Assessing Information Literacy Skills Using the ACRL Standards as a Guide

Introduction

Assessing instructor competencies and student learning outcomes are essential activities in evaluating library instructional programs. With library positions continually being re-evaluated and re-constructed with added responsibilities, it becomes paramount to incorporate assessment measures for instructional programs to validate that students are developing the necessary information literacy skills that support the broader educational outcomes. To assist in determining those skills, standards can be applied to identify appropriate learning outcomes for the instructional program and used to design assessment tools that measure the development of those skills.

Literacy standards have been developed by various disciplinary associations for use by librarians. The information competency standards (2002) created by the Association of College & Research Libraries (ACRL) have become a benchmark in information literacy programs. Discipline criteria have been designed to address required skills in specific subject areas. The ACRL Science & Technology Section delineated its own literacy standards for Science and Technology (ALA/ACRL/STS Task Force on Information Literacy for Science and Technology, 2006).

This article describes the creation and development of an assessment tool completed by graduate students enrolled in a chemistry bibliography course over a three year period at the University of Kansas. The two librarians responsible for instruction decided that a more definitive method of assessing skill improvement other than student evaluations and course grades was needed to justify the effort and time devoted to the class by the instructors and the students. Over a three year period, the instructors increasingly turned to the ACRL literacy standards and learning outcomes in the construction of assessment questions. The ACRL standards, performance indicators, and outcomes were also applied to creating course content and exercises utilizing the "backward design" (Wiggins and McTighe, 1998) of curriculum planning. This article describes the progression in designing the assessment tool through the three year period and the results. Specifically, the current authors' research revolves around a semester long, librarian taught, graduate course whose objective is to increase the student participants' information literacy skills, and to assess the degree of measured improvement using a pre- and posttest methodology. Furthermore, the assessment methodology employed several common components as it developed over the three year period: pre/post test; use of a control group to compare rates of improvement; problem-based scenarios delivered via interviews; web-questionnaire; and application of learning outcomes to inform the development of the assessment tool itself.

Literature Review

As academic librarians integrate the teaching of information literacy skills into their instruction sessions, the depth and breadth of the literature, both scholarly and gray literature, expand to describe the practices, theories and philosophies of such instruction. Within the field of library instruction the literature discusses the rich variety of assessment and evaluation methods. The literature is rife with papers that describe a variety of methods, objectives, student-groups and course environments in which the assessment of information literacy in academic libraries occur. Assessment of information literacy skills can and should be implemented at numerous levels. Iannuzzi (1999) describes four levels of learning outcomes assessment: "within the library; in the classroom; on campus; and beyond the campus". This paper will focus on assessment efforts in the classroom. Although not exhaustive, an attempt will be made here to review the literature that share characteristics or helped to inform the assessment methodologies and practices of the research done by librarians at the University of Kansas (KU).

The literature review is divided into these three broad categories: *methodologies* used to deliver the assessment or collect the assessment data; the *creation of effective assessment tools* and questions; and the instructional and library *environments* in which such assessments take place.

Methodologies:

A variety of methodologies are employed based on the needs of the scholastic environment and instructors. Research described in the literature outlines the variety of methodological techniques employed to assess information literacy instruction and include: skill-based assessment, student-perception assessment, use of pre- and posttest, use of controls, and paper/web/interviews/longitudinal methods to collect the data.

William's article (2000) serves as a good primer on methods to use when assessing information literacy skills, common place terminologies and practices, as well as alternative methods that can be employed. She provides a succinct definition of reliability and validity in assessment development The assessment tool is reliable if it can be used to test the skills of another group of students and it would reliably provide similar information about the skills meant to be measured. Validity of the assessment tool components assures that the questions are legitimate measures of what the researcher intends to measure—"Does the question asked provide a valid measure of what the instructor wants to know about the students' skills?" Williams looks at a variety of methods for asking questions in an assessment that will demonstrate competency of certain skills, or conceptual mastery. It is a useful paper to review prior to the development of an assessment tool.

Brown & Krumholz (2002) and Samson (2000) are two good examples, however, of assessment plans that utilized the tool development with close association between assessment questions and methodologies and the desired learning outcomes to be

measured, for course-integrated (aka single-session) library instruction sessions. Brown's research exemplifies the multifaceted approach that seeks data on students' skills throughout the semester. Brown & Krumholz utilized pre- and posttest assessment via a paper survey, as well as through student presentations, progressive paper writing and class participation to measure student gains in conceptual mastery of information literacy skills and other desired learning outcomes. Done in collaboration with teaching faculty their ambitious research utilized techniques most suitable for assessing certain skill sets. Some methods did not measure levels of competency but gave either credit or no credit for demonstrating a given competency. Still this was excellent work that provides examples of a range of techniques that can be employed to gauge students' ongoing acquisition of skills.

Samson (2000) provides a less ambitious but still very useful example of an assessment project which used a web-based assessment questionnaire to gather data on student skills. The scope and scale of the assessment is what sets her research apart from other assessment projects, as well as the early use of web-based questionnaires to collect the data, and as a handy tool to generate collections of data that would be easily analyzed later. Samson also reports on the development of the assessment questions, starting with instruction goals and building questions that would assess students' success at reaching those learning outcomes.

Each assessment methodology has its weaknesses. The use of pre/post tests for example, although a powerful method for noting rates of acquisition of skills between two points in time, if not built carefully can have skewed results. Daughtery & Carter discuss their concern (1997) that by using a test that is identical for both the pre- and posttest, the students are prepared for the posttest by the pretest itself. This would be a more prominent concern when the time between the pre- and posttest is a number of minutes, hours or days, rather than months. Researchers can also avoid this methodological weakness of the pre/post test by varying the component parts of a given question, from the pre- to the posttest, as Emde & Emmett's research (2004) describes. For example, if a student is asked to locate a particular book, the title of the book can vary, randomly, as the researcher pulls a book title from a pool of possible titles, and presents the student with one. This randomized the specifics of each assessment item, although not the general structure of the question.

The use of pre/post tests is not uncommon but mixed results are reported in the literature. Portmann & Roush reported no score improvement in a single instructional session for undergraduate students using a paper pre/post test (2004). The paper test measured both skills and student-perception of their library usage. Colborn & Cordell (1998) didn't find improvements in their students' skills using the pre- and posttest, although they did an excellent job discussing the tool development and possible reasons for the results they received. Both cases are examples of how single session instruction does not lend itself to pre- and posttest methodologies, whatever the results are, unless strong faculty collaboration allows for testing earlier in the semester, prior to the single library session, and the use of additional class time for the posttest, as in Carter's research (2002) and Colborn & Cordell (1998). One exception might be the use of the "clicker technology"

or student response systems that libraries are beginning to experiment with and would allow for instant feedback even in a 50 minute class session. Instruction feedback could be gathered using this technology in a pre/post test, by asking a few carefully designed questions to assess students' skills.

Creation of assessment tools:

More articles in the literature are focusing on the creation and design of assessment tools that will more effectively and reliably measure skills in students that participate in library-initiated instruction efforts. Themes emerge on the development of assessment tools: those that measure mastery of skills, (Brown and Krumholz, 2002, Samson, 2000), rather than, or in addition to, student attitudes and self-perceptions, (Knight, 2002); assessment of undergraduates' skills, (Daugherty and Carter, 1997, Verhey, 1999, to name but a few) with far fewer on graduate student skill acquisition and assessment of those skills (Cooney and Hiris, 2003, Emde and Emmett, 2004, Mabrouk, 2001).

A couple of recent research projects described in the literature have combined the strength of learning outcomes-based assessment tool development and certain data gathering methods to produce a more powerful picture of students' competencies that focus on problem-based, or "real life" information problem solving skills. Such a strategy has recently been described in the literature that seeks to further strengthen the validity of these outcomes focused assessment tools. Dunn (2002) writing about the research done for the California State University system comments that most assessment tests "cannot assess the effectiveness of student search skills in real life situations". Dunn describes the use of information-need scenarios provided to students in one-on-one interviews, during the complex, multi-year, multi-facetted assessment strategies employed by the California State University system. The use of "information-need scenarios" as the foundation of the assessment tool moves the assessment away from the test that measures in multiple choice or fill-in-the blank responses toward a problem-based, "real life" based scenario.

These types of information-need scenarios provide the advantage of framing the test questions as real life problems that students would encounter, and allow them to demonstrate their skills and conceptual mastery of finding information. Dunn (2002) and Emde & Emmett (2004) report the results of their research and the development of these information scenarios being purposefully and closely tied to the core skill competencies. In Dunn's case these core competencies were developed by CSU, and in Emde & Emmett's case the ACRL's information competencies were used in growing degrees to inform the development of the information-need scenarios presented in the first two years of their data collection. Balancing the need for valid and reliable evidence collected from students with the need to make assessment projects manageable given the time constraints of most library instructors is an ongoing challenge. Dunn's description of CSU's programmatic level, multi-year state supported efforts and Emde & Emmett's description of their research demonstrate one end of the continuum—the time intensive end.

Learning Environments:

Assessment occurs in a variety of learning environments. The environments include undergraduate, graduate, course-integrated library instruction, semester long courses, as well as subject specific instruction assessment projects.

Cooney & Hiris (2003) and Emde & Emmett (2004) assessed the skill development of graduate students, but only Emde and Emmett's research used a pre- and posttest with controls, in their semester long course. Cooney's assessment evaluated skills developed after course-integrated instruction. However, her research had important strengths: 1) the use of the final paper to assess the development of higher order learning outcomes and skills; and 2) strong collaboration with the business faculty to integrate information literacy learning outcomes into the curriculum of the graduate level course. Unlike Cooney & Hiris, Emde & Emmett developed their course, learning outcomes and assessment tool with little collaboration from the chemistry department faculty. Assessment of learning outcomes in semester long courses taught by librarians is less common, although the environment is far more conducive to pre/post test assessments. The combined use of pre/post test and controls is rare as well (Emde and Emmett, 2004, Wang, 2006).

Somerville (2003), Mesko (2003), Matthews (1997), Ricker (1997), and Ricker & Thompson (1999) write about information literacy of chemistry undergraduates. Ricker & Thomspon (1999) presented information on how the learning outcomes of the chemistry course were developed, and supplied good examples of assignments given to students, but no formal assessments were described. Only Calderhead (1998) discusses the summative/evaluative (skill based) and formative (learner perception and satisfaction of instruction) assessment of undergraduates in a chemistry course where library instruction occurred. In her paper "Reflections on Information Confusion in Chemistry Information Learning", she mentions the post-instruction session assessment conducted that evaluated both the student skills and student perceptions of the seminar sessions. Further research is needed that assesses the information literacy skills of students in the sciences (both undergraduate and graduate) and uses methods like the pre- and posttest to measure rates of improvement in the students' summative skills after instruction sessions. Brown & Krumholz's research (mentioned earlier, 2002) is the only substantive research found that assessed the information literacy skills of science students seeking to measure skills and competencies in a rigorous course-integrated science curriculum.

Previous assessment applications and research lay the groundwork for the study described in this paper which attempted to measure the mastery of information competency skills by chemistry graduate students enrolled in a semester long library bibliography class. No literature was found that matched closely the practices of this research, however several new monographs (Avery, 2003, Neely, 2006) have recently been published that cumulate case studies regarding the combination of information literacy training and assessment, and for the tools used to assess the skills in students and are worthy of review.

Background

Bibliography of Chemistry (CHEM 720) is a one hour credit course offered to 1st and 2nd year chemistry graduate students at the University of Kansas. The course satisfies the FLORS (Foreign Language or Research Skills) requirement expected of all chemistry Ph.D. students. The course was added to the curriculum in 1996 and has been co-taught by the chemistry and pharmacy subject specialists. Content includes instruction on the major resources in the chemical and biomedical literature, research strategies, bibliographic management, and ethical use of information. Guest lecturers are invited to share their expertise on some of the more specialized tools, e.g. EndNote. Classes are held once a week for 75 minutes to allow adequate time for a presentation and completion of exercises. Depending on the number of students enrolled, one to two sections may be offered. Grading is based on class attendance, completion of in-class exercises, final project and a final exam. The final project begins with a literature search on a topic of interest to the student in consultation with his/her advisor. A required essay with bibliography defines the topic, summarizes and compares individual studies, and illustrates the relationship between current research and their own research efforts in chemistry. An addendum to the essay details what resources were searched and how their search strategies developed. The grading system used is satisfactory/unsatisfactory and the students are required to earn 80% of the total points for the class in order to achieve a satisfactory grade. A newly hired chemistry subject specialist co-taught the class for the first time in 2003. Her experience prompted discussion on how to assess the total learning experience of the students in the class.

After co-teaching CHEM 720 for one year the instructors decided to initiate a project that would assess the information literacy skills students had at the onset of the class, and upon completion of the class. The study results would be used to inform the course and assessment development for the proceeding year. The next section of the paper will discuss briefly the three years of assessment, the evolving and increasing use of the ACRL literacy standards and learning outcomes as an inspiration in developing the assessment tool, as well as course content, and the results of those assessments.

Methodology and Findings

Year One-- 2004:
The first year of assessment for CHEM 720 was in Spring 2004. The instructors reflected on ways to examine student behavior to find evidence of information competency skills. Reflecting on the various literacy standards available, outcomes were used to inspire many of the questions on the assessment during the development phase. Ultimately 29 information-need scenarios were developed in an effort to do an "authentic assessment" (Knight, 2006, p.45) that would provide problem-based, real-life information-needs that students were expected to solve. (see Appendix 1 for a sample of the information-need scenarios developed.)

The instructors developed their research question "to what degree does the students' participation in CHEM 720 impact their information literacy skills?" The assessment tool was designed to be a pre- and posttest, with the data collected in one-on-one interviews

with one of the instructors prior to the first class of the semester and after the final class at the end of the semester. The instructors wanted to be able to observe the students' behaviors as they tried to answer the assessment questions.

Funding was sought from library administration to support this research endeavor and human subjects review was obtained in order to be able to report the results of the research. Researchers made various attempts to attract a pool of candidates to serve as a control group, students who were first or second year graduate students, studying in related chemistry disciplines but who had not completed, and were not enrolled currently in the CHEM 720. Incentives were used to attract "control group" participants. Ultimately, four students not enrolled in the class and 26 CHEM 720 students completed the pre- and posttests. All study participants, were scheduled during a two week period to meet with one of the instructor/researchers for their assessment.

During the interview in the instructor's office, the student was presented with information-need scenarios and data was collected on the steps taken to locate the material, the material found etc. The data was collected in handwritten notes. Generally each session lasted approximately one hour although some lasted nearly two hours. Students were allowed to use the computer in the instructor's office as well as any other materials in the libraries.

Once the qualitative data was collected, each question on each test was ranked on a 0-3 scale depending on the efficiency and effectiveness of the student's response. Each question was ranked independently by both co-instructors and later, where differences in the ranking occurred, instructors discussed the response and agreed on a score reaching an inter-rater reliability.

Findings-- 2004:
The highest possible score that could be earned on a single test was 72. The average total score for the 26 students in the class at the point of the pretest was 45 and for the four students not enrolled in the class the average was 48. At the time of the posttest the average score for students in the class was 65 and students not enrolled in the class it was 56. The rates of improvement from the pretest to the posttest for the students enrolled in the class were 44% while the four students not enrolled only improved 17%. (see Table I).

Take in Table I: 2004 assessment results

Year Two-- 2005:
Reflection on the previous year's success and challenges led to adjustments in data collection and recording procedures. Attempts were made to streamline these processes in order to more efficiently use the instructor time without losing the rich and varied data, as well as the instructive qualities that the scenarios themselves provided the students. The information-need scenario would continue to serve as the data collection method in 2005 since the data provided the instructors with a chance to see first-hand their students

"in action". The data was then used to guide the instructors in designing future class presentations and exercises.

The assessment tool itself, that is, the questions or scenarios asked, were adjusted slightly and the method of recording data was streamlined, allowing for more data to be quickly gathered that could be rated and quantified on the spot. See Appendix 1 for a sample of the revised information-scenarios presented. The data was again collected using the pre- and posttest model at the beginning and end of the semester. This time the data was inputted into a SPSS DataBuilder file during the interview session directly. The information-need scenarios were verbally presented to the students. A notes field in the instructors' software program allowed for observations to be typed in and a score to be assigned immediately.

Again the instructors tried to attract students not enrolled in CHEM 720 to serve as control group participants but again only a small group of six students completed the assessment which is not large enough for a valid control. Researchers still felt the data would be useful to compare with the enrolled student group even if not in a statistically valid way.

Findings-- 2005:
The results were again very satisfying to the researchers. Student scores improved significantly between the pre- and posttest, although the six students not enrolled in the course had significantly lower rates of improvements from their pre-semester score to their post-semester scores. Out of a total possible score of 120 that an individual student could receive on either the pre- or posttest, the mean score on the pretest was 61 for the enrolled CHEM 720 students, and the posttest was 99. The control group students had a mean score on the pretest of 73 (higher than the students enrolled) but a post of 85 (see Table II).

Take in Table II: 2005 assessment results

Year Three-- 2006:
In the third year, for the spring 2006 semester, there were several enhancements to the assessment tool, as well as a decision not to attempt to attract a control group. Using the backward design method described by Wiggins & McTighe (1998) in their book, *Understanding by Design*, the instructors started with the ACRL information literacy competency standards, (Association for College and Research Libraries, 2002) to develop the actual assessment questions. The idea behind the backward design method described by Wiggins & McTighe is very similar in concept to principles behind general research design processes—moving from the hypothesis and objectives of the study to measurable variables that are then formed into, in this case, questions or scenarios. No literature was found describing the application of this method in the development of assessment questions for library instruction.

The purpose of this method is to make the assessment question a valid measure of the concept or objective. The backward design (like the concept of reverse engineering)

poses the simple questions, "How will we know if students have achieved the desired results and met the standards? What will we accept as evidence of student understanding and proficiency?" (1998, p.12). If an instructor wants to know to what degree a student "identifies a variety of types and formats of potential sources for information" (from ACRL literacy standard 1.2) the instructor might then think of activities that would narrowly and conclusively determine to what degree the student is able to demonstrate this learning outcome.

The reader might see how challenging this can be and how many variables there are in this very broad objective, and in determining, perhaps more importantly what is a valid measure of the "degree to which" a student has mastered or demonstrated competency in a certain area. Not shying away from this challenge and understanding the limitations to all assessments of such broad skill sets, the instructors proceeded to design assessment questions that would be related to one, and in some cases, multiple learning objectives from the ACRL standards. In this way the results could indicate degrees of competence, areas that still needed more work, and perhaps weaknesses in the instruction program.

In the first year of assessment, the learning outcomes were used to inspire the development of the assessment tool. In the second year, again the outcomes inspired the assessment questions, and at the end of year, the assessment questions were mapped to the ACRL's learning outcomes. But in the third year using the backward design method, scenarios or questions were developed that would provide a vehicle for students to demonstrate their degree of competency, and identify which standards were being met. Each question developed was "mapped" to the performance indicators and outcomes, some questions were mapped to more than one standard or outcome. It was also decided to develop lectures/assignments that would address the learning outcomes, again starting with the outcome and determining what lecture content, assignment and hands on practice would help students in meeting the standards.

For this final year, 2006, the assessment tool was designed as a web-based multiple choice and short-answer test that students would take in a computer lab. Students would be allowed to use the web to find answers to the "information-need scenarios". The web test would be loaded into the course management tool, Blackboard, used by the University of Kansas. See Appendix 2 for the complete set of assessment questions.

Use of the interviews was reluctantly given up for the far more time efficient web-based multiple choice and short-answer test which the students could take all together in a one hour session. Making the decision to lose the one-on-one contact was difficult since the individual contact with students served to add additional impetus to their believing in the relevancy of the course and its content, and an opportunity to develop a rapport with each student. The web-based tool was developed and chosen as the data collection method because the interviews were found to be so time intensive for the instructors. BlackBoard provides instructors with the capacity to build quizzes or surveys and analyzes the data once completed by the student or other user. Pre-scored multiple choice question data was recorded and instructors ranked each short answer for each student. The data was downloaded into excel and analyzed.

The web-based assessment was set up as a pre- and posttest; with only students in the class taking the test. For the first time, the posttest was given as the "final". One of the requirements to pass the course was to earn 75% of the points on the final.

Findings--2006:
As was found in previous years the rates of improvements were high. Out of a total possible points of 80 that could be earned on either pre- or posttest, the pretest average score of the 16 students enrolled in CHEM 720 was 47.5 and the posttest average score was 74.5 (see Table III).

Take in Table III: 2006 assessment results

Figure 1 below indicates the average scores earned in the pre- and posttest by assessment question. Questions 1, 2 and 29 are not included because they ask either demographic information or the students' perception of their progress on the assessment.

Take in Figure 1: Pre-and posttest average points by question

Summary of Findings

The assessment results from all three years indicate marked improvements in the average student score from the pre- to the posttest as illustrated in Figure 2. The rate of improvement increased significantly between 2004 and 2005 for the enrolled students from 44% to 62%. The percentage increase (57%) for 2006 is comparable to 2005. Although statistically invalid due to low number of participants, improvement rates for the control groups (non-enrolled students) were significantly lower. It is interesting to note however that some skill development occurred without formal instruction.

Take in Figure 2: Improvement rates per year

As to the considerable difference between the rates in 2004 and 2005, the researchers reviewed and compared the processes between the two years. One particularly meaningful difference is the establishment of scoring rubrics prior to the pretest in 2005 to assist in ranking the students' responses immediately during the pre- and post-sessions. In 2004, rubrics were not established until after the students' responses were recorded and after the instructors began reviewing the data. A significant amount of time had also passed before the instructors began to evaluate the pretest responses. The lack of established rubrics in 2004 and time delay in evaluation of the data could have influenced the assignment of consistent, quantitative rankings. The establishment of a set of rubrics improved with each succeeding year.

Although the number of study participants not enrolled in CHEM 720 was small, the instructors were still given a glimpse, however anecdotally, of the students' pre- and posttest skills and rates of improvement compared to the students in the course. Although a causal relationship between students' improvements and the course cannot be proven by the study, there was a correlation between the two. Other factors that might influence the interpretation of results (e.g. previous or additional library/research instruction, number of semesters students were enrolled previous to the course, educational background) were not controlled for in a statistically satisfying way. But as Barclay (1993) indicated, librarians aren't given the luxury of time and funding to pursue the most rigorous of studies, but often these less rigorous studies can still inform practice and impact instruction and services.

Many excellent reasons exist to assess information literacy skills and tie the assessment process to the desired learning outcomes for the group of students. The process of developing the assessment tools, and developing the collection methods and analysis tools were highly instructive to the librarians. Perhaps the most rewarding process was observing the development of information competency skills during the semester and watching the students' reactions as they completed the assessments each year.

Conclusion

Application of the ACRL's *Information Literacy Competency Standards for Higher Education* in the development of an assessment tool, course content and exercises proved to be an invaluable mechanism in curriculum design for a semester long chemistry bibliography class for graduate students. Specific performance indicators and outcomes were selected that met the teaching objectives of the chemistry department. By the third year of a three year effort, the instructors fully adhered to designing the assessment tool and instruction methods according to the desired learning outcomes. The pre- and post-assessment tool provided clear evidence of skills developed over the course of the semester for specific outcomes. Additional outcomes, particularly from standards three and four, are applied through the completion of the final project which requires a literature search and written essay. Proficient assessment of these particular outcomes requires an extended knowledge of the subject field, involving additional assistance from the chemistry teaching faculty.

To improve upon the assessment tool models used during the past three years, the instructors plan to be more rigorous in using the backward design method to develop assessment questions directly from the desired outcomes. The differentiation among some of the performance indicators were at times indistinct and more time needs to be invested in clearly relating the stated performance indicators to questions and content. With the appearance of the final copy of the *Information Literacy Standards for Science and Engineering/Technology* (2006), the instructors will consider drawing upon these standards which are written specifically for science disciplines. Due to time constraints, the web format will continue to be used to determine the chemical information literacy skills that the students bring to the class at the beginning of the semester and repeated again to gauge the improvement of those skills at the end of the semester.

The resulting data and assigned outcomes need to be evaluated further with the chemistry faculty. Are the most relevant learning outcomes for the graduate students selected? Does the syllabus address the tools and research methodologies required for the students to be successful in their career at the university and future positions? Does the faculty observe continuing effects of skills gained in CHEM 720 in other chemistry classes? Further collaboration with the chemistry faculty will be requested to assist with meeting and assessing more of the learning outcomes, particularly those requiring a proficiency in the subject area.

Assessment is being applied to all facets of library services. Carefully constructed measurement tools can be beneficial to the design and development of services or lead to decisions of discontinuation. Assessment of instruction and learning outcomes are essential in determining the development of information competencies. Valuable assessment data can inform the creation and modification of class content and delivery. Techniques applied in this study can be appropriate to any discipline and to a variety of instructional settings. Library instructors may assess multiple learning outcomes for a semester long or multi-session instruction opportunity or may choose one or two well-chosen outcomes to assess the skills gained by students in the single sessions so often afforded to library instruction staff. A few, significant learning outcomes can influence the design and content of a single, fifty minute class session. The same outcomes can influence the development of a simple but measurable assessment tool. The development of more precise and efficient assessment tools will help increase the validity and reliability of the results and increase the ability to make well-informed changes to an instruction program or session. Information gained from assessments can justify the time and effort applied to class instruction.

References

ALA/ACRL/STS Task Force on Information Literacy for Science and Technology (2006), "Information literacy standards for science and engineering/technology", available at: http://www.ala.org/ala/acrl/acrlstandards/infolitscitech.htm (accessed September 18, 2006).

Association for College and Research Libraries (2002), "Information Literacy Competency Standards for Higher Education", available at: http://www.ala.org/ala/acrl/acrlstandards/standards.pdf (accessed August 28, 2006).

Avery, E. (2003), *Assessing Student Learning Outcomes for Information Literacy Instruction in Academic Institutions,* Association of College and Research Libraries, Chicago, IL.

Barclay, D. (1993), "Evaluating library instruction: doing the best you can with what you have", *RQ,* Vol. 33 No. 2, pp. 195-202.

Brown, C. and Krumholz, L. R. (2002), "Integrating information literacy into the science curriculum", *College & Research Libraries,* Vol. 63 No. 2, pp. 111-23.

Calderhead, V. (1998), "Reflections on information confusion in chemistry information learning: the meaning of the shift from library instruction to information literacy at the John Cotton Dana Library", *Research Strategies,* Vol. 16 No. 4, pp. 285-99.

Carter, E. W. (2002), "Doing the best you can with what you have: lessons learned from outcomes assessment", *Journal of Academic Librarianship,* Vol. 28 No. 1/2, pp. 36-41.

Colborn, N. W. and Cordell, R. M. (1998), "Moving from subjective to objective assessments of your instruction program. at Indiana University South Bend; revision of a paper presented at the 1998 LOEX-of-the-West conference", *Reference Services Review,* Vol. 26 No. 3/4, pp. 125-37.

Cooney, M. and Hiris, L. (2003), "Integrating information literacy and its assessment into a graduate business course: a collaborative framework", *Research Strategies* Vol. 19 No. 3/4, pp. 213-32.

Daugherty, T. K. and Carter, E. W. (1997), "Assessment of outcome-focused library instruction in psychology", *Journal of Instructional Psychology,* Vol. 24 No. 1, pp. 29-33.

Dunn, K. (2002), "Assessing information literacy skills in the California State University: a progress report", *Journal of Academic Librarianship,* Vol. 28 No. 1/2, pp. 26-35.

Emde, J. and Emmett, A. (2004), "Assessing information literacy skills in the real world: the good, the bad and the literate"*,* Brick & Click: An Academic Library Symposium, 4th Annual sponsored by Owens Library, Northwest Missouri State University, pp. 83-9. Maryville MO, available at: http://hdl.handle.net/1808/992 (accessed August 18, 2006).

Iannuzzi, P. (1999), "We are teaching, but are they learning: accountability, productivity, and assessment", *Journal of Academic Librarianship,* Vol. 25 No. 4, pp. 304-5.

Knight, L. A. (2002), "The role of assessment in library user education", *Reference Services Review,* Vol. 30 No. 1, pp. 15-24.

Knight, L. A. (2006), "Using rubrics to assess information literacy", *Reference Services Review,* Vol. 34 No. 1, pp. 43-55.

Mabrouk, P. A. (2001), "Research skills & ethics-- a graduate course empowering graduate students for productive research careers in graduate school and beyond", *Journal of Chemical Education,* Vol. 78 No. 12, pp. 1628-31.

Matthews, F. J. (1997), "Chemical literature - a course composed of traditional and online searching techniques", *Journal of Chemical Education,* Vol. 74 No. 8, pp. 1011-4.

Mesko, E. (2003), "Teaching information retrieval in the chemistry curriculum", *Chemistry Education: Research and Practice,* Vol. 4 No. 3, pp. 373-83.

Neely, T. (2006), *Information literacy assessment,* American Library Association, Chicago.

Portmann, C. A. and Roush, A. J. (2004), "Assessing the effects of library instruction", *Journal of Academic Librarianship,* Vol. 30 No. 6, pp. 461-5.

Ricker, A. S. (1997), "Chemistry information for the undergraduate in a one-credit course: faculty/librarian team teaching. at Oberlin College", *Science & Technology Libraries,* Vol. 16 No. 3/4, pp. 45-67.

Ricker, A. S. and Thompson, R. Q. (1999), "Teaching chemical information in a liberal arts curriculum", *Journal of Chemical Education,* Vol. 76 No. 11, pp. 1590-3.

Samson, S. (2000), "What and when do they know? Web-based assessment", *Reference Services Review,* Vol. 28 No. 4, pp. 335-42.

Somerville, A. N. and Cardinal, S. (2003), "An integrated chemical information instruction program", *Journal of Chemical Education,* Vol. 80 No. 5, pp. 574-9.

Verhey, M. P. (1999), "Information literacy in an undergraduate nursing curriculum: development, implementation, and evaluation", *Journal of Nursing Education,* Vol. 38 No. 6, pp. 252-9.

Wang, R. (2006), "The lasting impact of a library credit course", *portal: Libraries and the Academy,* Vol. 6 No. 1, pp. 79-92.

Wiggins, G. and McTighe, J. (1998), *Understanding by Design,* Association for Supervision and Curriculum Development, Alexandria, VA.

Williams, J. L. (2000), "Creativity in assessment of library instruction ", *Reference Services Review* Vol. 28 No. 4, pp. 323-34.

Appendix 1
2004 Assessment: Sample information scenarios presented to the students:

5. Suppose you need information on this topic (e.g. asymmetric organic synthesis) in the journal literature. Where will you go to look? If you're not sure, can you find a database from the library's website?

Please demonstrate how you would find this information in this database. How might you narrow down your topic?

Choose one article that looks like a good candidate. What if you want to read the entire article? What would you do next? Where might you look?

What if you can't locate the item at KU? What other ways might you find this article?

7. Suppose you are given this molecular structure for a compound (student presented with a structure) and you need to know whether it is a 'known' compound or not. What do you do?

Where could you find information that would tell you whether it is 'known'?

What could you use to find whether the compound is mentioned in the chemical literature?

11e. Please describe the steps taken to publish an article in a scholarly journal, from research to final publication.

2005 Assessment: Sample information scenarios presented to the students:

8. Suppose your advisor gives you the following citation:
> Burgstahler, Albert W.; Nordin, Ivan C. Stereospecific angular alkylation. A new application of the Claisen rearrangement. J. Am. Chem. Soc. 1961, 83(1): 198-206.

8c. Please take the steps needed if you were asked by your advisor to find all the references in the literature that cite this article.

13a. Suppose you need to find information on how to prepare a given compound for your lab. Please name at least one print and one electronic resource that will provide that information. Which of these two will provide you with the most reliable information and why?

13b. Please use one of the resources you mentioned above to find the preparation for the following compound (student presented with a compound).

Appendix 2
Assessment 2006

1	Multiple Answer	0 points

Years of graduate study in chemistry/ pharmacology & toxicology, at the University of Kansas?

☐ 0-12 months (1st year)
☐ 13-24 months (2nd year)
☐ 25-36 months (3rd year)
☐ 37-48 months (4th year)

2	Multiple Answer	0 points

Please select the area of chemistry that best describes your interest. Please choose only one.

☐ organic
☐ analytical
☐ biochemistry
☐ inorganic
☐ physical

3	Either/Or	1 point

You need to identify whether the University of Kansas Libraries owns a particular book that you are interested in. The title of the book is Biocatalysts in organic synthesis and the author is Jan Halgas. Please identify the correct call number for this book:

☐ QD 262 .H26 2002
☐ QD 262 .H248 1992
☐ TP 248.65 E59 S88 2002
☐ QP 517 .B5W33 2001
☐ I don't know.

4	Either/Or	2 points

At the time of this assessment, is the book, Biocatalysts in organic synthesis, checked out of the Library?

☐ Yes
☐ No

5	Short Answer	3 points

Please write out the steps taken to identify the call number of the book, Biocatalysts in organic synthesis. Tell us where you searched and how.

Answer

_____

_____

_____

6	Multiple Answer	3 points

One type of information retrieval system is the library online catalog. Please select from the list below types of information available from the library catalog. Please select all that apply.

☐ Titles and locations of books held at KU
☐ Full-text downloadable journal articles
☐ Titles and locations of journals held at KU
☐ Links to online journals and full-text articles
☐ Citations to journal articles
☐ I don't know

7	Short Answer	4 points

List four information fields (or types of information) that the search engine of the Library Catalog provides as means to search the catalog.

1. _____
2. _____
3. _____
4. _____

8	Multiple Choice	2 points

If a book you need is not owned by KU Libraries and you desperately need it, what service would most efficiently obtain this book for your use?

☐ Circulation
☐ Interlibrary Loan
☐ Library Purchase Request Form
☐ Library "Buy A Book" program
☐ I don't know.

9	Short Answer	3 points

Provide information about the service you chose above, as if you were giving directions to a friend who needed to use it for the first time. Please describe how you would submit a request, where the service is located, and how much it costs.

Answer:

_____

_____

_____

10	Matching	3 points

The following is a journal citation in a bibliography:

Burgstahler, Albert W.; Nordin, Ivan C. Stereospecific angular alkylation. A new application of the Claisen rearrangement. *J. Am. Chem. Soc.* **1961**, 83(1): 198-206.

Please match each component part of this citation with its correct name.

Match Question Items

A. 198
B. Stereospecific angular alkylation
C. 1
D. 83

Answer Items

A. Journal volume number.
B. First page of article.
C. Journal issue number.
D. Article title.

11	Either/Or	3 points

You would like to locate the following article:

 Ultra-Sensitive Immunoassays Using Multi-Photon-Detection in Diagnostic Proteomics of Blood. *Journal of Proteome Research* **2005**; 4:2375-2378.

Does the Library have access to the article in print?

☐ Yes

☐ No

12	Either/Or	3 points

Does the Library have access to the article above electronically?

☐ Yes
☐ No

| **13** | Short Answer | 3 points |

Please write out the steps taken to identify the availability of the article in print or electronically. Tell us where you searched and how.

Answer

_____

_____

_____

| **14** | Multiple Choice | 3 points |

Below is a citation for a journal article. From the following list, select the citation formatted correctly in the ACS (American Chemical Society) style.

99mTc-Annexin A5 uptake and imaging to monitor chemosensitivity. Spring, 2005. <u>Methods in Molecular Medicine.</u> Vol. 111, issue 10, pages 363-80. Thomas Z. Belhocine and Frank George Blankenberg.

☐ Thomas Z. Belhocine and Frank George Blankenberg, Methods Mol. Med. **111**, 363 (Spring 2005).

☐ Belhocine, T. Z., & Blankenberg, F. G. (Spring 2005). 99mtc-annexin a5 uptake and imaging to monitor chemosensitivity, *Methods Mol. Med., 111*(10), 363-380.

☐ Belhocine TZ, Blankenberg FG. 99mTc-Annexin A5 uptake and imaging to monitor chemosensitivity. Methods Mol. Med. 2005; 111(10): 363-80.

☐ Belhocine, T. Z.; Blankenberg, F. G. *Methods Mol. Med.* **2005**, *111*, 363-380.

☐ I don't know.

| **15** | Short Answer | 3 points |

Provide the specific names of 3 different information resources (indexing and abstracting tools) that help you to identify journal articles in your specialized subject area.

_____

_____

_____

| **16** | Short Answer | 4 points |

Select one of the information resources you chose above and provide the following information:
1) What is one strength of the resource in providing scholarly information in your subject area?
2) What is one weakness of the resource in providing scholarly information in your subject area?

_____

_____

| **17** | Short Answer | 3 points |

Using one of the electronic resources you listed above, describe what techniques or features of the resource you can employ to **narrow** your topic to a manageable number of retrieved records.

_____

_____

_____

| **18** | Short Answer | 3 points |

Using one of the electronic resources you listed above, describe what techniques or features of the resource you can employ to **broaden** your topic to expand the number of retrieved records.

_____

_____

_____

| **19** | Short Answer | 4 points |

Your need to find articles on the *epidemiology of lyme disease in the United States.* Please answer the following question in the space provided below. How would you construct a search statement that combines keywords using Boolean operators?

_____

| **20** | Multiple Answer | 3 points |

From the following list of sources, select the two that allow you to find all references in the literature that cite the following article:

Burgstrahler, Albert W.; Nordin, Ivan C. Stereospecific angular alkylation. A new application of the Claisen rearrangement. *J. Am. Chem. Soc.* **1961,** 83(1): 198-206.

- ☐ Google
- ☐ ChemNetBase
- ☐ Web of Science
- ☐ PubMed
- ☐ SciFinder
- ☐ I don't know

| **21** | Short Answer | 4 points |

Please use one of the sources mentioned above and answer the following two questions:

What source did you use?

_____

How many times was the article cited?

_____

| **22** | Short Answer | 3 points |

Provide the name of two sources (1 print and 1 electronic) that provide data information relevant to your subject area (e.g. property data; sequencing data)

_____

_____

23	Short Answer	3 points

Choose one of the resources you named above and provide the following information:

1. Give an example of an "information-need" that you might have that this resource would answer. An example might be, you would choose the Oxford English Dictionary when you had an "information-need" to know the etymology of a certain English word.

2. Provide the name of the resource you chose: _____

24	Multiple Choice	2 points

Select from among the following the tool(s) that manage reference or citations and therefore assist in writing research papers.

☐ SciFinder
☐ EndNote
☐ ChemOffice
☐ All of the above
☐ I don't know.

25	Short Answer	3 points

Describe two features of a software program that assist in managing citations.

_____

_____

26	Multiple Choice	2 points

In the U.S., written ideas have intellectual property rights associated with them. For a published journal article, who is more than likely to be the owner(s) of the intellectual property?

☐ Author(s)
☐ Publisher
☐ University
☐ Principal Investigator Only
☐ I don't know.

27	Short Answer	5 points

Pick 1 of the 3 websites listed below and answer each of the questions about that resource.

- ChemFinder: http://chemfinder.cambridgesoft.com
- Sigma-Aldrich: http://www.sigmaaldrich.com/Local/SA_Splash.html
- PubChem: http://pubchem.ncbi.nlm.nih.gov/

What is the name of the site you chose? _____
When was it last updated? _____
Who is the publisher or sponsor? _____
Can the information on this site be trusted, and why or why not? _____
What is the subject content of this site? _____

28	Multiple Choice	5 points

Take a look at the paragraph below. Assuming that you needed to add this information into a paper that you were writing, please select from the following drafts the one that would NOT be plagiarizing the original passage.

Original passage[1]:

> William Shakespeare was born in Stratford-on-Avon in April (probably April 23), 1564. His father was a citizen of some prominence who became an alderman and bailiff, but who later suffered financial reverses. Shakespeare presumably attended the Stratford grammar school, where he could have acquired a respectable knowledge of Latin, but he did not proceed to Oxford or Cambridge. There are legends about Shakespeare's youth but no documented facts.
>
> Abrams, M.H., ed. The Norton Anthology of English Literature. Vol. 1. New York: W.W. Norton & Co.k 1962. 629.

☐ Draft 1. William Shakespeare was born in 1564 in Stratford-on-Avon. His father was a citizen of some importance who became a bailiff and later suffered financial problems. Shakespeare probably attended a grammar school in Stratford where he gained significant knowledge of Latin, but didn't proceed to Oxford. Mainly legends exist about Shakespeare's youth since there are no documented facts. (Abrams, 1962)

☐ Draft 2. William Shakespeare was born in 1564 in Stratford-on-Avon. His father was an affluent member of the community. At one time a well-known and respected alderman and bailiff, he later lost his financial security. Experts suspect that Shakespeare went to the Stratford grammar school where he probably obtained a command of the Latin language, however, since there are no documented facts about his childhood, scholars rely on rumors and stories believed to be historically accurate. They do know that he did not continue his education at Oxford or Cambridge. (Abrams, 1962)

☐ Draft 3. William Shakespeare was born in 1564 in Stratford-on-Avon. His father was a prominent citizen who suffered financial losses after becoming an alderman and bailiff. Shakespeare may have attended the Stratford grammar school and learned Latin, but he did not go on to Oxford or Cambridge. There are no documented facts about Shakespeare's youth so scholars have to rely on legend. (Abrams, 1962)

☐ None of the above.

☐ I don't know.

29	Multiple Choice	0 points

Finally, please reflect on how you think you did on this assessment of your chemistry information fluency skills and select the number that best represents your score, 1 being the lowest and 5 being the highest.

☐ I didn't know anything.
☐ I knew a bit.
☐ I knew about half.
☐ I knew quite a lot.
☐ I understood everything.

---

[1] Jackson, P. (2006) "Understanding plagiarism, paraphrasing and citing sources", available at: http://infodome.sdsu.edu/infolit/exploratorium/Standard_5/plagiarism.pdf (accessed January 14, 2006). ["Content from this handout was written by Pamela Jackson. Portions of this content also appear in San Jose State University Library's *Plagiarism: The Crime of Intellectual Kidnapping* tutorial. This handout may be duplicated and distributed for educational, non-profit purposes as long as this statement appears."]