

A Cluster Analysis of LIS Students in Singapore and Implications for Defining Areas of Specialization

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A study of the subject interests of LIS students in Singapore was carried out via a questionnaire survey of students and graduates of the master of science (MSc) information studies program at the Nanyang Technological University, Singapore, as well as a survey of applicants to the program. Cluster analysis was performed on the questionnaire data. The respondents were clustered based on the elective subjects that they selected in the questionnaires. For both sets of data, two distinct clusters were found—a library-oriented cluster and an information technology (IT)/information management-oriented cluster. In each cluster, further sub-clusters were found that correspond to known specializations in the field. An analysis of the relationship between the clusters and the areas of specialization selected by respondents indicated some ways of improving the areas of specialization defined in the MSc program. The cluster analyses were found to yield useful results and provided a better understanding of the students' interests and how the interests were structured.

Introduction

Library and information science (LIS) schools have a diverse student body. Students come from a wide-range of educational and work backgrounds, and have diverse interests and career aspirations. The LIS field is itself very broad and multidisciplinary, and graduates of LIS programs assume a wide range of jobs in many different environments. In a short one- two-year program, it is difficult to prepare a student adequately for the range of possible information professions that the student might enter after graduation. Many LIS schools now define a number of specializations and even offer separate master's programs to prepare students for professional positions in those specializations.

This study was undertaken to find the subject interests and perceptions of students as well as applicants to the LIS program, to help in redesigning the curriculum and the different specializations (or tracks), and to better serve student needs and interests. Specifically, the school wanted to find whether there were well-defined and coherent clusters of LIS students and appli-

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cants who had similar interests in terms of the subjects that they preferred, what the “core subjects” were for each cluster of students, whether the core subjects corresponded to a known specialization in the field, and whether people in a particular cluster tended to choose a particular area of specialization.¹

Many factors are considered when designing areas of specialization. The following market-oriented criteria have to be considered:

- the area of specialization should correspond to jobs or positions that exist in public or corporate organizations
- the area of specialization should correspond to a particular type of library or information service
- a substantial market demand exists for the particular type of job (as reflected in the number of people employed, number of advertisements, and good remuneration)
- the job is distinct from other information-related jobs (e.g., there is a unique designation or label for the job)
- to perform competently in the job requires a coherent set of knowledge, competencies, and attitudes that are distinct from those of other specializations.

A student-centered institution should, however, take into consideration student perceptions and interests when defining specializations and the subjects for a specialization. Many LIS students have prior working experience, and so their perceptions, to some extent, reflect the perceptions of employers (many of whom do not have an LIS background). If a particular specialization and its subjects match closely the interests of a group of students, it follows that:

- it will be easier to explain the specialization and market it
- the set of subjects prescribed for the specialization is more likely to be perceived as reasonable and coherent
- it will be possible to predict the proportion of students interested in that specialization.

In this respect, if a particular cluster of students do not correspond to any area of specialization defined in the LIS program, the school can consider developing a specialization for them or support their needs in some way.

The MSc (Information Studies) program at the Nanyang Technological University, Singapore, forms the backdrop of this study. This is the only professional LIS program in Singapore.² The program began in 1993 with a curriculum that had six compulsory subjects, two elective subjects, and a master's thesis. A revised curriculum implemented in 1998 required students to take four compulsory subjects and four elective subjects (selected from a list of 17 subjects), and a master's thesis. Another major revision and a third curriculum was implemented just two years later in 2000. This latest curriculum has three compulsory subjects, six elective subjects (selected from a list of 27 subjects), plus a master's thesis. Also, eight areas of specialization are defined.

It was important to obtain feedback from potential employers as well as students and graduates during the rapid development of the information studies program at the Nanyang Technological University. Three questionnaires were developed to achieve this purpose: a survey of potential employers, a survey of students and graduates, and a survey of applicants for admission to the program. The analyses reported in this paper are based on the data from the students'/graduates' questionnaire and the applicants' questionnaire.

Literature Review

The debate on the issue of generalization versus specialization in the LIS curriculum is a long-standing one.³ Williams and Zachert provided a historical review of issues in the education of professionals for specialized areas in the LIS field, and argued that resistance in LIS programs to subject specializations and specializations in information science and information systems has caused the profession to be fractured into segments that rarely communicate with one another, and has limited the profession to a narrow portion of the work that it could be performing in the information society today.⁴

The resistance in LIS schools to specializations seems to be due, in part, to the lack of demand for specialized training from students, who are not well-informed about careers in the various specialties. Some evidence for this lack of student demand can be found in the survey by White and Mort.⁵ They surveyed 346 individuals (1980 graduates) of 13 LIS programs and found that geographic convenience was the primary criterion used by students in selecting a library school to attend, and this consideration was more important than perceptions of quality or availability of specialized courses in anticipation of certain careers. White and Mort also found that fewer than 50 percent of the graduates obtained the kind of job that they had expected on enrollment in library school and for which they had partially prepared. Nearly 50 percent of the respondents indicated that the elective

courses they took in library school were unimportant in getting them their first job. Students appear to have applied for positions for which they had not prepared for through course specialization, and employers also appear to hire new professionals without concern about specialized preparation.

White said that employers appeared to hire employees based on geographic availability, and many non-academic libraries would hire the first reasonable candidate.⁶ He concluded that concentrating on the general educational quality of LIS programs would be more useful than developing specializations.

However, the situation is changing. Pors reported that the private sector had, increasingly, been the main employer of graduates from the Danish Royal School of Librarianship.⁷ However, graduates had to compete with other professionals (such as teachers, economists, engineers, and marketing professionals) for these jobs, and the specializations chosen by students in the LIS program had an effect on job opportunities. The employment rate was lower for graduates who selected public-library oriented subjects than for those who specialized in subjects such as classification, indexing, bibliography, and information technology. However, Pors was not certain whether a specialist approach or a generalist approach in LIS education was more appropriate, since many of the new jobs were ill-defined jobs and were difficult to classify. It was also not clear whether graduates obtained their jobs because of their professional skills/qualifications, or because of their personalities, attitudes, and motivation.

Rehman and Myburgh found that, paradoxically, there is simultaneously a convergence and divergence in the LIS field.⁸ Myburgh noted that IT is convergent in nature. For example, all communication and computing technologies are coming together on the Internet. Similar kinds of IT are being used by all information professions, there is a corresponding convergence of information professions. Middleton stated that "the apparent convergence of information handling processes engendered by the technology has led to suggestions of an associated convergence of disciplines."⁹ Because of the technological convergence, the divisions between computer science, broadcasting, library science, and journalism are increasingly fuzzy and the fields are seen to overlap substantially.

The convergence of information professions suggests that there are areas that are common or fundamental to the information professions. Pemberton and Nugent identified the following areas of convergence in librarianship, archives, and records management:

- Information life-cycle concept
- Gatekeepers
- Information storage and retrieval
- Information representation
- Assistive and instructional roles
- Ethics
- Custodial and preservation concerns.¹⁰

Together with the convergence of formerly disparate fields, there is a divergence of specializations. Myburgh noted that a range of new information careers has appeared including knowledge managers and analysts, cybrarians, information brokers, corporate information managers, web masters, network navigators, information mappers and architects, etc.¹¹ LIS programs are offering courses in new disciplines and are defining new concentrations or specializations in their programs.

Cox and Rasmussen suggest that specialization offers the best way to orient students to the basic principles, theories, and issues of LIS, and that the core principles emerge better developed through specialization.¹²

Higgins and Khoo feel that information professionals can no longer be generalists.¹³ Information professionals have to be knowledgeable and competent in specialized areas to compete in the job market. In the past, the LIS program was designed to provide basic LIS education, and graduates were then expected to take entry-level positions in an organization (usually a library), and acquire experience and specialized professional knowledge on the job. However, in the current competitive market, fresh information professionals may not have the luxury of working in the collegial and protective environment of a library, but may have to work in isolation (they may be the only information professional in their organization) and compete with people from other backgrounds. Graduates of LIS programs have to be equipped to function immediately as competent professionals and hold their own in the marketplace.

The generalization versus specialization debate in LIS education continues to rage. Perhaps the right strategy for an LIS school to adopt is to strengthen the general LIS education as well as a small number of specializations. With the proliferation of new information professions, it is important to emphasize the basic principles and core areas of LIS and show that these underpin all the information professions. At the same time, each specialized area requires a peculiar set of knowledge and skills that are not important in other areas. In a job market where LIS graduates have to compete with graduates from other kinds of professional programs, the specialized skills should give them an edge—especially when applying for jobs in non-library settings. Furthermore, as Cox and Rasmussen have indicated, specialized subjects, when properly taught, strengthen students' understanding of the basic principles, theories, and issues of LIS.¹⁴

The situation today is quite different from the situation portrayed in the survey by White and Mort.¹⁵ At least in Singapore, LIS graduates no longer take jobs primarily in libraries. LIS students seem to have a clearer idea, at least broadly, of the kind of job they want: whether in the area of public libraries, school media centers, web-based information systems, or corporate information/knowledge management.

It is in this context that this study was carried out to identify clusters of students with similar subject interests, and to discover whether the "interest profile" of each cluster fits with particular specializations in the MSc (information studies) program at the Nanyang Technological University.

Research Method

Two sets of questionnaire data were analyzed: the first was from a survey of students and graduates of the program, and the second was a survey of applicants to the program.

The *students/graduates questionnaire* was mailed to about 300 students and graduates of the MSc (information studies) program in October 1998 to elicit their perceptions of the program. One of the questions asked the respondents to indicate four subjects that they “preferred” out of the list of 17 elective subjects offered in the curriculum. Eighty-nine people responded to the survey, giving a 30 percent return rate. The response rate was small, but the profile of the respondents broadly reflects the population profile in that about half the respondents indicated interest mainly in library science subjects and half indicated interest mainly in information technology and information management subjects. This is compatible with our estimate of the proportion of students in the program who are interested in work in a library and those who are not.

The *applicants questionnaire* was completed by 327 applicants who came for the admission test in April 2000. The applicants were asked to indicate one area of specialization (out of eight) and 6 elective subjects (out of 27) that “are of most interest” to them.

The Statistical Analysis System (SAS) software was used to cluster the respondents based on the subjects they selected—to identify clusters of people with similar interests, and the popular subjects for each cluster. An agglomerative hierarchical clustering method was used.¹⁶ The cluster analysis begins by treating each person as a cluster of one. At each stage in the clustering, the two closest clusters are merged into one cluster. This is done repeatedly, and more and more distant clusters are merged until only one large cluster remains.¹⁷ The clusters and sub-clusters thus form a hierarchical structure.

The analyst can specify the number of clusters to obtain—in which case the merging of clusters stop when the required number of clusters remain. Alternatively, the analyst can specify a threshold or maximum distance—in which case the merging of clusters stop when the two closest clusters exceed the threshold distance. In this study, at least four clusters were obtained and examined. More clusters were obtained if the additional clusters included at least five percent of the respondents.

There are many ways of calculating the distance between two clusters. The method used here was the average linkage method. To calculate the distance between two clusters, the distance between each person in the first cluster and every person in the second cluster is calculated. The average of these distances between pairs of persons, one from each cluster, is taken as the distance between the two clusters. This is one of the most commonly used clustering methods and generally gives good results compared to other methods.¹⁸

Three other clustering methods were tried: Ward’s minimum variance

method, the centroid method, and K-means iterative partitioning.¹⁹ The centroid method yielded one very large cluster and three singleton clusters, which were useless. Ward's method and K-means iterative partitioning tend to yield equal-sized clusters,²⁰ and this was found to be the case. As a result, these methods sometimes miss small but interesting clusters that are identified by the average linkage method. The average linkage method is able to identify clusters of different sizes. This is useful because only a small proportion of the applicants are interested in library science. Yet library science-related areas are at least as important to the mission of the program as information management and information technology-related areas.

The squared Euclidean distance was used as the distance measure between two persons. This is the default distance measure used by the cluster function in the SAS statistical software. In this study, the squared Euclidean distance between two persons is equivalent to the number of choices in which they differ. If Respondent 1 chooses subjects A, B, C, and D, and Respondent 2 chooses subjects C, D, E, and F, then the distance between them is four—the number of courses in which they differ.

Analysis 1: Students/Graduates Questionnaire

The cluster analysis of the data from the *students/graduates questionnaire* revealed two main clusters of students, which can be characterized as a *library-oriented cluster* and an *IT-oriented cluster*. The library-oriented cluster includes 58 percent (46) of the respondents and the IT-oriented cluster includes 42 percent (43). Table 1 gives the list of elective subjects and the percentage of the library-oriented and the IT-oriented respondents who selected each subject.

The following subjects were selected by both clusters of students (selected by at least 20 percent of each cluster):

1. Development of Internet services & products
2. Developing corporate information systems
3. Management of information agencies
4. Business information sources & services

They are *inter-cluster subjects* in the sense that they were of interest to both clusters of students.

In addition to the above four inter-cluster subjects, students in the library-oriented cluster also selected the following subjects (with at least 20 percent selecting each subject):

1. Collection development & management
2. Evaluation of information services & products
3. Bibliographic organization

Table 1
The Number and Percentage of People Selecting Each Subject Overall, in the IT-Oriented Cluster
and in the Library-Oriented Cluster

Subject	Overall (n=89)		IT Cluster (n=43)		Library Cluster (n=46)	
	No.	%	No.	%	No.	%
Development of Internet Services & Products	39	44%	27	63%	12	26%
Developing Corporate Information Systems	31	35%	22	51%	9	20%
Management of Information Agencies	28	31%	10	23%	18	39%
Business Information Sources and Services	27	30%	13	30%	14	30%
Collection Development & Management	28	31%	0	0%	28	61%
Evaluation of Information Services & Products	26	29%	1	2%	25	54%
Bibliographic Organization	21	24%	3	7%	18	39%
Computer Programming for Information Professionals	22	25%	19	44%	3	7%
Intelligent Information Systems	20	22%	17	40%	3	7%
System Analysis and Interface Design	18	20%	17	40%	1	2%
Information Retrieval Systems	15	17%	9	21%	6	13%
Database Management Systems	14	16%	11	26%	3	7%
Research Methods in Information Studies	16	18%	4	9%	12	26%
Children's Information Sources and Services	15	17%	3	7%	12	26%
Client-Centered Library Services	13	15%	2	5%	11	24%
Conservation of Information	12	13%	3	7%	9	20%
Data Communication and Networking	12	13%	9	21%	3	7%

Note: Percentages of 20% and above are indicated in bold

4. Research methods in information studies
5. Children's information sources and services
6. Client-centered library services
7. Conservation of information

These can be considered library-oriented subjects.

Students in the *IT-oriented cluster* selected the following subjects (with at least 20 percent selecting each subject):

1. Computer programming for information professionals
2. Intelligent information systems
3. System analysis and interface design
4. Information retrieval systems
5. Database management systems
6. Data communication and networking

Clearly, these are IT-oriented subjects.

The library-oriented and IT-oriented clusters can be divided into sub-clusters. The sub-clusters are shown in Table 2 together with the subjects selected by each sub-cluster. In this table, the subjects are re-arranged into three main areas, IT-oriented subjects, library-oriented subjects, and inter-cluster subjects.

Within the library-oriented cluster, the following four sub-clusters could be discerned:

1. LIB1—*Collection management cluster* (28 percent of the total 89 respondents). Most of these chose the collection development & management subject plus a range of library science subjects.
2. LIB2—*Children and public library services cluster* (10%). These chose courses on children's information sources & services, client-centered library services (i.e., public library services), evaluation, and collection development.
3. LIB3—*Management, evaluation, and research cluster* (9%) chose courses on management, research methods, and evaluation.
4. LIB4—*Business information, conservation, and networking cluster* (5 percent) chose courses on business information, data communication and networking, and conservation of information.

LIB3 and LIB4 clusters each have eight or fewer members, and should be considered tentative. Indeed these two clusters don't seem to have a clear focus and exhibit a mixture of subject interests.

The largest library-oriented sub-cluster was focused on collection management. Collection management is a known specialization in LIS. Johnson traced its evolution into a specialization, and Budd and Brill have identified the competencies that are important in this specialization.²¹

Table 2
IT and library sub-clusters, and percentage selecting each subject

Area	Subject	IT Sub-clusters			Library Sub-clusters			
		IT1* (n=16) %	IT2 (n=21) %	IT3 (n=6) %	LIB1 (n=25) %	LIB2 (n=9) %	LIB3 (n=8) %	LIB4 (n=4) %
IT	Computer Programming for Information Professionals	63	24	67	8	0	13	0
IT	Intelligent Information Systems	63	33	0	4	0	25	0
IT	System Analysis and Interface Design	56	29	33	4	0	0	0
IT	Database Management Systems	56	10	0	12	0	0	0
IT	Information Retrieval Systems	19	0	100	8	44	0	0
IT	Data Communication and Networking	31	19	0	0	0	0	75
Inter-cluster	Development of Internet Services & Products	50	81	33	32	33	0	25
Inter-cluster	Developing Corporate Information Systems	13	95	0	28	0	25	0
Inter-cluster	Business Information Sources and Services	6	48	33	40	0	13	75
Inter-cluster	Management of Information Agencies	0	38	33	44	0	88	0
Library	Conservation of Information	13	0	17	20	0	13	75
Library	Client-Centered Library Services	6	5	0	16	67	13	0
Library	Children's Information Sources and Services	0	5	33	16	78	13	0
Library	Research Methods in Information Studies	6	14	0	0	33	88	50
Library	Bibliographic Organization	0	0	50	52	33	25	0
Library	Evaluation of Information Services & Products	6	0	0	44	67	88	25
Library	Collection Development & Management	0	0	0	88	67	0	0

* Note: Percentages of 50% and above are indicated in bold

IT1—Pure IT cluster

IT2—Business IT cluster

IT3—Information retrieval cluster

LIB1—Collection management cluster

LIB2—Children and public library services cluster

LIB3—Management, evaluation & research cluster

LIB4—Business information, conservation and networking cluster

The IT-oriented cluster contains the following three sub-clusters:

1. IT1—*Pure IT cluster* (18%). These students selected a range of IT subjects.
2. IT2—*Business IT cluster* (24%). Their subject choices are focused on corporate information systems, the Internet, and business information.
3. IT3—*Information retrieval cluster* (6%). These students selected courses on information retrieval, computer programming, and bibliographic organization.

One of the questions asked whether it was worth the time and effort taking the MSc (information studies) program. Sixty-two percent of the respondents indicated it was worthwhile. What was interesting was that 70 percent of the library-oriented cluster indicated it was worthwhile, whereas only 53 percent of the IT-oriented cluster found it worthwhile. However, a Chi-square test of independence did not find a significant relationship between membership in a cluster and whether the student found the program worthwhile.

Analysis 2: Applicants' Questionnaire

The second analysis was based on data from a questionnaire administered to applicants to the MSc (information studies) program. This group of respondents was somewhat different from the group of students and graduates surveyed earlier. Applicants are admitted to the program after an admission test and an interview, not just to select the best applicants, but also to assess the fit between the students' aspirations and the program. Some applicants have the mistaken impression that the program is a computer science program or a technical IT program. Such applicants are "weeded out" during the interview.

The cluster analysis of the data again revealed two distinct clusters of applicants—one cluster (14 percent of the applicants) is clearly *library-oriented* and the other cluster (86%) is oriented towards *IT and information management* (IT/IM). Clearly, the department has been very successful in selling its program as an IT-intensive and information management program. Table 3 gives the list of elective subjects, and the number of applicants in each cluster who selected each subject.

The following are inter-cluster subjects selected by both clusters of students (selected by at least 20 percent of each cluster):

- Electronic commerce
- Internet and web technologies
- Web-based information systems
- Database management systems
- Information management
- Multimedia information systems

Table 3
The Number and Percentage of People Selecting Each Subject Overall, in the IT/Information Management-Oriented Cluster and in the Library-Oriented Cluster

Subject	Overall (n=327)		IT/IM Cluster (n=280)		Library Cluster (n=47)	
	No.	%	No.	%	No.	%
Electronic Commerce	222	68%	205	73%	17	36%
Internet and Web Technologies	204	62%	188	67%	16	34%
Web-Based Information Systems	178	54%	165	59%	13	28%
Data Communication and Networking	157	48%	150	54%	7	15%
Database Management Systems	156	48%	143	51%	13	28%
Business Information Systems, Services and Sources	131	40%	126	45%	5	11%
Computer Programming for Information Professionals	109	33%	104	37%	5	11%
Information Management	105	32%	90	32%	15	32%
Multimedia Information Systems	103	31%	93	33%	10	21%
Knowledge Management	86	26%	81	29%	5	11%
Systems Analysis and Design	75	23%	75	27%	0	0%
Information Mining Analysis	47	14%	44	16%	3	6%
Digital Libraries	47	14%	20	7%	27	57%
Intelligent Information Systems	39	12%	39	14%	0	0%

(continued)

Table 3 (continued)
The Number and Percentage of People Selecting Each Subject Overall, in the IT/Information Management-Oriented Cluster and in the Library-Oriented Cluster

Subject	Overall (n=327)		IT/IM Cluster (n=280)		Library Cluster (n=47)	
	No.	%	No.	%	No.	%
Knowledge-Based Organizations	38	12%	35	13%	3	6%
Academic and Research Libraries	33	10%	6	2%	27	57%
Collection Development and Management	33	10%	12	4%	21	45%
Information Organization	32	10%	26	9%	6	13%
Cataloging and Classification	28	9%	7	3%	21	45%
Information Retrieval Systems	27	8%	18	6%	9	19%
Human Computer Interaction	24	7%	21	8%	3	6%
Archives and Records Management	21	6%	12	4%	9	19%
Library Services for Children and Young Adults	17	5%	2	1%	15	32%
Public Libraries	17	5%	1	0%	16	34%
School Media Resource Centers	17	5%	3	1%	14	30%
Investigative Methods for Information Studies	9	3%	8	3%	1	2%
Imaging and Document Management	6	2%	5	2%	1	2%

Note: Percentages of 15% and above are indicated in bold.

In addition, applicants in the *library-oriented cluster* selected the following subjects (with at least 30 percent selecting the subject):

- Digital libraries
- Academic and research libraries
- Collection development and management
- Cataloging and classification
- Library services for children and young adults
- Public libraries
- School media resource centers

These are clearly library-oriented subjects.

Applicants in the *IT/IM-oriented cluster* selected the following subjects in addition to the inter-cluster subjects (with at least 30 percent selecting each subject):

- Data communication and networking
- Business information systems, services, and sources
- Computer programming for information professionals

In addition, a high percentage of the cluster selected the inter-cluster subjects—which happen to be IT-oriented.

Within each of the main clusters, two sub-clusters were found, listed in Table 4. Within the library-oriented cluster, the following two sub-clusters could be discerned:

1. A *library service cluster* (3 percent of the total 327 respondents). This cluster of applicants selected a wide range of subjects. Popular subjects in decreasing order of popularity are information management, public libraries, academic and research libraries, school media resource centers, information organization, collection development and management, library services for children and young adults, and multimedia information systems (with at least 40 percent of the cluster choosing each subject).
2. A *digital library cluster* (11%). Subjects chosen in decreasing order of popularity are digital libraries, academic and research libraries, cataloging and classification, collection development and management, electronic commerce, and Internet and web technologies.

The library service cluster is very small, comprising just 3 percent of the applicants. On the other hand the digital library is of a respectable size (11%).

The IT/IM-oriented cluster contains the following two sub-clusters:

1. An *IT cluster* (77%) with emphasis on electronic commerce and Internet technology. This cluster selected subjects on electronic commerce, Internet

Table 4
Sub-Clusters, and Percentage Selecting Each Subject

Subject	IT/IM sub-clusters			Library sub-clusters		
	IT (n=253) %	Knowledge management (n=27) %		Library service (n=10) %	Digital library (n=37) %	
Academic & Research Libraries	2	0		60	57	
Archives & Records Management	4	4		0	24	
Business Information Systems, Services & Sources	45	41		20	8	
Cataloging & Classification	2	11		0	57	
Collection Development & Management	4	4		40	46	
Computer Programming for Information Professionals	41	0		0	14	
Data Communication & Networking	59	0		0	19	
Database Management Systems	56	7		20	30	
Digital Libraries	6	19		20	68	
Electronic Commerce	77	33		20	41	
Human Computer Interaction	7	11		10	5	
Imaging & Document Management	1	11		0	3	
Information Management	30	52		80	19	

(continued)

Table 4 (continued)
Sub-Clusters, and Percentage Selecting Each Subject

Subject	IT/IM sub-clusters		Library sub-clusters	
	IT (n=253) %	Knowledge management (n=27) %	Library service (n=10) %	Digital library (n=37) %
Information Mining & Analysis	13	44	0	8
Information Organization	5	48	50	3
Information Retrieval Systems	6	11	30	16
Intelligent Information Systems	12	33	0	0
Internet & Web Technologies	71	30	10	41
Investigative Methods for Information Studies	1	19	0	3
Knowledge Management	23	89	20	8
Knowledge-Based Organizations	8	59	10	5
Library Services for Children & Young Adults	0	4	40	30
Multimedia Information Systems	34	26	40	16
Public Libraries	0	4	70	24
School Media Resource Centers	1	0	50	24
Systems Analysis & Design	28	11	0	0
Web-Based Information Systems	62	33	10	32

and web technologies, web-based information systems, data communication and networking, database management systems, business information, and computer programming (in decreasing order of popularity, but all above 40 percent).

2. A *knowledge management cluster* (8%), where subject choices are focused on knowledge management, knowledge-based organizations, information management, information organization, information mining, and business information.

It is interesting to find that the *knowledge management cluster* is closer to the IT cluster than the *library service* or *digital library cluster*.

The IT cluster is disproportionately large. The cluster was examined to see if it could be further divided into sub-clusters. Dividing it into sub-clusters yields one very big sub-cluster and other very small sub-clusters comprising less than 5 percent of the total number of respondents. The researchers concluded that it would not be useful to divide the IT cluster into further sub-clusters.

The *applicants questionnaire* had also asked the respondents to select an area of specialization (out of 8 specializations listed). Table 5 lists the specializations and the percentage of each cluster selecting a specialization.

Not surprisingly, 52 percent of the IT cluster selected the *Internet & multimedia-based information services* specialization. However, 28 percent of the IT cluster selected the *information systems & products development* specialization. This suggests that these two specializations are not very distinct from each other. Applicants with the same subject interests may opt for either specialization. These two specializations should perhaps be merged.

The majority of the applicants in the *knowledge management* cluster selected the knowledge management specialization, but 15 percent selected the *Internet & multimedia-based information services* specialization. The library service cluster is split between the *public libraries* and the *school libraries & media resources* specializations. However, the numbers are so small that this conclusion must be tentative.

The digital library cluster is split between the *school libraries & media resources* and the *Internet & multimedia-based information services* specializations. At first review, this suggests that the *school libraries & media resources* specialization should be combined with the *Internet & multimedia* specialization. However, as mentioned earlier, the *school libraries & media resources* specialization also figures prominently in the library service cluster, suggesting that the *school libraries & media resources* specialization represents an overlap between the library service and digital library clusters. Perhaps the number of applicants interested in *school libraries & media resources* is too small to exist as a separate cluster. Indeed the small number of school libraries and media applicants is a matter of concern in the program.

Table 5
Areas of Specialization, and the Number of People and Percentage of Cluster Selecting Each Specialization

Area of Specialization	Clusters											
	IT (n=253)			Knowledge management (n=27)			Library service (n=10)			Digital library (n=37)		
	No.	%	No.	%	No.	%	No.	%	No.	%		
Academic libraries	1	0%	0	0%	1	10%	2	5%				
Corporate information services	5	2%	3	11%	0	0%	1	3%				
Public libraries	0	0%	0	0%	2	20%	5	14%				
School libraries & media resources	1	0%	0	0%	4	40%	12	32%				
Document & records management	4	2%	2	7%	0	0%	1	3%				
Information systems & products development	72	28%	3	11%	1	10%	0	0%				
Internet & multimedia-based information services	132	52%	4	15%	1	10%	9	24%				
Knowledge management	32	13%	15	56%	0	0%	1	3%				
Not decided	6	2%	0	0%	1	10%	6	16%				

Focusing on the areas of specialization, the *Internet & multimedia-based information services* specialization figures prominently in two clusters—the IT cluster and the digital library cluster. This suggests that there were two groups of people who selected the Internet specialization: one group was mainly interested in E-commerce and IT, and a second (albeit much smaller) group was interested in digital libraries. Perhaps the Internet specialization should be divided into a *digital libraries* specialization and a *Web-based information systems & E-commerce* specialization.

As mentioned earlier, the *school libraries & media resources* specialization figure prominently in two clusters—the library service cluster and the digital library cluster. Applicants who were interested in school libraries seemed to have two kinds of perception about the school library—as a library service and as an electronic library. For the *public libraries* specialization, two persons are found to be in the library service cluster whereas five are in the digital library cluster. These results argue for a separate *digital libraries* specialization. Some applicants who selected the academic libraries, public libraries, school libraries, and the Internet specializations might have opted for a *digital libraries* specialization had it been available.

The data also suggest that the academic libraries, public libraries, and school libraries specializations can be consolidated into a unified *library services* specialization, since the people selecting them do not form separate clusters. Finally, it is surprising that although 10 percent of the respondents selected the subject *academic & research libraries*, only 1 percent selected the *academic libraries* specialization.

Discussion and Conclusion

In summary, cluster analyses were performed on two sets of data—from a questionnaire survey of students and graduates of an MSc (information studies) program, and from a survey of applicants for admission to the program. The respondents were clustered based on the elective subjects that they selected in the questionnaires.

For both sets of data, two distinct clusters were found—a *library-oriented cluster* and a non-library cluster that is oriented toward IT and information management. The faculty have long viewed students as being divided into two groups—those who want to work in libraries and those who don't. However, the faculty did not know whether this was just a biased worldview of librarians. The researchers were thus somewhat surprised to find this view confirmed by the questionnaire data, and to find the library/nonlibrary dichotomy reflected in the students' and applicants' subject interests. The two main clusters can be divided into sub-clusters, which correspond to known specializations in the field.

The profile of each of the clusters and sub-clusters were examined in

terms of the subjects selected. The set of subjects selected by each cluster and sub-cluster make sense and appear related, and there was little difficulty assigning a label to each sub-cluster. This provides some indication that the clusters found are valid.

The relationship between the clusters of applicants and their choice of specializations were also examined. The data suggest that the two specializations, *information systems & products development* and *Internet & multimedia-based information services*, are not distinct and should be merged and renamed *web-based information systems and E-commerce* to reflect the overwhelming interest in E-commerce. The data also indicate that there should be a new specialization in *digital libraries*. Furthermore, the specializations in academic libraries, public libraries, and school libraries can be consolidated into a unified *library services* specialization, since the people selecting them do not form separate clusters.

It should be noted that cluster analysis data provide only one set of criteria to be considered when defining areas of specializations in an LIS program. Other criteria have been listed earlier in the paper that should also be taken into consideration.

Cluster analysis is basically an exploratory data analysis technique. The technique can yield different clusters depending on the type of clustering technique used, the distance measure used, the subject titles listed, how the respondents interpret the subject titles (which depends on the respondents' background), etc. In this study, two different lists of subjects were used and two quite different populations were sampled—applicants and students/graduates. The fact that both data sets yielded a library-oriented and a non-library cluster suggests that these two clusters are robust and replicable, at least in Singapore. However, the two data sets yielded different sub-clusters.

Subsequent to this study, the same questionnaire was administered to the next batch of applicants in April 2001. The cluster analysis yielded the following clusters: information technology cluster, information management cluster, library cluster, and school library cluster. Partly because of these results, the division developed a separate master's program in knowledge management, which admitted its first batch of students in 2002. A separate master's program in information systems is also being planned.

In conclusion, the cluster analyses of students, graduates, and applicants based on their subject interests have yielded useful results, given the faculty a better understanding of student interests and how these interests are structured, and indicated how the areas of specialization defined in the program can be reoriented and improved. Similar studies should be carried out by other LIS schools in other countries to determine to what extent the subject interests of LIS students vary in different countries and different schools. The researchers' hypothesis is that similar results will be obtained for other LIS schools which have non-traditional, IT-oriented or information management-oriented programs.

References and Notes

1. The terms "subject" and "course" are used interchangeably in this paper.
2. There is also a program for paraprofessionals at the Temasek Polytechnic (a type of community college).
3. Robert Williams, "Specialization in the Education of Information Professionals," in *Encyclopedia of Library and Information Science*, Alan Kent, ed. (New York: Marcel Dekker, 1990), vol. 45, suppl. 10, 339–59.
4. Robert V. Williams and Martha Jane K. Zachert, "Specialization in Library Education: A Review of Trends and Issues," *Journal of Education for Library and Information Science* 26 (1986): 215–32.
5. Herbert S. White and Sarah L. Mort, "The Accredited Library Education Program as Preparation for Professional Library Work," *Library Quarterly* 60, no. 3 (1990): 187–215.
6. Herbert S. White, "Generalization Versus Specialization in the MLS," *Library Journal* 113 (1988): 148–49.
7. Niels Ole Pors, "The Changing Labour Market of the Information Professional: Challenges for Library School Education," *Librarian Career Development* 2, no. 3 (1994): 14–21.
8. Sajad ur Rehman, "Preparation of Information Professionals: Strategies and Directions," *Singapore Journal of Library & Information Management* 29 (2000): 1–15; and Sue Myburgh, "Education for Library and Information Science, a Means to an End, Not an End in Itself," *Singapore Journal of Library & Information Management* 29 (2000): 16–30.
9. Michael Middleton, "Differences in Implementation of Programs for the Education of Information Professionals with Reference to Models Developed by Professional Associations," in *47th FID Conference and Congress, FID/ET Seminar, Omiya, Japan, October, 1994*. Available at: http://sky.fit.qut.edu.au/~middletm/contrib/fid_et.html. Accessed Jan. 9, 2003.
10. J. Michael Pemberton and C.R. Nugent, "Information Studies: Emergent Field, Convergent Curriculum," *Journal of Education for Library and Information Science* 36 (1995): 126–38.
11. Myburgh, "Education for Library and Information Science."
12. Richard J. Cox and Eddie Rasmussen, "Reinventing the Information Professions and the Argument for Specialization in LIS Education: Case Studies in Archives and Information Technology," *Journal of Education for Library and Information Science* 38, no. 4 (1997): 255–67.
13. Susan E. Higgins and Christopher S.G. Khoo, "Exploring Cross-Cultural Issues in Information Studies Education in Southeast Asia and the Pacific," in *66th IFLA Council and General Conference: Conference Programme and Proceedings* (The Hague: International Federation of Library Associations, 2000). Available at: <http://www.ifla.org/IV/ifla66/66cp.htm>. Accessed Jan. 9, 2003.
14. Cox and Rasmussen, "Reinventing the Information Professions."
15. White and Mort, "The Accredited Library Education Program."
16. Mark S. Aldenderfer and Roger K. Blashfield, *Cluster Analysis* (Series: Quantitative Applications in the Social Sciences, no. 44) (Beverly Hills, CA: SAGE Publications, 1984).
17. H. Charles Romesburg, *Cluster Analysis for Researchers* (Belmont, CA: Lifetime Learning Publications, 1984).
18. *Ibid.*; and *SAS/STAT User's Guide*, version 6, 4th ed. (Cary, NC: SAS Institute, 1990), 56.
19. J. Ward "Hierarchical Grouping to Optimize an Objective Function," *Journal of the American Statistical Association* 58 (1963): 236–44; *SAS/STAT User's Guide*, vol. 1, chapt. 18; R.R. Sokal and C.D. Michener, "A Statistical Method for Evaluating Systemic Relationships," *University of Kansas Science Bulletin*, 38 (1958): 1409–38; Michael R. Anderberg,

Cluster Analysis for Applications (New York: Academic Press, 1973); and Jiawei Han and Michelle Kimber, *Data Mining: Concepts and Techniques* (San Francisco: Morgan Kaufmann, 2001, Chapt. 8.

20. Aldenderfer and Blashfield, *Cluster Analysis*.
21. Peggy Johnson, "Evolution of a Specialization from Selection to Collection Development and Management," *Technicalities* 19, no. 8 (1999): 1, 8–10; and John M. Budd and Patricia L. Bril, "Education for Collection Management: Results of a Survey of Educators and Practitioners," *Library Resources & Technical Services* 38, no.4 (1994): 343–53.