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INFORMATION LITERACY AND SEARCH STRATEGY PROFICIENCY: A NEED ANALYSIS

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ABSTRACT

Aim/Purpose	The aims of this study are to assess the current information literacy skills of students undertaking Capstone projects, identify the gaps in students' ability to find and evaluate literature material, and prove the need for developing scaffolded online instructional materials to support students' research activities in Capstone projects.
Background	Students today are digital natives who are expected to use information technology naturally. However, this digital literacy does not necessarily reflect their ability to conduct effective academic searches. This study addresses the gap between students' general digital literacy and their ability to perform advanced search techniques.
Methodology	A single case study approach was employed, using a survey with structured questionnaires. This study employed purposive, non-probability sampling techniques where 218 students who were enrolled in the Capstone project were the target respondents.
Findings	This research finds that, even though students are generally proficient in information technology, their fluency does not extend to advanced academic search skills essential for the Capstone project. Specific deficiencies include limited ability to conduct effective literature searches, insufficient proficiency with Boolean expressions, low familiarity with specialized academic databases, and a tendency to rely on general search engines over academic tools. These findings

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	underscore the urgent need for targeted instructional interventions to equip students with the skills necessary for efficient and comprehensive literature searches, ultimately enhancing their academic performance.
Contributions	This study contributes by confirming, through a focused case study approach, that students' general proficiency in information technology does not extend to advanced academic search skills. The study's findings underscore the importance of developing instructional modules tailored to bridge these skill gaps.
Recommendations for Practitioners	The research suggests implementing online modules and scaffolding learning strategies within Capstone courses to enhance students' search skills and effectively use academic resources.
Recommendations for Researchers	Future research should explore the development and effectiveness of specific instructional interventions in improving information literacy and search strategy proficiency.
Impact on Society	Addressing these gaps in information literacy is crucial for better preparing students for rigorous research, professional practice, and lifelong learning, ultimately contributing to a more informed and competent workforce.
Future Research	Future research could consider extending a single case study into a longitudinal study by administering the same survey across different student intakes. Repeating the survey with new intakes increases data reliability and helps confirm that the findings are not unique to a single cohort but are representative over time. This would allow the researcher to make broader generalizations, especially if the student demographics remain similar across cohorts.
Keywords	information literacy, search strategy, Boolean operators, capstone

INTRODUCTION

Undergraduate programs in Accounting and Finance have increasingly incorporated real industry cases into their courses to better prepare students for professional careers. The Capstone project is a key component of this preparation, which requires final-year students to synthesize and apply their prior learning while developing skills and attributes essential for employability (Lee & Loton, 2019). Among the most sought-after skills by employers are information retrieval competencies (Khuraisah et al., 2020). Therefore, it is crucial for students, especially those undertaking research projects like capstones, to sharpen their ability to locate, evaluate, and effectively use information from various sources. The ACRL Framework for Information Literacy for Higher Education (Association of College and Research Libraries, 2016) defines this ability as information literacy.

This case study explores students' information literacy levels and addresses the need to develop scaffolded online materials to help them kick-start their capstone projects. Capstone projects serve as pivotal milestones in the academic landscape, demanding students' adeptness in navigating the expansive realm of information to produce scholarly outputs. Information, underscored by frameworks such as the ACRL, emerges as a cornerstone in preparing students for this task (Borchardt et al., 2019). Notably, Dahlen and Leuzinger (2020) highlight the integral role of synthesis of information and source attribution within capstone projects, delineating critical areas of focus in information literacy education.

Students today are native to the digital landscape and often exhibit fluency in information and communication technologies (ICTs), primarily for leisure pursuits and social networking. However, gaming and video streaming do not necessarily cultivate robust technological or information literacy pro-

ficiencies (Senkbeil & Ihme, 2017). Developing information literacy skills remains a critical educational objective in academic contexts, as these competencies are essential for scholarly engagement and advancement.

Illustrating this commitment to fostering information literacy, the Account and Finance Department at Kolej Poly-Tech MARA (Malaysia), in collaboration with Dublin Business School (Ireland), explicitly incorporates information literacy objectives within its capstone project module. This underscores the recognized importance of these skills in preparing students for academic and professional endeavours. With a duration spanning 26 weeks, this year-long program equips students with essential research competencies, including the ability to manage research projects independently, conduct comprehensive literature reviews, discern primary from secondary sources, and present structured analyses and recommendations.

Central to this endeavor is the ACRL's Information Literacy Framework, comprising six interrelated frames that underscore the multifaceted nature of information literacy. Within this framework, "Searching as Strategic Exploration" emerges as a focal point, emphasizing the deliberate and systematic approach required to navigate the vast array of available information (Association of College and Research Libraries, 2016). As students embark on their capstone projects, adeptness in information exploration becomes paramount, guiding their efforts in defining research questions, identifying reference sources, and synthesizing literature material (Association of College and Research Libraries, 2021).

RESEARCH OBJECTIVES

Drawing on recommendations such as those proposed by the Association of College and Research Libraries [ACRL], (2021), this paper aims to achieve the following objectives:

RO1: Assess the current information literacy skills of students undertaking Capstone projects.

RO2: Identify gaps in students' ability to find and evaluate literature material and their ability to construct effective search queries with the use of advanced search tools.

RO3: Prove the need for incorporating Boolean search techniques into Capstone scaffolded instructional materials.

RO4: Demonstrate the need for developing scaffolded online instructional materials to support students' research activities in Capstone projects

By achieving these objectives, this study seeks to provide a foundation for improving students' information literacy skills, ultimately enhancing their ability to conduct thorough and effective research for their capstone projects.

LITERATURE REVIEW

Effective information retrieval is crucial for undergraduate students, especially when working on Capstone projects. This literature review highlights the importance of strategic searching, as outlined in the ACRL Framework. It explores the challenges students encounter when constructing keyword searches and emphasizes the role of Boolean expressions in advanced search techniques, using existing advanced Boolean search tools within databases such as Google Scholar, Emerald, and JSTOR. The review also discusses the integration of these tools into an online scaffolded intervention module to promote an effective search experience when looking for material during the completion of the Capstone project.

ACRL: Framework for Information Literacy for Higher Education

The Association of College and Research Libraries (2016) has developed a framework that plays a critical role in teaching information literacy and assessing students' learning outcomes. This framework is conceptualized around six interconnected core concepts, each emphasizing a distinct aspect of information literacy. Figure 1 visualizes all six frameworks in ACRL.

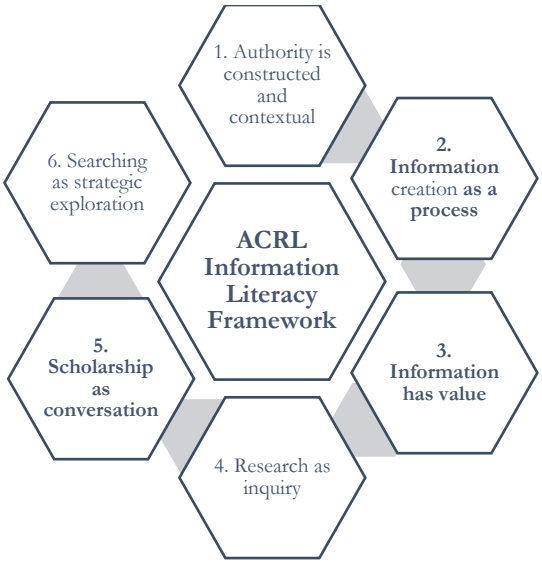

Figure 1. ACRL Information Literacy Framework (Association of College and Research Libraries, 2016)

The first concept in ACRL is the understanding that "Authority is constructed and contextual," which underscores the importance of recognizing that authority varies depending on the context. This concept encourages novice learners to respect expertise while remaining critical of its sources. Building on this. "Information creation as a process" highlights the iterative nature of researching, creating, revising, and sharing, all of which are essential for making informed decisions about information sources.

Further, the framework introduces the concept that "Information has value," manifesting in various forms such as intellectual property laws, access rights, and ethical use. Novice learners encounter these ideas through citation rules, plagiarism warnings, and the realization that even "free" information carries intrinsic worth. The progression of these ideas naturally leads to "Research as inquiry," which focuses on the iterative development of complex questions. This concept guides learners to refine their inquiries and methods while engaging in disciplinary dialogue, preparing them for deeper academic engagement.

In addition, "Scholarship as conversation" reflects the ongoing exchange of ideas among learners and experts, emphasizing the importance of understanding evidence and discourse, particularly within contexts influenced by power structures. Complementing this is "Searching as strategic exploration," which describes the nonlinear and iterative nature of the research process, where evaluating diverse sources and maintaining flexibility are key to discovering and accessing relevant information. These interconnected concepts provide a comprehensive approach to information literacy, allowing libraries and faculty to implement them in ways that best fit their unique contexts, including designing specific learning outcomes.

Building on this foundation, the Companion Document to the ACRL Framework (Association of College and Research Libraries, 2021) specifically suggests activities that can be conducted to enhance information literacy among tertiary education students. While the ACRL Framework defines information literacy conceptually (Burkhardt, 2016), the (Association of College and Research Libraries (2021) suggests practical methods for integrating these concepts into educational practices.

Consequently, the questionnaire items prepared in this study are based on the Marshal Information Competency Assessment Instrument (Marshall, 2006), the ACRL Framework, with careful consideration of the practical approach suggested in the Companion Document to the ACRL Framework (2021). This integration ensures that the study aligns with established frameworks and incorporates innovative approaches to fostering information literacy. The questionnaire, developed through this process, is later utilized to assess Capstone students' information literacy levels. The results of this survey will help justify the need to develop a Capstone online intervention module aimed at scaffolding students during the initial stages of their Capstone projects.

Determining the Connection Between Information Literacy and Capstone Projects

Building on the conceptual understanding provided by the Association of College and Research Libraries (ACRL) Framework, it is crucial to explore how information literacy is applied within the academic context, particularly in Capstone projects. Past research has consistently identified the potential for integrating information literacy development within Capstone classes across diverse disciplinary domains (Ault & Ferguson, 2019; Lin-Stephens et al., 2019). Studies examining Capstone programs in fields ranging from science and marketing to public health and nursing underscore the critical role of information literacy in preparing students for professional engagement (Jacobs et al., 2016; Leachman, 2018; Nelson-Hurwitz & Buchthal, 2019).

Throughout the Capstone journey, students' information literacy skills are rigorously assessed, providing valuable insights into their proficiency and areas for improvement. Recognizing the pivotal role of information literacy in enhancing students' employability, developing subject-specific information literacy modules is necessary (Borchardt et al., 2019). By embedding information literacy objectives within Capstone curricula, educators can effectively equip students with the requisite skills for scholarly engagement and professional success.

Challenges and Strategies in Constructing Effective Keyword Searches

Constructing effective keyword searches is a significant hurdle for Capstone students as they seek suitable literature for their projects. Moving from a theoretical understanding of information literacy to applying it in real research reveals how complex this transition can be. Studies by Dahlen et al. (2020) and Dahlen and Hanson (2023) reveal that many students struggle to identify the right keywords, leading to either an overwhelming number of irrelevant results or insufficient useful ones. This difficulty often arises from a lack of familiarity with advanced search techniques and limited experience navigating academic databases efficiently. Schoormann et al. (2021) highlight the importance of a strong foundation in research skills, emphasizing that defining a manageable research question is the first step. Developing search strategies requires an iterative approach, as students repeatedly refine questions and critically evaluate sources to reach a well-rounded understanding of their topics.

Addressing these challenges involves robust information-seeking strategies, particularly those focused on source selection. These strategies are essential as they refer to the searcher's plan for executing the search task, including specifying which source to use, the techniques for exploring them, and the order in which sources and queries should be explored and executed. By implementing these strategies, students can more effectively plan their search processes, select or exclude information sources, and ultimately decide when to stop searching (Savolainen, 2016). Thus, students can generally overcome the challenges of searches through more effective overall keyword strategies.

Using Boolean Operator to Refine Search Results

A key strategy in refining search results is the use of Boolean operators. For undergraduate students or novice researchers, it is crucial that their search domain is tailored to retrieving evidence and issues specific to their fields. This specialized approach differs significantly from general web searches or other types of searches. According to Russell-Rose et al. (2018), Boolean search remains the primary method for accomplishing the majority of professional search tasks, particularly when there is a very specific goal in mind. Data retrieval effectiveness depends on the student's capabilities and familiarity with search terms. They need to master search techniques to find the needed items. Although Saravanan (2020) acknowledged this, he did not concentrate on the obstacles students faced when utilizing the search terms, phrases, and Boolean operators to retrieve the data. Building on this, it becomes clear that undergraduate students must not only construct keyword searches but also learn to break down complex topics to precisely search words, broader searches, or add exclusions to their search strings.

Boolean operators – AND, OR, and NOT – offer powerful tools for refining search results, making the process more efficient and targeted. The AND operator ensures that search results include all specified keywords, narrowing the focus (e.g., "financial analysis AND risk management" retrieves results containing both terms). Conversely, the OR operator broadens the search scope by including any specified keywords, which helps explore topics with synonymous or related terms (e.g., "audit OR inspection"). The NOT operator helps exclude specific terms from search results, eliminating irrelevant or tangential material (e.g., "investment NOT cryptocurrency").

Furthermore, mastering Boolean search techniques significantly enhances students' ability to locate relevant and high-quality sources, elevating the quality of their Capstone projects. MacFarlane et al. (2022) highlight the importance of information retrieval in the research process, particularly during the literature search and study screening phases. They outline a comprehensive approach that begins with subdividing a review topic into key concepts and determining which concepts should be represented as discrete search facets. Terms are then collected for each facet and combined using Boolean operators. After testing the strategy, the results can be shared with team members before executing the search across different databases and adapting the strategy as needed. Finally, documenting and reporting the search strategy is crucial for ensuring transparency and replicability in research.

Breaking Down Keyword to Build Effective Boolean Search Strings

After understanding the utility of Boolean operators, the next crucial step for students is to master the process of deconstructing their research topics into clear, effective keywords. This is foundational for building search strings that yield accurate and relevant results. When faced with complex research questions, students may find it overwhelming to determine the best terms to search. Breaking the question down into key concepts and generating synonyms can simplify the search process and enhance the results retrieved from the database. Gusenbauer and Haddaway (2021) outline various search techniques, such as wayfinding, snowballing, filtering, successive fractioning, and the building block method, which primarily uses Boolean operators. Building blocks are typically applied in systematic searches, while snowballing serves both exploratory and systematic approaches.

Exploratory search is an intuitive interactive information retrieval, a straightforward way to find information online. Users who explore a topic often have limited knowledge of the topic and may not have clear goals to understand how to find the information they need (Soufan et al., 2022). However, teaching search as an intuitive, unstructured skill presents unique challenges, especially for novice researchers like the Capstone students. While structured search strategies can be taught in clear steps, exploratory searches require an adaptive mindset that many new researchers struggle to grasp without support. This challenge highlights the need for scaffolded instruction to help students build effective search strategies by learning to deconstruct their topics thoughtfully and use Boolean operators strategically.

Deconstructing is a critical component of this process, where the research questions are broken into a search string, a set of keywords connected by the Boolean operator (Muhammad, 2017). An effective tool for helping students break down keywords is the Chrome extension Boolean Search Assistant, which helps simplify the process of constructing Boolean search strings. By using these tools, students can experiment with combining keywords using operators such as AND, OR, and NOT and learn to refine their queries through trial and error. Additionally, as the university subscribes to academic databases like Emerald and JSTOR, familiarizing students with keyword breakdown techniques within these specific platforms can further enhance their search accuracy. Teaching students how to structure keywords into distinct concepts or blocks will enable them to utilize these resources more effectively, ultimately leading to more targeted and relevant findings that align closely with their research needs.

METHODOLOGY

To achieve the research objectives, we used a single-case study design and conducted a survey with structured questionnaires. The survey aimed to evaluate students' proficiency in information literacy according to the ACRL Information Literacy Framework. Additionally, it addressed broader research objectives related to students' search skills and overall literacy levels.

SAMPLING TECHNIQUES

The study employed purposive, non-probability sampling techniques to select participants. A survey was administered to 218 final-year undergraduate students from the Accounting and Finance Department who were enrolled in Capstone projects. These students represent a key demographic likely to face advanced research challenges, which this study aims to investigate. The purposive sampling ensured that participants were likely to possess some foundational knowledge of information literacy while needing to refine their search and information evaluation skills for Capstone work.

SURVEY INSTRUMENT

The questionnaire used in this study is adapted from the Instrument to Measure Information Competency (Marshall, 2006) and is aligned with the ACRL Information Literacy Framework. Table 1 illustrates the alignment between the Information Literacy Competency Assessment Instrument by Marshall (2006) and the ACRL Information Literacy Framework.

Table 1. Matching information literacy competency assessment instrument (Marshall, 2006) and information literacy framework (Association of College and Research Libraries, 2016)

Information literacy competency assessment instrument	ACRL information literacy framework
Identify Topic of Interest for The Capstone Project 1. I am confident in determining what topic to search for. 2. Sometimes, I feel lost because the topic I want to research is unclear. 3. I can take a complex topic and break it down into more useful, simpler items.	Authority is constructed and contextual
Assessing Confidence in Information Gathering Usage 4. "Confused" is probably the best term to describe me when starting the Capstone project. 5. I am sometimes unsure how much information I need for the Capstone project. 6. I am certain that I can use the information I find.	Information creation as a process

Information literacy competency assessment instrument	ACRL information literacy framework
Use of Information Technology 7. Given the project title: "The Practicum Performance of KPTM's Accounting Students in Industrial Internship Program," what search term(s) would you use to begin your research? (Please state your search keywords or phrases). 8. I will start my search at: a. Google b. Google Scholar c. DBS off-campus Library d. KPTM e-Library e. Others 9. I know how to broaden or narrow a search using Boolean operators (AND, NOT, and OR) and truncation. 10. I know how to use advanced search tools in Google Scholar.	Searching as strategic exploration
Find and Get Information 11. I know the difference between "primary" and "secondary" sources. 12. I can confidently use many different types of media (articles, annual reports, financial reports, etc.) as information for my Capstone project. 13. I can match information needs and search strategies to appropriate search tools.	
Evaluate Information 14. I can confidently spot inaccuracy, errors, etc., in the information from mass media. 15. The information I use is complete and reliable. 16. I am sure that the information I have answers my Capstone project research questions.	Information has value
Compile and Synthesise 17. I find it easy to categorise the information I have collected into relevant themes or topics. 18. Sometimes, my question changes depending on what information I find. 19. I know how to record or cite all my sources. 20. I can use at least one reference manager software confidently.	Research as inquiry
Presenting Information and Findings 21. I am confident in selecting the appropriate communication medium (e.g., slides, video) for delivering this information. 22. I understand my audience and am confident that the information I present meets their needs. 23. I am confident that the information I present is clear and well-organized.	Scholarship as conversion
Ethics and Validity of Information 24. I understand how to attribute and cite the original ideas of others properly. 25. I am aware of the ethical and legal guidelines for gathering and using information.	

The survey was comprised of 25 questions, using Likert scale items and semi-open structured questions. Each question assesses specific competencies outlined in the ACRL Framework, ensuring comprehensive coverage of information literacy skills.

Data Collection Procedure

The survey was conducted face-to-face in class with 218 students enrolled in the Capstone module, which facilitated immediate clarification of any questions and ensured a high response rate. For students who were absent, the questionnaire was also distributed online, targeting only those who missed the in-class survey.

Data Analysis

The survey primarily utilized Likert Scale questions, analyzed through descriptive statistics, to evaluate the distribution of responses related to information literacy competencies. By employing Likert Scale questions, the survey collected quantitative data to identify general trends in students' literacy skills, highlighting both areas of strength and challenges. To enhance this assessment, one open-ended question was included, allowing students to demonstrate their ability to formulate keyword searches based on a provided topic. This qualitative data enriches the findings by offering insights into the nuanced experiences of students, complementing the broader quantitative overview.

Results and Discussion

This section illustrates the results of our questionnaires. It is divided into four subsections based on research objectives. First, the current information literacy skills of these students are assessed, offering insights into their baseline proficiency level. Next, we identify specific gaps in students' abilities to effectively search for and critically evaluate literature, focusing on their use of advanced search techniques and query construction skills. Following this, findings underscore the need to incorporate Boolean search techniques into instructional materials for Capstone projects, providing evidence of their potential benefits in enhancing research outcomes. Finally, we discuss the necessity for scaffolded online instructional materials to support these students in navigating complex research tasks throughout their Capstone experiences. These results collectively inform recommendations to improve information literacy support for students.

RO1: Assess the current information literacy skills of students undertaking Capstone projects.

To evaluate students' information literacy skills in the Capstone project, we categorized their questionnaire responses based on the section in the questionnaire and later mapped it to the ACRL framework, as shown in Table 1. The box-and-whisker plot in Figure 2 illustrates the proficiency levels of students across these competencies.

The competencies in "Finding and Getting Information," which align with the ACRL's Searching as Strategic Exploration Framework, highlight the weakest areas. This finding reinforces the primary aim of this research: to assess students' current information literacy skills and to propose effective measures for improvement.

Figure 2. Visualization of information literacy competency

RO2: Identify gaps in students' ability to find and evaluate literature material and their ability to construct effective search queries with the use of advanced search tools

Figure 3 shows students' responses to the question about their preferred starting place when searching for Capstone materials. Of 218 students, 72% reported starting their searches with Google Scholar, making it the most popular choice. Similar findings were reported by Gusenbauer and Haddaway (2021), noting that Google Scholar is the most commonly used resource among researchers due to its straightforward, user-friendly access to a vast database of research records.

Another 47% of students indicated that they rely on Google as their starting point, highlighting a tendency to use general search engines over academic-specific databases. Only one student reported using the DBS off-campus library, and none used the KPTM e-library. This preference suggests heavily relying on accessible search engines over specialized academic databases. It indicates a significant underutilization of high-quality academic resources.

The finding that only one student used the DBS online library and none used the KPTM e-library is particularly concerning, given that both libraries subscribe to various databases. This shows a significant underutilization of valuable academic resources that are specifically tailored to support scholarly research. The lack of engagement with these specialized databases suggests that students may not be fully aware of the benefits or may not have the skills to navigate these resources effectively.

Later, in Figure 4, students were asked about their ability to use advanced search tools in Google Scholar. Advanced search tools offered by Google Scholar include features such as filtering results by publication years, author, and journal and including or excluding specific phrases with Boolean operators. These tools enable users to narrow their searches more precisely and locate articles that closely match their research needs. A significant percentage, 46% of students, confirmed that they know how to use the advanced tools, while 32% are uncertain, and 22% lack knowledge of these tools.

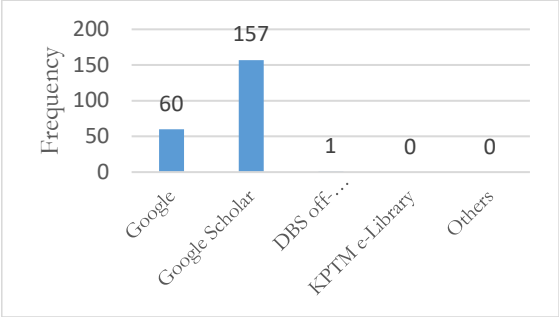

Figure 3. Starting place to start searching capstone material

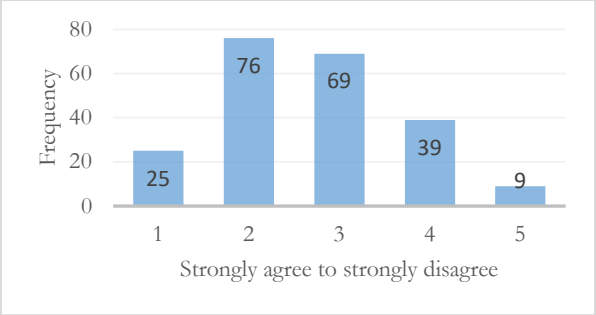

Figure 4. I know how to use advanced search tools in Google Scholar

The observation revealed significant gaps in students' ability to find and evaluate literature, particularly in their preference for general search engines over specialized academic databases. Another concerning finding was their limited knowledge of advanced search tools. The low usage of university-subscribed databases, combined with only moderate familiarity with Google Scholar's advanced features, highlights the necessity for targeted support.

To address this, providing students with structured training on utilizing Google Scholar's advanced search tools and encouraging them to engage with university databases will better equip them for thorough and efficient searches for their Capstone literature materials. Such initiatives are essential for enhancing students' information literacy skills and ensuring they fully utilize the valuable academic resources available to them.

RO3: Prove the need for incorporating Boolean search techniques into Capstone scaffolded instructional materials

Research objective 3 aims to establish the need to incorporate Boolean search techniques into Capstone instructional materials, addressing gaps in students' information literacy skills, particularly their ability to construct effective search keywords and refine searches using Boolean operators. This aligns with the identified need in the literature for structured information-seeking strategies mentioned by Dahlen and Leuzinger (2020) and Schoormann et al. (2021).

The bar chart shown in Figure 5 reveals a notable gap in students' confidence when constructing search queries using Boolean logic. This finding underscores a crucial deficiency in search strategy skills, consistent with the findings of past researchers Russell-Rose et al. (2018), which highlight the importance of Boolean techniques in achieving targeted and efficient information retrieval.

When asked for details about the ability to use Boolean expressions AND, NOT, and OR to narrow or broaden a search, only 11.5% of students reported strongly confident in using Boolean operators to refine their search keywords, 34.9% are confident they can construct keyword searches using Boolean expressions, while the rest, 54%, are not sure about their ability to do so. Schoormann et al. (2021) emphasise that effective research relies on the iterative refinement of search queries and critical evaluation of information sources, with Boolean operators being essential tools for managing search scope and locating pertinent literature. Figure 6 visualizes this situation.

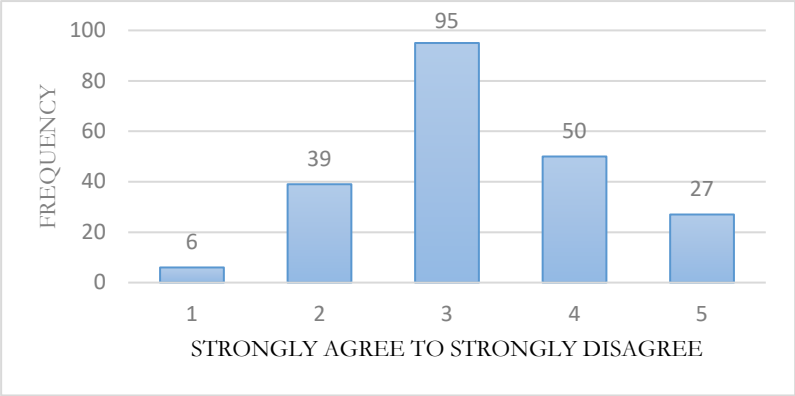

Figure 5. I know how to construct a suitable searching keyword using BOOLEAN expression to start my capstone project

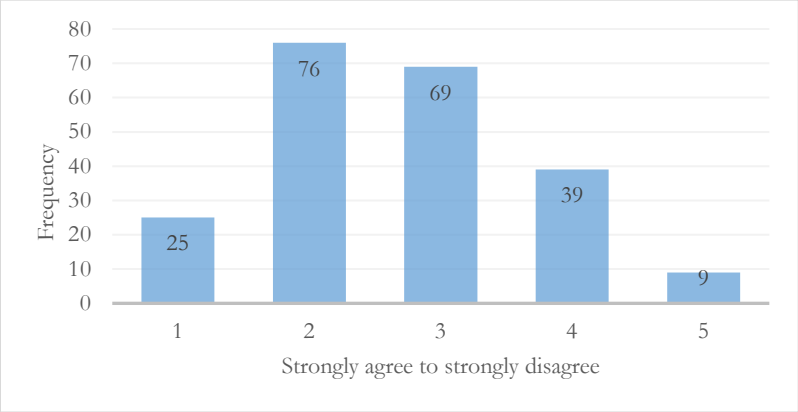

Figure 6. I know how to broaden or narrow a search using Boolean operators (AND, NOT, and OR) and truncation

The difficulty in broadening and narrowing down search string is not only faced by students undertaking the Capstone module. The limited familiarity with Boolean operators and truncation strategies further supports the need for targeted instruction. Lowe et al. (2020) propose that bridging these gaps through dedicated training in Boolean search methods can significantly enhance students' information literacy skills.

By identifying these deficiencies, this study sets the stage for the importance of incorporating Boolean search instruction into Capstone instructional materials. By addressing these skills, students will be better equipped to conduct effective, targeted literature searches, ultimately improving the quality of their Capstone research projects.

RO4: Demonstrate the need for developing scaffolded online instructional materials to support students' research activities in Capstone projects

Research objective 4 seeks to demonstrate the need to develop scaffolded online instructional materials to support students' research activities in Capstone projects. Findings from RO1, RO2, and RO3 clearly underscore significant gaps in students' information literacy skills, particularly familiarity with advanced search tools. These deficiencies emphasize a critical need for instructional interventions tailored to support Capstone research.

The results indicate that 72% of students started their search activity in Google Scholar, and 46% confirmed that they know how to use the advanced tools of Google Scholar. However, when they were asked for further details on their confidence in broadening and narrowing the keyword search (one of the advanced search filtering offered by Google Scholar), almost 79% of the students did not have confidence in doing so.

Other than the use of advanced search tools in Google Scholar, what is even more alarming is that only 0.4% of students used online databases subscribed to by the university libraries. Since this is a collaboration programme between Kolej Poly-Tech MARA Bangi (Malaysia) and Dublin Business School (Ireland), students have access to both online libraries. Among the databases subscribed to are Scopus, Emerald Insight, JSTOR, and IEEE Xplore. A very small percentage of usage shows underutilization of the resources designed for scholarly research. All these databases offer advanced search tools that require students to be able to break through the keywords, identify synonyms by using the OR operator, and narrow it down when there are specific exceptions.

Similar results were found by Lowe et al. (2020), which identified gaps in students' understanding of advanced search techniques, highlighting the importance of structured, guided support in search strategy development. An instructional approach that goes beyond merely teaching Boolean operators can better equip students by focusing on practical skills, such as breaking down complex research topics, identifying key terms, and generating synonymous or exclusionary terms to refine their search questions.

While there are various tools available for constructing Boolean search strings, such as BOOL: Boolean Search Assistant, which is available as a Chrome extension or advanced search functions in academic databases subscribed by the university, the true value lies in understanding how to effectively navigate these tools to address Capstone research objectives. These tools are just resources; what's more important is the knowledge and skill to use them in a way that yields precise and relevant search results.

These findings make it clear that students require structured, scaffolded support to build effective search skills for the Capstone projects. By developing comprehensive, scaffolded online instructional materials, students can learn to apply Boolean logic, use advanced search features, and critically analyze sources in ways that are directly relevant to their Capstone project.

CONCLUSION

The study identifies significant gaps in students' information literacy skills, particularly regarding their ability to construct appropriate search keywords using Boolean expressions and to utilize advanced search tools effectively. These deficiencies highlight the need for targeted instructional interventions to support students during their Capstone projects. Recommended actions include developing online instructional modules on advanced search techniques, adopting scaffolded learning approaches, and integrating these modules within the Capstone course. Addressing these gaps will improve students' abilities to locate and critically evaluate literature, ultimately preparing them for professional engagement and lifelong learning.

The limitation of this study is that it primarily highlights the need for scaffolded support during the information-seeking phase of Capstone projects. Future research should focus on developing and testing an online intervention module to determine whether scaffolded instruction significantly improves students' search precision and helps them achieve more accurate and relevant results. Such studies could confirm the practical benefits of tailored instructional support, especially in guiding students through complex research objectives and refining their search strategies.

REFERENCES

Association of College and Research Libraries. (2016). *Framework for information literacy for higher education.* https://www.ala.org/sites/default/files/acrl/content/issues/infolit/Framework_ILHE.pdf

Association of College and Research Libraries. (2021). *Companion Document to the ACRL Framework for Information Literacy for Higher Education: Research Competencies in Writing and Literature.* https://www.ala.org/sites/default/files/acrl/content/standards/framework_companion_LES.pdf

Ault, A. B., & Ferguson, J. (2019). Assessing undergraduate information literacy change over time. *Performance Measurement and Metrics*, *20*(2), 123–138. https://doi.org/10.1108/PMM-02-2019-0005

Borchardt, R., Salcedo, T., & Bentley, M. (2019). Little intervention, big results: Intentional integration of information literacy into an introductory-level biology lab course. *Journal of Biological Education*, *53*(4), 450–462. https://doi.org/10.1080/00219266.2018.1494029

Burkhardt, J. M. (2016). *Teaching information literacy reframed: 50+ framework-based exercises for creating information-literate learners.* American Library Association.

Dahlen, S. P. C., Haeger, H., Hanson, K., & Montellano, M. (2020). Almost in the wild: Student search behaviors when librarians aren't looking. *The Journal of Academic Librarianship*, *46*(1), 102096. https://doi.org/10.1016/j.acalib.2019.102096

Dahlen, S. P. C., & Hanson, K. (2023). In their words: Student reflections on information-seeking behaviors. *Journal of Academic Librarianship*, *49*(4), 102713. https://doi.org/10.1016/j.acalib.2023.102713

Dahlen, S. P. C., & Leuzinger, R. (2020). Impact of library instruction on the development of student skills in synthesis and source attribution: A model for academic program assessment. *The Journal of Academic Librarianship*, *46*(6), 102254. https://doi.org/10.1016/j.acalib.2020.102254

Gusenbauer, M., & Haddaway, N. R. (2021). What every researcher should know about searching – Clarified concepts, search advice, and an agenda to improve finding in academia. *Research Synthesis Methods*, *12*(2), 136–147. https://doi.org/10.1002/jrsm.1457

Jacobs, D. L., Dalal, H. A., & Dawson, P. H. (2016). Integrating chemical information instruction into the chemistry curriculum on borrowed time: The multiyear development and evolution of a virtual instructional tutorial. *Journal of Chemical Education*, *93*(3), 452–463. https://doi.org/10.1021/acs.jchemed.5b00427

Khuraisah, M., Fariza, K., & Hazrati, H. (2020). Preparing graduates with digital literacy skills toward fulfilling employability need in 4IR Era: A review. *International Journal of Advanced Computer Science and Applications*, *11*(6), 307–316. https://doi.org/10.14569/IJACSA.2020.0110641

Leachman, C. (2018). Engineering information for non-engineers: A case study in interdisciplinary application of the ACRL framework. *ASEE Annual Conference and Exposition, Conference Proceedings*, 2018-June. https://doi.org/10.18260/1-2--30413

Lee, N., & Loton, D. (2019). Capstone purposes across disciplines. *Studies in Higher Education*, *44*(1), 134–150. https://doi.org/10.1080/03075079.2017.1347155

Lin-Stephens, S., Kubicki, J. M., Jones, F., Whiting, M. J., Uesi, J., & Bulbert, M. W. (2019). Building student employability through interdisciplinary collaboration: An Australian case study. *College and Undergraduate Libraries*, *26*(3), 234–251. https://doi.org/10.1080/10691316.2019.1674027

Lowe, M. S., Stone, S. M., Maxson, B. K., Snajdr, E., & Miller, W. (2020). Boolean redux: Performance of advanced versus simple Boolean searches and implications for upper-level instruction. *The Journal of Academic Librarianship*, *46*(6), 102234. https://doi.org/10.1016/j.acalib.2020.102234

MacFarlane, A., Russell-Rose, T., & Shokraneh, F. (2022). Search strategy formulation for systematic reviews: Issues, challenges and opportunities. *Intelligent Systems with Applications*, *15*, 200091. https://doi.org/10.1016/j.iswa.2022.200091

Marshall, R. K. (2006). An instrument to measure information competency. *Journal of Literacy and Technology*, *6*(1), 1–27.

Muhammad, B. A. (2017). Efficiency of Boolean search strings for information retrieval. *American Journal of Engineering Research*, *6*(11), 216–222. https://www.ajer.org/papers/v6(11)/ZA0611216222.pdf

Nelson-Hurwitz, D. C., & Buchthal, O. V. (2019). Using deliberative pedagogy as a tool for critical thinking and career preparation among undergraduate public health students. *Frontiers in Public Health*, *7*(MAR). https://doi.org/10.3389/fpubh.2019.00037

Russell-Rose, T., Chamberlain, J., & Azzopardi, L. (2018). Information retrieval in the workplace: A comparison of professional search practices. *Information Processing and Management*, *54*(6), 1042–1057. https://doi.org/10.1016/j.ipm.2018.07.003

Saravanan, D. T. (2020). Evaluating the effectiveness of keyword, phrase, boolean operator [AND] in bibliographic data access and retrieval for the subject chemistry. *Library Philosophy and Practice*. https://digitalcommons.unl.edu/libphilprac/3952/

Savolainen, R. (2016). Information seeking and searching strategies as plans and patterns of action: A conceptual analysis. *Journal of Documentation*, *72*(6), 1154–1180. https://doi.org/10.1108/JD-03-2016-0033

Schoormann, T., Behrens, D., Fellmann, M., & Knackstedt, R. (2021). On your mark, ready, search: A framework for structuring literature search strategies in information systems. In F. Ahlemann, R. Schütte, & S. Stieglitz (Eds.), *Innovation through information systems* (pp. 558–575). Springer. https://doi.org/10.1007/978-3-030-86790-4_38

Senkbeil, M., & Ihme, J. M. (2017). Motivational factors predicting ICT literacy: First evidence on the structure of an ICT motivation inventory. *Computers and Education*, *108*, 145–158. https://doi.org/10.1016/j.compedu.2017.02.003

Soufan, A., Ruthven, I., & Azzopardi, L. (2022). Searching the literature: An analysis of an exploratory search task. *CHIIR 2022 - Proceedings of the 2022 Conference on Human Information Interaction and Retrieval* (pp. 146–157). Association for Computing Machinery. https://doi.org/10.1145/3498366.3505818

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