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The Evolution of a Testing Tool for Measuring Undergraduate Information Literacy Skills in the Online Environment

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FOCUS ON ASSESSMENT [ARTICLE]

THE EVOLUTION OF A TESTING TOOL FOR MEASURING UNDERGRADUATE INFORMATION LITERACY SKILLS IN THE ONLINE ENVIRONMENT

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ABSTRACT

The construction and validity of an assessment tool mapped to objectives in a high enrollment credit-bearing information literacy course delivered primarily online is the focus of this article. An open book and non-proctored objective test can be a reliable measure for assessing student competencies in basic information literacy skills, both at the course level and for reporting to national accrediting bodies and state agencies. An analysis of overall student performance on test items that are mapped to information literacy outcomes helps to identify competencies that need improvement in a course, as well as provide a baseline for informing the process of assessing student learning outcomes in an undergraduate curriculum.

INTRODUCTION

The creation of the Information Literacy Competency Standards for Higher Education by the Association of College and Research Libraries (ACRL) division of the American Library Association in 2000 helped to establish the objectives that colleges and universities could use to teach and assess information literacy skills (ACRL 2000). While there are many examples from library literature focusing on best practices and application of the standards in library instruction, standardized assessments, and discipline-based information literacy assessments from a variety of higher education institutions (Rader, 2002; Rattery, 2002; Thompson, 2002; Rockman, 2004; Neely, 2005; Scharf et al., 2007; Radcliff et al., 2007; Oakleaf,

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2008, 2009), the efforts to evaluate the outcomes of teaching of information literacy concepts and skills in a credit-bearing online course, specifically in the context of national standards and regional accreditation, have not been very well represented (Pausch & Popp, 2004; Saunders, 2008).

Much of the literature focuses on stand-alone assessments, such as the SAILS (Standardized Assessment of Information Literacy Skills) test developed at Kent State University, or the James Madison University's Information-Seeking Skills Test (ISST) that is tied to a required tutorial and general education cluster, library- and course-based instruction conducted by academic librarians, including locally developed assessments that may not have been rigorously reviewed while under development and may not be considered sufficient evidence for accrediting program reviews (Beile, 2008). A survey of primarily academic librarians in 2008 indicates that many librarians conduct assessment and use the results to improve instruction and increase student learning; of the 83% who use assessment results, 58% use them to inform future assessment efforts, and 52% to respond to calls for accountability (Oakleaf & Hinchcliffe, 2008, p. 162). The results of the survey also reflect the perception that there is "a need for centralized support of assessment activities and increased campus collaboration, and a lack of assessment tools that adequately measure information literacy skills and provide detail[ed] descriptions of student skills" (Oakleaf & Hinchcliffe, 2008, p. 163).

As institutions are increasingly called upon to report on student learning outcomes and the use of assessment results to improve student learning, reinforcing the connection between the assessments conducted in a variety of settings (library and course-based instruction, credit courses, research papers graded with rubrics) and the use of results to better inform further skills development in students' major programs is critical. While a comprehensive information literacy assessment plan across a curriculum is complex and needs a multi-dimensional approach, a locally developed objective test that is a reliable and valid assessment tool mapped to information literacy outcomes is a scalable and meaningful measure for assessing and reporting on students' competencies at both the course and institution level.

OVERVIEW

University of Maryland University College (UMUC) is one of 11 degree- granting institutions in the University System of Maryland. As an open-access global university, UMUC is the largest public provider of online education in the United States, with over 170,000 enrollments. Information Literacy and Research Methods, LIBS 150, is a one-credit course intended to provide undergraduate students with a foundation of basic research skills in an online environment. The course is offered primarily online in a 7-week format and enrolls thousands of students per semester. Since 2001, well over 70,000 students have completed the course all over the world.

While the UMUC library was actively providing library instruction there was no systematic means to ensure that students received instruction, especially students at a distance taking classes online. The course was first designated as a general education requirement in emerging issues within the first 18 credit hours at UMUC in 2001, based on the recommendations of the School of Undergraduate Studies (SUS) Information Literacy Task Force to the undergraduate dean. The intent was for the course to be a foundation for students on which faculty could build in succeeding courses in the curriculum using the Association of College and Research Libraries (ACRL) Information Literacy Standards for Higher Education as a framework. The course objectives are based on the standards, as are the School of Undergraduate Studies information literacy outcomes.

The information literate student:
  1. determines the nature and extent of the information needed

2. accesses needed information effectively and efficiently
3. evaluates information and its sources critically
4. individually or as a member of a group, uses information effectively to accomplish a specific purpose
5. understands many of the economic, legal, and social issues surrounding the use of information and access and uses information ethically and legally

A primary goal of the LIBS 150 course is to teach students the necessary skills to conduct academic research using the UMUC library resources online.

COURSE ROLE IN ASSESSMENT

UMUC began an institutional assessment initiative in preparation for a Middle States Accreditation Self-Study in 2003, and the university reports every 3 years on Student Learning Outcomes Assessment to the Maryland Higher Education Commission in areas related to general education skills that are identified in the accreditation process (Lyons, 2007). Several of the areas in the undergraduate curriculum were identified for this reporting by the university, including information literacy. In 2005, the final exam in the required course became the tool for institution-level information literacy assessment in the School of Undergraduate Studies. Table 1 summarizes the overall development of the course and its role in assessment in the undergraduate curriculum.

The ACRL standards focus on students at all levels in higher education, and include a range of outcomes for assessing student progress toward information literacy at both the higher and lower levels of thinking skills (ACRL, 2000). The outcomes and indicators described in the standards are a useful resource for identifying the targeted competencies by specific performance indicators and outcomes:

Standard
The information literate student determines the nature and extent of the information needed.

Performance Indicator
The information literate student defines and articulates the need for information.

Outcome
Identifies key concepts and terms that describe the information need.

TABLE 1—DEVELOPMENT AND ASSESSMENT OF A REQUIRED COURSE

2000–2001	• Task force recommended tiered approach based on national information literacy standards (ACRL); Required IL course as foundation (LIBS 150) • Course piloted for online delivery with 100 students per course section
2002–2003	• Multiple exam versions developed; pre-test added 2003 • First course revision
2003–2006	• Second course revision • Preassessment survey, quizzes and scored activities replace pre-test • Guided by the Office of Outcomes Assessment, final exam revised and mapped to course goals and module objectives • LIBS curriculum objectives adopted worldwide with one common final exam
2006–2007	• First global assessment of LIBS final exam results Spring 2006 and Spring 2007 • More reliable exam instrument developed
2008–2009	• Spring 2008 LIBS final exam results analyzed by student performance on SUS information literacy objectives • Third course revision

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The standards also serve as a framework for creating assessments based on the course goals as shown in Table 2.

All of the assessments in the course are aligned with the standards, outcomes and performance indicators and are designed to help students practice skills in a low-stakes environment with the learning activities before taking a quiz or other objectively scored assessment, such as the final exam. There are also two research log projects graded with a rubric. For the log, students are asked to locate, evaluate, and cite a selected article for a specific research question they select from a list (e.g., *Does telecommuting increase work productivity?)* that will be redesigned to help better measure the skill of using information effectively for a specific purpose (Standard 4). In general, individual student performance on the assessments correlates with their performance in the course overall (i.e., quizzes, the research log projects and final exam). The overall performance on the quiz questions related to evaluating information and its sources critically is higher than on the final exam questions. An analysis of student performance on the LIBS exam by individual item demonstrates that students have particular difficulty with higher order concepts, such as understanding researchable questions, source selection and evaluation (appropriate tool and relevance) and developing effective search strategies. The current exam includes two questions that ask students to apply evaluative skills (Standard 3) by identifying whether an article citation and abstract is relevant or irrelevant, or scholarly or not scholarly, for a specific information need. Student performance on these two questions indicates that critical evaluation of a source for an information need is a skill that needs further emphasis. The data are consistent with anecdotal observations about how well students are able to evaluate a relevant article for their research log project.

The goal of assessment in the required course has been mastery of the course content and some of the basic information literacy standards adapted by SUS. The development and refinement of the final exam has been one of almost continuous improvement since 2002, with the development of the instruments and analysis of the test results coordinated with research and assessment offices at the university. The data gathered from exam results, other course assessments, student evaluations, and faculty feedback have been incorporated into the course revisions. After the 2005 revision and intentional alignment of all the assessments to the course content, student retention in the course improved significantly. Withdrawal rates in online sections of the course decreased 60% on average worldwide, and students recommending the course in their required evaluations increased.

TEST DEVELOPMENT AND DATA SUMMARY

Initially, multiple versions of the exam were created to allay concerns about cheating, as well as making the exam open book. As Olt (2002) and Rakes (2008) have written, open book tests can reduce concerns about cheating and well-constructed tests can be a viable and rigorous means of assessing student learning in online classes. In 2003, a pre-test was created and mapped to the three post-tests to help measure student improvement by specific objectives. While an initial analysis of the results from the Fall 2003 semester showed some improvement on student performance overall, there were also areas where students showed a decline rather than an improvement. There were issues of reliability across three versions of the exam and the weaknesses with this method of pre- and post-assessments have been documented (Emmet & Emde, 2007). In 2005, the pre-test was replaced with a preassessment survey and the multiple versions of the exam were combined into one instrument that was rigorously reviewed as a part of a major course revision. In addition, the mouse control functions to save, copy or paste the exam content were disabled, and the exam results sent to students do not include corrected answers that could be shared with others.

As a part of the exam revision in 2005, the Office of Outcomes Assessment worked closely with the School of Undergraduate Studies to

TABLE 2—INFORMATION LITERACY AND RESEARCH METHODS COURSE ACTIVITIES AND ASSESSMENTS

Course Goals
• Demonstrate an understanding of the research process. • Select relevant print and electronic sources to answer research questions. • Effectively use Web search engines and UMUC's Information and Library Services electronic resources to find information. • Critically evaluate and correctly cite the selected information.

Standard	Module	Module Objectives	Activities
Standard 1	1. Information and Libraries	-identify types of information -identify types of libraries -identify Information and Library Services (ILS) resources and services	-Preassessment Survey -Learning Activity #1: Guided Exploration
Standards 1, 2	2. The Research Process	-describe the steps of the research process -define plagiarism -identify a researchable question -choose keywords and effectively develop searches - appropriately revise a search statement	-Learning Activity #2: Researchable Questions -Learning Activity #3: Using Boolean Operators (key concepts drag and drop, keyword brainstorming)
Standards 2, 3	3. Resources for Research	-identify types of information sources useful for academic research -explain how a database record is structured -select the appropriate research tool for an information need -access a UMUC database and locate an article	-Learning Activity #4: Catalog Search -Learning Activity #5: Identifying -- Resources -Learning Activity #6: Database Search -Research Log Project 1
Standard 3	4. Evaluating and Selecting Your Sources	-assess the authority of information in both print and Internet formats -identify differences between types of periodical literature -evaluate the quality and reliability of a Web Site	-Learning Activity #7: Locating a Book Record -Learning Activity #8: Web Search Activity -Learning Activity #9: Evaluating a Web Page -Learning Activity #10: Locating and Evaluating a Web Site
Standards 3,4, 5	5. Academic Integrity and Documenting Sources	-explain when to cite sources -identify examples of plagiarism -cite a journal article from the UMUC databases in APA style -explain a critical annotation of a source	-Learning Activity #11: Identifying plagiarism -Research Log Project 2

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align the final exam items with the SUS information literacy standards and the course goals and module objectives, using a matrix as shown in Table 3.

After ensuring content and construct validity, the test went through three phases of assessment and enhancement to ensure reliability. The first form of the test was piloted in Spring 2006, and the results from 3,000 students were analyzed and the test was enhanced accordingly. The enhanced form of the test was administered in Spring 2007 with 3,397 students; the newest form of the test was used in Spring 2008 with 3,760 students. Table 4 shows the summary statistics for each semester. The overall test performance data in terms of average achievement and dispersion of scores were always controlled for, to ensure that the test reflected the real performance. These results correlate with other course assessment (learning activities, quizzes, and projects) in the course. The mean and standard deviation among other indicators from Spring 2008 were stable and better reflected the performance of students.

After each assessment phase, the test items were reviewed and modified or replaced. Also, more items were added to improve overall test reliability. Items were analyzed after each implementation in terms of item difficulty and discrimination. Item difficulty was decided by the ratio of students who chose the correct answer to the total number of students. Table 5 and 6 show the difficulty and discrimination bands for the items each semester. In the final form of the test, most of the items have difficulty levels from 0.5 to 0.7. (Mehrens & Lehmann, 1991; Ebel & Frisbie, 1986). In a face-to-face and proctored environment an average difficulty for items with five options ideally is around 0.7. However, we maintained the difficulty at a lower level to adjust for the effect of the online and non-proctored situation. Table 5 presents the calculated item difficulty values for each individual item. The logic underlying item discrimination was to have items that can differentiate between students who did a good job on the whole test from students who did poorly. This was checked by measuring the correlation between the performance on the item and the overall performance on the test for each student. In the final test form there were no items with very low discrimination index (Oosterhof, 1990; Allen & Yen, 1979, Hopkins, 1998), as shown in Table 6.

TABLE 3—FINAL EXAM MATRIX

Information Literacy Standard	Course Goal	Module Objective	Test Item
1	1	1.1	You find a journal article that analyzes recent trends in genetically engineered crop research. This article would be considered which type of information? a. primary **b. secondary**

TABLE 4—OVERALL PERFORMANCE BY SEMESTERS

	Spring 06	Spring 07	Spring 08
Number of scores	**3,019**	**3,397**	**3,760**
Lowest score	19.2%	26.9%	22.5%
Highest score	100.0%	100.0%	100.0%
Median	88.5%	84.6%	82.5%
Mean	85.7%	85.1%	80.5%
Standard deviation:	8.4%	8.5%	11.9%
Number of items	26	26	40

The extent to which the measurements obtained from the test are consistent is examined from two perspectives: overall test and the item level. Between Spring 2006 and Spring 2008, the test reliability was improved significantly and the internal consistency alpha coefficient of reliability (Cronbach's alpha[1]) increased from 0.48 to 0.78. In general, an overall reliability value that is about 0.8 is satisfactory. At the item level, the focus was on the change in overall reliability when the items of interest were deleted. Table 7 shows the reliability figures over the three phases. In the last phase (Spring 2008 test), three items required minor adjustment and hence the final form of the test is expected to have a higher reliability.

In addition, item characteristic curves (ICC) were also used in all the phases to reveal problematic items. The item characteristic curve is drawn based on estimated student abilities and the probability that student will answer an item correctly. This was another way to understand the relationship between estimated ability and the corresponding chance to obtain correct answers. Figures 1-3 show graphs of some of the problematic items in the three phases.

TABLE 5—ITEM DIFFICULTY BY SEMESTERS

Index of difficulty	Spring 2006	Spring 2007	Spring 2008
.30:			Q20
.40:	Q10	Q10	Q33
.50:	Q6 Q8	Q1 Q6 Q8	Q6 Q17 Q25
.60:	Q1		Q10 Q32 Q34
.70:	Q4	Q4	Q1 Q11_7 Q16 Q18 Q19 Q24
.80:	Q5 Q9 Q11 Q12 Q13 Q14 Q19	Q5 Q9 Q11 Q12 Q13 Q14 Q19	Q7 Q8 Q11_1 Q11_3 Q11_6 Q14 Q15 Q22 Q23 Q26 Q31
.90:	Q2 Q3 Q7 Q15 Q16 Q18	Q2 Q3 Q7 Q15 Q16 Q17a Q17b Q17c Q17d Q17e Q17f Q17g Q17h Q18	Q2 Q3 Q4 Q5 Q9 Q11_2 Q11_4 Q11_5 Q12 Q13 Q21 Q27 Q28 Q29 Q30

TABLE 6—ITEM DISCRIMINATION BY SEMESTERS

	Spring 2006	Spring 2007	Spring 2008
.00:	Q1 Q8 Q9 Q10 Q13	Q1 Q8 Q9 Q10 Q13	
.10:	Q2 Q3 Q4 Q5 Q6 Q7 Q16 Q18	Q2 Q3 Q4 Q6 Q16 Q17c Q17d Q17e Q17f Q17g Q17h Q19	Q1 Q5 Q7 Q9 Q10 Q12 Q14 Q17 Q19 Q20 Q28
.20:	Q11 Q12 Q14 Q15 Q19	Q5 Q7 Q11 Q12 Q15 Q17a Q18	Q3 Q4 Q6 Q8 Q13 Q15 Q16 Q21 Q22 Q23 Q26 Q27 Q29 Q32 Q33
.30:		Q14 Q17b	Q2 Q11_3 Q11_4 Q18 Q24 Q25 Q30 Q31 Q34
.40:			Q11_1 Q11_2 Q11_5 Q11_6 Q11_7

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TABLE 7—TEST RELIABILITY BY SEMESTERS

Spring 2006			Spring 2007			Spring 2008		
alpha figures (alpha= .4811)			alpha figures (alpha= .4835)			alpha figures (alpha = .7797)		
Without	*alpha*	*change*	*without*	*alpha*	*change*	*without*	*alpha*	*change*
Q1	0.503	**0.022**	Q1	0.516	**0.032**	Q1	0.779	0.000
Q2	0.466	-0.015	Q2	0.468	-0.016	Q2	0.774	-0.006
Q3	0.463	-0.018	Q3	0.466	-0.017	Q3	0.776	-0.003
Q4	0.477	-0.004	Q4	0.476	-0.007	Q4	0.778	-0.002
Q5	0.46	-0.021	Q5	0.459	-0.024	Q5	0.779	0.000
Q6	0.469	-0.013	Q6	0.473	-0.01	Q6	0.777	-0.003
Q7	0.467	-0.014	Q7	0.463	-0.02	Q7	0.780	**0.000**
Q8	0.486	**0.005**	Q8	0.492	**0.009**	Q8	0.776	-0.003
Q9	0.479	-0.002	Q9	0.484	**0**	Q9	0.779	-0.001
Q10	0.496	**0.015**	Q10	0.494	**0.011**	Q10	0.781	**0.001**
Q11	0.453	-0.028	Q11	0.455	-0.028	Q11_1	0.765	-0.014
Q12	0.451	-0.03	Q12	0.46	-0.024	Q11_2	0.771	-0.009
Q13	0.498	**0.017**	Q13	0.504	**0.02**	Q11_3	0.771	-0.008
Q14	0.448	-0.033	Q14	0.438	-0.045	Q11_4	0.775	-0.004
Q15	0.456	-0.025	Q15	0.458	-0.026	Q11_5	0.769	-0.011
Q16	0.467	-0.014	Q16	0.475	-0.008	Q11_6	0.766	-0.014
Q17a	0.463	-0.018	Q17a	0.462	-0.022	Q11_7	0.765	-0.014
Q17b	0.464	-0.017	Q17b	0.459	-0.025	Q12	0.778	-0.002
Q17c	0.474	-0.007	Q17c	0.476	-0.007	Q13	0.776	-0.003
Q17d	0.476	-0.005	Q17d	0.48	-0.004	Q14	0.779	-0.001
Q17e	0.481	0	Q17e	0.482	-0.002	Q15	0.777	-0.003
Q17f	0.477	-0.004	Q17f	0.477	-0.006	Q16	0.777	-0.003
Q17g	0.476	-0.005	Q17g	0.477	-0.007	Q17	0.781	**0.001**
Q17h	0.475	-0.006	Q17h	0.477	-0.007	Q18	0.773	-0.007
Q18	0.466	-0.016	Q18	0.464	-0.02	Q19	0.778	-0.001
Q19	0.458	-0.023	Q19	0.474	-0.009	Q20	0.780	0.000
						Q21	0.777	-0.003
						Q22	0.777	-0.003
						Q23	0.776	-0.003
						Q24	0.773	-0.007
						Q25	0.772	-0.008
						Q26	0.774	-0.006
						Q27	0.775	-0.005
						Q28	0.778	-0.002
						Q29	0.776	-0.004
						Q30	0.775	-0.005
						Q31	0.773	-0.007
						Q32	0.775	-0.005
						Q33	0.776	-0.004
						Q34	0.773	-0.006

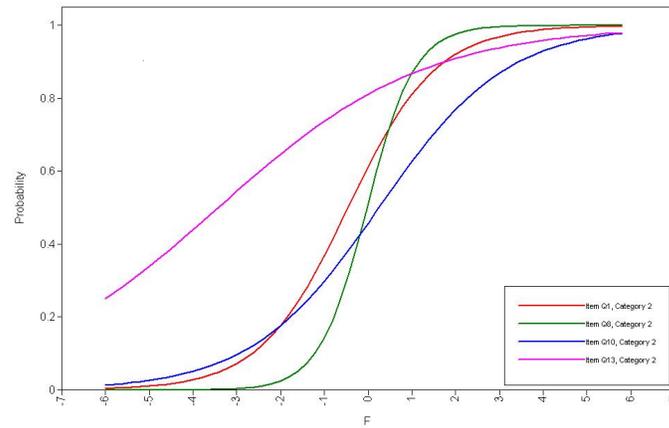FIGURE 1—ICC FOR SPRING 2006 LIBS 150 TEST

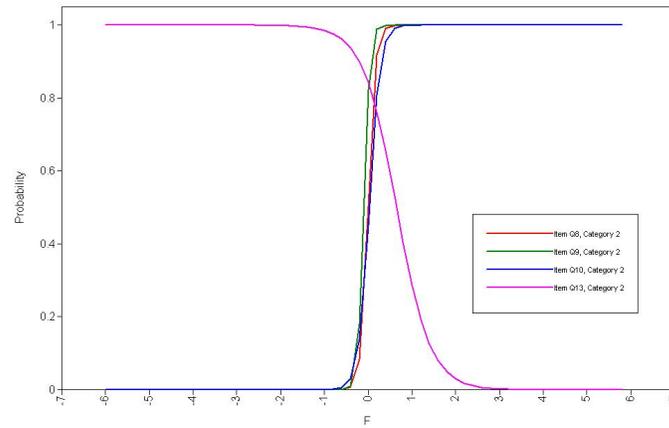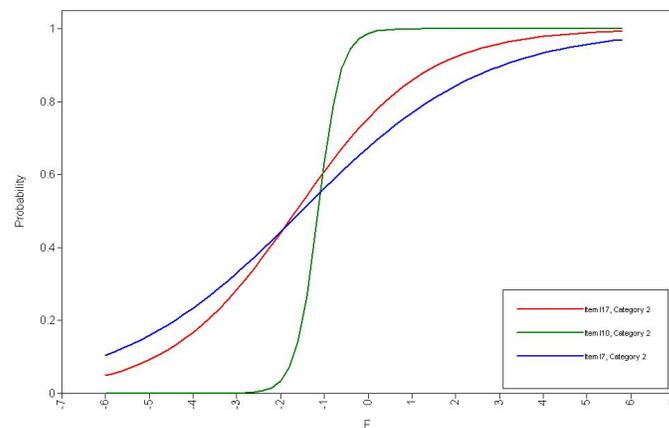FIGURE 2—ICC FOR SPRING 2007 LIBS 150 TEST

FIGURE 3—ICC FOR SPRING 2008 LIBS150 TEST

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CONCLUSION

In conclusion, we were able to systematically develop a tool with the psychometric properties of good reliability, difficulty, and discrimination that fit the course objectives well, and was well designed to accommodate online students in a non -proctored environment. This tool made it possible to assess student competency in information literacy and contribute to improving and aligning the undergraduate curriculum in this area. The School of Undergraduate Studies recently revised its approach to program level assessment, and with this organizational change comes an opportunity to expand the scope of assessment in the required course from a focus on the final exam to other measures. While the final exam is an important indicator of overall student performance in information literacy, other measures in the course to assess learning outcomes include scored learning activities, quizzes, and two research log projects. The course revision project will use the item analysis from the exam results and a systematic review of all learning activities to revise or create new ones as needed to better support skills development in areas needing improvement. For example, student performance on source evaluation questions on the exam indicates a need for more practice with reading citations and article abstracts in determining appropriateness for their use in academic research. There also need to be additional measures of the ability to articulate a research question and select the appropriate tools to investigate an information need. The data from the exam results are consistent with anecdotal faculty observations about how well students are able to select and evaluate a relevant article for their research log project in the final project for the course. A formal assessment of the research log projects will help to measure student performance on using information to accomplish a specific purpose.

The use of an objective test provides a snapshot of overall student performance for reporting learning outcomes to accrediting and state agencies, and establishes a baseline of performance that can be used to compare student performance on information literacy outcomes in later writing and research courses and courses in the major, such as capstone courses. This use of multiple measures of student performance by objective will further corroborate the exam results and inform our analysis of the specific skills that need further emphasis, both in the required course and students' later courses. All of this data will provide a more complete picture of student learning that will be shared with deans and program directors to help inform sequenced skills development in the major programs.

NOTE

1. Cronbach's α determines internal consistency and measures how well a set of items measures a single, unidimensional latent construct (Cronbach, 1951).

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