Specialized Critical Thinking: Scientific and Psychological Literacies

by STP Psychological Literacy Task Force Subcommittee[1]

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2011 Presidential Task Force on Psychological Literacy White Paper

Empowering Teachers, Inspiring Learning

President: Regan A. R. Gurung (2011)

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Beginning with the first introductory psychology courses were taught in the second half of the 19th century, psychology educators were interested in the degree to which students can learn, remember, and apply psychological knowledge. Although applying the science of psychology to understanding psychology education outcomes is nothing new, the formal study of psychological literacy did not emerge until near the end of the 20th century with the work of Boneau (1990). It is our contention that psychological literacy is a specialized case of scientific literacy, which is also subsumed by the general notion of critical thinking. In the following essay we trace the path from critical thinking to psychological literacy, with the hope of describing where we have been and where we need to go within the realm of psychological literacy.

The Big Picture: Critical Thinking

Critical and scientific thinking are not natural to most people. As cognitive researchers have documented, people make use of heuristics that lead to fast and generally useful decisions. In everyday life, such heuristics can result in more positive than negative outcomes, even if they are not based entirely on rational considerations (Gigerenzer & Goldstein, 1996). However, in more abstract and complex considerations, fast and frugal heuristics may not provide the best approach to decision making. Some psychologists have speculated that people evolved to attend to the concrete (i.e., frequency of events) rather than abstract (i.e., probability of events) information. Given the abundance of abstract and probabilistic information surrounding decisions people make, people may need to develop a strategy different than the fast and frugal heuristics that often prove useful. Evaluation of information is highly important. In fact, Supreme Court Justice Stephen Breyer has his own version of evaluating scientific information: He finds an expert who he has learned to trust (Breyer, 1998).

In this regard, critical thinkers show the ability to formulate questions clearly and precisely, gather and test relevant information, recognize their assumptions and perspectives, and communicate effectively to develop solutions (Defining Critical Thinking, 2009). Further, students must learn to recognize whether information is credible. There is no algorithm; rather, there are, at best, tentative heuristics, and critical thinkers must identify their own and others' biases and assumptions (Smith, 2002). These characteristics relate to scientific literacy. The National Academy of Sciences (NAS) has declared that scientific literacy comprises knowledge and understanding of the scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity (NAS, 1996). NAS conceived of scientific literacy emphasizing the process of knowledge development, the connection between science and society, and an understanding of scientific concepts as critical to such literacy. On the other hand, of less importance are isolated facts, knowledge independent of application, and a separation between what is known and how that knowledge is generated.

The level of scientific literacy in the United States is low but has improved over the past couple of decades, increasing from around 10% of the population in 1988 to perhaps 28% (Miller, 2007). For the purposes of the present discussion, it may be useful to distinguish scientific literacy and science literacy. Scientific literacy means knowing the process of science—how to ask and answer questions. On the other hand, science literacy reflects knowledge of facts and concepts (Maienschein with students, 1998). This distinction can be important because facts, even scientific facts, are provisional. But the process of generating knowledge is relatively standardized within the various sciences.

Psychology appears to be a useful domain for the development of critical thinking; note that here we refer to the broad area of critical thinking skills which can subsume components of psychological literacy. For example, Lehman, Lempert, and Nisbett (1988) demonstrated that graduate students in the social domains of psychology were proficient in applying statistical and methodological rules to everyday problems as well as to the critique of research. That is, they could use the knowledge gained in formal instruction in nonacademic contexts. Their abilities were comparable to those of medical students and superior to graduate students in chemistry and law. Lehman et al. speculated that the uncertainties and complexities in the social areas of psychology alerted students to the need for more sophisticated assessment of causal agents. Subsequent to this investigation of graduate education in psychology, Lehman and Nisbett (1990) studied undergraduates to see if reasoning abilities increased over time. They followed students across four years in the natural sciences, humanities, social sciences, and psychology. Lehman and Nisbett discovered the same phenomenon at the undergraduate level, namely that reasoning regarding uncertainty improved dramatically among psychology and social science students, but not among students in the humanities and natural sciences. Lehman and his colleagues in both studies did find that the disciplines that fostered less improvement in statistical and methodological reasoning fostered more improvement in conditional reasoning (i.e., deductive reasoning, such as that involving conditional probabilities). In Hong Kong, Cheung, Rudowicz, Kwan, & Dong (2002) reported a similar pattern of research results to Lehman and colleagues. Their students in the social sciences and humanities outperformed students in business and science/technology in types of critical thinking.

Although there is still controversy about the degree of transfer of training that takes place in varied tasks, a number of psychologists have demonstrated increases in critical thinking and reasoning as a result of classroom instruction (e.g., Bensley, Crowe, Bernhardt, Buckner, & Allman, 2010; Kosonen, & Winne, 1995; Lawson, Schwiers, Doellman, Grady, Kelnhofer, 2003; Leshowitz, DiCerbo, & Okun, 2002; Marin & Halpern, 2011). The common denominator seems to be a reliance on understanding that in conditions of uncertainty, it is important to generate alternate hypotheses to help conceptualize the situation.

The research showing that tutelage in psychology fosters critical thinking indicates that psychology students at the undergraduate and graduate level develop sound reasoning skills. But this does not necessarily mean that students are scientifically literate in the senses embraced by the NAS or that they possess the specific qualities and traits that comprise psychological literacy. However, Holmes and Beins (2009) have provided such data. They studied students who were at varied points through their psychology program and found that on a measure of scientific literacy (Carrier, 2001), the level of scientific literacy of psychology students showed an increase across the curriculum, with a particular increase after having taken a course in research methods (Beins, 2010). Prior to a deeper exploration of progress made regarding psychological literacy, what might we learn from our colleagues in other disciplines about the development of specified critical thinking skills?

Areas of Progress: Literacy Efforts Outside of Psychology

Each year, the National Survey of Student Engagement (NSSE) collects data from participating institutions on the educational efforts engaged in by students and the degree to which institutions are accomplishing their curricular goals (NSSE, n.d.). Across institutions, over ten percent of first-year college students had not engaged in any coursework that pertained to quantitative literacy such as using graphs to represent data or communicating graphical information in words (NSSE, 2010). Arum and Roksa (2011) reported that 45% of college students emerge from higher education without appreciable gains in critical thinking, analytical skills, and writing. In their study, Arum and Roksa discovered that in a given semester nearly

25% of students do not both write papers of substantial length over the course of the semester and read more than 40 pages of text per week. They suggested that to improve upon students' literacy, competencies, and skills, higher education must focus on teaching students these skills while emphasizing the process of learning through strategic curricular changes such as requiring substantial writing and reading. Seemingly, each discipline makes a plea to have its own discipline-specific literacy be an integral part of college curriculum. On the other hand, other types of literacy pertain to broader concerns for producing generically literate citizens. In a search of the *Chronicle of Higher Education* archives using the keyword literacy, several different types of literacy were revealed: information, spatial, civic, historical, financial, cultural, scientific, mathematics, computer, media, visual, environmental, and literary literacy. But in many cases, these calls for discipline-specific literacies lack much in the way of formal operalization. In a study investigating the assessment of media literacy, for instance, Christ (2004) admitted, "there are no U.S. communication or media associations that have directly addressed media literacy standards for higher education" (p. 93) but that they are implied in the standards a program must meet to be accredited.

Though accreditation-granting entities do not explicitly refer to them as literacies, their standards may reflect the skills and competencies needed to emerge from a degree program with a discipline-specific literacy (e.g., American Library Association, 2000). For example, the American Chemical Society (ACS) stipulates guidelines that present much like the outcomes specified by definitions of scientific literacy. To grant a degree in chemistry, institutions must require that students are engaged in broad introductory courses, foundational courses, in-depth courses, laboratory experience, degree concentrations, and experience in similar disciplines outside of the major coursework. Additionally, the ACS (2008) outlined skills that degree recipients must have including problem-solving, information-gathering, data analysis and synthesis, communication skills, ability to work as a team, and ethics in science. Many of these curriculum requirements and skill sets, though not specifically referred to as literacy, achieve the goals of literacy. Though there are urgent pleas made for the advancement of a discipline's own literacy, few have been formalized to the degree that scientific and information literacies have.

Scientific Literacy

More than 20 years ago, the American Association for the Advancement of Science's (AAAS) National Council on Science and Technology Education published a set of guidelines to encourage scientific literacy for all Americans and that specify the characteristics of a scientifically literate person. These standards center around three themes: (a) possessing a scientific world view, (b) knowledge of scientific methods, and (c) appreciation of the scientific endeavor (AAAS, 1989). A person who is scientifically literate is one who has "an appreciation of the basic principles of science and its methodology and an understanding of what scientific research produces" (Clough, 2011, p. 1). These guidelines became the basis of the AAAS's Project 2061.

Due to the pursuit of the AAAS and the number of years spent in this endeavor, Project 2061 has yielded a rich body of evidence supporting the establishment of standards and benchmarks of scientifically literate students and the assessment methods for science education. Additionally, it is through the work of Project 2061 that a process of educational reform has been established. These efforts and outcomes can be looked to as guidance for other groups attempting to identify the characteristics of a literate person, curriculum reforms that aid in achieving literacy, and assessment tools that measure the literacy.

Primarily, the work of Project 2061 focuses on science education in grades K-12, with the express purpose of reforming the educational system to produce scientifically literate students. The impetus of the project was the realization that students were emerging from school with a limited understanding of science, scientific thinking, and an appreciation for the scientific process when, arguably, they must possess these skills as they emerge as the next generation of leaders, voters, and consumers of information (AAAS, 1995). To this end, the AAAS and the members of Project 2061 initiated a program of reform that would admittedly take decades to realize. The accomplishment of curricular and social reform was designed as a multi-phased program in which experts in the field first set the standards and benchmarks of scientifically literate students, next designed and tested curricular models, and finally secured commitment from stakeholders. The AAAS's Project 2061, having established standards and benchmarks with learning goals to accompany them and taken steps to evaluate curricula according to these standards, sought to enact the reform of educational practices to ensure a scientifically literate citizenry (Nelson, 1997,; 1999). Reform efforts involve a multi-stepped process. The primary caution issued by Nelson (1997) was against trying to find short-term fixes to problems, but instead to focus on long-term reform.

Information Literacy

Another area rich in information about literacy initiatives, particularly in the realm of literacy assessment, is information literacy. Information literacy is defined as the skills and competencies that a person needs to be able to find, consume, interpret, analyze, synthesize, create and use information and to be able employ these skills to participate in and contribute to society as we further progress into the information age (Buschman & Warner, 2005; Pinto, 2010). Information literacy is a literacy that cuts across all disciplines (ALA, 2000), which is probably why there has been a focused effort to identify the characteristics of information literate people and to develop assessment tools to measure those characteristics.

With the support of the American Library Association (ALA) and the Association of College and Research Libraries (ACRL), experts have identified a set of five standards with accompanying performance indicators which must be met to achieve information literacy (ALA, 2000). A student should be able to identify "the nature and extent of the information needed" (ALA, 2000, p. 8), access the needed information in an effective and efficient manner, critically evaluate and synthesize the information into "his or her knowledge base and value system" (p. 11), and accomplish these tasks for a specific purpose (see also, Pinto, 2010). The ALA's establishment of mutually agreed upon standards by a central authority corresponds to the first step of the process of reform suggested by the AAAS's Project 2061, and which is essential to achieving the long-term goal of discipline-specific literacy.

There are several assessment tools available for measuring the information literacy skills mentioned above, the most popular of which is the iSkills test developed and validated by the Educational Testing Service (Pinto, 2010). The iSkills assessment was developed using an evidence-centered design in which developers identified the purpose of the assessment tool by determining who would be assessed and why, the proficiencies students were expected to have and which would be assessed with the assessment tool, the evidence that was intended to demonstrate students' proficiencies, and tasks designed to amass evidence of the proficiencies inherent to information literate people (Egan & Katz, 2007), suggesting that assessments such as the iSkills can be used to advise students into courses that can help to develop their information literacy skills.

Whereas reform efforts play a primary role in Project 2061's pursuit of scientific literacy efforts described above, specific and active reform initiatives have taken a backseat in the realm of information literacy. Perhaps this is due to a focus on information literacy at the higher education level rather than the K-12 level, where meeting of standards can be legislated. Indeed, the ALA (2000) recommended that "an institution [of higher education] should first review its mission and educational goals to determine how information literacy would improve learning and enhance the institution's effectiveness" (p. 6). In effect, this places the burden of responsibility of curricular reform on the institution; to support this effort, the ALA has provided the tools to assess information literacy.

Simultaneous Literacies

Although many discipline-specific literacies are individually promoted, it is likely that many of these literacies combine and interact with one another. For instance, Elrod and Hovland (2011) added to the growing discussion of the importance of simultaneous literacies among college educated citizens. Instead of simply adding yet another type of literacy to the list of literacies students must gain during their tenure in college (Tritelli, 2009), Elrod and Hovland argued for the intersecting nature of those literacies. For a person to be literate in global diversity, one must necessarily also be literate in science. Additionally, being both information and science literate are important in a world in which national and economic advancement depend on the two (Luu & Freeman, 2011). In their research investigating the interaction between scientific and information literacy, Luu and Freeman found a positive correlation between college students who had access to and confidence with information and communication technology and their scientific literacy.

Psychology educators have concentrated for years in the general promotion of critical thinking skills, and more targeted efforts at developing scientific and informational literacy have enjoyed success. In reviewing these antecedent efforts, work toward psychological literacy should include establishing what psychological literacy is and the standards that identify psychological literacy; obtaining buy-in from stakeholders; developing meaningful assessments that measure psychological literacy; offering curriculum resources known to promote psychological literacy; providing professional development opportunities so that educators can put these literacy efforts into practice; and fostering a spirit of reform within the discipline. What might specific efforts targeted toward psychological literacy look like?

Psychological Literacy

The foundational antecedent work in the area of psychological literacy comes from educator's efforts to develop critical thinking skills; current efforts in psychological literacy seek to strengthen available resources and focus more on the specialized development of psychological literacy rather than a more generalized understanding of critical thinking or scientific literacy as they relate to psychology. In this section we briefly review major methodological approaches and available measures of psychological literacy, and our recommendation to narrow the focus of current efforts so that clear operationalizations of psychological literacy can emerge.

Major Methodological Approaches

As identified by a comprehensive review of the literature, the three major methodological approaches to date in the area of psychological literacy include the core terms approach, studying student perceptions and the alleviation of misperceptions, and examination of changes over time regarding students' views of psychology as a science.

Core Terms. Boneau's (1990) work followed on the heels of the popular American trend at the time to identify a core listing of facts and figures that citizens should know. Boneau divided psychology into 10 subfields and created listings of at least 200 psychological terms per subfield. Textbook authors each rated terms using a 5-point scale, and this allowed Boneau to create not only an all-time 'Top 100' list of terms and concepts, but he also created a 'First 100' list for each of the 10 subfields. Other researchers following with similar efforts in introductory psychology (Griggs, Bujak-Johnson, & Proctor, 2004; Landrum, 1993; Quereshi, 1993; Zechmeister & Zechmeister, 2000) and even statistics (Landrum, 2005). From this perspective, psychology educators may surmise that to be a psychologically literate citizen, the core terms of the field must be known so that they can be emphasized throughout the undergraduate psychology experience.

Alleviating Misperceptions. With regard to the general notion of psychological literacy, the most popular approached to date (evidenced by the number and recency of publications) involves the study of student misperceptions about psychological and scientific beliefs. The typical approach in these studies is to first measure the level of misperception or belief in pseudoscientific claims and then implement a pedagogical approach in an attempt to alleviate the belief in misperceptions (that is, to reduce psychological illiteracy). This 'within-a-semester' approach is featured in a number of publications regarding introductory psychology (Gardner & Dalsing, 1986; Gutman, 1979; Kowalski & Taylor, 2009; Kuhle, Barber, & Bristol, 2009; Miller, Wozniak, Rust, Miller, & Slezak, 1996; Vaughan, 1977), research methods (Kagee, Allie, & Lesch, 2010; LoSchiavo & Roberts, 2005), and even the history of psychology course (Woody, Viney, & Johns, 2002).

Other researchers used a cross-sectional design to examine differences between groups where psychological literacy differences would be expected. For instance, Glass, Bartels, Ryan, and Stark-Wroblewski (2008) examined how psychology courses could reduce the belief in psychological myths in university students, junior college students, and a community sample. Both Standing and Huber (2003) and Holmes and Beins (2009) tested different students in different courses regarding perceptions and beliefs. Additional work in this area addresses the sources of such psychological misperceptions (Chew, 2006), with one suggestion being that the misperceptions of academicians are a key source of student misperceptions (Gardner & Hund, 1983). An approach that is less popular but also of value is to note how students' ratings of psychology as a science may change over time (Amsel, et al., 2009; Friedrich, 1996). If alleviating misperceptions is analogous to reducing psychological illiteracy, perhaps increases in beliefs that psychology is a science is analogous to improvements in psychological literacy.

Available Measures

As with the study of any psychological construct, appropriate psychometric measures must be developed and tested prior to more complex research regarding how a construct like psychological literacy is influenced by and related to other variables, how interventions can change measurement values and the underlying construct, and so on. Although many researchers have creatively developed their own measures, the four scales presented below seem well-suited for those SoTL researchers interested in launching research projects that impact one's level of psychological literacy.

Vaughan (1977) was one of the earlier researchers to develop a psychological misperceptions scale (20 items, true-false) and make it publicly available for other researchers (which includes concerns from other researchers as well—see Ruble, 1986). Standing and Huber

(2003) developed their own 20-item true-false scale testing for student beliefs in psychological myths, with the outcome of the scale yielding a Huber score. Rather than focus on psychological myths or misconceptions, Friedrich (1996) developed the 15-item Psychology as a Science (PAS) scale where respondents provide 5-point Likert-type agreement ratings to each of the statements presented. Another potential route for researchers is to utilize the Scientist-Practitioner Inventory, developed by Leong and Zachar (1991). This 42-item scale consists of scientist and practitioner subscales, with associated tasks and activities rated from very low interest to very high interest. Although there are certainly multiple scale choices that provide measures of constructs related to psychological literacy, it is yet to be determined if any of these measures captures the psychological literacy construct in its totality.

Narrowing the Focus

The idea of psychological literacy certainly existed prior to the emergence of the term ‘psychological literacy’ in 1990 starting with Boneau’s publication in the American Psychologist. This notion of psychological literacy and the idea of a psychological literate citizen is again in the forefront of our disciplinary consciousness with work of McGovern, et al. (2010). In this work, psychological literacy is defined as:

- having a well-defined vocabulary and basic knowledge of the critical subject matter in psychology;
- valuing the intellectual challenges required to use scientific thinking and the disciplined analysis of information to evaluate alternative courses of action;
- taking a creative and amiable skeptic approach to problem solving;
- applying psychological principles to personal, social, and organizational issues at work, relationships, and the broader community;

- acting ethically;
- being competent in using and evaluating information and technology;
- communicating effectively in different modes and with many different audiences;
- recognizing, understanding, and fostering respect for diversity; and
- being insightful and reflective about one's own and others' behavior and mental processes. (p. 11.)

Upon closer examination of some the points here, some of the work cited previously overlaps with these main points. For instance, the prior work in core terminology identification is useful to "having a well-defined vocabulary and basic knowledge" (Bullet 1). Applying psychological principles certainly relates to one's ability to recognize and identify psychological myths and misperceptions (Bullet 4). Overall, however, it does not appear that much overlap exists with prior efforts within the realm of psychological literacy and the McGovern et al. (2010) configuration as presented here.

There is good work in this area, and we encourage such efforts to continue. For example, Holmes and Beins (2009) used a cross-sectional design consisting of students from introductory psychology, statistics, research methods, and research assistants and administered Leong and Zachar's (1991) *Scientist-Practitioner Inventory*, Friedrich's (1996) *Psychology as a Science* scale as well as other measures. Holmes and Beins (2009) reported that although increases in scientific thinking increased over an undergraduate career, students' belief that psychology is a science did not increase. Interestingly, whether students expressed higher scores for scientific interests or practitioner interests in psychology was related to students' personality traits.

The operationalization of psychological literacy is vital if our understanding of this complex construct is to advance. Part of this challenge is in distilling the multiple components of the psychological literacy definition offered by McGovern et al. (2010) into measurement-level constructs. For instance, will one grand ‘psychological literacy’ scale emerge with nine subscales, one for each of the bulleted points presented? Will current measures like the PAS be mapped onto components of this nine-part definition? Narrowing and defining the focus of the definition of psychological literacy is vital now so that research in this area may continue efficiently. For instance, with these concepts in clear view, we will be able to ask research questions such as ‘does alleviating psychological illiteracy equal promoting psychological literacy?’

The establishment of a firm operational definition of psychological literacy, now, is not a trivial matter. One only need to glimpse at the progress of the literature within the Scholarship of Teaching and Learning (SoTL) to realize that definitions and labels matter. Boshier (2009) identified in his study of SoTL efforts over time at least 26 different definitions and descriptions are used to describe this general topical area. This confusion over the subject matter of SoTL continues to exist in some circles today (Boshier, 2009). Rather than let the definition and operationalization of psychological literacy sway to and fro for too long, the advances we make in understanding psychological literacy are tied to the clarity of definitions offered, our ability to apply these principles is measured, and the passionate promotion by psychology educators to ensure that increases in psychological literacy have real-world benefits for students and ultimately our citizenry continues.

Author Note

1. The authors of this document are (listed alphabetically) Barney Beins, Eric Landrum, and Dee Posey; each contributed equally to this document. Views expressed in this essay do not

necessarily reflect the view of the Society for the Teaching of Psychology (APA Division Two) nor its leadership.

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