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Initial Development of a Medical Information Literacy Questionnaire

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INITIAL DEVELOPMENT OF A MEDICAL INFORMATION LITERACY QUESTIONNAIRE

by

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DISSERTATION

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Initial Development of a Medical Information Literacy Questionnaire

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ABSTRACT

Purpose

The purpose of this dissertation was to develop and pilot test an instrument measuring information literacy (IL) competence in resident physicians. Originating from the library science literature, information literacy is defined as a broad set of skills and abilities necessary to locate, evaluate and use information ethically and legally. This important skill set is incorporated into general competency requirements for post graduate residency programs, however no standardized instrument currently exists to measure resident physician IL knowledge and skills.

Method

The author constructed a questionnaire of sixty-nine multiple-choice items to assess skills covering five IL domains. Evidence of test content was evaluated by a panel of twenty physicians and five health sciences librarians. A draft instrument was administered to a convenience sample of resident physicians at the University of New Mexico during a two week period in 2014. Psychometric properties of the tested items were evaluated using item analyses. Scores from the pilot test were analyzed to examine the structure of the draft instrument.

Results

The internal consistency reliability coefficient using Cronbach's alpha was good (α = .872). Data from the item analyses for each item was used to guide the item retention process. Each item was reviewed for corrected item-total correlation value to gauge level of item discrimination and P-values for item difficulty. Cronbach's alpha-if-item-deleted, CVR scores established by the validity panel, and the test blueprint were also considered. Based on the analyses, 32 items (46%) were eliminated from the original pool of 69 items tested. The remaining 37 items now constitute a revised instrument (α = .858). Although Principal Component Analysis (PCA) with Varimax rotation was conducted on the revised instrument, the large amount of variance unaccounted for (45%) made it impractical to interpret or label the extracted components.

Conclusions

Further investigation is needed before the revised instrument is used as an assessment tool.

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Introduction

In today's data driven, information rich society, the meaning of the term "literacy" has moved beyond the simple ability to read and write to one incorporating various types of "literacies" across multiple domains. At the most basic level, core reading and writing literacy skills are necessary to function in daily life. However, to be considered a truly "literate" person, individuals must go beyond the literal translation of words and be able to seek out information, measure the reliability and validity of information within the context from which it was received as well as have the ability to communicate information to others. These additional skills generally describe the construct known as "Information Literacy".

As defined by the field of library and information science, information literacy is a broad set of skills and abilities necessary to locate, evaluate, and use information. Information literacy is said to encourage higher level critical thinking and problem-solving skills, and encourages life-long learning. Competency standards developed by the Association of College and Research Libraries (ACRL) (Association of College and Research Libraries & American Library Association, 2000) serve as a framework for information literacy instructional and assessment practices across the educational continuum.

Information literacy skills are especially pertinent for those in information intensive fields such as medicine. Medicine has become increasingly complex and specialized, providing challenges to physicians as they care for patients. In order to provide good patient care, physicians are expected to keep up to date with the latest medical knowledge. In this environment, it is critical physicians have the ability to locate current literature in their field, evaluate information they find, use the information to support clinical decisions and patient care, and communicate that information to various audiences. While the term “information literacy” is not widely recognized in the medical field, information literacy skills exemplify the steps found in the research process and in “evidence-based medicine” (EBM), a well understood concept in healthcare, and skills that have been incorporated into the general competency requirements for postgraduate residency programs (Accreditation Council of Graduate Medical Education, 2009). Whether called Information Literacy or Evidence-Based Medicine, these skills are recognized as important skills for all learners by the Association of College and Research Libraries (ACRL), the American Association of Medical Colleges (AAMC), the Accreditation Council for Graduate Medical Education (ACGME) and other major health professional associations (Accreditation Council of Graduate Medical Education, 2009; Association of American Medical Colleges, 1998; Association of College and Research Libraries & American Library Association, 2000; Eldredge, Morley, Hendrix, Carr, & Bengtson, 2012) .

Background and Significance

However, despite this recognition, neither specific training nor assessment of these skills has been explicitly prescribed thus providing an opportunity for further research. Whereas information literacy tests have been developed for use with undergraduate college students, information literacy tests for use in graduate student populations have been less well investigated, and none of the currently published instruments target medical or health sciences populations. Information literacy is relevant to graduate medical education. An instrument capable of measuring information literacy skills in the medical setting has practical implications for identifying gaps in physician trainee knowledge. The ability to measure information literacy proficiency in this population would provide formative feedback to residency program directors and health sciences librarians. This feedback would be applicable as an assessment tool to document resident information competencies or as a diagnostic tool for revising instruction to enhance resident education. Therefore, the purpose of this study was to develop, field test, and evaluate an information literacy measurement tool designed for graduate medical education trainees.

Specific aims of this project were to

Aim 1. Generate an initial pool of information literacy items;

Aim 2. Establish validity evidence for the draft items;

Aim 3. Design and pilot test the draft instrument; and

Aim 4. Evaluate psychometric properties of the tested items.

Drawing upon the ACRL standards, ACGME competencies, and a blueprint developed from previously conducted research, a pilot study was conducted with medical education subject matter experts to validate test items. Items approved by the panel were incorporated into a draft instrument and tested in a resident physician population. Psychometric properties of the instrument were examined using item analyses.

This study is important not only because there is no information literacy instrument available for healthcare providers but because the development of a survey instrument that reliably measures residents' information literacy skills will provide a means by which graduate medical education residency programs can identify areas of additional or continued education needs related to ACGME competencies.

Literature Review

Information Literacy

Derived from the Latin word *littera*, meaning letter, literacy has been defined as "the quality or state of being literate, especially the ability to read and write" (Webster's Third New International Dictionary of the English Language, 1993). At this most basic level, reading and writing are thought to make it possible for people to function in society with the potential of furthering one's goals and abilities (Bhola, 1994; Committee on Performance Levels for Adult Literacy, 2005). Although these core skills are recognized as a foundation of literacy, the ability to decode symbols is not viewed by all as true literacy**.** Freire (1983) argued the additional steps of critical reflection, interpretation, and communication with others are necessary before one can be considered a literate person (Freire, 1983). Freire and others consider literacy a multidimensional concept that is an essential skill across multiple domains and one which has been described as a world view, social practice, and way of knowing (Bhola, 1994; Bruce, 1998; Committee on Performance Levels for Adult Literacy, 2005; Freire, 1983; Mackey, 2002; Owusu-Ansah, 2003).

More recently multiple literacies have emerged to enhance and expand what it means to be "literate" in the modern era. "Literacy has multiple conceptions, which range from a focus on the most fundamental survival skills to more complex definitions that encompass the skills needed to thrive in a variety of contexts." (Committee on

Performance Levels for Adult Literacy, 2005). The types of literacy referred to in the previous statement include, but are not limited to: *adult literacy, civic literacy, computer literacy, cultural literacy, digital literacy, economic literacy, environmental literacy, family literacy, health literacy, information literacy, information and communications technology literacy, media literacy, network literacy, oral literacy, political literacy, scientific literacy, visual literacy,* and *workplace literacy* (Bhola, 1994; Kirsch, 2001; Mackey, 2002; Owusu-Ansah, 2003; Shanbhag, 2006). It is not difficult to imagine how some of these literacies overlap with or are dependent upon one another but each has its origin in different domains or fields and each has its own particular focus.

One such literacy, information literacy, is broadly defined by the field of library and information science as "a set of abilities requiring individuals to 'recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.'" (Presidential Committee on Information Literacy & American Library Association, 1989, para.3). This construct includes finding and using quality print and electronic resources effectively and ethically. The overarching concept of information literacy addresses the comprehensive research process from generating hypotheses to retrieving, analyzing and evaluating information that can then be used or communicated to others (Grafstein, 2007; Owusu-Ansah, 2004). Information literacy is a broad set of skills and abilities identified as a critical skill necessary for all students throughout the education continuum (Baker & Boruff-Jones, 2009; Barbour, Gavin, & Canfield, 2004; Thompson, 2002; Virkus, 2003) and is thought to encourage higher level critical thinking, problem-solving, and life-long learning (Barbour et al., 2004; Grafstein, 2007; Grassion & Kaplowitz, 2011).

Information Literacy, a term in use since the mid 1970's (Zurkowsky, 1974), has its roots in library instruction. Also known as library user education or bibliographic instruction, traditional library instruction in an educational setting had orientation to and awareness of the library and its resources as its focus. The earliest type of instruction, library tours and one-on-one or group instruction on how to use the card catalog or a printed index to locate materials in the library was based on a narrow set of skills in a print environment. Typically, instruction was taught by a librarian and was separate from the curriculum (C. S. Bruce, 1997; Thompson, 2002). Moving away from the more narrowly defined "library skills" to a broader concept of "information skills" the information literacy movement first advanced by the 1988 Model Statement of Objectives for Academic Bibliographic Instruction (Arp, 1987) and later explicated in the *Information Literacy Competency Standards for Higher Education* (Association of College and Research Libraries & American Library Association, 2000).

Information Literacy Standards

These standards outline knowledge, skills, and abilities in five content areas deemed important for students at the college level (see Table 1.) The five standards ("*know", "access", "use", "evaluate"* and *"ethical/legal"*) encompass 22 performance indicators with 87 associated learning outcomes. The outcome statements, based on Bloom's Taxonomy of Learning Objectives (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956), combine both technical and intellectual skills that fall into three cognitive levels:

- Level 1: knowledge/remembering
- Level 2: comprehension/understanding & application
- Level 3: analysis & synthesis / creating & evaluating

Table 1.
ACRL Information Literacy Competency Standards for Higher Education

	Standards	Performance Indicators	Learning Outcomes
1	Determine nature and extent of information needed *(Know)*	4	17
2	Access needed information effectively and efficiently *(Access)*	5	22
3	Evaluate information and sources critically *(Evaluate)*	7	25
4	Uses information effectively to accomplish a specific purpose *(Use)*	3	10
5	Understands ethical, legal, and socioeconomic issues surrounding information and information technology *(Ethical/Legal)*	3	13

Note. Adapted from Association of College and Research Libraries, & American Library Association. (2000). *The information literacy competency standards for higher education.* Retrieved November 15, 2008, from http://www.ala.org/ala/mgrps/divs/acrl/standards/informationliteracycompetency.cfm

The ACRL Standards, endorsed by the Middle States Commission on Higher Education (Middle States Commission on Higher Education, 2006), were developed as a framework for instructional and assessment practices for information literacy in undergraduate and graduate education. The ACRL Model Statement, revised in 2001, delineated learning objectives that tie to specific performance indicators and outcomes in the ACRL competency standards.

Information literacy describes both technical and intellectual skills, combining critical thinking and facility with information technology (Atton, 1994; Baker & Boruff-Jones, 2009; Kasowitz-Scheer & Pasqualoni, 2002; Lih-Juan ChanLin & Chwen-Chwen Chang, 2003; McCarthy & Pusateri, 2006; Walton & Archen, 2004). As a result of this paradigm shift, today's library education and training attempts to be more in-depth and discipline specific (Grafstein, 2002; Manuel, 2004). The literature confirms this trend in the area of business (Cooney, 2005; Fiegen, Cherry, & Watson, 2002; Roldan & Yuhfen Diana Wu, 2004; Rutledge & Maehler, 2003), the basic sciences (Aydelott, 2007; Brown & Krumholz, March 2002; Garritano, 2010; J. A. Porter et al., 2010; J. R. Porter, 2005; Ward & Hockey, 2007), and the liberal arts (McCarthy & Pusateri, 2006; Sjoberg & Ahlfeldt, 2010; Studstill & Cabrera, 2010). The allied health professions also are well-represented in the literature (Baker & Boruff-Jones, 2009; Cobban & Seale, 2003; Cobus, 2008; Flood, Gasiewicz, & Delpier, 2010; Ford, Foxlee, & Green, 2009; Kipnis & Frisby, 2006; Morris, 2005; Nail-Chiwetalu & Ratner, 2006; Peterson-Clark et al., 2010; Peterson-Clark, Aslani, & Williams, 2010; Powell & Case-Smith, 2010; Shanahan, 2006; Spang, Marks, & Adams, 1998; N. Thompson, Lewis, Brennan, & Robinson, 2010). Nursing, in particular, understood and adopted the concept early on (Cheek & Doskatsch, 1998; Dorner, Taylor, & Hodson-Carlton, 2001; Fox, Richter, & White, 1989; Fox, Richter, & White, 1996; Francis & Fisher, 1995; Kerfoot, 2002; Rosenfeld, Salazar-Riera, & Vieira, 2002; Verhey, 1999) and has continued to promote information literacy in relation to evidence-based practice (Courey, Benson-Soros, Deemer, & Zeller, 2006; Jacobs, Rosenfeld, & Haber, 2003; Klem & Weiss, 2005; Moch, Cronje, & Branson, 2010; Pravikoff, 2006; Ross, 2010; Shorten, Wallace, & Crookes, 2001; Tanner, Pierce, & Pravikoff, 2004).

Ideally, information literacy skills should be taught throughout the undergraduate and graduate curricula in higher education. However, some research suggests that many students earning a 4-year degree graduate with less than adequate information literacy skills (Educational Testing Service, 2006; Gross, 2005; Maughan, 2001). The truth of the matter is information literacy instruction is not fully integrated into most college curricula (Brown & Krumholz, March 2002; Burrows, Moore, Arriaga, Paulaitis, & Lemkau, 2003; Kaplan & Whelan, 2002; K. Kingsley et al., 2011; Kingsley & Kingsley, 2009; Rader, 2002).

Information Literacy in Medicine

Evidence-based Medicine

In the field of healthcare, the corollary to information literacy is evidence-based practice (Kaplan & Whelan, 2002) involving "the process of acquiring, systematically reviewing, appraising and applying research findings to aid the delivery of optimum clinical care to patients."(Das, Malick, & Khan, 2008, p. 493). Initially introduced in the early 1990's, evidence-based medicine (EBM) is a five step clinical decision making process whereby the health care provider 1) develops a structured clinical question; 2) performs a literature search to locate the best available evidence on that topic; 3) systematically reviews and critically appraises the evidence; 4) applies the findings in a clinical context; and 5) evaluates the process (Sackett, 2000). Informatics, another related concept often used in conjunction with evidence-based medicine, is "concerned with the optimal use of information, often aided by the use of technology, to improve individual health, health care, public health, and biomedical research." (Hersh, 2009, "Discussion", para.3).

Medical schools employ various teaching models (Azer, 2011; Parmelee & Michaelsen, 2010; Schmidt, Rotgans, & Yew, 2011; Searle et al., 2003) and many have a particular emphasis integrating one or more topics throughout the curriculum or provide a particular track for those interested (Anderson & Kanter, 2010; Gotterer, O'Day, &

Miller, 2010). Most undergraduate medical schools now incorporate evidence-based medicine instruction into the curriculum through a variety of means (e.g. lecture, laboratory, computer assisted instruction, etc.) however only 22 schools report EBM as an independent course (Association of American Medical Colleges, 2012). An increasing number of medical schools emphasize research in their curricula or offer a "scholarly concentration". Some schools offer a month long research elective, others require six months of research with a capstone project including both written and oral presentations, while still others elect to provide students with a longer, more in-depth concentration (Green et al., 2010). Of 157 medical schools, 84 institutions report a research requirement with 10 of those schools requiring a written thesis (Association of American Medical Colleges, 2012). Information literacy is a necessary foundation for both research and evidence-based medicine.

Rating medical school instruction as *inadequate, appropriate,* or *excessive,* most graduates responding to a 2013 survey reported evidence-based medicine training as *appropriate* (Association of American Medical Colleges, 2013). Also rated as *appropriate* were interpretation of clinical data and research reports (86.9%), ability to conduct a systematic literature review (83.7%), and decision analysis (86.9%). When asked about confidence in their knowledge and skills, 49.4% (agree) and 36.7% (strongly agree) self-reported their ability to carry out sophisticated searches of medical information databases along with 49.1% (agree) and 31.3% (strongly agree) who were confident they could critically review published research (p.22-23). When asked about preparation for residency, the respondents agreed (53.9%) or strongly agreed (40.2%) that they had basic skills in clinical decision making and application of evidence based information to medical practice.   It should be noted here this is self-reported data. There is no standardized instrument presently in place to verify actual knowledge or skills in these areas, although the Committee to Evaluate the USMLE Program (CEUP) has proposed adding assessments to address medical student ability to access, evaluate, and apply information with the new test (Kies & Shultz, 2010). The USMLE Step 3 *Foundations of Independent Practice (FIP)* examination will contain content related to interpreting medical literature and will comprise “newer item formats based on scientific abstracts and pharmaceutical advertisements” and will take place beginning 2014 (USMLE, 2013).

Given the educational requirements for acceptance to and graduation from medical school one must assume physicians are, in the broadest sense, literate. The practice of medicine, increasingly complex and specialized, provides challenges to physicians as they care for patients. In this environment, it is critical therefore that physicians are also information literate – that is, able to locate current literature in their field, evaluate the information they find, and able to use and communicate that information. By the time a student graduates from medical school and moves into post-graduate training he or she should be capable of and comfortable with locating, evaluating, and incorporating information into daily practice. However, as previously described, students experience different exposure to information literacy in the college years and to research, evidence-based medicine, and medical informatics during medical school (Association of American Medical Colleges, 2010; Citrome & Ketter, 2009; Krause, Roulette, Papp, & Kaelber, 2006; McGowan, Passiment, & Hoffman, 2007; Scott, Shaad, Mandel, Brock, & Kim, 2000; van Dijk, Hooft, & Wieringa-de Waard,

2010) thus leading to varying information literacy skill levels among physician trainees during the post-graduate years.

Graduate Medical Education

Post-graduate training (aka "residency") is the second phase of a physician's education. Medical school graduates take a licensure exam to become physicians but, depending upon the medical specialty they have chosen, must then spend between three and six years in the post-graduate years (PGY) learning to become competent practitioners. A residency in a primary specialty such as Family Medicine, Internal Medicine, Psychiatry or Pediatrics takes three years to complete while the surgical specialties require more years of training. Post-graduate medical training programs in the U.S. are governed by the Accreditation Council for Graduate Medical Education (ACGME). The most recent census lists 3,399 unique institutions providing post graduate education to 109,482 physicians in 91,384 core programs and 18,098 subspecialty programs (Accreditation Council for Graduate Medical Education, 2013). The ACGME has a standard set of guidelines and competencies for all residency programs (Accreditation Council of Graduate Medical Education, 2009) with additional requirements set forth by Residency Review Committees (RRC) for individual medical specialties (Accreditation Council for Graduate Medical Education, 2011a).

Before 1910 medical education followed a model vastly different from today. Education in the basic sciences was a very minor aspect of training and "students" paid physicians to be an apprentice, caring for patients while living in the hospital (hence the term "residents") (Joyner, 2004). This changed with the Flexner Report (Flexner, 1910) which was the impetus for regulating undergraduate medical education training. More recently, graduate medical education has evolved from a process-based to a competency-based model that includes outcomes-based assessment (Baum & Axtell, 2005; Carraccio, Wolfsthal, Englander, Ferentz, & Martin, 2002; Leach, 2002; Long, 2000; Marple, 2007; Meyers et al., 2007). While there continues to be an aspect of "apprenticeship", the major focus of postgraduate training is resident education. This education is both didactic and experiential with individual residency programs now expected to develop program goals and objectives, integrate learning objectives into the curricula, and document the educational outcomes of their trainees (Goroll et al., 2004; Joyner, 2004; Lurie, Mooney, & Lyness, 2009)

ACGME Competency Standards

In 1999 the Accreditation Council for Graduate Medical Education (ACGME) developed a ten year plan to define six general competencies (1999-2002), define and develop assessment tools (2002-2006), and integrate the competencies and assessment into learning and clinical care (2006-2011) (Lurie et al., 2009). The core competencies set forth by the ACGME fall into six general domains: Patient Care, Medical Knowledge, Practice-Based Learning and Improvement (PBLI), Interpersonal and Communication Skills, Professionalism, and Systems-Based Practice (Accreditation Council of Graduate Medical Education, 2009; Rousseau, Saucier, & Cote, 2007). Skills learned in one competency domain may be applied to other domains. For example, the understanding and incorporation of specific content knowledge found in *Medical Knowledge* is related to the skills development described in the *Practice-based Learning and Improvement* domain and key to appropriate and effective *Patient Care*. Likewise, it is assumed the competent physician will exhibit *Professionalism* across all domains.

While some groups have adapted the ACRL competency standards to better meet the needs of their discipline (Anthropology and Sociology Section Instruction and Information Literacy Committee Task Force on IL Standards, Association of College and Research Libraries, & American Library Association, 2008; Psychology Information Literacy Working Group, Education and Behavioral Sciences Section, & Association of College and Research Libraries, 2010; Task Force on Information Literacy for Science and Engineering Technology, Association of College and Research Libraries, & American Library Association, 2008), other potential stakeholders, such as those in the medical education field, are either unaware of the information literacy standards or have not been incorporated into the discussion.

Most directly related to the concepts of information literacy, evidence-based medicine and informatics is the ACGME competency for Practice-based Learning and Improvement (PBLI) (Kaplan & Whelan, 2002; Moskowitz & Nash, 2007; Ogrinc et al., 2003; van Dijk et al., 2010; Wood, Kronick, & Association of Medical School Pediatric Department Chairs, Inc, 2008). Within this domain, resident physicians are expected to:

- Locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems;
- Apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on diagnostic and therapeutic effectiveness
- Use information technology to manage information, access on-line medical information; and support their own education
- Facilitate the learning of students and other health care professionals

Although this language generally corresponds to that found in the information literacy competency standards, clearly written, measurable indicators are lacking. While ACRL standards can be adapted to represent the needs of the medical community neither of these professional bodies has specified how the standards are to be assessed.

Information Literacy Assessment

Information assessment instruments and tools described in the library science and medical literature exhibit similar traits. In general, the majority of available instruments assessments are frequently tied to specific courses or institutional resources thus precluding generalization to another setting; rely on self-reported data; are missing elements of the domain under investigation (i.e., plagiarism); and, even when objective measures are used, reliability and validity data frequently are not reported. While the medical education literature does address assessment for post-graduates, most college level instruments are intended to measure undergraduate student skills.

Library Science Assessment

The library science literature reports numerous studies related to the assessment of information literacy skills and evaluation of information literacy instruction. Information literacy tools in one review of 70 college-level assessments were categorized as six types: attitudinal, freshman skills, institution-based, pre/post- test, subject or discipline oriented, and technology skills and observed that most were not based on the ACRL standards (Neely, 2006). Further investigation by this author in 2011 showed none of the reported instruments listed by Neely were health related and many were no longer available on the websites referenced. Another more current review provides information regarding the methods used in information literacy testing while also addressing the question of instrument reliability and validity (Walsh, 2009). From a sample of case studies (N=91) Walsh found multiple-choice questionnaires were most often used (34%), followed by analysis of bibliographies using scoring rubrics (19%), quizzes (15%) containing both multiple-choice and short answer questions, and self-assessment (11%). Less often employed were portfolios (9%), essay (7%), simulation (2%), observation (2%), or final course grade (1%). Within this review, only 9 studies were found to contain reliability and validity data (3 multiple-choice, 2 Quiz/Test, 2 simulation, 1 each portfolio and self-assessment).

Graduate Medical Education Assessment

The ACGME "Outcome Project" was initiated to provide a compendium of competency assessment methods and examples of instruments. Closely mirroring methods found in the Walsh review (Walsh, 2009), the *Toolbox of Assessment Methods©*, a joint initiative of the ACGME and the American Board of Medical Specialties (ABMS), lists thirteen methods of evaluation used to assess skills found within each of the six general competencies. These methods include: Record Review, Chart-Stimulated Recall; Checklist; Global Rating; Standardized Patient; OSCE (Observed Structured Clinical Examination); Portfolios; Exam MCQ; Exam Oral; Procedure or Case Logs; and Patient Survey and is accompanied by a grading scale suggesting methods most appropriate for assessing each of the required skills (Accreditation Council for Graduate Medical Education, 2011b). A 2009 review of ACGME competency assessment methods by Lurie, Mooney, and Lyness (2009) concluded that multiple dimensionality across competencies, problematic issues with methodology and samples, in addition to the overall lack of psychometric data, created concerns about the ability to accurately measure necessary skills. Despite these challenges, the authors remarked upon the need for continued effort toward effective measurement.

During the postgraduate training years, residency program directors and other medical educators may assume a level of expertise on the part of the resident physician that is not there or they themselves may not have the knowledge or proficiency necessary to model, teach, or assess the necessary skills (Holmboe et al., 2011; Maggio & Posley, 2011; Swiatek-Kelley, 2010). If this is the case, then one must ask the question "How do medical educators know what information literacy knowledge, skills, and abilities resident physicians have?"

Information literacy Instruments

The instruments described in the following section are commercially available or open-source, encompass validated and non-validated tools, and were considered (in whole or in part) for use in this dissertation project.

1. ***Information Literacy Test (ILT)*** (Cameron, Wise, & Lottridge, 2007; Wise, Cameron, Yang, & Davis, 2010) The ILT, measuring ACRL Standards One, Two, Three, and Five, is a validated, web-based multiple-choice test (N=60) for use with undergraduate college students. The ILT is available for purchase and may be used to assess individual student information literacy competence or as a program evaluation tool. Lower order *knowledge* skills make up two-thirds of the items with higher order *application* skills making up the remainder. Validity evidence was gathered from results of four studies and a validation panel. In one study a significant positive correlation (r=.45) was found when comparing ILT scores of 524 sophomores to their freshman scores on an earlier version of the

test. A comparison of sophomore and freshman student scores in two other studies illustrated improved scores in students who had been provided information literacy instruction (Wise, Cameron, Yang, & Davis, 2010). Finally, freshman ILT scores (years 2008 and 2009) from four universities and five community colleges compared against JMU freshman scores from 2004 showed incoming students, regardless of institution type, have similar levels of information literacy skills. A validity panel of three librarians rated the 60 items in relation to the ACRL standards. Inter-rater agreement was good. All raters were in agreement on 70% of the items (N=42) while at least two concurred on 98% (N=59). Internal reliability is high (Cronbach's alpha = 0.88).

2. ***Standardized Assessment of Information Literacy Skills (Project SAILS®)*** Kent State University (2001) http://www.projectsails.org Based on outcomes and objectives from the ACRL Standards (excluding Standard Four), the SAILS test is a web-based, information literacy knowledge assessment tool. Questions are grouped into skill sets and each is referenced to the applicable ACRL standard, performance indicator, outcome, and objective. The test, accessible for a fee, employs a multiple-choice format and provides either individual or cohort benchmarking data to institutions. The instrument was externally validated through comparison of participant scores on the SAILS with their SAT/ACT scores. Test developers found high scoring students on SAT/ACT also achieved high SAILS scores. Performance on the SAILS test also was compared against performance data from the JMU Information Literacy Test (ILT). Item reliability

estimates were greater than .80 and inter-rater reliability analyses on item difficulty across skill sets was deemed satisfactory (ranging from .65 to .80). Instrument item level difficulty is geared toward the undergraduate college student population and is, therefore, not available for testing primary, secondary, or graduate school students.

3. ***ICT Literacy Assessment (iSkills™)*** (Katz, 2007) Covering seven content areas, this instrument assesses information and communication technology (ICT) and is available for purchase from the Educational Testing Services (ETS). "ICT literacy is using digital technology, communication tools and/or networks to access, manage, integrate, and create information in order to function in a knowledge society." (Candy, 2002). The *iSkills*™ exam is a performance-based instrument assessing skills related to web use (i.e., e-mail, instant message, browser use, bulletin board postings, and search engines), database management (i.e., database search queries and file management), and software (i.e., word processing, spreadsheets, presentation and graphics programs). The instrument is appropriate for students (10th grade through college) and adults in the workplace. Questions simulate real-world scenarios; there are no multiple-choice items in this test. Internal reliability is reported to be approximately.88 (Cronbach's alpha). Although aligned with the ACRL Standards, the ETS instrument differs in content from other information literacy tests. Here the focus is on competence with technology and less related to other information literacy domain skills as delineated by the ACRL.

4. ***Beile Test of Information Literacy for Education (B-TILED)*** (Beile, 2008). Devised to measure information literacy knowledge in undergraduate students in an education program, this instrument initially began as items developed for the Project SAILS test bank. The original items, aligned with ACRL objectives and National Educational Technology Standards for Teachers (NETS*T), were reduced in number (N=22) and pilot tested as the *Information Literacy Assessment Scale for Education (ILAS-ED)* (Beile, 2005). Reliability coefficient, using Kuder Richardson 20 test, was deemed only “adequate” (.675) due to small number of test items. Item difficulty ranged from .32 to .89. Item accuracy (mean score of 2.67) was evaluated by five content experts on a scale of 0 (low) to 3 (high). Results from a subset of eight questions from the measure were evaluated for validity against a performance exam with comparable questions. Results indicated a high correspondence between tests, however the sample size was small (N=10).

   Further revision of the *ILAS-ED* led to the development of the *B-TILED*, a freely available, multiple-choice test containing 25 content questions (covering concept identification, search strategies, document types, search tools, and using results) specific to the discipline of education and 21 demographic questions. Reliability and validity data for the revised instrument has not been published.

5. ***Information Competency Proficiency Exam (ICPE)* Bay Area Community Colleges** (The Bay Area Community Colleges information competency assessment project, 2004). The ICPE is a two part proficiency exam whose purpose is to assess information literacy skills in a community college population.

Based on national and local information literacy standards this test serves as a means to earn credit for an information competency requirement. Part A (N=47) incorporates questions using multiple-choice, matching and short answer formats; Part B has three performance-based activities each with sub-parts (N=12). Detailed test specifications are provided: practices used in item development, organization and formatting, instructions and comments, suggestions for scoring, level of performance, and timing, as well as charts mapping competency outcomes to test items. In addition, the developers make available documents for scoring the rubric, answer key, scoring sheets and a scoring manual for Parts A & B. Scores from this instrument have not been statistically analyzed therefore no reliability or validity evidence has been reported.

6. ***Berlin Questionnaire*** (Fritsche, Greenhalgh, Falck-Ytter, Neumayer, & Kunz, 2002). Two psychometrically equivalent sets of questions (N=15) were developed, validated, and field tested for this evidence based medicine instrument. The validation phase included administering the 15 item instrument to a group of EBM experts (N=43) and a control group of medical students (N=20) with no prior knowledge. Pre- and post-test data was obtained from participants (N=203) attending a 3 day intensive EBM course. Experts scored high at 0.81; pre-test scores for course participants were moderate at 0.42; and the control group at 0.29 scored lowest. Cronbach's α was 0.75 (set 1) and 0.82 (set 2). There was an educationally significant increase (57%) in the post scores of course attendees. This instrument measured critical appraisal skills and interpreted

quantitative measures. Other skills such as literature searching and question formulation were not assessed.

7. ***Fresno Test of Competence in Evidence Based Medicine*** (Ramos, Schafer, & Tracz, 2003). This performance based measure was specifically developed to assess an EBM course taught in a Family Practice residency program at the University of California. Utilizing two clinical scenarios test takers answer 17 open ended questions related to four key EBM domains - developing a focused clinical question; searching and critiquing the literature; identifying article relevance and validity; and calculation skills. Standardized grading rubrics and criteria were developed and revised using expert opinion and expected responses. Each item is awarded points (0-24). Raw scores are summed across items to yield a possible range of 0 - 212 with higher values indicating greater level of knowledge. Cut score for passing was assigned based on the authors' professional judgment. Test results from the development dataset showed very good internal consistency (Cronbach's alpha = 0.88); no negative or weak items (item discrimination index = 0.47 to 0.75). Validity dataset inter-rater reliability (2 scorers) ranged from 0.72 to 0.96 for individual items and 0.97 for total scores. While found to be appropriate for Family Medicine physicians, both novice and expert, the Fresno Test is intended to measure the effectiveness of a specific EBM training course and has not been validated in other medical disciplines.

While the instruments described above address information literacy assessment, none were appropriate for the project envisioned here, although individual questions were considered, given publisher permission and appropriate attribution. This study was intended for postgraduates, not the undergraduate population most tested with these instruments. Ease of instrument administration and scoring was a consideration thus eliminating performance-based testing. More importantly, only two are validated for use in a medical education setting and none encompass the full domain as defined by the ACRL Standards. For these reasons, an instrument capable of easily measuring information literacy skills in a graduate medical education population was developed, tested, and evaluated for evidence of reliability.

Development of the Medical Information Literacy Questionnaire (MILQ)

Blueprint Creation

The first step in instrument development is the creation of a test blueprint (also known as a table of specifications). The test blueprint provides the framework for classifying learning objectives, ensuring proper emphasis is given to each objective, guides item development, and is used to improve validity of test scores (Anderson & Morgan, 2008;Thorndike, 1997). The operational definition of the content domain to be measured is represented by the test blueprint.

The test blueprint for this dissertation was developed using data from a prior research study conducted at the University of New Mexico Health Sciences Center (Morley, 2009). The specific purpose of the study was to investigate the content validity of the ACRL information literacy standards in a graduate medical education setting using a Q-sort methodology. Card sorting, an exploratory technique used to elicit information about how individuals or groups think about and categorize topics (Morse & Field, 1995;

Rugg & McGeorge, 2005), was used to capture expert judgment about core information literacy competencies necessary for resident physicians to know or be able to do.

Method

Participants

Sixteen UNM Health Sciences Center physicians (38% Female, 62% Male) representing eleven specialties took part in the study. Study participants included those with responsibility for residency training programs (56%) and those working closely with resident physicians in their role as educators or attending physicians (44%). These subject matter experts (SMEs) were invited to rank content and behavioral objectives of the construct known as information literacy. As defined by the ACRL, each of the five broad competency standards includes a number of associated performance indicators which are further articulated by 87 specific learning outcomes or objectives, herein referred to as *information literacy statements*. Working individually, the subject experts ranked each information literacy statement as *"essential", "useful but not essential", "not necessary", or "unsure"* as they pertained to resident physician knowledge and ability.

Analysis

Data from the card sort were analyzed using a statistical descriptor of expert consensus known as the Content Validity Ratio (CVR) formula (Ford & Wroten, 1982; Ford & Wroten, 1984; Lawshe, 1975; Pray & Popovich, 1985). Twenty-nine statements rated as *"essential"* had CVR values .49 or greater which constitutes the cut score established by Lawshe (1975, p. 568) and were thus retained for inclusion in the blueprint (Appendix A). (Note: information on this technique is more fully described in the Chapter 2 Phase II Validation Panel.)

The test blueprint used in the study described herein was based upon information literacy competencies identified by physicians as essential to resident competence. Various forms of this test blueprint (see Appendices A and B) were employed throughout the dissertation study to guide item writing, verify a match between item content and targeted objective, and measure item balance across the standards (Li & Sireci, 2005; Rothman, Slattery, Vranek, & Resnick, 2002).

Summary

The previous sections describe the information literacy construct and its alignment with graduate medical education competencies and evidence-based medicine. The literature shows physicians and accrediting bodies consider information literacy an important skill set for resident physicians to master. In addition, although information literacy assessment tools exist, no validated instruments covering all aspects of the information literacy domain were found specifically designed for the graduate medical education population. To address this deficiency, the author designed, validated, and field tested items for a new information literacy instrument called the Medical Information Literacy Questionnaire (MILQ). Chapter 2 describes in detail the study design and methods employed in this project.

This study is centered on the ACRL Information Literacy Competency Standards for Higher Education and draws upon research and ideas from educational and psychological measurement, evidence-based medicine, graduate medical education, and information sciences.

CHAPTER 2

METHODS

This chapter presents a detailed description of the procedures employed in constructing, pilot testing and assessing the reliability, validity, and internal structure of a newly developed instrument entitled the Medical Information Literacy Questionnaire (MILQ). Following established instrument development processes (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999), the study was executed in four phases.

> **Phase I:** The first phase of the study focused on generating items from which the eventual MILQ would be constructed. This item generation was guided by a previously developed test blueprint (Morley, 2009) and employed a number of item writers.
>
> **Phase II**: Initial validity evidence for the pool of draft items was gathered from a volunteer panel of subject matter experts (SMEs) in the second phase of the study. A statistical descriptor of expert consensus, the Content validity Ratio (CVR) method (Lawshe, 1975), was employed in the analyses.
>
> **Phase III**: Validated items from Phase II were field tested using cross-sectional survey methodology in a sample of resident physicians from the University of New Mexico.
>
> **Phase IV**: In the final phase of the study, psychometric properties of the tested items were evaluated using item analyses. Scores from the field test were analyzed to examine the structure and reliability of the draft instrument.

Statement of Instrument Purpose

The MILQ is intended for use by residency program directors and health sciences librarians as a diagnostic tool to measure resident physician information literacy skills. The MILQ, a criterion-referenced test (Glaser, 1963;Berk, 1986), is intended to measure maximum performance, as judged by the correct answer, at the time of testing and not as a predictor of future IL skills or abilities. Scores from this instrument will provide necessary data for formative evaluation of IL instruction and the assessment of skills found within the required ACGME general competencies. Information from administration of this instrument will be used to improve curriculum and instructional programs thus enhancing resident education. Program directors may also elect to report test results as verification of resident ability to meet ACGME competencies (e.g., Practice Based Learning and Improvement) or, in the case of increased IL training, as documentation of resident education.

In order to meet the purpose, certain things need to be true of the final instrument. The instrument should be a web-based, best-answer, multiple-choice test employing case vignettes or application of knowledge stems (Case & Swanson, 2001). The test is meant to be completed in one sitting. While time for completion depends upon the number of items included in the final form, ideally the test should take less than 30 minutes.

Phase I*:* Initial Item Generation

Items representing the IL construct as defined by the ACRL Standards (*"know, "access", "use", "evaluate",* and *"ethical/legal"*) were developed by the researcher and a volunteer group of subject matter experts (N=11), that included librarians, medical educators, physicians, and researchers. Item writing took place between October 1, 2013 and December 10, 2013. After review, items either were revised or eliminated from consideration for inclusion in Phase II validation activities.

Item-writer qualifications

Because the proposed instrument is intended as an information literacy assessment tool in graduate medical education, it was important to obtain volunteers who were familiar with the clinical setting, knowledgeable about the skills necessary to address physician's information needs, and have experience teaching information literacy skills to resident physicians or medical students. Initially, volunteers considered for the item writing phase of the study were health sciences librarians with a minimum of two years' experience teaching evidence-based medicine or information literacy to resident physicians or medical students. Item writing experience was preferred but not mandatory.

Item-writer recruitment

Using convenience and snowball sampling methods, regional and local health sciences librarians were invited to participate in the item writing phase. The goal was to accrue a minimum of five health sciences librarian volunteers to assist with item writing. An initial call for volunteers was made to education librarians at the 2013 annual meeting of the South Central Chapter of the Medical Library Association (SCC/MLA). A follow-up e-mail describing the study process was sent to the SCAMeL Education listserv following the conference. Because the initial call and subsequent follow-up email elicited only one response, the recruitment plan was revised. Individuals known to the researcher were targeted and the potential pool was expanded to include other professionals with experience in medical education and those with item writing expertise.

Once confirmation was received from persons willing to take part in the exercise, a second email was sent containing a copy of the detailed version of the blueprint (Appendix A). Each item writer was asked to submit as many questions or ideas for questions as they wished. Participants were encouraged to complete and return all questions within two to three weeks of receiving the instructions.

Using an expanded version of the test blueprint as the framework, standardized item writing rules were employed to create items for the initial pool (Anderson &

Morgan, 2008; Case & Swanson, 2001; Haladyna, Downing, & Rodriguez, 2002; Haladyna, 2004; Thorndike, 1997). Three types of multiple-choice formats were used in developing items for this project.

1. Conventional multiple choice- consisting of explicitly stated questions (stem) and three to five answer options.
2. Extended matching – a group of questions with one list of options for all the items.
3. Context-dependent item set – material (i.e., picture, table, or abstract) followed by a set of questions whose answer options are predicated upon information found within the material.

Content for the items was informed by material found in textbooks and journal articles, evidence-based medicine and health sciences library courses, curricular materials, currently published information literacy tests, and items from a UNM School of Medicine test bank. Each item was developed using scenarios, vignettes, or other materials considered relevant to a resident physician. Answer options covered information resources commonly used by a majority of residents (e.g., PubMed Medline) regardless of where they went to medical school. To avoid bias universally recognized online resources were included as answer options while specific resources licensed by the University of New Mexico were avoided.

Demographic Characteristics

Eleven volunteers provided questions or ideas for questions. The group was predominately women (N=10) and health sciences librarians (N=7). Other volunteers included a doctoral student in Public Health, an associate professor with expertise in health literacy item writing and instrument development, and an assistant professor from Psychiatry with expertise in assessment. The only male in the group, a professor of Internal Medicine, granted permission to use a series of his previously developed test items.

Analyses

A total number of 147 items were developed during the item generation phase. An assessment expert from the UNM School of Medicine reviewed the proposed items for adherence to item writing best practice and provided comments and suggested changes. In many cases several iterations were necessary before items were deemed acceptable. Items were revised as necessary or eliminated. Items were deleted from the initial pool if the stem and/or answer option were out of scope, lacked clarity, were ambiguously or poorly worded and difficult to revise, or did not fit the MCQ format. Furthermore, in domains where there were large numbers of overlapping questions, the weakest questions were eliminated. Ninety items (61%) from the original pool were approved for inclusion in the Phase II validation panel. These items were conventional multiple-choice questions (N=25), matching (N=16); and context-dependent item set (N=28) made up of 7 separate scenarios/sets of materials.

Phase II: Item Validation Panel

To establish some initial validity evidence that the items did, indeed, map to the test blueprint and adhered to best-practice recommendations, a volunteer panel of subject matter experts (SMEs) reviewed the item pool for representativeness of the draft items to the content domain and significance to resident physicians. Data gathered from the validation panel were used to determine item inclusion in the draft instrument tested in

Phase III pilot with resident physicians. The validation panel investigation took place December 13, 2013 through January 12, 2014.

Subject Matter Experts Eligibility Criteria

Experienced health sciences librarians (as defined in Phase I) and physicians were eligible to take part in the validation panel process. Physician participants were expected to have demonstrated experience working with resident physicians in a clinical or educational setting.

SME Recruitment

An e-mail describing the study and the validation panel process was sent to a purposive sample of thirty-five health sciences librarians (n=6) and physicians (n=29). Three of the invited librarians contributed to the item development phase and ten of the physicians previously took part in the card sort study (Morley, 2009) that resulted in the test blueprint used in the present study (see Appendix B).

Psychometric Process

Once agreement was received, individuals received a follow-up email thanking them for their participation. Included in the email were instructions for completing the required tasks along with the necessary attachments: a copy of the detailed blueprint (Appendix A), a demographic form (Appendix C), and five separate Word documents containing multiple-choice items covering each of the five domains. Domains 1 and 2 contained eight items each; Domain 3 and 5 contained thirty-five items each; and Domain 4 contained four items.

Using the Content Validity Ratio method (Lawshe, 1975) panelists rated each item for relevance to the specific domain from the blueprint to which it aligned. Panelists were invited to provide information as to the suitability and accuracy of the items. Also, as part of the review process, SMEs were asked to agree or disagree with the researcher's placement of each question within a particular domain.

Panelists completed a questionnaire ranking their agreement or disagreement with items from the item pool. Utilizing a three-point rating scale ("*essential",* "*useful but not essential",* or "*not necessary"*), panelists provided a relevance rating for each draft item. According to Kline (2009) scales containing 5-9 points may be optimal in terms of reliability and ability to discriminate between the scale values while Sierci (Sireci, 1998a) explains that the use of even numbered scales prevents the excessive use of neutral points; see also (Ritter & Sue, 2007). However, because the purpose of the validation panel was to gather opinion about item inclusion or exclusion, the Lawshe (1975) CVR three–point scale was deemed more appropriate than a wider spread scale.

To finalize the questions to be included in an instrument, a determination must also be made whether or not each item is representative of the content category in which it was placed. Therefore, in order to show evidence of validity, panelists were asked to verify assignment of each item to the blueprint (*"yes"* or *"no")*. Responses from the completed forms were entered into an Excel spreadsheet.

Demographic Characteristics

Of the thirty-five experts invited to lend their professional expertise to the project, twenty-eight (80%) agreed to participate; four (11%) declined to participate; and three (9%) did not respond to the invitation or a subsequent follow-up e-mail. Of those who initially agreed two (7%) failed to return their forms by the deadline and a third person did not follow the instructions for ranking the items thus making their contribution ineligible for inclusion. Twenty-five persons (out of 28) completed the CVR questionnaire, a response rate of 89%. There were similar numbers of men and women on the panel (Female 52%); Fifty percent of the physicians identified themselves as a residency program director, assistant/associate program director, or former program director. Demographic forms for three physicians were not returned. Apart from academic and departmental status, gathered from the institutional website, and gender, missing data were otherwise excluded from the analysis. See Table 2 for details of the demographic characteristics for this panel of volunteers.

Table 2.
CVR Participant Demographic Characteristics

Participant Demographic Characteristics	n[1]	Valid Percent[2]
Ethnicity		
White	20	80%
Hispanic	2	8%
Asian/Pacific Islander	1	2%
Gender		
Female	13	52%
Male	12	48%
Degree		
Master level or above Librarian	5	20%
M.D.	20	80%
Resident Program Responsibility		
Program Director	5	25%
Assistant Program Director	1	5%
Former Program Director	4	20%
Physician Specialty		
Internal Medicine	9	45%
Pediatrics	4	20%
Emergency Medicine	2	10%
Anesthesiology	1	5%
Neurosurgery	1	5%
Pathology	1	5%
Psychiatry	1	5%
Surgery	1	5%

1 n≠ 28 due to missing values from non-response.

2 Valid percent refers to frequencies excluding missing values.

Analyses

In order to determine which items showed acceptable evidence of validity, data gathered from the participants were statistically analyzed using the content validity ratio (CVR) method developed by Lawshe (1975). The Content Validity Ratio (CVR), a statistical descriptor of expert consensus, has been used in a number of research studies for instrument development and content validation (Alotaibi & Youssef, 2013; Ford & Wroten, 1982; Pray & Popovich, 1985; Wallace, Blake, Parham, & Baldridge, 2003). Panel members individually rated each item based upon whether, in their judgment, the item represented an 'essential' resident physician skill or knowledge. The content validity ratio for each item was calculated using the formula **CVR= (n_e-N/2) / N/2**.

Utilizing a one-tailed significance test at alpha=.05, and based on a panel of 25 raters, each item should receive a minimum CVR score of .37 in order to be considered for inclusion in the draft instrument for the pilot study. It should be noted here that not every SME rated all the items (range 18-25). To allow for missing data, computation was based on the total number of panelist responses for each individual item and not the total sample size. Because the published guidelines do not provide scores for every permutation of panel size the interpretation of the cut scores was based on the span of numbers provided in Lawshe's table (Lawshe, 1975, p.568). For example, a CVR score of .49 is the recommended cut score based on fifteen raters. For 20 raters the recommended CVR is .42. Following Lawshe's guidelines, items were retained if the minimum CVR values fell within a permissible range.

Results

The validity panel of 20 physicians and 5 librarians rated ninety multiple-choice items assessing IL knowledge and skills divided into five domains of knowledge. A content validity ratio (CVR) score was calculated for each item. Of the ninety original items, sixty-seven (74%) met or exceeded the minimum CVR score recommended by Lawshe. Despite lower than minimum CVR scores, two marginally ranked items were retained in Domain 4 to ensure sufficient domain coverage.

Phase III: Pilot Test Draft Instrument

Purpose

Based on the results from the Phase II validation panel, an electronic version of the instrument was created using the REDCap (Research Electronic Data Capture) online survey tool. The 69 items retained from Phase II were pilot tested in a resident physician population using a web-based questionnaire. This phase took place January 29, 2014 through February 12, 2014.

Sample and Participant Selection

Using a convenience sample, individuals eligible to participate in the study were: (1) employed by the UNM Health Sciences Center as a resident physician, (2) in post-graduate year one through six, and (3) had an institutional GroupWise email address. Based upon these criteria there were 472 residents from 14 residency programs in the population. No eligible participant who wished to take part was excluded from the study.

Using a saturation sampling technique (Ritter & Sue, 2007), the sampling frame consisted of email addresses from the official UNM HSC e-mail system (GroupWise version 8.0, Novell Corp.). An alphabetic listing by email address was provided as an

Excel spreadsheet to the researcher by the UNM Health Sciences Center GroupWise account manager.

To introduce and gather support for the project, information about the study was presented to the Associate and Assistant Deans for Graduate Medical Education at an operations committee meeting (GMEC). A follow-up email was sent to the program directors for each residency program. An explanation of the survey and request for participation was communicated by e-mail, in-person, or a presentation during a residents' meeting. No compensation or incentives were offered for participation. This study was approved by the University of New Mexico institutional review board.

Data Collection

Study data were collected and managed using REDCap electronic data capture tools hosted at the University of New Mexico (DHHS/NIH/NCRR #8UL1TR000041). REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources (Harris et al., 2009).

All current UNM resident physicians at the time of the survey were sent an email invitation to participate in the study (Appendix D). A hyperlink connected directly to the survey was included in the email. By clicking on the link, the resident agreed to participate. Participants were assured their responses would be kept confidential. E-mail identifiers within the survey tool were used for invitations and reminders only. Data downloaded from the survey tool into Excel did not include email addresses or other unique identifiers. Each survey response was given a sequential record_id (i.e., 1, 2, etc.)

Questionnaire Description

The initial MILQ that was field-tested consisted of 69 multiple-choice questions measuring the information literacy construct contained within five domains or subscales.

- Subscale one (six items) determining the nature and extent of the information need
- Subscale two (five items) information access
- Subscale three (23 items) evaluating information
- Subscale four (four items) information use
- Subscale five (31 items) addressing ethical and legal issues related to information and information resources

Respondents were instructed to read each item then choose the BEST answer option for the item.

Because the length of the questionnaire could reasonably be expected to lead to survey fatigue, two parallel forms of the instrument were created. The intent of having two forms was to capture as many responses as possible for each question in the event the respondent failed to complete the entire questionnaire. Each form contained the same questions but was ordered differently by domain. Form A (N=235) started with domain one, question one and continued through to the final question of domain five. Form B (N=237) began with questions from domain five, followed by domain three, four, two, and ending with domain one questions. Email addresses for the sample were divided into two subsets by choosing every other address. Each subset was then copied and pasted into the REDCap survey tool as an invitation list for Form A or Form B.

Each online survey was assigned a unique identifier so that follow-up email could be sent to non-responders. The literature indicates varying response rates for email surveys (Dillman, 2007; Kaplowitz, Hadlock, & Levine, 2004). In one study surveying health educators, survey response rate was shown to increase following one reminder but only slightly more with a second reminder (Kittleson, 1997). UNM residents are surveyed throughout the year on a variety of topics (e.g. ACGME duty hours, faculty and annual program evaluations). Based upon the literature and UNM specific data, one email reminder was sent on day four to those in the sampling frame who had not responded. Reminder emails to those who only partially completed their survey (N=16) were sent on day eight. A second reminder to the larger group of non-responders was sent on day nine following the initial survey launch. Residency program directors and chief residents were enlisted to assist with general reminders to the residents in their programs prior to the initial launch and before a third and final email reminder was sent on day twelve. The survey remained open for 14 days.

Analyses

Participant responses from the field test were exported from the REDCap survey tool into a Microsoft Office 2007 Excel spreadsheet then imported into the SPSS statistical package (IBM SPSS Statistics, version 22.) Initial evaluation was conducted through item analyses. The purpose of item analyses is to assess overall test performance and individual items. This evaluation entails quantitative and interpretative review and was used to reduce the test length by eliminating poorly performing items. Item means, standard deviations, alpha-if-item-deleted, corrected item-total correlation (item discrimination), and P values (item difficulty) were computed and examined. Data from this analysis were used in conjunction with the blueprint to examine items for retention in a final form.

Using exploratory factor analytic techniques, test score data were analyzed to investigate the internal structure of the instrument. Exploratory factor analysis (EFA) was chosen as the model of analysis because it allows exploration of underlying construct dimensions and is frequently used in instrument development (DeVellis, 2003; Henson & Roberts, 2006; Kieffer, 1999; Pett, Lackey, & Sullivan, 2003; Tabachnick & Fidell, 2007). Four common elements of the EFA methodology used in this study for decision making and reporting are described below.

To determine factors appearing to represent the construct under study, first the Principal Axis Factor (PAF) extraction method was employed followed by Principal Component Analysis (PCA) extraction method. These methods are used to compute confidence intervals and a wide range of goodness of fit indices as well as statistical significance testing of factor loading and correlation among factors (DeVellis, 2003).

An oblique method of rotation was used with the PAF extraction method to look for correlation between the factors. Three factor matrices (pattern, structure, and correlation) resulting from the oblimin rotation were examined. Orthogonal rotation (Varimax) was conducted as part of the PCA extraction method to confirm the results when the oblimin rotation displayed factors with close to zero correlation (Reise, Waller, & Comrey, 2000).

The following tests were run to assess internal consistency: Cronbach’s alpha, alpha-if-item-deleted, Eigenvalues (>1), scree test, and factor saturation.

Summary

Multiple-choice items, developed by a volunteer group of librarians, physicians and researchers, underwent a validation process utilizing an expert panel of physicians and librarians. Items meeting a minimum CVR threshold score were included in an initial form of the instrument tested with resident physicians at the University of New Mexico. Item analyses and factor analyses were conducted. Information gained through the process led to the elimination of poorly functioning items and the development of an item pool which was then pilot tested with a sample of resident physicians. Results from the pilot test are fully described in Chapter 3.

Chapter 3

RESULTS

This chapter presents the results of the procedures utilized in the initial study conducted with resident physicians at the University of New Mexico of the preliminary Medical Information Literacy Questionnaire (MILQ). These procedures were used to identify and eliminate weak or problematic items leading to a reduced set of items for a final form of the instrument. Finally, these results were examined to see if they provided any validity evidence of the internal structure of the MILQ. Reported here are the results from the following procedures:

1. Initial item analyses;
2. Item selection for retention;
3. Evaluation of the final form;
4. Initial evidence for the internal structure of the MILQ.

Data Collection

Data for all four stages were collected from the administration of a questionnaire consisting of an initial item pool of 69 items and a demographic form. Using a web-based online survey tool (REDCap), questionnaires were sent out via email January 29, 2014 to all current resident physicians at the University of New Mexico (n=472). Five were returned as undeliverable. The total response rate (68 residents; 15%) was low. The survey closed on February 12, 2014.

Demographic Characteristics

Not everyone answered all questions. Consequently there are two samples, herein referred to as "completers" and "non-completers". The demographic characteristics representing each of the samples are reported in table 3.

Table 3.
General demographic profile and academic characteristics of survey participants

Participant Demographic Characteristic	Non-completers *n*[1]	Percent[2]	Completers *N=22*	Percent
Ethnicity				
White	46	69%	15	68%
Hispanic	8	12%	1	5%
Asian or Pacific Islander	7	10%	4	18%
Black	1	1%	0	0
Native American/ Alaskan Native	1	1%	0	0
Prefer not to answer	4	6%	2	9%
Gender				
Female	38	57%	12	54%
Male	29	43%	10	46%
Post-graduate Year (PGY)				
PGY 1	20	30%	9	41%
PGY 2	20	30%	5	23%
PGY 3	18	27%	4	18%
PGY 4	4	6%	3	14%
PGY 5	4	6%	1	4%
PGY 6	1	1%	0	0
Specialty				
Pediatrics	14	21%	5	23%
Internal Medicine	8	12%	2	9%
Psychiatry	8	12%	2	9%
Pathology	7	10%	3	13%
Surgery	6	9%	3	13%
Emergency Medicine	5	7%	2	9%
Family & Community Medicine	5	7%	0	0
Neurological Surgery	3	5%	1	5%
Orthopedics	3	5%	2	9%
Radiology	3	5%	1	5%
Obstetrics & Gynecology	2	3%	0	0
Anesthesiology	1	1%	1	5%
Dermatology	1	1%	0	0
Neurology	1	1%	0	0

[1]*n ≠ 68 due to missing values from non-response.*
[2] *Valid percent refers to frequencies excluding missing values.*

Thirty-six participants (“non-completers” 53%) partially completed the survey answering between six and sixty-eight of the total items with a mean of 19.8 (SD = 13.7). Ten persons (15%) answered demographic questions only. Fifty-seven percent of the total respondents were female and the majority of respondents self-reported their ethnicity as white (67%) which closely matches that of the entire UNM resident population at 46% and 66% respectively. Overall, participants represented 14 specialties and post-graduate year one through six.

From the original sample of 68, Twenty-two participants (“completers” 32%) who completed all questions represented ten medical specialties, were predominantly white (68%), and closely split between female (54%) and male (46%). No resident from post-graduate year six completed the survey. The results described in this chapter come from the sample of completers and do not include data from the non-completer sample.

Psychometric Analyses

Initial Item Analyses

Performing item analyses on the scores from the tested items provided the level of difficulty for each item; how well the item was able to discriminate between participants with high and low competencies; and the degree to which each item contributed to the reliability of the overall scores. The statistical indicators for the scores from the initial pool of sixty-nine items are displayed in Table 4.

The internal consistency reliability coefficient, calculated for all 69 items using Cronbach's alpha, was good (α = .872) for this instrument with this sample (DeVellis, 2003).

Item difficulty (range .09 to .97), represented as P-value in Table 4, is the percentage of participants who selected the correct answer option. On a scale of .0 to 1.0, items with a P-value less than .30 may be considered very difficult or, at the lower end of the scale, flawed in some way. Items earning a P-value of greater than .8 would be classified as easy or very easy. In both cases easy and difficult items merit further review.

The item discrimination index for individual items in this instrument is reflected as corrected item-total correlation coefficients (range = -.02 to .84) and is shown in Table 4. These scores indicate the relationship between an item score and the total test score and are used to provide information about how well the item discriminates between individuals with higher and lower levels of knowledge or ability. Positive high scores indicate individuals with higher total scores selected the correct answer option while negative or low scores signify these same individuals chose one of the distractors instead of the correct answer option. Low values indicate poor discrimination, that is, a poor ability to distinguish individuals with high levels of knowledge from those with low levels of knowledge. Negative are an indication the item may be flawed and should be reviewed. The answer may be keyed incorrectly or something in the wording, presentation, or content may explain the discrepancy. Ebel and Frisbie (Ebel & Frisbie, 1991) suggest items with values $\geq$ .40 indicate very good discrimination, .30 to .39 are reasonably good, and .20 to .29 signal marginal discrimination and need revision or elimination of the item.

The value listed in the alpha-if-item-removed column of Table 4 communicates whether and how much the Cronbach's alpha would increase if the item in question was removed from the instrument. It is a useful indicator of the contribution of the item to overall score reliability. Little variation in this statistic was observed for these items (range .864 to .880) with a total alpha of .872.

The means, standard deviations (SD), and frequency distributions of each of the above convey information about the quality of the overall set of items. The mean P-value of .64 indicates that, on average, 64% of respondents got each item correct. It suggests that overall the items were neither too easy nor too difficult. The range of difficulties demonstrates a mix of easy, moderately difficult, and difficult items, all important for examinee motivation. Too many easy items would not be sufficiently challenging to maintain interest, though too many difficult items would be demoralizing. A range of .60 to .80 is considered acceptable for multiple choice examinations (Lord, 1952). The corrected item-total correlation mean (.28) is close to the .30 threshold for good discrimination, although 33.32% of items fell below that threshold. This indicates minimally acceptable average levels of item discrimination. The values in the CVR column characterize the analysis of the overall reviewer ratings for each item (range 0.24 to 1.0). With 91% at or above the recommended threshold (4.2), most have excellent scores to support evidence of test content validity. These summary values constitute benchmarks against which the shorter form can be assessed.

Table 4
MILQ Initial Item Analyses

Items (69) [ff] = retained in final form	CVR	P Value (Item Difficulty)	Corrected Item- Total Correlation	Cronbach's alpha if Item Deleted
Domain 1				
Q1[ff]	0.42	.82	.31	.870
Q2[ff]	0.57	.09	.28	.871
Q3[ff]	0.65	.59	.13	.873
Q4	0.39	1.00	Zero variance	
Q5[ff]	0.67	.68	-.21	.878
Q6[ff]	0.74	.77	.39	.869
Domain 2				
Q1[ff]	0.50	.59	.17	.872
Q2	0.55	.77	-.17	.877
Q3[ff]	0.67	.59	.34	.870
Q4[ff]	0.58	.41	.17	.873
Q5[ff]	0.67	.73	.39	.869
Domain 3				
Q1[ff]	0.58	.73	.49	.867
Q2[ff]	0.58	.55	.26	.871
Q3[ff]	0.91	.64	.14	.873
Q4[ff]	0.57	.59	.28	.871
Q5[ff]	0.58	.64	.12	.873
Q6	0.67	.82	-.42	.879
Q7[ff]	0.74	.91	.40	.869
Q8[ff]	0.50	.96	.39	.870
Q9[ff]	0.44	.91	.84	.865
Q10	0.83	1.00	Zero variance	
Q11	0.50	.32	.21	.872
Q12[ff]	0.75	.91	.84	.865
Q13[ff]	0.75	.64	.51	.867
Q14[ff]	0.65	.91	.84	.865
Q15[ff]	0.82	.91	.26	.871
Q16[ff]	0.92	.82	.76	.864
Q17[ff]	0.48	.50	.11	.873
Q18[ff]	0.55	.55	.39	.869
Q19[ff]	0.39	.91	.52	.868
Q20[ff]	0.33	.59	.23	.872
Q21	0.83	.68	-.24	.878
Q22[ff]	0.91	.82	.55	.867
Q23	1.00	.96	.75	.868
Domain 4				
Q1[ff]	0.92	.96	.75	.868
Q2	0.42	.96	.75	.868
Q3	0.24	.59	.19	.872
Q4[ff]	0.24	.96	.39	.870

Items (69) ff = retained in final form	CVR	P Value (Item Difficulty)	Corrected Item- Total Correlation	Cronbach's alpha if Item Deleted
Domain 5				
Q1	0.76	.86	.75	.865
Q2 ff	0.76	.59	.28	.871
Q3	0.84	1.00	Zero variance	
Q4	0.75	.86	.15	.872
Q5	0.75	.91	.15	.872
Q6	0.67	.68	.45	.868
Q7	0.76	.77	.41	.869
Q8 ff	0.67	.45	.52	.867
Q9	0.58	.27	.28	.871
Q10 ff	0.74	.73	.41	.869
Q11	0.67	.82	.08	.873
Q12 ff	0.75	.50	.38	.869
Q13 ff	0.67	.59	.46	.868
Q14 ff	0.50	.64	.33	.870
Q15	0.83	.91	.84	.865
Q16	0.71	.73	.18	.872
Q17	0.43	1.00	Zero variance	
Q18 ff	0.48	.96	.75	.868
Q19	0.45	.27	.22	.871
Q20	0.36	.32	.21	.872
Q21	0.45	.86	.33	.870
Q22	0.67	.68	.49	.867
Q23	0.92	.50	-.29	.880
Q24	0.83	.96	-.22	.874
Q25	0.67	.82	.45	.868
Q26 ff	0.74	.82	.39	.869
Q27	0.83	.91	.67	.867
Q28	0.65	.96	.75	.868
Q29	0.64	.96	-.22	.874
Q30	0.55	.59	-.02	.876
Q31	0.89	.73	.15	.872
Means and SD's	.60 (1.8)	.64 (2.2)	.28 (2.6)	.872
Frequency Categories (f and %)				
Negative	-	-	8 (11.6%)	-
0-.99	-	2 (2.9%)	5 (7.2%)	-
1 - 1.99	-	-	11 (15.9%)	-
2-2.99	2 (2.9%)	2 (2.9%)	10 (14.5%)	-
3-3.99	4 (5.8%)	2 (2.9%)	11 (15.9%)	-
4-4.99	8 (11.6%)	7 (10.1%)	8 (11.6%)	-
5-5.99	14 (20.3%)	7 (10.1%)	4 (5.8%)	-
6-6.99	14 (20.3%)	11 (15.9%)	1 (1.4%)	-
7-7.99	13 (18.8%)	13 (18.8%)	7 (10.1%)	-
8-8.99	8 (11.6%)	14 (20.3%)	4 (5.8%)	-
9-9.99	6 (8.7%)	11 (15.9%)	-	-

Item Selection

In an attempt to comprehensively cover all relevant aspects of the IL construct, at the same time expecting item attrition, the initial pool of items was purposively large (Nunnally & Bernstein, 1994) . The ultimate goal of this project was to develop a streamlined instrument containing items of sufficient quality and breadth while retaining the integrity of the blueprint (described in Chapter 2). The item retention process was based on both statistical and interpretive considerations. Inspecting data from Table 4 above, each item was reviewed for corrected item-total correlation value to gauge level of item discrimination and P-values for item difficulty. Additionally, to help with the decision making, Cronbach's alpha-if-deleted values and CVR scores, established by the Phase 2 validity panel, were noted. The guidelines used for evaluating test items for this process followed general recommendations found in the literature (DeVellis, 2003; Ebel & Frisbie, 1991; Haladyna, 2004).

Taking a holistic approach to selecting items for the final form, decisions were based on the following criteria. Threshold scores for consideration consisted of P-values between .30 to .70 and values $\geq$.20 for the corrected item-total correlation. The stem and answer options for those questions slated for possible elimination were evaluated. A global assessment of the blueprint was also an important component of the review. Consideration was given to how item removal might affect the match of the proportion of items in each domain on the final form to the test blueprint proportions.

Using the above considerations, a total of 32 items (46%) were eliminated from the original pool of 69 items tested. First to be eliminated were items reporting zero variance (N=4) which indicates that all respondents gave the same answer (P-value = 1.0). Items with negative corrected item-total correlation values (N=8) were scrutinized next as these indicated possible flaws in the item stem or the answer options. Seven items in this group were removed due to issues related to an internal flaw while also exhibiting either a low end CVR score or a P-value >.70 indicating an easy item. One such item made a statement about use of a genetics table in a presentation then asked whether or not a citation was needed. The stem was not in the form of a question and the answer options were actually true/false in nature. An additional fifteen items were removed based on P-value ≤.30 (N=2) or ≥.82 (N=8) or DI ≤.22 (N=5). A set of four items was removed because they duplicated similar items elsewhere in the questionnaire. In this case, two sets of questions regarding the legal use of an image were asked. The stem and answer options were the same but the images and the source from which they originated differed (i.e., government web site and electronic textbook). An additional two items were dropped because values for both corrected item-total correlation and P-value were low indicating a difficult question without the benefit of discriminating between groups of test takers. In order to preserve appropriate percentages in the blueprint, several items were retained despite less than optimal item characteristics.

After removing 32 flawed items from the pool, the remaining 37 items now constitute a revised instrument. The scale-dependent item analyses (corrected item-total correlation and alpha-if-item-deleted) and the reliability coefficient were recalculated as seen in Table 5.

Table 5.
MILQ Final Form Item Analyses and Principal Component Analysis

Items (37)	CVR	P Value (Item Difficulty)	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted	Component			
					1	2	3	4
Domain 1								
Q1	0.42	.82	.24	.857	-.018	.492	.117	.083
Q2	0.57	.09	.29	.856	.037	.057	.065	.488
Q3	0.65	.59	.07	.863	.091	.502	-.122	.427
Q5	0.67	.68	-.18	.868	-.163	-.001	-.456	.151
Q6	0.74	.77	.33	.858	-.052	.604	.273	.047
Domain 2								
Q1	0.50	.59	.27	.857	.483	.009	-.155	.099
Q3	0.67	.59	.29	.857	.484	.158	-.158	-.074
Q4	0.58	.41	.14	.861	.446	.151	-.033	-.398
Q5	0.67	.73	.42	.853	.491	.226	.251	-.198
Domain 3								
Q1	0.58	.73	.42	.853	.526	.110	.147	.169
Q2	0.58	.55	.36	.855	.156	-.008	.221	.577
Q3	0.91	.64	.25	.858	.252	-.272	-.254	.676
Q4	0.57	.59	.22	.859	.076	.115	.577	.116
Q5	0.58	.64	.14	.861	-.094	.436	.061	.046
Q7	0.74	.91	.39	.855	.700	-.304	.010	.216
Q8	0.50	.96	.46	.855	.823	-.382	.307	.087
Q9	0.44	.91	.84	.847	.833	.339	.349	.152
Q12	0.75	.91	.84	.847	.833	.339	.349	.152
Q13	0.75	.64	.54	.850	.283	.138	.015	.663
Q14	0.65	.91	.84	.847	.833	.339	.349	.152
Q15	0.82	.91	.33	.856	.655	-.106	-.077	-.042
Q16	0.92	.82	.68	.848	.606	.253	.183	.348
Q17	0.48	.50	.19	.860	-.007	.224	-.420	.540
Q18	0.55	.55	.47	.852	.444	.096	-.287	.589
Q19	0.39	.91	.49	.853	.297	.787	-.172	-.015
Q20	0.33	.59	.30	.856	.349	.241	-.197	.173
Q22	0.91	.82	.55	.851	.554	.095	.355	.296
Domain 4								
Q1	0.92	.92	.68	.852	.327	.850	.176	.123
Q4	0.42	.96	.46	.855	.823	-.382	.307	.087
Domain 5								
Q2	0.76	.59	.21	.859	.164	.143	.619	-.163
Q8	0.67	.45	.48	.852	.018	.082	.523	.703
Q10	0.74	.73	.30	.856	-.016	.364	-.007	.478
Q12	0.75	.50	.43	.853	.000	.161	.714	.355
Q13	0.67	.59	.41	.853	.083	.159	.804	.211
Q14	0.50	.64	.28	.857	.071	.514	-.389	.293
Q18	0.48	.96	.68	.852	.327	.850	.176	.123
Q26	0.74	.82	.37	.855	-.007	.577	.391	-.110
Means and SD's	.63 (1.6)	.69 (2.2)	.39 (2.2)	.858	-	-	-	-

Frequency Categories (f and %)								
Items (37)	**CVR**	**P Value (Item Difficulty)**	**Corrected Item- Total Correlation**	**Cronbach's alpha if Item Deleted**				
Negative	-	-	1 (2.7%)	-	-	-	-	-
0-.99	-	1 (2.7%)	1 (2.7%)	-	-	-	-	-
1 - 1.99	-	-	3 (8.1%)	-	-	-	-	-
2-2.99	1 (2.7%)	-	9 (23.3%)	-	-	-	-	-
3-3.99	2 (5.4%)	-	7 (18.9%)	-	-	-	-	-
4-4.99	4 (10.8%)	7 (18.9%)	7 (18.9%)	-	-	-	-	-
5-5.99	10 (27.8%)	5 (13.5%)	3 (8.1%)	-	-	-	-	-
6-6.99	7 (18.9%)	9 (24.3%)	1 (2.7%)	-	-	-	-	-
7-7.99	8 (21.6%)	5 (13.5%)	2 (5.4%)	-	-	-	-	-
8-8.99	1 (2.7%)	7 (18.9%)	3 (8.1%)	-	-	-	-	-
9-9.99	4 (10.8%)	3 (8.1%)	-	-	-	-	-	-

Analysis of the initial study data showed internal consistency was good for the initial 69 items tested (α=0.872) and remained good (α=0.858) when the instrument was reduced to 37 items. The P-value mean increased slightly from .64 to .69, at 2.2 the SD remained the same. Once less than optimal items were removed, the corrected item-total correlation mean improved markedly. Previously .28, the revised mean of .39 denotes good discrimination for the overall score set which is precisely what was desired. In the revised instrument, the percentage of items below the CVR value threshold dropped from 8.6% to 4.3% further evidence of test content validity for this set of items.

Initial Evidence of the Internal Structure of the Instrument

Once the pool of items was reduced to maximize both item characteristics and match to the blueprint (Table 6), principal component analyses were used to examine the structure of the latest version of the instrument.

Table 6.
Test Blueprint for the MILQ Final Form

Content Areas	Blueprint %	No. of Items in Final Form	Final Form %
Determine nature and extent of information needed	21%	5	13%
Access needed information effectively and efficiently	11%	4	11%
Evaluate information and sources critically	48%	18	49%
Uses information effectively to accomplish a specific purpose	3%	2	5%
Understands ethical, legal and socio-economic issues surrounding information and information technology	17%	8	22%
Total	**100%**	**37**	**100%**

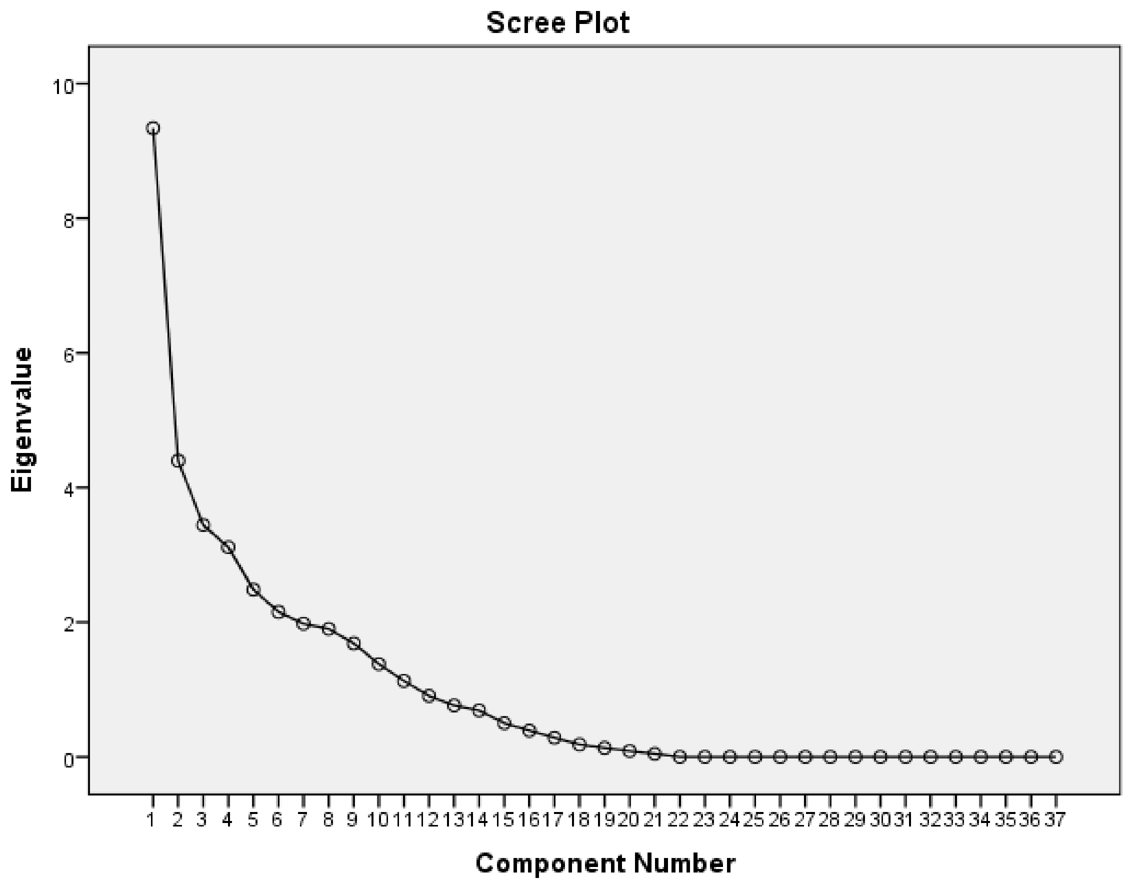
Factor analytic techniques, used in instrument development, determines whether or not the items adequately reflect the structure indicated by the blueprint. The question to be answered in this section is whether the analysis suggests evidence of validity based on the internal structure of the revised instrument.

An exploratory factor analysis using principal axis factoring with an oblique rotation returned no results because the correlation matrix was defined as “not positive definite” indicating zero or negative eigenvalues. This outcome most likely was due to the extremely low respondent-to-item ratio (22 respondents for 37 items).

A principal components analysis with oblique rotation was next attempted, which returned eleven components. Given low inter-component correlations, PCA with varimax rotation was used. It also produced 11 components with eigenvalues greater than 1. A visual inspection of the scree plot (Figure 1) displayed a break after the fourth component.

Figure 1

Scree Plot



The analysis was run once more, this time constraining the criteria to four components. The four-component solution (Table 5) explained a total of 54.8% of the variance, with Component 1 contributing 19.18%, Component 2 contributing 13.71%, Component 3 contributing 11.15%, and Component 4 contributing 10.80%. Component loadings are shown in Table 5.

These results indicate evidence to suggest some items represent elements of the IL construct however the large amount of variance unaccounted for (45%) makes it impractical to interpret or label the extracted components.

Summary

The purpose of the analyses conducted on scores from the initial test was to explore psychometric properties of the initial instrument. After computing and examining item score P-values, the corrected item-total correlation matrix, CVR values, and Cronbach's alpha, individual items were reviewed with consideration to preserving the test blueprint proportions between domains in order to revise the instrument. A final pool of 37 items was developed. This revised instrument underwent further evaluation utilizing factor analytic techniques to see if any components could be identified. These analyses confirm the need for more empirical investigation.

Chapter 4

DISCUSSION

The purpose of this research study was to develop, test, and refine an information literacy measurement tool designed for postgraduate medical education trainees. This chapter provides an overview of the project with results and outcomes discussed in relation to the specific aims outlined in Chapter 1 and in context of the research literature. Also found in this chapter are concluding remarks regarding implications of the study and recommendations for future research.

The following research aims guided this study:

Aim 1. Generate an initial pool of information literacy items;

Aim 2. Establish validity evidence for the draft items;

Aim 3. Design and pilot test the draft instrument; and

Aim 4. Evaluate psychometric properties of the tested items.

All Aims of the study were met.

The creation of items for this study was one of the more difficult and time consuming aspects of this project. Item writing is a special skill requiring knowledge and practice and one not regularly taught in higher education. Best practice guidelines for item writing are available (Case & Swanson, 2001; Haladyna et al., 2002; Moss, 2001; Nitko & Brookhart, 2007; Norcini, Swanson, Grosso, & Webster, 1985) however one cannot fully appreciate the challenge until writing that first (good) question. Item writing for professional exams is most often conducted in a group setting over a period of time. Protected time to concentrate solely on item writing was not available to either this writer or the volunteers who generously assisted in this effort and, except in one instance, the item writers never met face to face. This is not to say the items produced for the instrument were not good; they are. One of the strengths of this instrument lies in the diversity of the item writers. Another is the incorporation of context-dependent sets in which higher thinking skills are tested. Rather the point to be made here is that a panel brought together for the sole purpose of generating items would have expedited the process and might have produced a more cohesive, targeted, and larger pool of items. This should be a consideration for anyone attempting this type of project.

As recommended, various sources of validity evidence (i.e., subject matter experts, test format, test administration, and proposed use of the test scores) were examined (American Educational Research Association et al., 1999). The IL construct as described in the literature (Association of College and Research Libraries & American Library Association, 2000) was used as the conceptual framework for developing the test blueprint. Utilization of subject matter expert judgment in the development of the blueprint and for reviewing the draft items lends credence to the importance and appropriateness of the test content and the relationship to the blueprint. Developing a test blueprint utilizing a small pool of subject matter experts (N=16) from one institution could affect generalizability. However ACGME accredited programs have standardized requirements throughout the United States, making it unlikely that these experts' knowledge and experience differs in important ways from others in the U.S. Likewise, the "expert" eligibility criteria and selection process used for the item development and validity panels may be called into question by others. While there is some controversy surrounding what constitutes an "expert" (Hasson, Keeney, & McKenna, 2000) expert panels are commonly used to develop, review, and evaluate test specifications and content (American Educational Research Association et al., 1999; Rubio, Berg-Weger, Tebb, Lee, & Rauch, 2003; Sireci, 1998b; Sumsion, 1998; Wallace et al., 2003). The pool of physician educators and health sciences librarians was judged sufficient to find the "competent, diverse, and representative sample" necessary for this project. The role of these experts in conjunction with the CVR statistical methodology was important to the development of the initial instrument. Items with acceptable CVR values included in the instrument reflect SME consensus about the ability of the items to capture the IL construct.

Although it could be argued the multiple-choice format is not the only, or perhaps even the most effective, method to measure competence, the proposed instrument is meant to provide a snapshot of information literacy that can be used as a formative assessment by health sciences librarians and GME Program Directors. The MILQ is not intended as a performance-based assessment, which is more costly and time intensive than the MC format. Instead the MILQ is a competency-based measure that could be used as a surrogate for actual performance and one ideally to be used in conjunction with other assessment methods.

Utilizing an online survey tool was expected to provide easy access to the questionnaire for both study participants and the test creator. Certainly the researcher found the tool trouble free when sending out the initial survey and subsequent reminders and for importing response data into SPSS. What is not known is how study participants accessed the survey (i.e., mobile device or desktop computer) or how the survey behaved on a personal device such as a table or smart phone. Although REDCap is said to be compatible with a variety of devices, many items contained images or were text heavy which may have affected participant willingness to take or complete the questionnaire.

Cognitive testing prior to launching the survey did not take place and would have been prudent.

The sample for the pilot test was made up solely of resident physicians from one university therefore the findings may not be generalizable to another institution. However, resident physician experiential learning and competencies are governed by the ACGME making it unlikely there would be significant differences between UNM residents and those elsewhere in the United States. Similarly, although the use of convenience samples can be problematic, the UNM resident physician population shows evidence of diversity in gender, ethnicity, and prior education thus demonstrating a mixed population similar to other graduate medical education programs in the United States (Accreditation Council for Graduate Medical Education, 2013). For 2013-2014, the UNM Graduate Medical Education Office reported a total of 562 resident physicians and fellows in 50 programs. Of the total number 29% were educated at the UNM School of Medicine, 50% graduated from other US medical schools and 21% were foreign graduates; male (54%), female (46%), Asian (18%), Hispanic (12%), Native American (2%), African American (2%), and Caucasian (66%).

While the initial test design, deployment and management were completed successfully, the resulting participant response rate was disappointingly low. While it is impossible to know specifically why residents did not respond to the survey, several possible or likely reasons for the minimal response are considered here. First and foremost, resident physicians are incredibly busy people who have multiple and competing duties including clinical responsibilities, educational requirements, supervision of medical students and other residents, as well as research or quality improvement projects, among other obligations. Additionally, multiple times throughout the year residents are expected to complete surveys related to: satisfaction with multiple aspects of their residency program, evaluation of program faculty, number and type of procedures achieved, etc. thus leading to survey fatigue. In January and February, around the time of the initial test, trainees from thirteen residency programs completed detailed annual program evaluation surveys and the largest residency program (Internal Medicine) was launching a pilot program with major revisions to their call schedule. Two or three faculty members also suggested the fact there was no compensation for study participation may have had an adverse effect on responses.

Finally, the instrument was unavoidably lengthy. In the overall scheme of instrument development, the number of items was appropriate. Without a large pool of items to test, the researcher may not retrieve the data necessary to review the properties of the instrument and upon which decisions are made. The purpose of instrument development is to examine which items measure the construct being studied, eliminate flawed items, and produce the smallest set of items that will measure the construct. Having said that, the number of items participants were expected to complete for this study appears to have been too many and may provide an explanation for the number of "non-completers" in the overall sample. While it was expected demographic characteristics (Table 2) could be used to compare scores across different groups (e.g., postgraduate year) due to the extremely small sample size, no conclusions can or should be inferred.

Realistically the sample of participants was not large enough to perform factor analysis on the scores gathered however collecting pilot data from this small number of participants did allow for examination of internal consistency among items. It is important to note that reducing the number of items by half from the initial test did not affect the quality of the newly revised instrument. While the CVR data and the test blueprint display compelling evidence of test content validity for this set of items.

Based on the item analyses conducted on 69 items, it was possible to identify those items contributing most to the homogeneity of the measurement tool. Inspection of frequencies, item difficulty, and corrected item-total correlation provided information needed to consider which items did not enhance reliability and could be eliminated. Reduced to 37 items, the corrected item-total correlation for the final form was improved over the initial form of the instrument. This improvement, at .39, denotes good discrimination for the overall score set, and is well within conventional standards. The final form exhibits an appropriate level of difficulty (P=.69) has an acceptable alpha (α=.858) and maps relatively well to the blueprint (Table 6).

Implications for Future Research

Instrument development is an iterative process. Certainly working on this study has proven this to be true. The analyses performed on scores from the initial study confirm the need for more empirical investigation. Additional work needs to be performed before the MILQ can be called ready for use as an assessment tool with resident physicians. This section discusses next steps to move the project forward toward that goal.

Conducting distractor analysis is the first activity to undertake. Although the P-value and corrected item-total correlation provided useful information neither addressed how distractors (incorrect response options) contribute to item performance. Looking at all answer options, not just the correct answer option, will contribute to an additional level of item review. The data from this analysis would allow the researcher to see the percentage of respondents per option, leading to a better understanding of whether the distractor is worded clearly, without multiple interpretations, and is plausible. The analysis also would offer insight into which respondents (high or low knowledge) are choosing which option choices.

Once the analysis is finalized, distractors may be immediately rewritten or it may be further indication the item should be removed entirely. This may mean the current 37 item instrument needs to be revised. If this is the case, some items previously removed may be placed back into the instrument after consideration to CVR value, corrected total-item correlation, and Cronbach's alpha. Item analyses will be re-run for the newly revised instrument and checked against the blueprint.

Although the item to blueprint ratio is appropriate for most of the domains (see Table 6) there are areas needing improvement. Additional items should be written to better cover Domain 1which currently has only five items. These five items represent 13% of content but should be 21%.

Because it is difficult to draw any conclusions based on such a small sample of responses, larger samples are needed to investigate the reliability of the measure. Given the open nature of the IRB approval, a revised instrument could be tested in summer 2014 with the incoming resident group (N=~125). Hopefully an instrument with a reduced number of items will be more palatable to respondents thus increasing the response rate.

A health sciences librarian has expressed interest in testing the instrument with residents at her institution. This would entail new IRB approvals but will be explored further.

Conclusion

The purpose of this study was the initial development of an instrument capable of measuring information literacy competence in the postgraduate medical setting. The intent was to add to the knowledge base of information literacy and graduate medical education assessment. The aims of this study have been met. The current version of the instrument needs testing before being finalized. The steps taken throughout this project have continued the effort toward more effective measurement in both the library science and graduate medical education. Physician educators working with postgraduate trainees provided positive feedback and enthusiastically supported this project making it imperative work in this area continues.

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APPENDIX A

MILQ Test Blueprint: Detailed Listing of Specific Topics in the IL Domain

I. **Determine nature and extent of information needed (21%)**
   a. Explores general information sources to increase familiarity with the topic
   b. Defines or modifies the information need to achieve a manageable focus
   c. Identifies key concepts and terms that describe the information need
   d. Identifies the value and differences of potential resources in a variety of formats (e.g. multimedia, database, website, data set, audio/visual, book)
   e. Identifies the purpose and audience of potential resources (e.g. popular vs. scholarly, current vs. historical)
   f. Reviews the information need to clarify, revise, or refine the question

II. **Access needed information effectively and efficiently (11%)**
   a. Selects efficient and effective approaches for accessing the information needed from the investigative method or information retrieval system
   b. Identifies keywords, synonyms and related terms for the information needed
   c. Identifies gaps in the information retrieved and determines if the search strategy should be revised

III. **Evaluate information and sources critically (48%)**
   a. Reads the text and selects the main ideas
   b. Restates textual concepts in his/her own words and selects data accurately
   c. Identifies verbatim material that can be then appropriately quoted
   d. Examines and compares information from various sources in order to evaluate reliability, validity, accuracy, authority, timeliness, and point of view or bias
   e. Analyzes the structure and logic of supporting arguments or methods
   f. Recognizes prejudice, deception, or manipulation
   g. Determines whether information satisfies the research or other information need
   h. Uses consciously selected criteria to determine whether the information contradicts or verifies information from other sources
   i. Draws conclusions based upon information gathered
   j. Determines probable accuracy by questioning the source of the data, the limitations of the information gathering tools or strategies, and the reasonableness of the conclusions
   k. Integrates new information with previous information or knowledge

l. Selects information that provides evidence for the topic
m. Investigates differing viewpoints encountered in literature
n. Determines whether to incorporate or reject viewpoints encountered
o. Determines if original information needs has been satisfied or if additional information is needed

IV. **Uses information effectively to accomplish a specific purpose (3%)**

a. Communicates clearly and with a style that supports the purposes of the intended audience

V. **Understands ethical, legal and socio-economic issues surrounding information and information technology (17%)**

a. Uses approved passwords and other forms of ID for access to information resources
b. Preserves the integrity of information resources, equipment, systems, and facilities
c. Legally obtains, stores, and disseminates text, data, images, or sounds
d. Demonstrates an understanding of what constitutes plagiarism and does not represent work attributable to others as his/her own

*Based upon Association of College and Research Libraries, American Library Association. The information literacy competency standards for higher education. http://www.ala.org/ala/mgrps/divs/acrl/standards/informationliteracycompetency.cfm. Updated 2000. Accessed November 15, 2008.

APPENDIX B

Specifications for the Medical Information Literacy Questionnaire Domain of Knowledge		
Domain Content Area	Percent of Test	Specific content to be tested
Information Need	21%	Identify and assess resource value and purpose
Information Access	11%	Design and appraise search strategies
Information Evaluation	48%	Synthesize and evaluate information
Information Use	3%	Communicate appropriately
Information Ethics	17%	Appropriate use of resources; understanding of copyright and plagiarism

APPENDIX C
Validation Panel Demographic Form

1. Gender:
   Male ☐

   Female ☐

2. Ethnicity:
   American Indian, Alaskan Native ☐

   Asian/Pacific Islander ☐

   Black ☐

   Hispanic ☐

   Non-Hispanic White ☐

3. Age: _____
4. Please indicate your academic background: (check all that apply)
   Ed.D. ☐

   MD ☐

   MLS/MLIS/MILS ☐

   Ph.D. ☐

   RN/BSN ☐

   Other (please indicate) ___________________________________

5. What is your medical specialty? _____________________________

6. What is your job title? ______________________________________

7. Are you currently a Program Director for a Graduate Medical Education residency program?
   Yes ☐

   No ☐

8. Are you currently an Assistant Program Director for a Graduate Medical Education residency program?
   Yes ☐

   No ☐

9. If not currently a director or assistant director, have you been a Program Director for a Graduate Medical Education residency program in the past?
   Yes ☐

   No ☐

10. Who do you <u>primarily</u> teach or supervise?
    Resident Physicians ☐

    Medical Students ☐

    Other healthcare professional students (please indicate) _____________________________

11. On average, what percentage of time do you spend with the following groups?
    Resident Physicians _____

    Medical Students _____

    Other healthcare professional students _____

12. How many years have you been teaching?
    Resident Physicians _____

    Medical Students _____

    Other healthcare students _____

13. Employment:
    Institution _________________________________

    City & State _______________________________

Questions regarding information skills self-assessment

Please describe your skill level in the following areas:	**Some Skills**	**Good Skills**	**Expert Skills**
14. Defining the topic	☐	☐	☐
15. Identifying keywords or subject headings	☐	☐	☐
16. Teaching evidence-based medicine (EBM)	☐	☐	☐
17. Incorporating EBM into daily practice	☐	☐	☐
18. Using a database to identify articles	☐	☐	☐
19. Searching PubMed	☐	☐	☐
20. Assessing resident information skills	☐	☐	☐
21. Assessing medical student information skills	☐	☐	☐
22. Use information under US copyright law	☐	☐	☐
23. Knowledge about plagiarism	☐	☐	☐

Thank you for your assistance with this project. Please return this demographic sheet and your CVR rating sheets to:

Sarah Morley smorley@salud.unm.edu

OR

Sarah Knox Morley
Clinical Services Librarian
UNM Health Sciences Library and Informatics Center
MSC 09 5100
1 University of New Mexico
Albuquerque, NM 87131-0001

APPENDIX D

University of New Mexico Health Sciences Center

Informed Consent Cover Letter for Anonymous Surveys

STUDY TITLE
Information Literacy in Graduate Medical Education: Instrument Development

Sarah Morley, M.L.S. from the UNM Health Sciences Library and Informatics Center and Jay Parkes, Ph.D. from the Educational Psychology Program, are conducting a research study. The purpose of the study is to pilot test items for inclusion in an information literacy instrument. You are invited to participate in this study because you are a resident physician currently in training at the University of New Mexico.

Your participation will involve answering a series of multiple-choice questions about locating, using, and evaluating information. The survey should take about 20-30 minutes to complete. Your involvement in the study is voluntary, and you may choose not to participate. There are no names or identifying information will be collected. You can refuse to answer any of the questions at any time. There are no known risks in this study, but some individuals may experience discomfort when answering questions. If published, results will be presented in summary form only.

Items producing reliable scores and evidence of validity will be incorporated into a final pool of information literacy test items for validation in a future research study.

If you have any questions about this research project, please feel free to call Sarah Morley at (505)272-3773. If you have questions regarding your legal rights as a research subject, you may call the UNMHSC Office of Human Research Protections at (505) 272-1129.

By clicking on the web link provided, you will be agreeing to participate in the above described research study. **[REDCap link here]**

Thank you for your consideration.

Sincerely,

Sarah Knox Morley, MLS
Clinical Services Librarian
smorley@salud.unm.edu

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The University of New Mexico Institutional Review Board (IRB)