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Information literacy: in an inquiry course for first-year science undergraduates: a simplified 3C approach

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Rangachari PK, Rangachari U. Information literacy in an inquiry course for first-year science undergraduates: a simplified 3C approach. *Adv Physiol Educ* 31: 176 –179, 2007; doi:10.1152/advan. 00092.2006.—In this article, we describe a simplified approach to teach students to assess information obtained from diverse sources. Three broad categories (credibility, content, and currency; 3C) were used to evaluate information from textbooks, monographs, popular magazines, scholarly journals, and the World Wide Web. This 3C approach used in an inquiry course for freshmen in an undergraduate science program can be readily transferred to other settings.

literature search; faculty-librarian interaction; critical appraisal; credibility; content; currency

THE ROLE OF THE TEACHER as a mere dispenser of information has been drastically altered with the emergence of the World Wide Web. The students who enter the portals of a modern university are not only more computer literate than their teachers but they take for granted that all the information they need will be available on their computers. Duncan (4) calls this the "Ali Baba" effect, where "instead of three rubs on the proverbial magic lamp, they expect two clicks of the mouse will produce the desired result." Although students may be "computer avid," they are not necessarily "information literate" and may be ill equipped to evaluate the information that they obtain (9). It has been recognized for decades that student skills at searching for information need to be enhanced (5, 13), but the ready avail-ability of internet sources has made the problem more acute. Therefore, teachers and librarians have joined forces to help students seek, synthesize, and integrate information from di-verse sources (3, 5–7, 13, 14).

In this article, we describe one such venture where an educational resource specialist (U. Rangachari) and a teacher (P. K. Rangachari) tried to foster information literacy among freshmen students in an undergraduate science course in an Honors Program in Health Sciences at the University of Calgary.

METHODS

The course and the students. The course was taken by 60 students at the University of Calgary in the Bachelor of Health Sciences (Honours) Program. Most of them had just entered the university after 12 yr of schooling, although some of them were transfer students who had been in the university for 1 yr or more. The objective of this inquiry course was to permit freshmen students to explore one important facet of modern scientific practice viz. communication. Using science-based news items published in newspapers or popular magazines, students explored not only how scientists communicated with each other by looking at peer-reviewed papers but also how scientific research is communicated to the public by the mass media. Since this was an inquiry course, students were actively engaged in their learning. The expectations and outcomes of the course have been previously published (10). In that version of the course, students were given a very general orientation to information sources, but we recognized that it was not precise or detailed enough for them. Therefore, when the course was taught the second time around, we specifically targeted information literacy.

Information literacy: an operational definition. The term "information literacy" has been interpreted in diverse ways. We used available information to frame an operational definition of information literacy that suited our purposes (2, 7). The most explicit and helpful information came from the standards-based exercises published by the American Library Association guide (2). For our purposes, a student who was competent in that regard was one able to *1*) frame a clear question to be answered, *2*) list sources needed to obtain the relevant information, *3*) found sources if possible, *4*) evaluated the credibility of the source, and *5*) synthesized the information available. Given the specific requirements of this course, we wanted students to assess not only scientific literature but popular magazines as well. We restricted our attentions to popular magazines that had science-based articles.

The process. On the first day of the course, we split the class into three groups, and, over a 30-min period, the librarian conducted a brief survey of the students to obtain baseline information about their comfort levels in using diverse sources of information and their awareness of criteria for evaluating the information they found. As expected, students seemed to be quite comfortable with the use of computers but were less certain of what criteria were required to assess the value of the information obtained from different sources. The following week, the same groups were given a 45-min orientation to library resources, emphasizing not only the catalog but also other facilities like interlibrary loans and document deliveries.

In the third week, we divided the class into two groups and spent an hour with each group discussing information literacy as it pertained specifically to the tenets of the course. The sessions were held in a room appropriately wired for searching on-line material. They were given the handout, which we had developed jointly, detailing the criteria for evaluating information from *1*) books (textbooks, dictionaries, encyclopedias, and monographs); *2*) popular journals and magazines; *3*) scholarly journals; and *4*) web sources. From published sources (1, 2), we developed a simplified set that we termed the 3C approach. Each source was assessed on three criteria: credibility, content, and currency. These are described in Tables 1– 4.

We emphasized the differences between scholarly, peer-reviewed journals and popular magazines. We told them that although certain popular magazines had fact checkers, there really was no systematic

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SIMPLIFIED 3C APPROACH FOR INFORMATION LITERACY

Table 1. *Evaluation of print resources (books, textbooks, dictionaries, and encyclopedias)*

Credibility
1. Authors: dictionaries/encyclopedias are published by reputed companies (check credentials), and material is contributed to by scholars in the field whose credentials are given. Books (textbooks/monographs) are written by scholars with credentials given and affiliations specified to institutions or organizations.
2. Publishers: several specialize in certain fields (e.g., Elsevier, Lipincott, and Mosby for the sciences; Sage for social sciences; Josey-Bass for education, etc.); others are more general (e.g., Penguin).
3. Material: well referenced with footnotes, etc., to corroborate information.

Content
1. General content: dependent on subject.
2. Presentation: written clearly with figures and/or tables for illustrative purposes.
3. Material: based on other sources, not original information.
4. Perspective: usually balanced, but, on occasion, monographs (in particular) may present specific points of view.

Currency
1. Books, particularly textbooks, present consensus information; they are not cutting edge and therefore not as current as scholarly journals.
2. The date of publication and dates of references are good indicators as to the currency of information.
3. Some classic titles still remain significant despite being dated (e.g., Charles Darwin's *The Origin of Species* and Claude Bernard's *Introduction to the Study of Experimental Medicine*).

peer review. Since journalists often worked under time pressures and demands, the information provided may not have been thoroughly revised. We spent a considerable period of time discussing web pages and emphasized that although "Googling" may be an easy way to begin, they needed to confirm or deny statements made on web pages.

Swanson (12) emphasized that it is important to get students to not only learn how to use tools properly but also to teach them about information itself. Therefore, we discussed the flow of scientific information from raw data gathered in privileged spaces (laboratories) to published papers, standard texts, and, finally, mass media. We also told them that many peer-reviewed journals made their contents

Table 2. *Evaluation of popular journal, magazine, and newspaper articles*

Credibility
1. Authors: articles are usually written by staff writers or freelance journalists; some have established credentials because of experience.
2. Accuracy: journalists work under time constraints, which may hamper information reliability/accuracy.
3. Verification of information: weekly and monthly magazines often use fact checkers; newspapers rarely do.
4. Bias: content can be modified by editorial decisions or dependent on advertisements/subscriptions.

Content
1. General content: articles are written for a general audience and, therefore, simplified.
2. Material: do not publish results of original research; information is taken from other sources, but often no extensive references or bibliographies are given, which could make it difficult to trace provenance.
3. Presentation: may use figures and/or diagrams for illustrative purposes only. Presentations are glossy.

Currency
1. Currency is varied. Some magazines may focus on current issues; information may not be up to date as these are derived from secondary sources.
2. Check the frequency of publications as a good indicator as to the currency of information.

Table 3. *Evaluation of scholarly journal articles*

Credibility
1. Authors: articles may have multiple authors, but their academic credentials and institutional affiliations are given.
2. Publishers: usually published by societies, professional organizations, scholarly presses, or universities.
3. Accuracy: peer reviewed, so facts and methods have been verified. Detailed references, footnotes, etc., are given so that facts can be corroborated.
4. Bias: generally there are no advertisements, but clinical journals could be sponsored, so certain pressures may be placed on the editorial board you're your best judgment).

Content
1. General content: field specific with highly specialized language and a more specific audience. Often, there are editorials to draw attention to specific papers.
2. Material: designed to publish original research.
3. Presentation: usually articles are longer than in popular journals and more detailed. There are figures and tables to provide new information, not just for illustrative purposes.

Currency
1. The frequency of publication varies from weekly to monthly or even quarterly; information is new and, therefore, current for a specific field.
2. State-of-the-art reviews summarize new information periodically.

available online, and we had a brief discussion about the issues of open access. Given that these were freshmen students, we could not deal with some of these issues in the depth that we would have liked to.

The sessions tried to make the information meaningful within the context of the course. We used a news item related to prostate cancer from a newspaper as an example and showed them how the scientific statements made could be corroborated using different sources (online dictionaries, standard texts, web pages, and peer-reviewed journals). We also used the checklists and showed them how they could apply the criteria that we had given them to gauge the reliability of the information obtained.

Table 4. *Evaluation of web pages*

General Information
The evaluation of web pages is particularly challenging when used for scholarly purposes. In general, cite web sites only if you can evaluate the site. Information from sources like peer-reviewed articles, standard text, or published literature is preferable unless these are not available.

Credibility
1. Author/institution/publisher: check credentials, qualifications, affiliations, and contact information on the site.
2. Accuracy: clues can be gained from the URL of the site. Domains are as follows:
   .gov (dependable factually, but info could be biased)
   .edu (reliable generally, but exercise caution if it is individualized)
   .com (commercially oriented)
   .org (nonprofit; may have useful information but could be influenced by special interest groups)
   .net (network providers to commercial/individuals; personal sites are indicated by or % or users/members).

Content
1. Purpose: does the site provide factual information, persuade, advocate, entertain, or sell a product?
2. Corroboration: is the information corroborated with references, footnotes, and links to reputable and scholarly sources?

Currency
1. This is variable. Check the date that the page was created and last revised. Check if any links are live; often, the main page may be updated but not the links.
2. You can evaluate the page by using alexa.com URL information, which provides site statistics like ranking, links, reviews, contact, and ownership of the domain name. Cut and paste the URL in alexa.com's search box.

The tests. We then tested the students on their ability to assess information sources. We tried to model our test as closely as possible to the requirements of the course. A trial test was held on the fourth week following the two sessions on information literacy. This was done to defuse any test anxiety.

Students were again divided into two groups, and the trial test, which lasted 45 min, was held in a room adjacent to the Health Sciences Library and was well equipped with computers. Students could readily access the library catalog as well as the internet. This test consisted of two parts. In the first part, we gave them a news item from which we had extracted a list of scientific "facts." Students were asked to identify the best sources to verify these facts. In the second part, we gave them specific sources and asked them to assess these based on the criteria we had given them. This session was followed by a debriefing.

For this test, we selected a news item that appeared in *The Globe and Mail*, a national Canadian newspaper, on July 28, 2005. The story, entitled "Researchers give Echinacea the cold shoulder," was based on an article in the New England Journal of Medicine. Although the lead author was identified as Ronald Turner from the University of Vir-ginia School of Medicine, the precise date of the publication was not given. To understand the news item, readers would need information about several scientific items. We labeled these as "facts" that needed to be verified. The facts in this particular story fell into two broad categories: one set dealt with Echinacea and the other set dealt with clinical trials. Among the facts that needed corroboration in the former category included those that related to the plant itself and its purported therapeutic effects, the different parts of the plant that contained the active ingredients, the different preparations used for treatment, and a determination of the appropriate dose. Similarly, in relation to the second category, the items needing verification related to placebos, the conduct of clinical trials, and the symptoms of the common cold. Students were asked to indicate what they thought would be the best sources for obtaining information on each of those items. Once they had completed their answers, we had a discussion.

We demonstrated to them how they could use a variety of sources to obtain further information on these facts ranging from dictionaries (not only general ones but also specialized ones related to herbs), encyclopedias, and texts on pharmacognosy and herbal medicines, etc. This helped them appreciate the range of sources available. We helped them to gauge the value of each by using the three criteria. For other facts, such as the exact procedures used in the reported study to extract the active ingredients, such sources would be less reliable than reading the actual article on which the news item was based.

As part of this practice test, we gave them the following web pages of varying provenance and asked the students to assess them using the preset criteria:

1. http://www.celestialseasonings.com/products/product/480.php
2. http://botanical.com/botanical/mgmh/e/echina01.html
3. http://www.consumerlab.com/results/echinacea.asp
4. http://www.herbmed.org/Herbs/Herb6.htm
5. http://nccam.nih.gov/health/echinacea/

In addition, we asked them to evaluate a CRC book on Echinacea by Sandra Carol Miller that was available in the university library. Although they obviously could not read the book, they could check some of the preliminary information from the library catalog and apply the criteria we gave them in the handout.

Once they had completed this section, we had a debriefing session. This was an important component as it gave the students an opportunity to ask questions and for us to clarify any misunderstandings. The fact that they had just taken a "test" gave them a sharper focus.

Two weeks later, students took the test proper. This time they were given an hour. Here, we modified the procedures. We selected the news item, but rather than specifying the facts that needed corroboration we asked the students to identify them. For each of the "facts" they selected, they had to indicate the best sources that would give them the most reliable information. For the next part, we then gave

them specific sources related to some of the facts in the news item and asked them to evaluate the credibility of those sources. The news item we chose for the final test was a piece related to severe acute respiratory syndrom (SARS) that appeared in a Canadian newspaper, *The Edmonton Journal*. The two sources we gave them were a web page (http://www.niaid.nih.gov/factsheets/sars.htm) and a book on SARS, which was a summary of a workshop that was also available in an electronic format and that could be accessed through the online catalog.

Students were also given a short quiz. This was a set of eight questions of the true-false type. Most of these questions dealt with the particulars of the university catalog since we wanted to be assured that the students were quite familiar with it. We did include a few general questions about acronyms such as URLs and the relative merits of standard texts and peer-reviewed journals.

Apart from the sessions, we made ourselves available to students in person as well as by e-mail to answer specific questions. Students who requested it were also given individual attention in relation to search-ing strategies. We shared these responsibilities, with U. Rangachari giving specific guidance and P. K. Rangachari providing help in relation to aspects such as the peer review process and scientific practice.

RESULTS AND DISCUSSION

From our perspective, the sessions went well. We were asked a number of questions related to specific sources. The handouts were discussed and the comments made with respect to each source were amplified and extended. We felt that both the trial test and the final one were well received. At the end of the term, students were given a detailed questionnaire about the course as a whole. They were given a series of statements and asked to indicate the strength of their agreement with each statement on a five-point scale (where *1* strongly disagree to *5* strongly agree). Among the questions asked was their familiarity with criteria to assess diverse information sources. This same question had been asked in the information literacy survey given to them before the course. The differences in responses, as shown in Table 5, were highly significant (P 0.01).

They did not, however, seem overly enthusiastic about the information literacy test we gave them. The mean score was 3.43 0.93. Although the students made a number of comments about the course as a whole, they were few specific ones made about this component. One student noted that "the course was useful, however, in terms of teaching us how to analyze information sources and credibility of these," another said "I learned a lot from this course about finding credible information," and a third noted that the "library sessions were extremely useful when it came to information retrieval." They were no specific reasons given as to why they gave lower

Table 5. *Student familiarity with criteria for the evaluation of information from different sources*

Source	Precourse Survey Score	Postcourse Survey Score
Books	3.29 0.96	3.75 0.85*
Journals/magazines	2.69 0.98	4.16 0.74*
Internet sources	3.14 1.03	4.37 0.64*

Data are means SE; 56 students responded to the precourse survey and 60 students responded to the postcourse survey. Values were evaluated on a 5-point scale, where *1* strongly disagree and *5* strongly agree. *Significant difference (P 0.01).

scores for the test. We can only infer that this test, like many others, did not generate great enthusiasm. In retrospect, it was perhaps not a good idea to have imposed the artificiality of an assessment on this exercise. We should have stressed the significance of obtaining this skill and left it up to the students to practice it on their own and take it seriously or lightly as they chose to. It was pleasant to note that the students appreciated our efforts. On the same five-point scale, they gave us scores of 4.4 0.8 (U. Rangachari) and 4.1 0.76 (P. K. Rangachari) for contributing to their learning in this course.

We set up this approach to stimulate students to look at information critically. Access to information is crucial not only for students but for society to function. The two crucial elements have always been quality and authority (11). From the searcher's perspective, two sorts of judgments are made: a predictive judgment as to what they expect to find when they chose a document and an evaluative one as they gauge the quality of the information available (11, 12). What has really been altered is that the usual filters that had been placed in the past have become leakier. In the traditional print-based world, one could infer quality from reviews, the refereeing process (11, 12), the reputation of the publishing house, etc., but those checks become difficult to use in a web-based world. In our sessions, we tried to highlight some of these issues. We attempted to provide scaffolding so that freshmen could begin to recognize the problems in assessing information. We adopted a checklist approach, since that seemed to be a simpler one at the freshman stage. This method has been roundly criticized by Meola (8). He argues that when librarians and academics criticize material posted on the web, they fail to take into account the enormous amount of legitimate, well-reviewed material available. In our sessions, we took great pains to point that out to our students. Meola also doubts that students are naive or gullible and argues that they cite web sources not because they are unaware of their unreliability, but merely because they can get away with it unless their grades suffer. He also ridicules some of the points emphasized by certain check-lists. His most telling criticism is that the checklist approach promotes a mechanical and algorithmic way of evaluation that is not consonant with the promotion of higher-level judgment. We agree wholeheartedly with that sentiment, and, although we did try to get our students to use the checklist, we did point out the pitfalls of slavish adherence to the checklist items.

Our decision to exclude critical analysis of audiovisual sources (TV or radio) was not done lightly. We debated at length about that but reluctantly decided to exclude consideration of such sources on pragmatic grounds. We wanted to keep a tighter focus seeing that we had limited time at our disposal. Furthermore, we were constrained by our decision to conduct the tests of information literacy within a limited time frame. Also in our initial discussions with the students, they noted that they would like more guidance on using journals and web-based sources, so we concentrated on those. This is clearly an area worth exploring, since students (much like the general public) get a lot of information through such sources.

It has been suggested that such instruction needs to start in a comprehensive way in lower-level courses and expand into more discipline-specific courses in later years (7). The students were involved in both group and individual projects (described in detail in Ref. 10) while we conducted the sessions. They found the sessions useful for those activities, as their comments on the questionnaire showed. However, it was difficult to say whether they continued to practice these approaches after they had completed this specific course. When we began, we fully intended to follow the students as they went through the program. We never considered the tests we gave them as anything more than an interim measure of their ability to assess information critically. Unfortunately, midway through the term, the position of the education resources specialist was made redundant, so we could not follow through in upper-level courses. We feel, however, that this approach has merit and should be replicated in other settings where the possibility of longer term follow-ups is available. Although we used this approach in an inquiry-based course, we feel that such approaches can be readily adapted and would prove useful to students in other courses elsewhere.

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