

# Journal of Information Literacy

ISSN 1750-5968

Volume 11 Issue 2

December 2017

## Article

Bury, S., Craig, D., & Shujah, S. 2017. Celebrating undergraduate students' research at York University: Information literacy competencies of high-achieving students. *Journal of Information Literacy*, 11(2), pp.4–27.

<http://dx.doi.org/10.11645/11.2.2219>



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Chan, L. et al. 2002. Budapest Open Access Initiative. New York: Open Society Institute. Available at: <http://www.soros.org/openaccess/read.shtml> [Accessed: 18 November 2015].

# Celebrating undergraduate students' research at York University: Information literacy competencies of high-achieving students

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## Abstract

This article analyses the information literacy (IL) competencies of high-achieving undergraduate students through the lens of undergraduate research celebrations in a North American University. This article focuses on York University's Undergraduate Research Fair, and shares findings from an analysis of students' IL award submissions including lower-year (first and second year of university) and upper-year (third and fourth year of university) applicants. Submissions are analysed using a qualitative content analysis approach. The study's findings point to the positive value of both IL and reference help in building high-achieving undergraduate students' IL skills. Results indicate important future directions for IL instruction, such as the role of the flipped classroom, and the critical importance of embracing the Association of College and Research Libraries' (ACRL) Framework for Information Literacy for Higher Education to engage undergraduates with high-order IL concepts.

## Keywords

academic libraries; ACRL; assessment; higher education; information literacy; information literacy model; student award; student research; undergraduate students; US

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## 1. Introduction

Scholarly research is no longer merely the realm of professors and graduate students in higher education. Increasingly, undergraduate students are engaging with research in a variety of ways that is relevant and interesting, making them part of the scholarly conversation in academe. The promotion and celebration of undergraduate research in North American universities is gaining momentum with some institutions engaging in formal recognition and events. Also, many universities are recognising undergraduate research as a strategic priority, as it raises an institutional profile, builds retention, and provides experiential education opportunities for students to be involved in research pursuits (Jones & Canuel, 2013). However, despite these developments,

very little research has been done to investigate high-achieving undergraduates' information literacy (IL) skills and conceptions and how these are reflected in the research accomplishments that many universities are seeking to promote or celebrate.

In 2013, York University Libraries in Toronto (Canada) initiated an IL award in conjunction with an annual Undergraduate Research Fair that was also founded the same year. The main goal of the Fair was to celebrate, recognise, and establish a higher profile for undergraduate research and students' academic achievements (York University, 2017). Through the creation of the IL award, the library encouraged student submissions of strong research papers that utilised IL skills acquired through students' various interactions with library services and resources, including IL classes, reference assistance and embedded librarians.

York's Fair is sponsored both by the Libraries and by York's Office of the Vice-President Research and Innovation, which highlights the institution's commitment to undergraduate research. The 2013 inaugural, multidisciplinary Undergraduate Research Fair included four faculties and focused on the following disciplinary areas: social sciences, humanities, fine arts and environmental studies. Due to its success, the Fair is now an annual event that includes all faculties, featuring individual and group research projects.

The Fair showcases high-achieving undergraduate students' research posters that are based on research papers already graded as part of a course requirement. The Fair provides participants with an opportunity to exhibit and develop academic literacy skills, including writing, presentation, and IL competencies. The Libraries provide workshops and other resources to assist students with writing an abstract that forms the basis of their application to participate in the juried Fair. Librarians also teach successful applicants how to transform their research projects into poster presentations. The posters are exhibited in a friendly market-style atmosphere during the Fair day to an audience comprised of people from the broader York community, including peers, academic staff (faculty), librarians, family and administrators.

The overall Fair message is that participants are already winners for being accepted into the Fair, although there are monetary and non-monetary prizes across a range of categories (IL award, best poster presentation, best lower-year project, best upper-year project, best thesis/Major Research Paper (MRP), best group project, and the people's choice award). The IL award is the largest monetary prize offered, and applicants answer IL related questions (Appendix 1), in addition to their abstract submission. The purpose of the IL award questions is for applicants to reflect on the resources used in their research projects: how they identified or found resources, how they evaluated resources, and what library services or resources they used. During the adjudication process, applicants are assessed on how they approached the questions, the depth of their understanding of IL skills, the extent to which they engaged with resources cited, and the use of proper citation conventions in their submitted papers.

This research discusses findings on the IL skills and conceptions of these high-achieving undergraduate students by outlining common threads or patterns that were observed in the IL award submissions to York's Fair in 2013 and 2014. High-achieving undergraduates are defined as students with B+ grades or higher, or in the words of Bonnet et al. (2013, p.38), they are 'apprentice undergraduate researcher(s)'.

Apart from the aforementioned study by Bonnet et al. (2013), no other research was discovered that examined what is known about high-achieving undergraduates' IL conceptions and abilities in

the specific context of a university initiative to celebrate and honour undergraduate research. This research adds to the scholarly conversation initiated by Bonnet et al. (2013). It also draws on research conducted on the IL competencies of senior undergraduates engaging in capstone courses (culminating courses usually taken in the last year of study that provide an in-depth look at a subject) or thesis research as shared by Miller (2013) and Wright (2001), as the skill set of this type of student has parallels with the context examined in this study. Though the studies are similar, the range of analysis in this study is unique.

This study stands apart from others by offering a comparative analysis of upper-year students' skills relative to those of lower-year students. This study shares data on undergraduate IL skills and conceptions, relates this to other studies, and discusses potential implications of these results for IL practice and further research. It is important to establish a framework of reference in the form of either standards or guidelines for students' IL skills in a digital age. Throughout this paper, the Association of College and Research Libraries' Framework for Information Literacy for Higher Education (ACRL, 2015) is used as an approach to investigate the students' higher order IL cognitive skills.

## **2. Literature review**

### **2.1 Celebrating undergraduate research in north American universities**

The Council on Undergraduate Research (CUR) defines undergraduate research as 'an inquiry or investigation conducted by an undergraduate student that makes an original, intellectual, or creative contribution to the discipline' (2016). Here, the student is a collaborator in research rather than a 'passive learner' (Jones & Canuel, 2013, p.538). In the 1960's and 1970's, MIT and CalTech pioneered the celebration of undergraduate research. The current trend to promote and celebrate undergraduate research in higher education can be explained by a range of factors, including the goals of fostering the student as an active learner and contributor to academic research, improving students' portfolios for graduate school, achieving strategic educational objectives, and enhancing retention and recruitment.

The celebration of undergraduate research in higher education is increasingly prolific, taking diverse forms including explicit incorporation in university or college mission statements, awarding of research grants for projects where undergraduates are co-collaborators with academics acting as mentors, and the initiation of summer institutes, research fairs and undergraduate research journals, among other initiatives. See Table 1 for some examples of undergraduate research initiatives.

**Table 1:** Examples of undergraduate research initiatives at selected academic institutions

Institution	Year	IL Award	Undergrad Research Celebration	Individual/Honor Thesis Students Focus	Library Involved	Adjudication Process	Institutional Repository	Student Journal	IL workshop(s)	Website
York University	2013	✓	✓		✓	grade, faculty comments, IL related questions, citations		✓	✓	<a href="http://undergradresearchfair.blog.yorku.ca/">http://undergradresearchfair.blog.yorku.ca/</a>
University of Michigan	2010		✓	✓	✓	reference letter, bibliography list				<a href="http://www.lib.umich.edu/undergraduate-research-award">http://www.lib.umich.edu/undergraduate-research-award</a>
University of Alberta	2005/6 (Award)	✓	✓		✓	communication, interdisciplinary, early career, international research		✓		<a href="http://www.uri.ualberta.ca/">http://www.uri.ualberta.ca/</a>
	2011 (Symposium)									
Indiana University-Purdue University Indianapolis (IUPUI)	1999		✓	✓	✓	Abstract, reference letter			✓	<a href="http://crl.iupui.edu/">http://crl.iupui.edu/</a>
University of Wisconsin	2004	✓	✓		✓	short essay, poster, faculty letter of support				<a href="https://ugradsymposium.wisc.edu/">https://ugradsymposium.wisc.edu/</a>
University of Illinois	2007		✓			poster, presentation	✓	✓		<a href="http://www.eui.illinois.edu/">http://www.eui.illinois.edu/</a>
McGill University	2005 (Science)		✓	✓	✓	Application, faculty referral			✓	<a href="http://www.mcgill.ca/science/research/ours/urcl">http://www.mcgill.ca/science/research/ours/urcl</a>
	2011 (Arts)		(Separate science and arts fairs)		(Arts only)				(Arts only)	<a href="http://www.mcgill.ca/arts-undergraduate-research/annual-undergraduate-research-event">http://www.mcgill.ca/arts-undergraduate-research/annual-undergraduate-research-event</a>
Pennsylvania State University	2013	✓	✓		✓	references, use of archival or primary sources			✓	<a href="https://undergradresearch.psu.edu/exhibition/index.cfm">https://undergradresearch.psu.edu/exhibition/index.cfm</a>
Illinois Wesleyan University	1990		✓	✓	✓	abstract	✓		✓	<a href="https://www.iwu.edu/jwpr/">https://www.iwu.edu/jwpr/</a>
MIT	1969			✓		Application, faculty referral				<a href="http://web.mit.edu/urop/">http://web.mit.edu/urop/</a>
University of Missouri	2014		✓	✓		Application, abstract, faculty referral				<a href="http://undergradresearch.missouri.edu/">http://undergradresearch.missouri.edu/</a>
University of Maryland	1998		✓			Abstract, presentation				<a href="http://www.aap.umd.edu/McNairConference/2015/">http://www.aap.umd.edu/McNairConference/2015/</a>

The following are illustrative of undergraduate research celebrations, which receive detailed coverage in specific journal articles. The University of Michigan Libraries developed an undergraduate research award for individual and group projects in 2010. Adjudication requires students to submit a letter of support from academic staff (faculty), a bibliography, and a personal essay outlining their research strategies. Adjudicators look at the sophistication of search strategies, students' comprehension of material, and use of appropriate resources. There is an award ceremony for winners, and projects are submitted into the institutional repository. The University of Alberta has celebrated undergraduate research since 2011 and has offered a 'Student Award for Library Research' to selected graduating students since 2005/6. Jones and Canuel (2013, p.539), and Stamatoplos (2009, p.239) discuss Purdue and Illinois's celebration of upper-year students' work, where projects involve independent research. Such celebrations exclude lower-year students and students who complete research inside a classroom. Institutions that have an IL award or a library research award quite often establish them as stand-alone initiatives, with adjudication criteria similar to those that apply at York, and only a few (University of

Georgia, UC-Irvine, and University of Washington) offer them in collaboration with their undergraduate research programs (Jones & Canuel, 2013, pp.538–539).

York differs from most other institutions that celebrate undergraduate research, as the IL award was an important catalyst in establishing the Undergraduate Research Fair, and it forms an integral part of this overall celebration of undergraduate research. In addition, the Fair involves participation from undergraduates from all departments, recognises a range of different research accomplishments, and is linked to the strategic university goal of fostering lifelong learning.

Establishing an IL award in conjunction with a research celebration highlights the library's role in undergraduates' research accomplishments. An IL award that is linked to the celebration of research raises the profile of the library, unleashes new funding opportunities, magnifies academic librarian collaboration, and improves student career or graduate school prospects by promoting presentation, publication and dissemination opportunities (Jones & Canuel, 2013, pp.538–539). Furthermore, involving students in scholarly communication from the outset is important to help them understand that 'dissemination is the final step in the research cycle...' (Jones & Canuel, 2013, p.541). Thus, York's Fair supports the publication of an open access undergraduate research journal, *Revue YOUR Review* (<http://yourreview.journals.yorku.ca/>). Selected Fair students morph projects into peer-reviewed articles with support from York University Libraries and Writing Centre. By disseminating undergraduate student submissions in *Revue YOUR Review*, York University acknowledges the student as a knowledge producer who is quintessential to the new definition of IL found in the ACRL Framework for IL for Higher Education (ACRL, 2015).

## **2.2 Undergraduate students' information literacy skills in a digital age**

Much of what is known about university students' IL skills and habits at the current time has been informed by a couple of large-scale research projects conducted recently in the United States.

In a 2009 article, the work conducted under the auspices of Project Information Literacy (PIL) uncovers important results about how US university students do research in a digital age (Head & Eisenberg, 2009). The major findings indicate that although students have access to myriad online resources, they rarely use new sources, and instead depend on 'close at hand, tried and true' (Head & Eisenberg, 2009, p.3) resources including course readings, Google, and well-known aggregator databases (for example JSTOR and ProQuest). The article describes a new generation of students who value efficiency and utility above all else, and who do not interact with scholarly online materials in the way earlier generations of students interacted with print resources. This large scale study also finds that while librarians are often the original sources of student information regarding relevant scholarly research databases, their role quite typically stops there, with course instructors being asked for ongoing advanced research help, not librarians (Head, 2013). A second significant recent study on students' IL skills is another large scale project, the Ethnographic Research in Illinois Academic Libraries (ERIAL) project (Kolowich, 2011). ERIAL, a two-year study conducted across five university campuses in Illinois, reveals that students rarely ask librarians for help even when they need it, turning to academic staff (faculty) more often instead. Often they do not actually know what a reference librarian does. At the same time, the study indicates that librarians overestimate students' research skills. As a result students are left feeling alienated and intimidated by the libraries. Furthermore, ERIAL indicates that academics do not generally refer students to the library for research help, as they view libraries primarily as purchasing agents. Additionally, students are found to be pragmatic and self-sufficient researchers. However, they tend to overuse Google, misuse scholarly databases, and 'lack understanding of

search logic' (Kolowich, 2011), for example Boolean, which is likely to be because popular databases assume operators.

Minimal research has been conducted on the specific context of IL competencies of high-achieving undergraduate students. Yet uncovering studies similar to this one, which specifically explore the skills of this cohort, is valuable as this group represents an important constituency who tend to be highly motivated, and are frequent users of library resources. In terms of studies with similar contexts to this one, i.e. the celebration of undergraduate student research, this study stands alone with that of Bonnet et al. (2013). In addition, this article purports that studies examining the IL skills of students in capstone courses or engaging in thesis research, while not an identical context, also have some important parallels with this study. As in the Undergraduate Research Fair context, such students experience acculturation to the academic environment as a result of the high research expectations they encounter as they participate in the scholarly communication process in an involved way.

Bonnet et al.'s study (2013) shares results from an analysis of students' personal essays describing their research trajectories; the essays were originally submitted for consideration of an undergraduate research award. The authors state that their study contributes unique scholarship to what is known about the 'apprentice undergraduate researcher' (Bonnet et al., 2013, p.38). In contrast to other studies about undergraduate students at large, they focus on a set of students who are high achieving, and motivated by something 'more complex than the exigencies of a harried effort to secure a grade' (Bonnet et al., 2013, p.39). These students have personal connections with the subjects explored, and are invested in their research. Interestingly, Bonnet et al. (2013), in contrast to the aforementioned studies, do find that these high-achieving students often rely on librarians for help with research, draw on a wide range of tools and research strategies, and demonstrate understanding, sophistication, and creativity in their research strategies, including the ability to critically evaluate information sources. Furthermore, these students demonstrate a productive use of web resources and 'not only used the free Web in creative ways to support their research, but their evaluative statements indicated that they displayed critical thinking skills in these endeavors' (Bonnet et al., 2013, p.46). Based on this new understanding, librarians at the University of Michigan are now forging new and relevant teaching techniques that will foster undergraduate research.

In terms of studies examining high-achieving undergraduate cohorts working on capstone or thesis projects, this paper focuses on three studies by Miller (2013), Wilson (2012), and Wright (2001) that review undergraduate students' IL skills. All these studies find that while students display good abilities with certain IL competencies, they are still on a learning curve when it comes to higher-order cognitive abilities, and struggle with the ambiguity and non-linearity of the research process.

Miller (2013) studies the research skills of 'upper-division' (upper-level) undergraduate students at a mid-size university completing a capstone project using survey and interview research. She labels her students 'almost experts' because they demonstrate many competencies as researchers and apply a wide range of information sources and search tools when doing research. A majority (57%) also consult librarians for help with research tasks. However, high-level research abilities, such as topic formulation, and evaluating and filtering information sources, need development among these students.

Wilson (2012) engages in citation analysis of 88 undergraduate research theses at the University of South Alabama. Students demonstrate research strengths, for example the ability to search and

identify a wide range of relevant book and article sources both locally and from other institutions, as indicated by citation frequencies for different sources cited. However, issues with IL abilities are found, including many poorly formed citations, and some inappropriate resource usage, such as references to books and articles that are more dated than expected, and citing Wikipedia.

Wright (2001) makes the case for the benefits of a library credit course to support undergraduate students engaged in thesis research, similar to the course offered by Pennsylvania State University Libraries. This course evolved to address recognised gaps in IL abilities of upper-year undergraduate students especially in terms of higher-order cognitive skills. It addresses advanced search strategies for using databases effectively, as well as skills in evaluating information resources, while also developing students' understanding that research is a recursive process. The nature of the information cycle in different disciplines is explored, as well as copyright and issues pertaining to research and information ethics.

In conclusion, there is a dearth of studies which explore the research practices of the high-achieving or advanced undergraduate student, while studies of undergraduate students broadly speaking are more plentiful. Studies examining this smaller cohort of more advanced students vary somewhat in their findings. A common finding, however, is that this type of student is highly motivated and demonstrates a core set of foundational IL skills in contrast to findings from the PIL and ERIAL studies (Head & Eisenberg, 2013; Kolowich, 2011) that examine undergraduate students at large. Overall, there is evidence for improving undergraduate students' IL skills, including those of high-achieving students. In terms of higher order IL abilities, additional instruction is needed for full mastery of research tasks in their existing contexts.

### **3. Study design: student demographics**

A majority of Fair participants in both years examined in this study are affiliated with the social sciences (64% in 2013 and 59% in 2014) or humanities (21% in 2013 and 13% in 2014). In 2014, when all faculties participated, 24% of applicants were in the Health and Science disciplines. A smaller number of applicants is observed in Environmental Studies, Fine Arts, and Education. The subject area affiliation is reported separately for 2013 and 2014, since the pilot year included participation of fewer faculties.

For both years, the vast majority of applicants are upper-year students (80%). In terms of grades received, out of the overall applications 49% of IL award applicants received an A+ grade on their paper, while 43% had an A grade, and 8% had a B+ grade.

### **4. Methodology: qualitative assessment of students' IL award applications**

In this study, a total of 93 IL award submissions, submitted in 2013 and 2014 respectively, were reviewed. Students who formed the subject of research gave the Fair organisers permission to utilise their applications for research purposes upon submission of their IL award applications.

The data analysis process involved reviewing students' IL award submissions including bibliographies to learn more about their IL competencies. A qualitative content analysis approach was applied, as described by Bryman, Bell and Teevan (2012), where texts are analysed and codes emerge to convey thematic patterns and narratives. This approach is used where a specific

theme or phenomenon is not well researched in existing theory, such as where a study is exploratory in nature. In this case there is a dearth of theory on the IL competencies of high-achieving undergraduates in the digital information age. Wildemuth (2009) explains that 'qualitative/thematic content analysis requires relatively small, purposively selected samples' (p.298). Although this is a methodology which may be criticised for lack of generalisation beyond the group studied, this study provides a richness of information that can be replicated by others and can inform approaches to IL.

While it was necessary to develop a system of codes within the context of responses to three broad categories of IL award questions, the set of specific codes and associated names for categories emerged from textual analysis of the IL award submissions. Therefore, the three overarching thematic categories were applied at the outset of the content analysis process, with subsets of codes emerging from analysis and discovery of patterns observed in the texts analysed. These three broad overarching themes were as follows:

1. Student approaches to identifying relevant search tools and applying search strategies
2. Student strategies for information evaluation and review
3. Student usage and learning about key library resources/tools and services through the process of researching

Similar to the approach described by Rempel, Buck and Deitering (2013), where undergraduate research for assignments formed a focus using interview transcripts and content analysis, the research process of developing codes for content analysis started in this case with a pilot review of twenty IL award submissions to test codes. Each member of the research team independently coded this sample, noting codes or relevance. The team met to compare notes and create a single final coding scheme to be applied, while resolving the set of codes for application to this initial pilot group of twenty. The codes evolved from the three broad categories outlined above. It should be noted that some specific codes applied were institution specific, for example coding for usage of certain tools/services developed in house.

Once a set of finalised codes was developed, submissions were analysed based on the presence or absence of coded items within the three broad categories (Appendix 2). For example, in the first area focusing on search and retrieval, items were ultimately coded based on whether or not certain search tools were mentioned (for example, was an articles database used), or based on what search strategies were described (for example, was Boolean used or shown). In the second category, the presence or absence of recognised criteria for information evaluation and review was considered, such as whether a distinction was made between scholarly and popular sources, and whether references were made to authority, currency, etc. of sources used. Finally, with regard to student usage of library tools and services, references to specific forms of IL instruction or research help formed a focus of content analysis. In addition, the research team identified and kept record of relevant textual extracts in student submissions to illustrate examples of trends/patterns.

Coding for every submission was done independently by a minimum of two researchers to eliminate possible errors and to ensure higher validity of data. If areas did not align, the team discussed and resolved coding to be implemented. Having multiple coders and agreement is denoted essential in reducing bias in the analysis of the content analysis (Wildemuth, 2009).

Within each of the broad thematic areas, upper versus lower-year submissions were analysed for discrepancies and relationships within coding groups. Relevant frequencies of code patterns were tallied and used to generate tables and graphs.

## 5. Results

### 5.1 Students' IL abilities

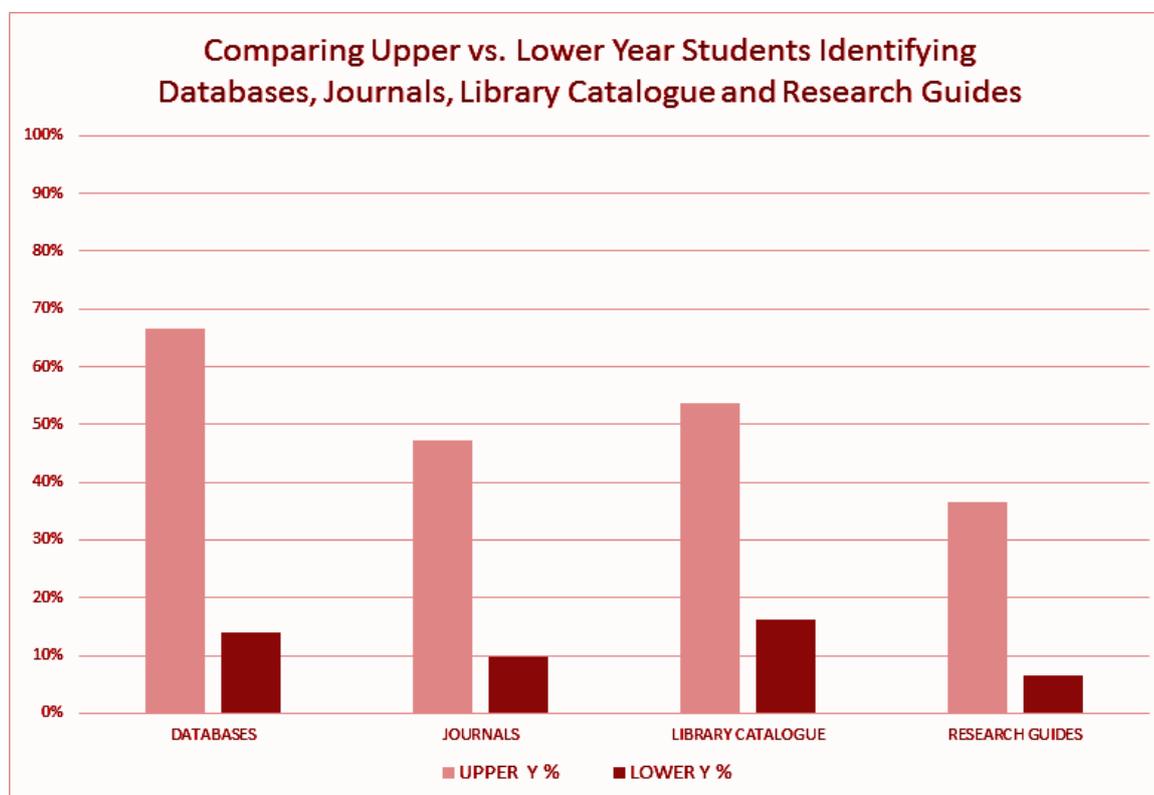
#### 5.1.1 Students' ability to identify and search for sources for research projects

Students were prompted to address the types of information sources used, databases or search engines chosen, keyword searches, or other search strategies adopted. From the responses, insights were gleaned as to how the students approached research inquiry.

#### 5.1.2 Students' ability to identify a range of academic sources to initiate research inquiry

Overall, upper-year high-achieving undergraduates demonstrate that they more frequently use databases, journals, the library catalogue, and research guides in helping them to identify sources for their research than their lower-year counterparts (Figure 1).

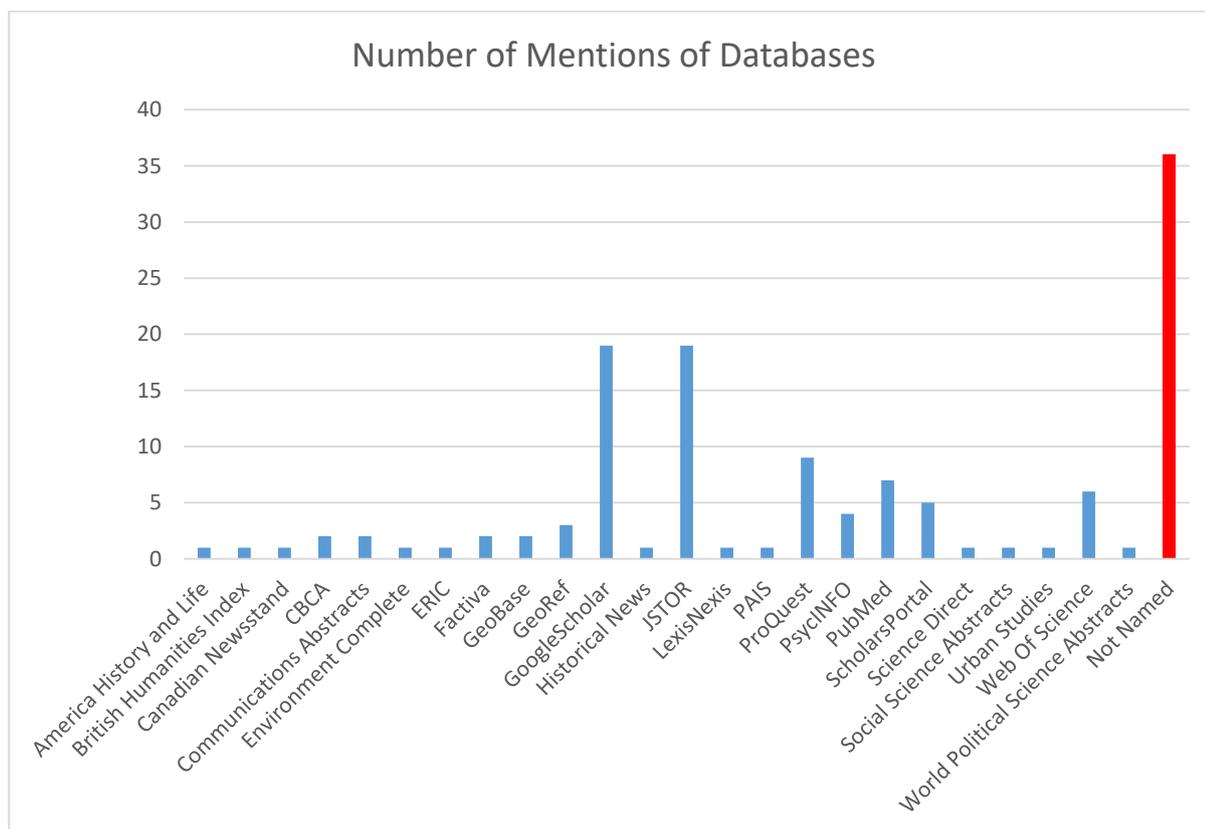
The vast majority of York's IL classes include instruction that uses subject research guides. It was found that 43% of the IL award applicants make note of them, with about a third of upper-year students and under a tenth of lower-year students indicating use of research guides. In this study one high-achieving undergraduate says they 'found most of [their] digital scholarly sources by looking under the 'Research Guides' tab for "History, Canadian"'. They were able to locate an index, 'America: History & Life', that was closely connected to their research and articulate the value of using a research guide to help them find databases to search for articles.



**Figure 1:** Comparing upper-year and lower-year students' ability to identify a range of academic sources to initiate research inquiry

### 5.1.3 Usage of article databases and journals

A majority (81%) of high-achieving undergraduates indicate that they use article databases. Thus, it is clear that databases are an important tool to this particular student population. However, digging deeper, only 39% of these students name one or more specific databases (Figure 2). It is striking that high-achieving undergraduates more often name Google Scholar, or large well-known aggregator databases, such as ProQuest and JSTOR, than they do subject-specific databases. The relatively lower popularity of Web of Science and PubMed can be explained by an applicant pool mostly comprising social science and humanities students.



**Figure 2:** The graph depicts the databases students' identify as used to retrieve journal articles

As the quote below illustrates, these high-achieving undergraduates mention that Google Scholar is often key in getting started, followed by, in fewer cases, use of subject-specific article databases. The quote is an example of students' perceived ease of use of Google Scholar and a conception of the research process in a similar vein to ACRL's threshold concept, 'Research as Inquiry' (ACRL, 2015):

Often times Google Scholar was the primary lead in discovery as it allowed excellent granularity to narrow the scope of discovery and once a source was located Pubmed and Scopus was employed to locate the target article and to discover similar articles through their 'related' search functions.

Some students rely primarily on Google Scholar, as the easiest route to article searching:

I also used Google Scholar for articles I could not retrieve easily from York's databases.

It is worth noting that a small number of advanced high-achieving undergraduates with higher order IL cognitive abilities do show a strong ability to move beyond popular aggregator databases to subject-specific databases and specialist online portals to retrieve quality sources. In addition, they show a good comfort level with reevaluating needs depending on the outcome of initial searches, as in they understand the idea that the searching process is fluid and nonlinear, as suggested in ACRL's threshold concept, 'Searching as Strategic Exploration' (ACRL, 2015). For example, one student says:

I initially turned to databases in the environmental studies stream for information about state and international action on climate change. I quickly discovered, though, that these databases were more suitable for natural sciences students, and that I was looking at the politics of the environment, not the science of it. I then turned to articles and databases in the political science stream.

In terms of journal usage, only 57% of high-achieving undergraduates mention they use journals, and only seven students mention a journal by name. In most cases, these students have a somewhat vague understanding of the role of journals in comparison to databases and articles.

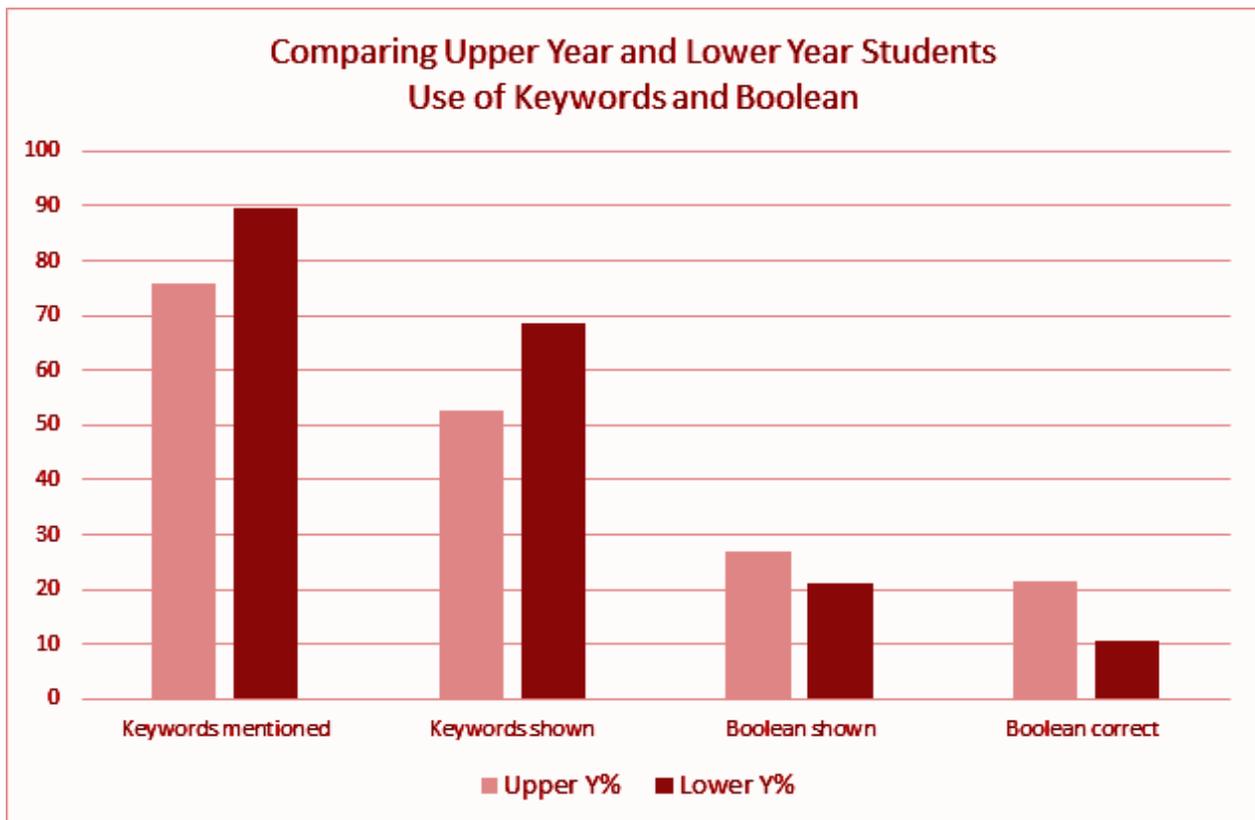
#### **5.1.4 Usage and naming of the library catalogue**

Data analysis suggests that student and librarian nomenclature for the library catalogue is divergent. A majority (70%) of high-achieving undergraduates mention use of the library catalogue. However, when the concept of the catalogue is mentioned, only 62% actually name it the 'library catalogue', and instead use other terms such as 'the library database', 'the library web site', 'the library system' or 'the library search engine'.

#### **5.1.5 Keywords and boolean**

The data analysed suggests that high-achieving undergraduates are more inclined to research a topic by identifying keywords, but seldom demonstrate that they understand Boolean. Interestingly enough, lower-year high-achieving undergraduates were more likely than upper-year high-achieving undergraduates to mention keywords and show keywords in the Fair application process. However, upper-year students who did show keywords were more likely than their lower-year counterparts to understand the use of Boolean and to apply it correctly (Figure 3).

From the data collected, these high-achieving undergraduates show a tendency to use phrases rather than Boolean. For example, an applicant says, 'I used such queries as "feminization of medicine", "female physician workforce" and "rise of women doctors"'. Overall, the percentage of students who demonstrate correct use of Boolean is minimal. Thus, it seems that applying and using Boolean is an issue for a range of different undergraduate student cohorts.



**Figure 3:** Comparing upper-year and lower-year students' ability to use keywords and Boolean

### 5.2.1 Thinking critically about the relevance and authority of information sources

Evaluation is a skill defined as thinking 'critically about information (e.g. selects main ideas from text, restates ideas in own words, evaluates information for relevance/topic/credibility/currency, recognizes bias, determines if additional information is needed, draws conclusions based on information gathered)' (Dubicki, 2013, p.121). Similarly, in this study, thinking critically about the relevance and authority of information resources includes the following abilities: understanding subject headings, citations and book/journal content, evaluating source types, and assessing the quality of sources (including relevance, currency, authority, purpose/point of view) in addition to whether sources are scholarly or popular, peer reviewed, primary or secondary.

### 5.2.2 Subject headings, citations, and content

This study finds that 42% of upper-year and 11% of lower-year high-achieving undergraduates use the reference list to locate further resources. In this study, one high-achieving undergraduate demonstrates understanding of the threshold concept of 'Scholarship as a Conversation' (ACRL, 2015) by recognising how references serve to link key authors and their works in a given body of knowledge and represent areas of harmony and of debate:

After we had relevant studies, we read those studies and searched within their references section to see what studies they referenced then examined those as well. Once we had all the articles we felt we could obtain through this method, we acquired additional studies by searching for other studies published by each author. After this, we had quite a comprehensive collection of studies, including studies that agreed with each other and studies that didn't.

Upper-year high-achieving undergraduates show stronger abilities than their lower-year counterparts with respect to using subject headings, reference lists, and in-text citations or

footnotes. In some ways it makes sense that upper-year students understand the concept of controlled vocabulary, and the value of reference lists more than lower-year students. These are higher-order IL concepts learned through the practice and experience of doing research assignments that upper-year students have developed over time. In a rare example a student describes using controlled vocabulary, and demonstrates some mastery of ACRL's threshold concept 'Searching as Strategic Exploration' but does not grasp the exact terminology to describe the process (ACRL, 2015):

once I found an article on one of these databases, I made sure to look at the keywords which had been tagged and add any that were useful to my search terms.

In contrast, the tendency to scan or engage in browsing of a book or journal for useful information found in the table of contents, acknowledgements and headings, among other areas, is stronger in lower-year students (47%) than upper-year students (24%).

A lower-year student describes engaging in this process in the following way:

Once this [use of reference list] has been accomplished I then will physically find these sources and examine their table of contents, and if necessary a quick perusal of pages to deem relevance to the topic at hand.

It is not entirely clear why the data depicts more lower-year students than upper-year students engaging with the content of the book or journal. One possible explanation is that the IL award application does not explicitly ask students about using contents and subject headings, so not everyone was prompted to articulate this point. In the Rochester study (Duke & Asher, 2012), this is found to be a rare information seeking behaviour of a student, yet this study shows it as more prevalent and developed among high-achieving undergraduate students.

### **5.2.3 Source type**

Over two thirds of high-achieving undergraduates evaluate a resource on whether it is scholarly or popular, about 40% identify peer review as an evaluation criteria, and about one third mention the importance of evaluating if a source is primary or secondary. Upper and lower-year high-achieving undergraduates did similarly in this area of critical evaluation of resources.

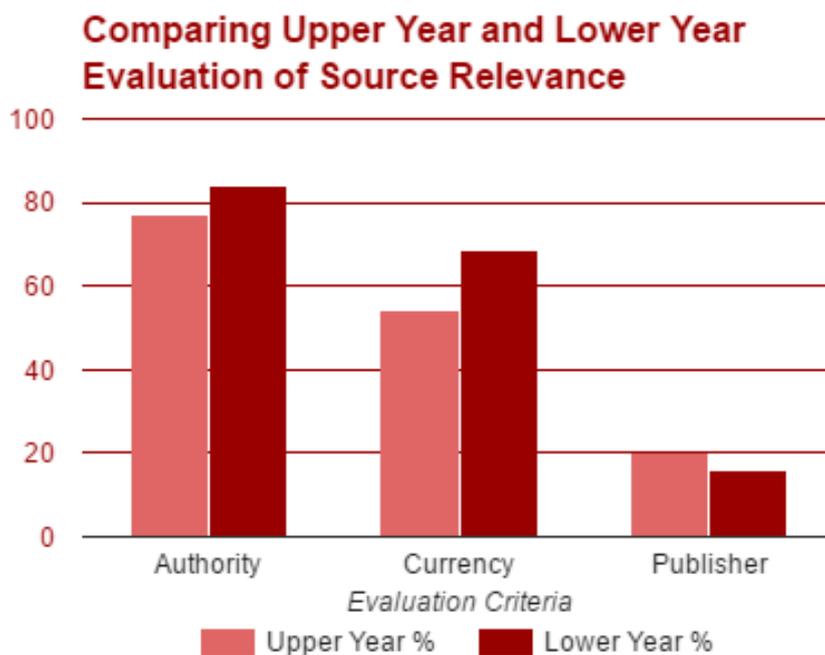
### **5.2.4 Authority, currency and publisher**

Overall, high-achieving undergraduates commonly mention authority (75%), followed by currency (57%), and less often cite the publisher (19%) as important factors in source evaluation. Lower-year students did slightly better than upper-year students in reflecting on authority of sources, and considering their currency (Figure 4). In a rare example, a high-achieving undergraduate recognises source validity in a multi-faceted way:

When selecting our sources, we examined several things, including: the author or creator (What are the author's credentials (educational background, past writing, experience) in this area?); publisher: Is it a university press or a large reputable publisher?; and what does the author write about?

It was the norm for students to recognise authorial credibility as critical to source evaluation, and in the words of one high-achieving undergraduate, this is 'an important factor' involving 'look[ing] up the author's institutional affiliation alongside her/his past writings.' However, occasionally

applicants mention the term ‘authority’ without necessarily describing how they know the source is authoritative, or why authority is an important evaluation criterion. The data collected found that students look to currency as a criterion to evaluate information found through the library. Additionally, in this study, high-achieving undergraduates lack awareness of the importance of a publisher when evaluating source authority. One possible reason is a lack of understanding of the scholarly publishing process.



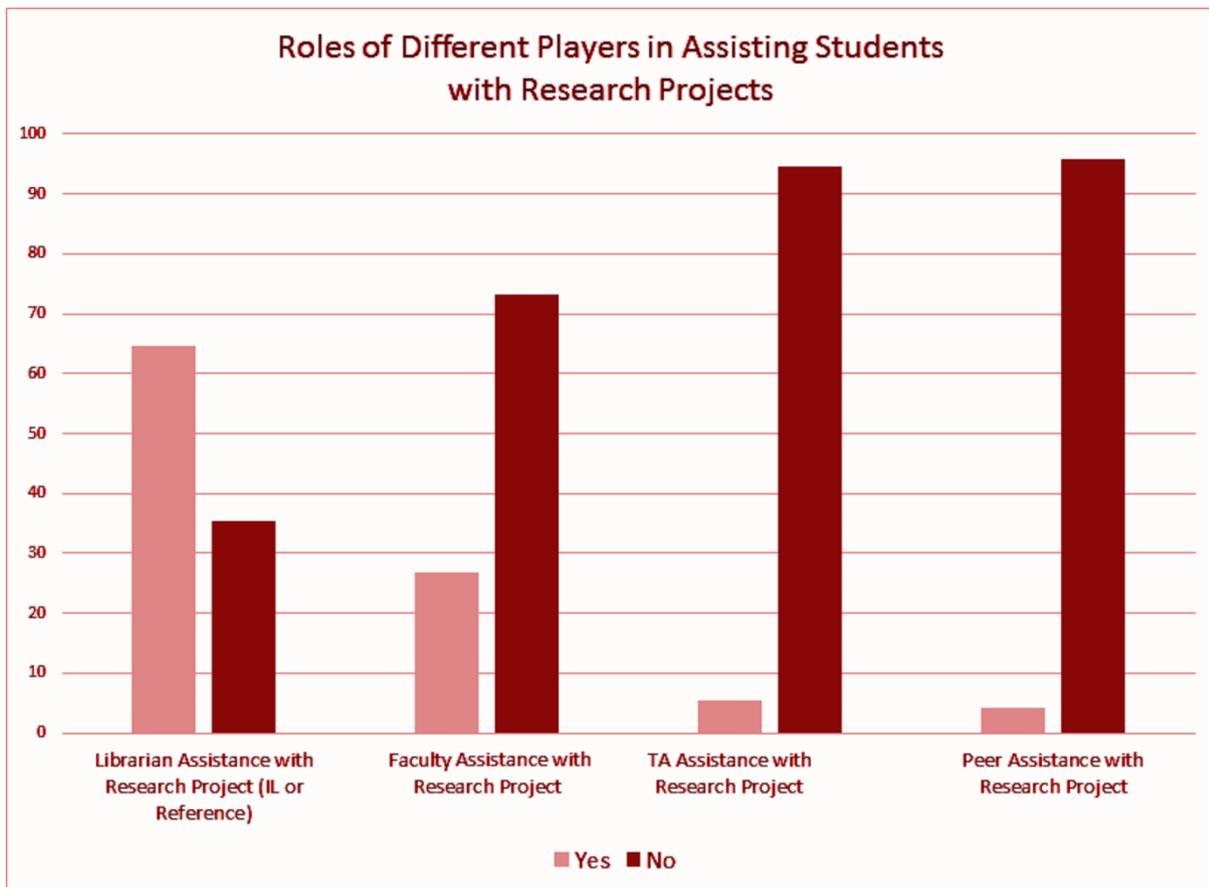
**Figure 4:** Comparing upper-year and lower-year students’ ability to evaluate resources based on source authority, currency, and publisher

### 5.3.1 Services and sources of help

This section describes and reflects on library information resources and services that played a role in student research projects. Several examples of resources and services were provided as prompts, including: consulting with a librarian or archivist; using virtual library help services; attending a drop-in workshop or other library class; or consulting a library research guide.

### 5.3.2 Role of librarians, academic staff (faculty), teaching assistants (TAs), and peers

Four stakeholders – librarians, academic staff (faculty), TAs, and peers – were identified as sources of research help in students’ submissions (Figure 5).



**Figure 5:** Different stakeholder roles in assisting students with their research projects

About two thirds (64.5%) of these high-achieving undergraduates indicated they had received guidance from a librarian, a result that was viewed as encouraging. This includes those who had received reference help or IL instruction (drop-in workshop or course-related instruction) or both. There is virtually no difference in this trend when comparing upper-year students (65%) to lower-year students (63%). The number of times these students indicate receiving guidance from academic staff (27%) is quite a bit lower, with upper-year students being three times more likely than lower-year students to describe the role of academic staff (faculty) help. While the reasons for this are not certain, this may be because of smaller class sizes in upper-years, and/or stronger expectations that students carry out research. TAs are mentioned very infrequently (5%), and peers even less (4%). These results are consistent when comparing upper and lower-year students.

A total of 60 (64.5%) IL award applicants identified either IL instruction or reference support as affecting their research projects, either in the current semester or earlier. IL was the main type of assistance students received (either wholly or alongside reference support), and applied in the case of 45% of students, while reference support was received by 38% of students, either solely or alongside IL. It should be noted that 18% of students indicated that they had received both forms of help.

In terms of differences between upper and lower-year students, the prevalence of IL instruction as a form of help was somewhat higher among lower-year students (52%) compared with upper-year students (43%). In addition, a starker difference applied to reference help where 37% of lower-year students had used reference services, compared with 21% of upper-year students.

The help received among the 60 students includes those who received IL instruction only (42%), reference help only (28%), and both forms of help (30%)

Of the 42 students who received IL instruction, course-related instruction is the most significant (59%) form of IL instruction. Some 36% of students identify drop-in workshops as their source of IL help, whereas just 5% of students indicate that they have attended both a course-related IL session and a drop-in workshop.

Data analysis of the forms of reference help students received shows that assistance in person (either by using a drop-in reference desk service or consultation service) is the predominant form of help (66%), with 31% of students indicating that they received research help through both in-person and chat services, and just 3% of students using chat reference only.

The role of IL instruction and reference in learning effective searching and retrieval is emphasised by students. For example, a student says:

Although I did not consult with a librarian for this research paper, my previous consultations with the librarians helped a lot as I was shown how to use certain databases and also how to find articles by the year and by specific authors. Based on previous sessions and small courses with librarians, I knew how to use the library catalogue to find an article that I found on Google scholar.

To a lesser degree, the role of IL sessions and reference in helping students differentiate information sources and identify reputable sources is mentioned:

This provided me with a wider understanding of how to narrow down my keyword searches, as well as distinguish between academic, alternative, and popular mainstream publications.

Also, quite commonly, students indicate that both IL instruction and reference support had played a role in alleviating anxiety or confusion, or got them through a barrier of understanding which then allowed them to proceed with their research:

As I was a first year student, I was very confused on how to use library services. My professor arranged a session where a library representative came to one class to lecture us on research skills...I believe this session was extremely important to me as I felt I could tackle the research paper easily.

When describing the role of academic staff (faculty) in helping with their research projects, students most commonly reference staff advice on specific authors or resources, or staff input on resources uncovered by students themselves:

I asked assistance from my professor in order to find the best possible sources and keywords...[and] to determine if sources were reliable.

### **5.3.3 Student self sufficiency**

Just over one third of the students who applied for the IL award (35.5%) indicate that they are operating independently of library assistance.

In response to the third IL award question that asks students to reflect on the role of *both* library services and resources, a vast majority (85%) reference the role of library search tools or wayfinding tools, a higher percentage of respondents than for any other type of resource or service mentioned. By far the most commonly identified tools in the data analysed are the library catalogue and databases or resources, followed by library research guides.

Moreover, a consistently confident tone is observed, as students reflect on the resources used:

The only library service I used to complete my research was the 'Search Library Resources' tool. This tool served as my main way of finding potential databases and monographs to use for my essay.

## 6. Limitations

Some study limitations are acknowledged. Applicants when submitting their application may have been guarded in what they disclosed, given the context of an award application, where they are 'putting their best foot forward'. This study does not provide information on the IL skills of students with low grades. This study recognises the current number (93) serves as a baseline for future research and that the analysis of IL skills will improve with an increased number of students to examine.

## 7. Discussion, implications and conclusion

This study corroborates some results of other major studies, such as by demonstrating students' ease of working in an online information environment where they often show a preference to be self-reliant and prioritise time-saving methodologies. Large-scale research studies such as the University of Rochester, the ERIAL, and PIL studies, show students indicate a preference for independence when doing research, and for using online search tools heavily. However, in contrast to these large-scale studies focusing on undergraduate students at large, this study finds that this cohort of high-achieving undergraduate students are not driven by a desire to satisfice and be efficient, but rather by strong interest in their subject matter, and a desire to engage in an in-depth approach. In terms of studies of similar scope and focus to this study, Bonnet et al. (2013, p.48) find that their apprentice researchers are 'extremely proactive about finding resources' and uncover strong evidence of high levels of independence among the students who applied for the undergraduate research award at the University of Michigan.

Students tend to rely on a small suite of familiar tools for research (Figure 1), including course readings, Google, and well-known aggregator databases (Figure 2), such as Google Scholar, JSTOR, and ProQuest. Students also engage in simple searching of search engines used, and lack knowledge of standard search logic and controlled vocabulary (Figure 3). Similar results were found by Bonnet et al. (2013), Miller (2013), Reeb and Gibbons (2004), Kolowich (2011) and Burns and Harper (2007).

In other respects, the results of this study diverge from large-scale major studies such as ERIAL and PIL (Burns & Harper, 2007; Head, 2013; Miller & Murillo, 2012) showing a higher percentage of students indicating that the librarian role is significant in their research projects, particularly with regard to reference and IL assistance (Figure 5). In the case of Bonnet et al. (2013) a high percentage of students consult librarians, which is similar to this study's findings. The relatively infrequent mention of the role of academic staff (faculty) in this study is likely a result of lack of a

formulated question to explore this area specifically; in contrast students were asked to explicitly address the role librarians had played in their research projects. It may also indicate that high-achieving students are more likely to identify the role of librarians in helping with their research projects than the general undergraduate population.

Students in this study commonly recognise the value of authority and currency as markers of quality, describing why they selected their sources, and pointing to the value of using peer-reviewed articles as discussed in sections 5.2.3 and 5.2.4. Interestingly, Bonnet et al. (2013) found that students' submitted personal essays showed similar traits. Also, Ganley, Gilbert and Rosario's (2013) research found that 54% of students think peer-reviewed sources are important when searching for information. It is only possible to speculate as to why this study's results are different to those of large scale major studies. However, it may be that this select group of high-achieving students possess more sophisticated IL skills than the general undergraduate student population. Students in this study certainly indicated that they had engaged with several library information resources (Figures 1 and 2), and had developed some research strategies (Figure 3), while many had availed of librarian help with their research (Figure 5). The use of a range of library information sources cited and embedded in research papers was generally born out in a majority of student papers and bibliographies, where scholarly books and journal articles featured commonly, with an average number of citations per paper at 17 in 2013 and 20 in 2014. This study finds some strengths with regard to students' ability to evaluate information, but it also finds room for development. With similarity to Bonnet et al. (2013) this study finds that students often refer to authorial credibility when selecting sources. At the same time, with similarity to Miller (2013, pp.20–21) and Wilson (2012, pp.47–48) this study finds that high-achieving undergraduate students experience some challenges in filtering and evaluating information sources when identifying those most relevant to their research contexts. Additionally, in their IL award submissions, students sometimes reference the importance of authority without referencing why sources are authoritative or why authority is an important criterion.

The results of this study point to useful future directions for IL instruction. It appears indisputable that students can benefit uniformly from being taught more explicitly that research is iterative and nonlinear in nature, and that roadblocks are to be expected along the way, as described in the Framework's 'Searching as Strategic Exploration' and 'Research as Inquiry'. Moreover, students are clearly availing of both formal and informal networks, including working with librarians and drawing extensively on citations they find in sources. Reinforcing these research habits, and expanding students' understanding of research networks and connectivity as captured in the threshold concept 'Scholarship as Conversation', is also recommended as a useful focus for librarians' IL practice.

This study shows some gaps with regard to students' use of search strategies such as Boolean operators. However, databases are starting to embed operators, so that they work behind the scenes. This includes the strong adoption of discovery layer systems in academic libraries. One recommendation is that librarians' instructional practice place less emphasis on the mechanics of searching and retrieval in the future. Greater adoption of flipped classroom approaches will help here, as the mechanics of searching, needing elaboration in the context of current discovery systems, can instead be covered in an online tutorial.

In addition, this study indicates the importance of building students' higher-order IL competencies, including their ability to evaluate and contextualise information sources. While students in this study, for the most part, certainly display a reasonable level of competency here, there is room for

improvement. Integrating the threshold concept 'Authority is Constructed and Contextual' into IL instruction will be beneficial when defining types of authority and recognising subject expertise.

Other study findings point to the need to avoid library jargon in IL instruction. It has been shown in this and other studies that students do not tend to identify 'the library catalogue' by this name; instead, they apply other labels, such as library database or search engine. In addition, this study shows that some very useful resources remain undiscovered by significant student numbers, especially library research guides. Research conducted by Reeb and Gibbons (2004) about the general undergraduate student population arrive at a similar conclusion that students often fail to connect with academic libraries' subject-based research guides, and conclude that course-focused guides are most clearly useful to them. Thus, promotion and integration of online library guides and toolkits will be important in the future, and in tandem with IL practice.

Undergraduate research fairs can play a valuable role in promoting students as knowledge creators and contributors in the publishing of an undergraduate journal. This has been shown to foster appreciation of the research dissemination process, and to build students' awareness of themselves as knowledge creators (Jones & Canuel, 2013, p.539), which is an important facet of the ACRL IL Framework, specifically the threshold concepts 'Authority as Constructed and Contextual', and 'Information has Value'.

As students' patterns of interacting with information evolve, academic libraries and their librarians must use strongly rooted theoretical practice to adapt deliverables to new technologies, and changing research habits. Overall, this study on high-achieving undergraduate students indicates a need to consider higher order IL cognitive skills which include strategic searching, evaluating sources, research networks, and scholarly communication. There is a relative dearth of studies about the IL abilities of high-achieving students especially in the context of undergraduate research fairs. Therefore, further research in this area will be important in defining future directions for IL practice, and ways to enhance undergraduate research more generally. This will foster more in-depth knowledge about undergraduates' research trajectories and IL conceptions, and will inform information specialists about potential new teaching directions. To conclude, undergraduate student research fairs offer an excellent way to value and celebrate students as knowledge creators and contributors, and a way for academic libraries to nurture and showcase academic literacy skills.

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## Appendix 1

### IL Award Online Application Form

1. Describe strategies that you used to search for relevant resources for this research project. For example, outline why you chose specific databases or other search tools/engines available at the library or beyond it, provide examples of keyword searches used, and approaches you applied to develop or refine your search strategies as your research progressed etc. Please be as detailed as possible.
2. Describe strategies that you used to select the relevant types of resources for this research project and explain how this may have influenced your decision to use them. (i.e. relevance, currency, authority, purpose/point of view, scholarly vs. popular, peer-reviewed, primary vs. secondary sources etc.)
3. How did you use library services and/or library resources for this research project? (i.e. Did you consult with a librarian or archivist? Did you use the library catalogue to find your resources? Did you use virtual library help? Did you attend library drop-in sessions or library classes? Did you use LibGuides/Research Guides? What new library services and /or resources did you learn about in conducting this research project?)

## Appendix 2

Final list of codes used to text analyse submissions. Most questions answered with Y/N, unless otherwise indicated.

	<b>Submission:</b>
1	Grade
2	Course Code
3	Faculty mention of IL skills in comments
4	Comments if available
5	Number of citations
6	Faculty comments about citations
7	Comments if available
8	Issues with citations (good / ok / poor)
9	Paper length (include whole pdf length of paper only)
10	IL submission vs. Overall submission (good / ok/ poor)
11	Articles Databases mentioned (name database mentioned)
12	Journals/Periodicals mentioned (provide name if mentioned)
13	Concept of Library catalogue mentioned
14	Library catalogue named differently
15	Name of catalogue
16	Call number shelf value colocation
17	Guides mentioned
	<b>Identify and Evaluate:</b>
18	Use of keywords mentioned
19	Keywords shown
20	Boolean used/shown
21	Boolean correct or not
22	Subheading value (concept of controlled vocabulary)

23	Faculty role
24	TA role
25	Peer role
26	Reference / research help role
27	- Through IL (indicate where Y)
28	- Through ref help (indicate where Y)
29	Value reference list or citations
30	Scanning book journal contents useful (TOC, acknowledgements, headings etc.)
31	Scholarly / popular mentioned
32	Peer review
33	Primary / Secondary mentioned
34	Authority
35	Currency
36	Publisher
	<b>Services:</b>
37	Drop-in workshop
38	Course IL session
39	Research / reference desk
40	Chat service
41	LC hub
42	SPARK
43	Circulation service
44	RACER
45	Reserves
46	Space
47	Library research tools (cat., guides, e-resources)
48	List tools mentioned