CD-ROM Search Techniques of Novice End-Users: Is the English-as-a-Second-Language Student at a Disadvantage?

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This study compared the CD-ROM search techniques of 42 undergraduate native speakers (NS) of English with those of 34 undergraduate English-as-a-Second-Language (ESL) speakers in a controlled experiment. Native speakers were significantly more likely to use plural word forms when searching and to experiment with synonyms and alternative words to search for topics. Both groups of students underutilized basic search techniques, such as Boolean operations and indexing, and searched inefficiently. These findings suggests that bibliographic instruction targeted for ESL students can focus on techniques that circumvent difficulties with plurals and limited vocabulary. General bibliographic instruction in CD-ROM usage can address the other problems that ESL students share with novice users in general.

he introduction of computerized bibliographic retrieval systems into academic libraries has brought profound changes affecting library users, staff, service policies, and budgets. Newly empowered end-users can access databases from within traditional library settings or from remote sites. This emerging body of diverse users is now accessing a widening variety of electronic databases. With this empowerment come new constraints—each particular database's interface design and help screens are constant for everyone, regardless of the user's research needs and skills.

The explosion of access to computerized retrieval coincides with the continuing increase of international students (students in the United States on visas) attending American institutions of higher education. While bachelor's degrees earned by American students increased by only 10 percent between 1977 and 1989, students here on visas earned 72 percent more degrees during that same time period.[1] In addition to students on visas, the 1990 Census statistics for New York City, where this study took place, indicate a continued increase in the city's foreign-born population. In 41 percent of homes in New York City a language other than English is spoken; this represents a 19 percent increase since 1980.[2] Baruch College of the City

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University of New York reflects the increasingly diverse population of a multicultural urban public institution of higher education. Within its population of 16,000 students, international students (on visas) make up 12 percent of the student body, and more than half of the 1991 and 1992 freshman classes come from homes where a language other than English is spoken.[3,4] Four-fifths of the incoming freshmen come from families in which neither parent is a college graduate.[5] These statistics suggest that students are entering college from a multitude of economic, social, cultural, and educational backgrounds, and some may have limited English proficiency (LEP).

Some search mechanisms, such as Boolean operations, proximity relationships, and word indexing, are basic tools in successful retrieval. Other search techniques rely much more on the user's language skills. These include synonym searching, pluralization, compound words, and variant spellings. The extent of one's vocabulary is a prime component in the process of preparing search strategies in text-based databases. With the increasing reliance on self-service databases, ESL students may be at a disadvantage in using information resources. By identifying specific problems that ESL students encounter, librarians can focus bibliographic instruction for them in these areas.

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This study was a simulation experiment comparing the search strategies of 76 novice users divided into native English speaking (NS) ($N = 42$) and English-as-a-Second Language (ESL) ($N = 34$) groups with particular attention to vocabulary-based strategies. The search topic replicated a typical research assignment given in a required speech or English course. The search results were analyzed for significant differences based on whether the user was a native English speaker or an ESL student. These differences in formulating CD-ROM searches could affect bibliographic and technical instruction for these groups of students.

LITERATURE REVIEW

While the language-diversified student body at Baruch is not unique to an urban, public campus, few studies exist in the literature that focus on the relationship of ESL to search strategy vocabulary, with particular emphasis on novice users. The literature in this broad area of CD-ROMs, English-as-a-Second-Language, and international students generally contains self-reported user surveys, samples of user populations with very diverse levels of skill, and reports of international students' use of the academic library primarily focusing on cultural aspects.

The research literature investigating CD-ROM users and interface design supports what we know from years of experience in academic libraries. College students generally prefer to use CD-ROMs for speed and ease of use.[6] A large percentage of users in self-reporting studies are satisfied with their search results, regardless of precision.[7] Self-reported satisfaction with results is not an objective measure; user satisfaction does not have a high correlation with commonly accepted recall and precision evaluation measures nor with the quality of citations.[8,9]

Human-computer interactions, system inefficiencies, and syntactic and semantic problems continue to exist in information retrieval.[10] Additionally, other tasks, such as formulating search strategies with correct vocabulary and Boolean connectors, transferring/learning commands from one system to another, and understanding keyword capabilities present serious obstacles to users.[11]

These studies offer important insights into the overall user population in regard to CD-ROM database searching. Nonetheless, we must consider specific campus populations and survey techniques before generalizing from the con-

clusions of these studies. These studies may not be representative of an urban, multicultural student population, nor do they differentiate the goals of the novice undergraduate searcher from those of the graduate student and academic researcher. Additionally, the survey studies utilize self-reporting instruments that measure only post hoc user attitudes and opinions. These surveys exercise little control over the type of search the user required, and there is typically no control data against which we can compare the results.[12]

Other studies that focus on novice users typically recruit subjects who are already enrolled in Information Science courses. Because these courses feature instruction and practice with computerized databases, the external validity of these studies is weak. The information science student may not be representative of the novice undergraduate user with no previous instruction.[13]

Issues relating to CD-ROM training and the needs of both graduate and undergraduate students have been documented. In a study exploring CD-ROM training needs, 89 inexperienced undergraduates attending bibliographic instruction classes at the University of Illinois' Champaign-Urbana campus rated one-to-one training as the most valuable form of instruction, especially with regard to the development of search strategy and Boolean logic.[14] This is an unsurprising finding, but few institutions can afford such an approach. Elsewhere, the development and use of computer programs that teach the use of CD-ROM tools have been proposed, specifically because individualized instruction is labor-intensive.[15] Despite vendors' claims of user-friendly systems and the self-reported user satisfaction with CD-ROMs, there is a consensus among information science professionals that relevance of citations and search speed improve with training.[16]

International and ESL students in the academic library have been the focus of considerable attention, mostly centered on language and cultural differences apparent at the reference desk or in a bibliographic instruction setting. Suggestions for improving service include greater sensitivity, alertness, empathy, and understanding of these differences by all library staff and faculty, library orientation in native languages, staff development workshops, translations of library procedures, rules, and terminology into students' native languages, and bibliographic instruction and orientation specifically for international graduate students.[17-21] Nevertheless, little mention is made of ESL students' use of CD-ROMs, especially with regard to language facility (i.e., pluralization, synonyms, alternative spellings or compound words), use of the Boolean operators *and* and *or*, and general searching strategies and techniques. These skills are critical in retrieving information successfully from CD-ROMs.

EXPERIMENTAL DESIGN

The basic experiment compared the search techniques of a group of English-as-a-Second-Language (ESL) undergraduate users ($N = 34$) to the techniques used by a group of native English-speaking (NS) undergraduate users ($N = 42$). Search strategies and retrieval results were printed out and analyzed by all three authors using standardized measurements devised through pretesting.

The Subjects

All participants were undergraduate novice users enrolled in four sections of an introductory course in Business Computer Information Systems taught by one of the authors. Each student had limited online search retrieval experience using the Boolean *and* with Baruch's online public access catalog, CUNY+.

The average age of the subjects was twenty-two years; 45 (59 percent) were female and 31 (41 percent) male. The participants reported little experience with CD-ROMs, with more than 65 percent having no previous experience. The ESL group and NS group were fairly evenly matched in terms of ages, gender, and previous CD-ROM experience (table 1). Additionally, the final grades from

TABLE 1
DEMOGRAPHIC CHARACTERISTICS OF THE SUBJECTS

Characteristic	Native Speakers		ESL Speakers		Pooled	
	N	%	N	%	N	%
Sample size	42	55.3	34	44.7	76	100.0
CIS course mean grade		86.0		84.7		85.4
CD-ROM experience						
Mean response	0.55		0.56		0.55	
0 = never	29	69.0	21	61.8	50	65.8
1 = 1 or 2 times	7	16.7	8	23.5	15	19.7
2 = 3 to 5 times	2	4.8	4	11.8	6	7.9
3 = 6 or more times	4	9.5	1	2.9	5	6.6
ESL student's native language						
Spanish			11	32.4		
Chinese/Korean/Japanese			13	38.2		
European			5	14.7		
Other Asian			5	14.7		

Note: All percentages are columnwise.

the CIS course were compared to ensure that academic ability was not a confounding factor.

Sixty-three percent were first- and second-year undergraduates. Sixty-seven percent of the two samples received their high school diplomas in this country; of those 21 percent were ESL students. Of the 34 students who indicated that English was not their first language, 13 (38 percent) spoke Chinese, Korean, or Japanese, 11 (32 percent) were Spanish-speaking, 5 (15 percent) spoke other European languages, and 5 (15 percent) spoke other Asian (e.g., Urdu, Vietnamese) languages.

The Search

The study took place at Baruch Library's Graduate Business Resource Center, a small electronically based center where conditions were easily controlled. The subjects were instructed to search the topic "Who takes care of the children when the parent is at work?" in the journal database of SilverPlatter's PsycLit. Written information was presented so that students would consider searching for abstracts including concepts such as *day care* or *child care*, and *working mothers* or *working fathers*. The

experiment's instructions excluded any hints which might lead the student to use a specific search technique with specific topics, such as the use of Boolean operators.

Several criteria led to the development of this search problem. The experiment's search topic was representative of a typical essay assignment given to undergraduates. Second, the topic afforded opportunities to use Boolean operations with the intersection of some concepts (employment, child care, parenting) and the union of others (day care or child care). PsycLit provided some implicit intersection and union operations, but the subject could improve search effectiveness by using the Boolean operators *and* and *or*.

In an attempt to replicate the autonomous searching experiences one may encounter in a busy library, individual assistance was not offered. The subjects received the American Psychological Association's PsycLIT Quick Reference Guide of June 1992, which is available to all users.[22] Upon completion of the search, participants filled out questionnaires soliciting basic demographic information as well as language background and previous CD-ROM usage experience. This questionnaire was filled out

afterward so that if a student realized that the experiment was examining searches based on language background, it would be too late for this realization to affect those searches.

After data collection, the authors evaluated the search histories and citations, using a carefully designed set of measurements. Some of the major factors analyzed included: (1) language-based techniques such as plurals, synonyms, alternative concepts for *caretaker* such as *babysitter* or *grandparent*, keywords, variant spellings, descriptors; (2) procedural techniques such as correct and incorrect employment of Boolean connectors with vocabulary or previous search sets or indexing; and (3) effectiveness and efficiency measures, such as the ratio of the relevant citations compared to total number selected and the use of previous search set numbers. The subjects' use of the concepts of employment, parenting, or child care in their searches received particular scrutiny.

Selection of the Database

The subjects searched SilverPlatter's PsycLIT CD-ROM because this database permitted several observations. It allowed the examination of vocabulary usage in the context of a text-based database. Recorded search histories provided data for examining techniques such as pluralization of keywords, Boolean operators, proximity connectors, field searching, truncation, and use of the thesaurus and word index. Since some Asian languages do not offer different words for singular and plural meanings, the database's absence of automatic pluralization proved useful to this study.

Statistical Methods

Because the sample sizes of both groups were greater than 30, parametric two-sample testing was used in comparing quantitative variables; chi-square evaluations were used for categorical data. A significance level of .05 was selected. STATGRAPHICS Version 5.0 was the statistical package used for the data analyses.

ANALYSIS AND DISCUSSION

An examination of the search steps indicated that many students in both groups encountered similar difficulties in searching effectively and efficiently. Many basic features available in the PsycLIT database were not used by these novice searchers. Whereas some features (permuted thesaurus, field searching) may be too advanced for casual users, other features such as Boolean operators, search modification, and pluralization remain essential elements of computerized searching.

Search Results

Table 2 illustrates measures for the search results. The measures fall into two areas: the number of subsearches (the individually searched terms or phrases) performed and utilized in the overall search statement; and the ratios of the targeted search topics to the number of citations finally utilized.

TABLE 2
MEASURES OF SEARCH RESULTS

Characteristic	English Group Mean	sd	ESL Group Mean	sd	Pooled Mean	sd	p <
Number of subsearches	10.14	9.57	7.82	6.69	9.11	8.51	
Number of used subsearches	2.45	1.94	1.50	.93	2.03	1.57	.02
Ratios of topics-to-citations							
No. of employment citations/ all citations	.67	.38	.59	.45	.63	.42	
No. of parenting citations/ all citations	.75	.35	.70	.43	.72	.39	
No. of childcare citations/ all citations	.76	.34	.68	.44	.72	.39	

There was no difference between the NS and ESL subjects in the total number of subsearches they performed for their entire searches. Native English-speaking users, however, selected their citations from a greater number of their subsearches ($M = 2.45$ subsearches) than did ESL students ($M = 1.5$ subsearches), $t = 2.63$, $p < .02$. It is possible that ESL students selected a lower number of subsearches because of language difficulties in interpreting the instructions or capabilities of the CD-ROM system.

The ratios for the citations relevant to specific search topics to the total number of selected citations were calculated. These measured the precision of the subjects' selected citations. Although the ESL students had lower ratios, the differences between the groups were not significant.

Vocabulary-based Measures

There were significant differences in techniques that related most directly to vocabulary skills. The findings are grouped in three areas.

Use of Singular versus Plural Word Forms. Native English-speaking users were significantly more likely to use plural word forms, X^2 $(1, N = 76) = 10.09$, $p < .002$, when searching (table 3). This increased the number of hits these subjects found for the search topic. Another aspect of this issue that showed a significant difference was the *dangling singular*. This term refers to a subject's use of a singular term without using the corresponding plural form in another subsearch, thus limiting search results. On the "parenting" search term that the majority of subjects used—*mother/mothers*—the ESL group was more likely to use only the singular *mother* without the plural *mothers* when searching, X^2 $(1, N = 76) = 8.05$, $p < .005$. This limited the number of citations that PsycLIT found.

This phenomenon had a significant impact on the searches in several cases. PsycLIT recalls only those citations that use the same word form. Table 4 provides an illustration of this anomaly; if a user searches only for the singular term *mother* in a search, far fewer citations would be found, limiting the likelihood of finding relevant hits.

Even though truncation can easily circumvent the singular/plural anomaly, only one out of 76 students made use of truncation to retrieve word endings. The PsycLIT Quick Reference Guide mentioned truncation as a retrieval tool, but neglected to specifically suggest or il-

TABLE 3
SEARCHING TECHNIQUES USED

Characteristic	English Group N	English Group %	ESL Group N	ESL Group %	Pooled N	Pooled %	p <
Boolean techniques							
and used at all	23	54.8	19	55.9	42	55.3	
and used correctly	23	54.8	18	52.9	41	53.9	
and used incorrectly*	3	7.1	2	5.9	5	6.6	
or used at all	8	19.0	10	29.4	18	23.7	
or used correctly	8	19.0	6	17.6	14	18.4	
or used incorrectly*	3	7.1	4	11.8	7	9.2	
Other techniques used							
Thesaurus	2	4.8	3	8.8	5	6.6	
Index	7	16.7	5	14.7	12	15.8	
Expanded terms	16	38.1	4	11.8	20	26.3	.01
Root (truncation)	1	2.4	0	0.0	1	1.3	
Plural forms	40	95.2	23	67.6	63	82.9	.002

* Four subjects, three in the NS group and one in the ESL group, used the Boolean operator *and* both correctly and incorrectly. Three subjects in the NS group used the Boolean operator *or* correctly and incorrectly.

TABLE 4
DIFFERENCE IN NUMBER OF
CITATIONS FOUND USING *MOTHER*
(*MOTHER* [SINGULAR] VERSUS
MOTHERS [PLURAL])

No.	Search Terms
948	Child care
10	Working mother
70	Working mothers
0	(Working mother) and (child care)
15	(Working mother) and (child care)

lustrate its use in searching for both singulars and plurals. Unfortunately, SilverPlatter as well as other major producers such as Dialog OnDisc do not provide for automatic pluralization.

Synonyms and Expanded Terms. An important aspect of vocabulary usage in electronic databases is synonym searching. The NS students were more likely to use expanded terms or synonyms such as *parents* or *grandparents* than were their ESL counterparts, X^2 (1, $N = 76$) = 6.72, $p < .01$. Almost 40 percent of NS students searched on alternative words or concepts—for baby-sitters or nannies—where only 12 percent of ESL speakers did so. This provided NS students with more robust searches. This finding is not surprising, as knowledge of vocabulary is strongly bound to the user's language; a native speaker's vocabulary will typically be greater and deeper than that of a non-native speaker, no matter what the language.

Underutilization of Other Search Techniques

Other basic search techniques were so underutilized in the search strategies of both groups that no significant differences were found in these areas:
- Slightly more than half (55 percent) of the students used the Boolean *and*.
- Twenty-four percent used the Boolean *or* (more than one-third of those students used the *or* incorrectly).
- Sixteen percent used the index.
- Seven percent used the thesaurus.
- Only 1 student used truncation.

Students virtually ignored advanced techniques, such as field searching,

that were exhaustively illustrated in the PsycLIT Quick Reference Guide. These findings are generally consistent with those reported previously with a smaller sample size.[23]

The lack of significant difference between the groups in terms of Boolean usage was not surprising. Many languages, particularly Indo-European languages, contain words that translate to *and* and *or*, and Boolean use is probably a simple translation problem for those students whose native languages contain these words. Some Asian languages, particularly Chinese, do not contain words for *and* and *or*. For this reason, the authors examined Boolean usage between the native English-speaking students and those whose first language was Chinese. There was no significant difference between the two groups, which weakens the translation explanation.

Boolean concepts are logical or algebraic concepts which cross linguistic lines. Evidence suggests that users separate the natural language usage of *and* and *or* from the Boolean use of these words for intersection and union, switching between their respective connotations depending upon the context. This is true for both Computer Information Systems majors and computer programmers; both groups of subjects used the words *and* and *or* quite differently in natural language contexts as opposed to computer programming contexts requiring Boolean operations.[24,25] If natural language usage and Boolean operations are two different bodies of knowledge, the semantic concepts behind Boolean operations—union, intersection, and negation—can exist across languages.

Word Index

Searching from the word index for the terms *child care* or *day care*, both of which were retrievable as single and compound words, can be problematic. Since recall is limited to the exact way a term is entered, the system does not retrieve variant spellings or compound words. Unlike the thesaurus, there are no links or suggestions that additional hits may be found by entering the term differently.

TABLE 5
RETRIEVAL USING
ALTERNATE SPELLINGS

No.	Spelling
264	Childcare
948	Child care
1,057	Childcare or child care

TABLE 6
INCONSISTENCIES IN LINKING
ALTERNATIVE SPELLINGS IN THE
THESAURUS AND INDEX

No.	Spelling
73	Child-care in de (thesaurus)
366	Child-day-care in de (thesaurus)
137	Child-care (index)
264	Childcare (index)
948	Child care (index)

As illustrated in table 5, approximately 800 abstracts could be missed by an inexperienced student searching only for *childcare* and not for *child care*. The problem is compounded by the screen display of the index; it is necessary to scroll through several screens to find the word in an alternative spelling form. Although a useful feature, index searching could benefit from an enhancement that provided automated links to alternative (and plural) spellings.

Thesaurus

Only 5 students (7 percent) used the sophisticated permuted thesaurus which automatically *or*s the selected descriptor terms, suggests related or narrower terms, and explodes terms. The PsycLIT Quick Reference Guide, however, does not directly relate the use of the broadening *or* to its thesaurus. By listing the term as *childcare*, the thesaurus inadvertently reinforces the use as such, although there are more instances of *childcare* or *child care* in the index (table 6).

CONCLUSIONS

This study provides a better understanding of the problems novice ESL and NS undergraduate end-users encounter when searching a CD-ROM database.

Because many undergraduates at public urban universities speak English as a second language, the authors were interested in determining whether there were significant differences in searching strategies between ESL and native English-speaking undergraduates. The main difficulties of ESL students that differed significantly from those of native English speakers were concentrated in vocabulary issues—utilization of plural forms, and the use of synonyms and expanded concepts for more robust searching.

The findings of this experiment showed statistically significant differences between the two groups in two language-based areas. First, NS users were more likely to use plural word forms when searching ($p < .002$). The lack of automatic pluralization in some CD-ROM interfaces puts ESL students at a disadvantage. Secondly, NS users were more likely to experiment with synonyms and alternative words to search for some topics ($p < .01$).

The main difficulties of ESL students which differed significantly from those of native English speakers were concentrated in vocabulary issues—utilization of plural forms, and the use of synonyms and expanded concepts for more robust searching.

Other basic search techniques were so underutilized in the search strategies of both groups that no significant differences were found in these areas; 55 percent of the students used the Boolean *and*, less than a quarter used the Boolean *or*, 16 percent used the index, and 7 percent used the thesaurus. Only one student used truncation. These findings are generally consistent with findings reported previously with a smaller sample size.[26]

This suggests that CD-ROM bibliographic instruction for the general user should include Boolean logic, index and thesaurus usage, and truncation. Bibliographic instruction for ESL students should focus on techniques to circum-

vent difficulties with plurals and limited vocabulary. Such instruction could focus on the use of truncation and wild-card characters for plural searching, and thesaurus use for alternative vocabulary. Additionally, all database producers should use interface standards that include intelligent automatic pluralization—not merely appending "s" or "es" to singular word forms—and automatic alternative spellings to assist ESL and NS searchers.

Areas of Future Study

These conclusions come with the usual cautionary note that the size of the sample group ($N = 76$) should be considered before suggesting generalizations. Nonetheless, the relative homogeneity of the user level (undergraduate users who were not Information Science students) reflects typical problems novice undergraduate end-users may experience. The results may have more external validity when applied to this growing user population than other studies using more diverse levels of users, or those using students in Information Science courses as subjects. The results warrant future investigation using much larger sample groups.

Although the language backgrounds of the ESL students were representative of students at the City University of New York, the samples were too small to examine significant differences within the ESL group. Where the two groups differed significantly may be a factor based on a specific native language. An examination of users grouped by their native language backgrounds may produce findings that identify those ESL students more likely to encounter difficulties with CD-ROM searching. Expansion of our sample size should enable a more thorough investigation.

The underutilization of some techniques by all students suggests a need for more research on which specific tools are actually useful to novice users. It was particularly telling that techniques featured prominently in the Quick Reference Guide—the field search, the thesaurus, and the index—were underutilized by the users in this sample. While these are powerful techniques for the skilled researcher who needs to perform searches that are both precise and exhaustive, they may be conceptually too difficult for the autonomous novice user who does not need such high quality searches. For the novice user, bibliographic instruction that focuses on simpler techniques and addresses some of the anomalies presented here might prove more useful.

Recommendations

CD-ROM databases contain many features that make them attractive to autonomous end-users. Nonetheless, Information Science professionals must become aware of the implications of providing computerized information to an ever-increasing number and variety of users. One of these implications is the need for bibliographic instruction for all users in the problem areas discussed in this paper with specialized, if limited, additional assistance for ESL users.

Automatic pluralization, alternative spellings, uniform truncation commands, and synonym searching options will improve the searching capabilities of all users.

Additionally, when developing future interface designs and standards, producers and vendors of "user-friendly" CD-ROM databases should consider some of the problems searchers face. Automatic pluralization, alternative spellings, uniform truncation commands, and synonym searching options will improve the searching capabilities of all users. Although the adoption of the Z39.50 protocol or other standards will provide greater standardization across a variety of interfaces, a better goal would be to provide an interface that provides a high level of usability across a variety of users.

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