

# Stretching PICO: Implications for Database Searching and Perceived Searching Confidence

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## Abstract

The purpose of this small, interdisciplinary, teaching and learning study is to examine database search strategy development in a class of first year undergraduate library technician students, comparing the effectiveness of structuring a search employing PICO, a clinical question formulation tool used in evidence based medicine, to using the generic keyword concept map commonly taught in information literacy contexts. This study also investigates these students' preferences, and the impact on their perceived searching confidence when using the two approaches. Structured worksheets were used to guide students through the application of the two methods, and student results were captured via an online survey. Analysis revealed comparable recall scores for database search results between the methods, higher precision scores for PICO, and comparable self-rated searcher confidence.

**Keywords:** information literacy, reference services, database searching, library technicians, library education

## Introduction

Library technician students develop knowledge, expertise, and skill in answering library patron reference questions on diverse topics in order to prepare them for future careers in the library field. The Canadian Federation of Library Association's "Guidelines for the Education of Library Technicians" (2011) notes in their Introduction that "library technician program' refers to such programs as library studies, library arts and documentation technology, [and] library and information technology" (para. 3). In Canada, there is a strong connection between the post secondary undergraduate library technician diploma programs and the library technician diploma qualification for employment purposes. Upon graduating with their diploma, library technicians support the many services offered in a variety of library environments.

In libraries, reference questions are received from patrons seeking information on a variety of topics, and a key element of library service is to provide assistance, resources, and information to help answer these information seeking questions. Students in library education programs develop the requisite knowledge and expertise for translating diverse library patron questions into effective search strategies. A preliminary step of this information literacy process is to identify the key concepts

inherent within the question (Adams, 2014). In information literacy education, often the guidance for this step is to have students develop a generic concept map in order to identify searchable terms.

In Evidence Based Practice (EBP) in the health and medicine fields, this step is structured much more specifically using PICO (Adams, 2014; Hoogendam, de Vries Robbe & Overbeke, 2012; Kloda & Bartlett, 2013). PICO is an acronym wherein P represents patient or population; I represents Intervention; C represents Comparison; and O represents Outcome. PICO is an approach to formulating focused, answerable clinical questions from a patient or population scenario, revealing relevant keywords to begin database searches (Adams, 2014), with some seeing its potential for enabling learners to develop search directed thinking (Snowball, 1997). Welty, Hofstetter and Schulte (2012) suggest that PICO, with its inherent structure for guiding searching, should be considered outside of the clinical context, and taught as a more effective approach to structuring a search strategy in information literacy instruction.

This small, interdisciplinary, teaching and learning study explores how PICO could be modified and applied outside of the clinical EBP context as a novel teaching approach in information literacy education. Specifically examined is the effectiveness of PICO vs generic concept mapping as searching strategies for these first year library technician students, also considering student preferences, and differences in perceived searching confidence between the two strategies. This study addresses gaps in the published literature on the effectiveness of applying PICO outside of the clinical, health or medical contexts.

## **Literature Review**

The use of generic concept mapping assists searchers in articulating the information need, finding focus for searching, and translating this into a structured search strategy, and has been associated with more competent searchers, better search results, and increased searcher confidence (Gordon, 2000; Kuhlthau, Heinström, & Todd, 2008). Concept mapping has been shown to be particularly useful in the focus formulation stage of Carol Kuhlthau's Information Search Process (ISP), a stage of the ISP that is critical to the development of searcher competence and confidence (Gordon, 2000; Kuhlthau, 1991; Kuhlthau, Heinström, & Todd, 2008).

In evidence-based practice in healthcare, PICO is used to formulate answerable clinical questions, and can be applied as a structured concept mapping approach to develop more focused search strategies for retrieving more relevant results (Adams, 2014; Booth, 2006). The application or adaptation of PICO for use beyond a strictly medical or clinical context has been suggested in the literature (Booth, 2006; Crumley & Koufogiannakis, 2002; Davies, 2011; Kloda & Bartlett, 2013). For example, Crumley and Koufogiannakis (2002) adapt and apply the principles of PICO to the discipline of librarianship, in the formulation of well-built research questions to guide evidence-based librarianship, with Booth (2006) building on their work to propose a revised mnemonic for structured question formulation for information professionals. The application of the

principles of PICO to information literacy education more generally has been proposed by Welty, Hofstetter and Schulte (2012), who argue that the PICO elements, particularly the P and the I elements, can be easily adapted as a means of guiding students through the search process across many disciplines.

In their study involving physicians and medical residents, Hoogendam, de Vries Robbe and Overbeke (2012) compared the precision and recall scores for structured PICO searches on therapeutic questions versus unguided searches in PubMed, finding no significant difference in recall and precision scores between the PICO and the unguided searches. This small study also explores the effectiveness of a PICO search strategy versus a generic search strategy as measured by recall and precision scores. However, the researchers of this small study are interested in the usefulness of PICO, and the structure it provides, to novice searchers, assumed to have little to no prior topic knowledge, unlike the physicians and medical residents of the Hoogendam, de Vries Robbe and Overbeke (2012) study, with presumably more experience in searching on therapeutic questions, in addition to their greater knowledgeability of the topic area. There was no identified research into the effectiveness of the application of PICO by novice searchers in structuring searches on non-clinical queries, outside of the therapeutic or medical fields.

## **Methods**

The student population chosen for this study was a class of first year undergraduate students enrolled in the library technician program at MacEwan University, in Edmonton, AB, Canada. This student group was chosen as the convenience sample for this study because one of the researchers, also the professor for this particular student group, was willing to integrate this small teaching and learning study into regularly scheduled class time. Additionally, the curriculum for this particular course includes instruction on generic concept mapping as an information literacy tool, so the addition of instruction on PICO was a relevant match for both the course curriculum and level of prior student knowledge. In fact, PICO is traditionally taught to these students in their second year during a unit on health libraries and medical reference instruction. As future library paraprofessionals, an additional benefit of choosing this particular student group was that the researchers could involve the students in the research process in a library context, which added contextual learning to skills and knowledge necessary for future careers within a library environment.

This small study set out to answer the following questions for our particular student population:

Will using PICO produce better search results, as measured by precision and relevance, than using a generic concept map?

Will using PICO improve perceived searching confidence when compared to using a generic concept map?

In January 2018, the researchers, the professor and a nursing librarian at [A University] Library, collaboratively facilitated guided searching activities during one 80 minute

lecture period in a computer lab. Separate worksheets were used by the professor to model the procedures for the generic concept map strategy during the first part of the lecture period, and by the librarian to model the procedures of PICO during the second part of the lecture period (see Appendix A). Immediately following each of the two demonstrations, students employed the respective strategy, first generic concept map and then PICO, to address sample library patron reference scenarios (see Appendix B). The students used the worksheets (see Appendix A), which were not collected, to record their thinking, and an online form (see Appendix B), which was collected, that provided the following: permalinks to database search results, indication of preferred strategy, perceived confidence scores, and qualitative comments.

This study received Research Ethics Board approval from [A University]. A Participant Consent Form was explained and included on the online form and consent was implied by completing and submitting the online form at the end of the class period. So as not to sway the professor's grading during the term, only the librarian had access to the research data until after all the students' grades were finalized upon term completion.

## Results

Although 37 students were enrolled in the course, not all were in attendance during the class and only 29 completed the survey. As the aim of this study was to compare search strategy methods, data resulting from extensive errors in student application of search strategy methodology, such as exceedingly incorrect use of Boolean operators, were removed from the dataset prior to analysis. Students were required to provide a permanent link to their searches for analysis, and results that did not provide a viable permanent link were also removed.

Viable database search results were analyzed for recall, the effectiveness of the search strategy in retrieving relevant results, and for precision, the percentage of relevant results within the results retrieved. Major database subject headings and key search terms were used by the librarian to establish the set of relevant articles for each topic, to which student search results were then compared. Recall and precision scores were calculated for both the generic concept mapping search results and the PICO search results, as follows:

R = Established set of relevant articles within the database for the given topic

X = Search result count (total articles retrieved in search)

N = Number of R (relevant articles) within X (search results)

Recall score:  $N/R * 100$

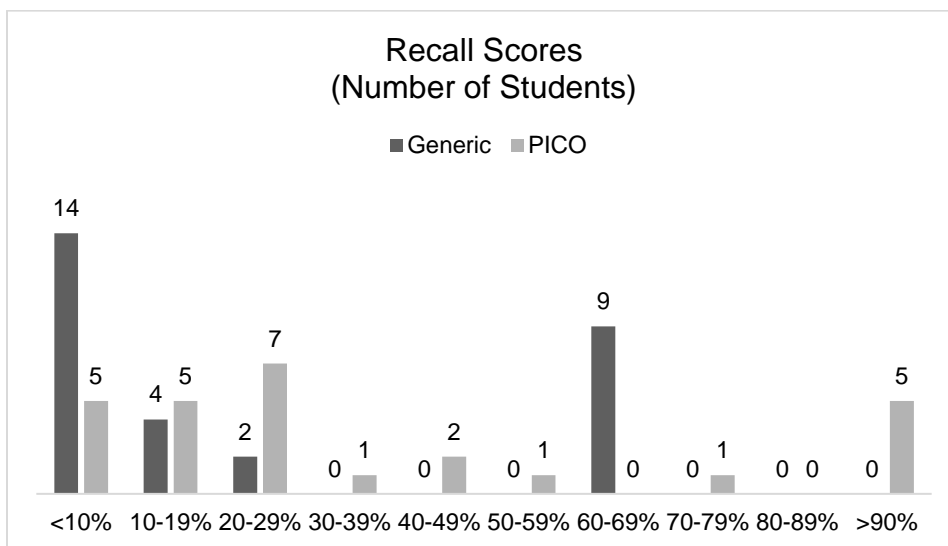
Precision score:  $N/X * 100$

Note that recall and precision scores were calculated for all 29 generic concept map responses, and for 27 of the 29 PICO responses. Two student results for the PICO search strategy were omitted from the analysis. In one case the results were not available because the student did not provide a permanent link to the database search

results, and in the second case the search string employed erroneous Boolean operators, producing search results that were not on the subjects being analyzed.

### **Recall Scores**

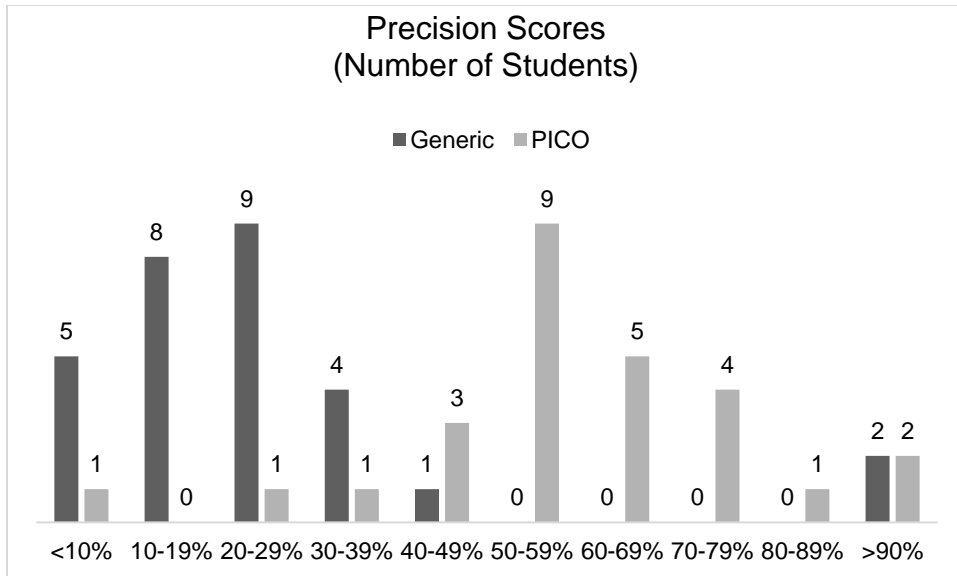
Recall Scores address the question: how many of the articles identified as 'relevant' were retrieved by the search? Recall scores were determined by calculating the percentage of the established relevant articles actually retrieved by the students' database searches. The highest recall scores were for PICO searches, and the greatest number of low scores were for Generic searches, however, the results showed no statistically significant difference in average recall scores between the Generic (25%) and PICO (36%) methods. The range for both methods varied widely.



Graph 1: Recall Scores

### **Precision Scores**

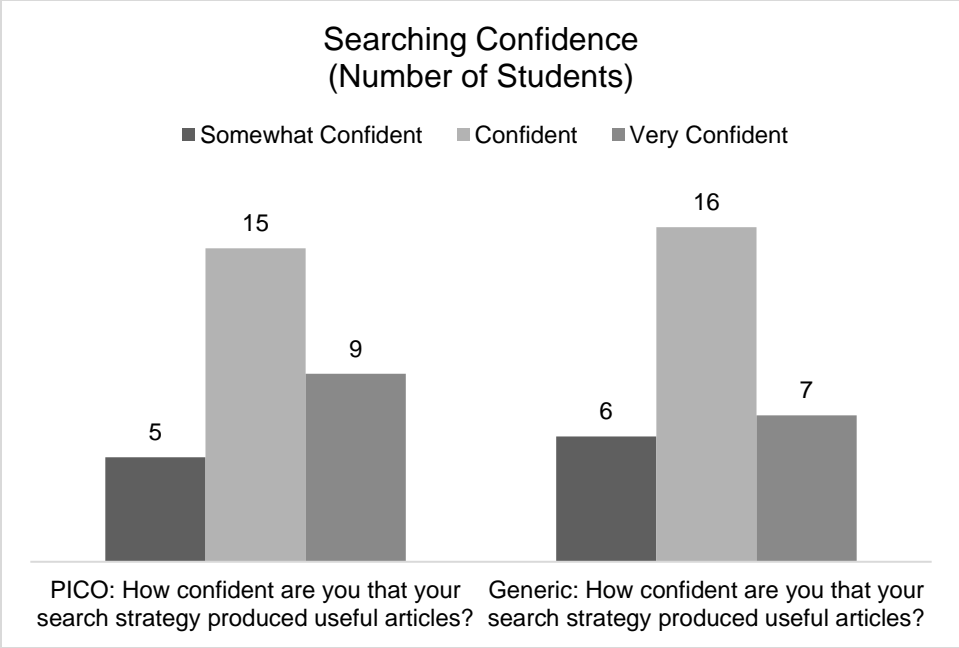
Precision scores address the question: of the results retrieved, how many were actually relevant to the topic? Precision scores were determined by calculating the percentage of established relevant articles within the list of results retrieved by students. The highest average precision score was for the PICO method (58%), higher than the average precision score of the Generic method (26%).



Graph 2: Precision Scores

### ***Searching Confidence***

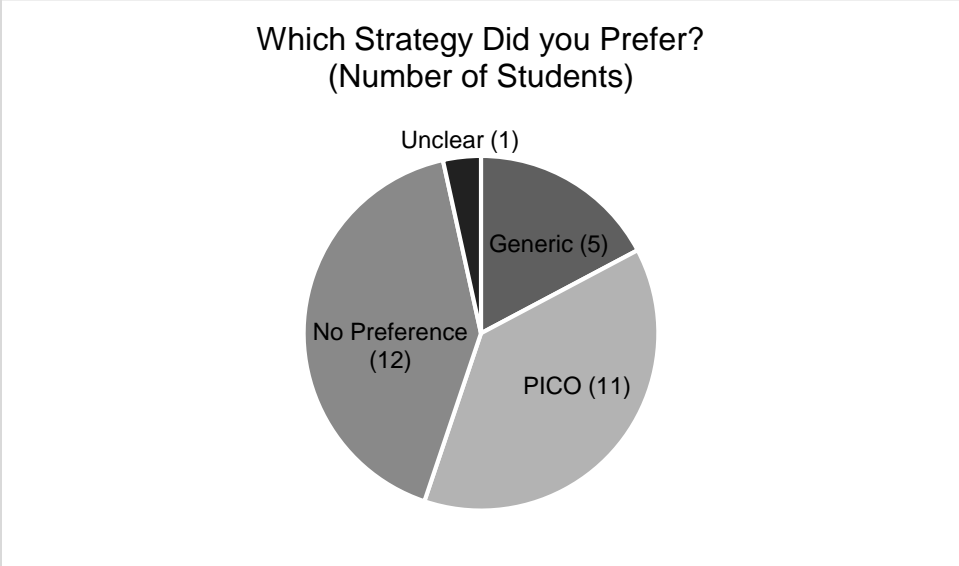
Students were asked to rate their confidence for the question: how confident are you that your search strategy produced useful articles? Ratings were similar for both PICO and the generic concept map, with 9 students (31%) reporting they were very confident that PICO and 7 students (24%) reporting they were very confident that the generic concept map produced useful articles. Confident ratings for PICO (15 students or 52%) compared to generic concept map (16 students or 55%) and somewhat confident ratings for PICO (5 students or 17%) and generic concept map (6 students or 21%) were likewise close. No students chose Not Very Confident or Not at all Confident for either search strategy.



Graph 3: How confident are you that your search strategy produced useful articles?

**Search Strategy Preference**

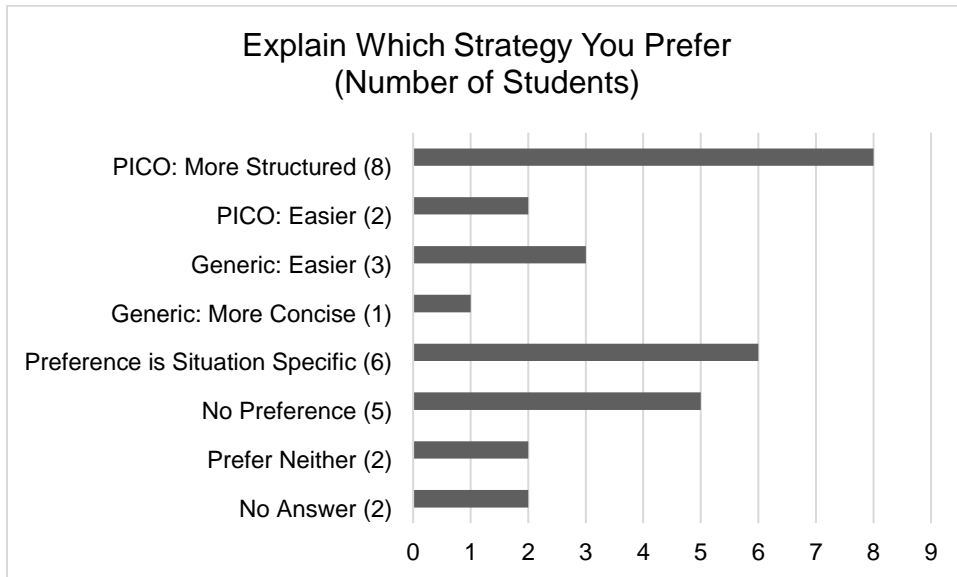
Twenty-nine students answered the question: which search strategy did you prefer using? Of these 29, the majority (12 students or 41%) had no preference. PICO was the preferred strategy for 11 students (38%), while 5 students (17%) preferred the generic concept map and 1 result (3%) was unclear.



Graph 4: Which search strategy did you prefer using?

Students were asked to explain their chosen search strategy preference. The responses for the 29 students who submitted a response to this question were thematically

grouped as to preference and explanation. From the comments provided, the majority of students who commented on their preference for PICO noted it provided more structure for searching, while the majority who commented on their preference for generic concept map stated it was easier to use. Many students (6 students or 21%) commented that their strategy selection would be situation specific.



Graph 5: Which search strategy did you prefer using? Explain your answer.

Student comments explaining their search strategy preferences are included in Table 1.

Preference Themes	Student Comments
Generic Concept Map	<p>“Using a generic concept map is more concise with less search terms.”</p> <p>“I felt like [PICO] was a lot to try to remember for something that produced very similar results. I prefer something more streamlined.”</p> <p>“I'm not confident in my "O" answer for PICO. The format for the generic concept map is easier to work with.”</p>
PICO	<p>“The chart is more organized and can create a better search.”</p> <p>“The process of PICO before searching the actual terms helps to clear up what it is that you want specifically, giving you a much more accurate search to start compared to generic concept mapping.”</p>



	<p>“PICO helped narrow down the search to specifically what needed to be focused on in the search. It was easier to brainstorm additional keywords.”</p> <p>“It helps to structure it better, and I got wanted results far faster than when using keyword searching.”</p>
Situation Specific	<p>“I think it really depends on the topic and the kind of search that you're doing. Of course, it depends on the type of patron as well.”</p> <p>“It depends. Health-related question PICO probably works better.”</p>
No Preference	<p>“PICO makes you look at the larger concept of things but even a general concept can get you there depending on how you search personally.”</p> <p>“I found they both gave good answers.”</p> <p>“They both make sense to me, just two different methods of writing the same kind of ‘sentence’.”</p>

Table 1: Sample Student Comments by Preference Theme

**Discussion**

Analysis of the search results revealed a wide range of recall scores for both the generic concept mapping strategy and PICO strategy, indicating that with this particular student group both strategies were comparable at producing relevant results. However, unlike Hoogendam, de Vries Robbe and Overbeke (2012), who also reported similar precision scores, results from our study showed a greater average precision score with PICO searches, indicating that the percentage of established relevant results within the total number of results retrieved were higher when PICO was used. The application of PICO in the development of a strategy from a scenario necessarily involves specifying additional topical aspects, and thus may also lead to greater specificity regarding search term selection for these aspects, resulting in the greater precision for the PICO searches. As Crumley and Koufogiannakis (2002) have observed, “having a well-built question focuses your search for information” (p. 62).

One of the distinguishing elements of the Hoogendam, de Vries Robbe and Overbeke (2012) study was that the searchers were already expert practitioners in medical fields. It is likely that this greater knowledge base and search history experience prior to

undertaking a natural language or PICO query would affect search outcomes. Hoogendam, de Vries Robbe and Overbeke (2012) did note potential impact of this topic familiarity on search effectiveness, observing, “increasing knowledge of a subject area may have a stronger effect on recall than on precision” (p. 121). In information literacy instruction, in this case with first year library technician students, there cannot be an assumption of topic knowledge prior to undertaking a search.

Analysis of the self-rated searching confidence scores revealed no difference between the two strategies, though the review of the student qualitative responses provided insight into their experience with the two strategies. Despite the lack of preference indicated by students, various comments highlighted the effectiveness of PICO specifically for structuring a focused search. This echoes Hoogendam, de Vries Robbe and Overbeke (2012) who state “some questions may be more suitable for the PICO method than others” (p. 125). Additionally, several students noted their preference would be situationally determined, thus demonstrating the ability to think critically about the context and value of question formulation to the search process.

A number of limitations to this small study can be identified. As this was a class activity, and not a controlled research environment, it is possible that students collaborated on their answers, which may have affected results. In order to ensure that the class worksheet and activities were engaging to the student group, different scenario questions were used for the generic concept map and PICO examples, respectively (see Appendix A). As search strategy development may differ for different topics, this may have affected the precision and recall comparison. Furthermore, due to the availability of assigned database subject headings for the two topics, the process for constructing the database searches and establishing the set of relevant articles for the analysis differed slightly between topics.

Additionally, as the entire class completed the same examples in sequence, improved precision scores for PICO may be a reflection of skills developed in prior practice via the application of generic concept mapping. It was imperative for all students to receive the same instruction as only one class period was available, so a control group or staggered instruction could not be employed in this circumstance. It should be acknowledged that the sample size was small, due to the convenience sampling used for this study, and that the results may not be generalizable to a wider population. In terms of the student attitudes and comments regarding search strategy preference, it is possible that our use of the term ‘generic’ may have unintentionally introduced an element of bias.

The researchers were not interested in the formation of correct or efficient search strings incorporating Boolean operators, phrase searching and truncation, for example. Though students were taught Boolean operators and search string formation prior to this study, this was not emphasized or reviewed during the class period when this study took place. Additional insight into student searching behavior may have been revealed if emphasis on and analysis of search string effectiveness had taken place, though the researchers decided this was out of the scope of this particular study.

## Conclusion

This group of library technician students did not demonstrate any difference in confidence ratings between, or indicate a clear preference for, the PICO and generic concept mapping search strategies. Nevertheless, the qualitative findings indicate that the students found both strategies to be useful, depending on their personal searching abilities, context of information need, or sample library patron reference scenario. Based on these results, the professor will continue to provide this class activity in future first year course offerings. It is believed that these first year library technician students benefited from being exposed to the PICO search strategy, not only for their future post secondary studies but also for their future careers as library reference providers. Additionally, as incoming second year students will now already have this foundational knowledge of PICO, health library related curriculum in year two can be scaffolded accordingly, with the instructional focus being directed towards advanced health information searching topics such as database controlled vocabulary.

It is imperative to teach future library and information paraprofessionals a range of strategies to develop searching expertise and enhance flexibility for future patron reference interactions. PICO can be considered a valuable tool that could be adapted for general reference practitioners, but also general populations of undergraduate students as a tool for information seeking success. Thus, similar future research could be conducted with a general undergraduate student population in order to ascertain the degree to which PICO improves relevant student search results, perceived searching confidence, and the ability to think critically about information in context.

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# Appendix A: Worksheet

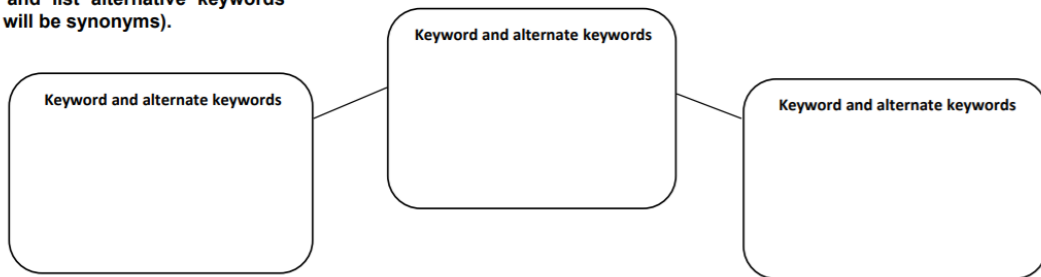
## Create a Concept Map for Your Topic

Complete a Concept Map to identify the keywords and concepts you will use when you search for articles about your topic. It can help you identify what you know about your topic and begin to think about your topic in new ways.

1. Write your topic in the box below. Circle or underline your keywords or keyword phrases:

TOPIC:

2. Enter your keywords in the boxes below and list alternative keywords (these will be synonyms).



3. Use Boolean, Phrase searching, and / or Truncation to create a search string.

### Using PICO with Your Topic

Use PIC(O) to identify the keywords and concepts you will use when you search for articles about your topic. It can help you identify what you know about your topic and begin to think about your topic in new ways.

1. Write your topic in the box below. Circle or underline your keywords or keyword phrases:

<b>TOPIC:</b>
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2. Enter your keywords in the columns below and list alternative keywords (these will be synonyms).

People? Population? Patient? WHO?	Issue? Intervention? Issue? WHAT?	Context? Comparison? WHERE? WHEN?	Outcomes? WHY?
Keywords & synonyms	Keywords & synonyms	Keywords & synonyms	Keywords & synonyms

3. Use Boolean, Phrase searching, and / or Truncation to create a search string.

## **Appendix B: Online Form Questions**

### **Part I**

Scenario: A patron at the public library comes to the reference desk looking for ideas for how to overcome morning sickness during pregnancy.

Fill in the aspects from your concept map below:

Subject area #1, and alternate keywords:

Subject area #2, and alternate keywords:

Subject area #3, and alternate keywords:

After conducting your search in Academic Search Complete, paste in the permanent link to your search in the space provided, and then answer the questions below.

Permanent link to search:

How confident are you that your search strategy produced useful articles? (Not at all confident 1 to 5 Very confident)

How confident are you that your search results answers the patron's reference question? (Not at all confident 1 to 5 Very confident)

### **Part II**

Scenario: Your patron is researching post-traumatic stress disorder in the Canadian military.

Fill in the aspects from your PI(C)O model below:

P (Patient, Population, Problem), and alternate keywords:

I (Intervention, Issue), and alternate keywords:

C (Comparison, Context), and alternate keywords - (Optional):

O (Outcome / desired Outcome), and alternate keywords:

After conducting your search in Academic Search Complete, paste in the permanent link to your search in the space provided, and then answer the questions below.

Permanent link to search:

How confident are you that your search strategy produced useful articles? (Not at all confident 1 to 5 Very confident)

How confident are you that your search results answers the patron's reference question? (Not at all confident 1 to 5 Very confident)

### **Part III**

Which strategy did you prefer using?

- A. Generic concept map
- B. PICO
- C. No preference

Explain your answer.