belong to and what type of journals they should publish in. As evidenced by this study and several others, there is no single intellectual home for the iField, thus there is no single set of journals to publish in. This challenge will continue for the iField, and for the individual scholars as their careers continue to evolve. Being consciously aware of this constant challenge can be reassuring to the young scholars in that they are not alone and this is natural. What young scholars can do to address the challenge are to identify the particular iSchools that they find best suited to their own intellectual substances, and identify those academic twins or triplets (either young or established scholars) whom they can approach to borrow, share, and contrast research ideas, as well as to seek as potential collaborators or external reviewers for tenure or promotion.

Research Contributions

Understanding the iSchools and the iField better is a timely and challenging task. The present study supports and clarifies some of the existing heuristics and formal conceptualizations, and provides additional empirical evidence to shed light on the iField phenomenon. In addition, the study has several research contributions.

The research method and process yield a rich set of classifications that can be used in future studies. For intellectual heritages and journal disciplinary areas, we verified and refined the classification by Wiggins & Sawyer (2011). The new classification can be used in future studies to address issues that require comparisons of scientific disciplines. For research foci, the PITM classification, built on the I-Model (Zhang & Benjamin, 2007), is demonstrated to be an effective one to delineate different intensity levels of research topic foci. It provides a foundation for any further development of the classification, such as to have more levels of intensity or nature of coverage on the four components. Few studies so far have focused on either the contexts or the levels of analysis in research articles by scholars in the iField. The classifications for these two expand previous ones (Zhang & Li, 2005) and provide a comprehensive coverage on all possible contexts and all possible levels of analysis for research investigations so far.

We also utilized several visualization tools to communicate our findings more convincingly. In addition to the commonly used bar charts, pie charts and tables, some additional charts proved to be very helpful. For example, both Excel radar charts and Google radar charts help us convey the messages hidden in the data, allowing human eyes to easily detect interesting patterns in the data.

Conclusion

The iSchools and iField are developing rapidly and attracting tremendous attention from various constituencies. This paper provides a timely and relatively comprehensive understanding on the intellectual characteristics of the iField. Such an understanding, in conjunction with existing work on understanding the iField, enhances communication and collaboration with other fields, and further development of the iField itself. Our findings indicate that collectively, the iField can be better conceptualized by examining the presence of and relationship among four main components: People, Information, Technology and Management. The iField is truly inter- and multi-disciplinary, demonstrated by knowledge contributors coming from a very diverse set of disciplines, conducting research with very diverse emphases within very diverse contexts and at various levels of analysis, and publishing in journals that belong to many different disciplines. Such diverse disciplinary nature of the iField imposes both challenges (such as faculty recruitment and development) as well as opportunities to create and contribute interesting and unique knowledge.

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References

Babbie, Earl R. (2010). *The Practice of Social Research* (12 ed.): Cengage Learning.

Bar-Ilan, Judit. (2010, Feb. 3). *Measuring research impact: A first approximation of the achievements of the iSchools in ISI's Information and Library Science category -- An exploratory study.* Paper presented at the iConference.

Bureau, Sylvain. (2008). "Schools of Information": what do they mean by that? *Le Libellio d'AEGIS, 2008*, 43-55.

Chen, C. (2008, October 24-29). *Thematic maps of 19 iSchools.* Paper presented at the The American Society for Information Science and Technology, Ohio.

King, John Leslie. (2006). Identity in the I-School Movement. *Bulletin of the American Society for Information Science and Technology*(April/May), 13-15.

Larsen, Ronald. (2004, October 19-22). *Reinforcing the "I" in IT education.* Paper presented at the Educause.

Larsen, Ronald. (2005). *I-school for the 21st century: An introduction to the School of Information Sciences at the University of Pittsburgh*. Personal Communication.

Liddy, Elizabeth. (2012). Keynotes. *The 7th I-Conference*. Toronto, Canada. Feb. 2012.

Liu, Xiaozhong, Benjamin, Robert, & Zhang, Ping. (2007). *Examining IT Enabled Change Cases with A Model of the Information Field: The Tiger Creek Case.* Paper presented at the Hawaii International Conference on System Sciences (HICSS).

Olson, Gary, & Grudin, Jonathan. (2009). The Information School Phenomenon. *Interactions*(March + April), 15-19.

Wang, Chingning, & Zhang, Ping. (2012). The Evolution of Social Commerce: An Examination from the People, Business, Technology, and Information Perspective. *Communication of the Association for Information Systems, 31*(5), 105-127.

Webber, Sheila. (2003). Information Science in 2003: A Critique. *Journal of Information Science, 29*(4), 311-330.

Wiggins, Andrea, & Sawyer, Steve. (2011). Intellectual Diversity and the Faculty Composition of iSchools. *Journal of American Society for Information Science and Technology, 63*(1), 8-21.

Wobbrock, J.O., Ko, A.J. , & Kientz, J.A. (2009). Reflections on the future of iSchools from inspired junior faculty. interactions. *Interactions, 16*(5), 69-71.

Wu, Dan, He, Daqing, Jiang, Jiepu, Dong, Wuyi, & Vo, Kim Thien. (2011). The state of iSchools: an analysis of academic research and graduate education. *Journal of Information Science, 38*(1), 15-36.

Zhang, Ping, & Benjamin, Robert I. (2007). Understanding information related fields: A conceptual framework. *Journal of the American Society for Information Science and Technology, 58*(13), 1934 - 1947.

Zhang, Ping, & Li, Na. (2005). The intellectual development of Human-Computer Interaction research: A critical assessment of the MIS literature (1990-2002). *Journal of Association for Information Systems, 6*(11), 227-292.