

The Expert Ceiling in Epistemological Beliefs

Lucy Barnard

Texas Tech University

Abstract

Paulsen and Wells (1998) stated that, “it seems unlikely that substantial differences in epistemological beliefs across domains would persist in studies of faculty or other more advanced experts,” (p. 380). This statement implies the existence of an upper limit or ceiling effect in the epistemological beliefs among experts. Faculty members are ostensibly considered experts in their fields of study. The purpose of this study was to examine differences in the epistemological beliefs of faculty members as a matter of gender and academic discipline while controlling for years of experience in higher education so as to discern whether the hypothesis that an expert ceiling in epistemological beliefs could be supported. The determination of an expert ceiling in epistemological beliefs is relevant for educators as these beliefs have been linked to a variety of cognitive and motivational factors.

Introduction

Epistemological beliefs are relevant for study as they have been linked to a variety of behaviors associated with academic performance along with various cognitive and motivational factors (Hofer & Pintrich, 1997). Previous research has indicated that students who believe that knowledge is fixed, for instance, have difficulty accepting tentative answers (Schommer, 1990), will exhibit helpless behaviors when confronted with difficult academic tasks (Dweck and Leggett, 1988), and are less likely to engage in self-regulated learning behaviors (Paulsen and Feldman, 1999). As differences in academic performance have been associated with differences in sophistication of epistemological beliefs, numerous studies have considered differences in the epistemological beliefs as a matter of gender (e.g. Baxter Magolda, 1992; Hofer, 2000), academic discipline (e.g. Hofer, 2000; Jehng, Johnson, & Anderson, 1993; Paulsen & Wells, 1998), age (Schommer-Aikins, Duell, & Hutter, 2005; Schommer, 1993b), and even parenting style (Ricco & Rodriguez, 2006).

Research considering differences in epistemological beliefs as a matter of academic discipline has been extensive. In surveying 290 students attending a large public university, Paulsen and Wells (1998) examined differences in epistemological beliefs across six major fields of study categorized according to Biglan’s classification model (1973a & 1973b) as either *hard* versus *soft* or *pure* versus *applied*. Among their findings, Paulsen and Wells (1998) determined that students majoring in business, classified as a *soft* and *applied* field, were significantly more likely to have naïve beliefs about simple knowledge than those students majoring in either the

natural sciences, classified as *hard* and *pure* fields, or the humanities and fine arts, noted as *soft* and *pure* fields. Students majoring in business were also more likely to have naïve beliefs about quick learning than those students in the social sciences consisting mainly of *soft* and *pure* fields. Paulsen and Wells (1998) further noted that students majoring in the *pure* fields tended to have more sophisticated beliefs about knowledge than students in *applied* fields while students majoring in the *soft* fields tended to have more sophisticated beliefs about knowledge than those students majoring in the *hard* fields with the exception of the natural sciences. Additionally, Jehng, Johnson, and Anderson (1993) found that the epistemological beliefs of college students majoring in the arts, humanities, and social sciences appeared to be more sophisticated than those students majoring in engineering and business. Palmer and Marra (2004) similarly found differences in the epistemological beliefs of engineering and science students as less sophisticated than students majoring in the humanities.

These differences in epistemological beliefs as a function of academic discipline suggest a degree of domain specificity of epistemological beliefs. In contextualizing a domain specific, epistemological beliefs questionnaire for the fields of mathematics, social sciences, and business, Schommer-Aikins, Duell, & Barker (2003) discerned that there was moderate evidence to support the hypothesis that the epistemological beliefs of college students are more likely domain-general rather than domain specific when controlling for a variety of background variables such as academic discipline. In controlling for background variables such as age, gender, educational level, grade point average, and academic major (classified according to Biglan's classification system), Schommer-Aikins et al. (2003) discerned no differences in the epistemological beliefs in mathematics, social sciences, and business. These findings lend support to the results of a similar study conducted by Schommer and Walker (1995) comparing the domain-specific epistemological beliefs of college students in mathematics and the social sciences where results also suggested a certain degree of domain generality of epistemological beliefs. According to Schommer's work, epistemological beliefs as a whole appear to be more or less domain general *when* controlling for a variety of background characteristics including academic discipline, which indicates a certain degree of association of academic discipline with epistemological beliefs. When not controlling for academic discipline (as did Paulsen and Wells (1998)), Jehng et al. (1993) discerned differences in epistemological beliefs of college students, "who study in the *soft* fields (i.e. social science and arts/humanities) have a stronger tendency of believe that knowledge is uncertain, are more reliant on their independent reasoning ability, and have a stronger feeling that learning is not an orderly process than students in hard fields," (p. 23). Hofer (2000) found strong disciplinary differences among college students whereas students in psychology more so viewed personal knowledge as a basis for justification of knowing than students in science while students in science viewed authority and expertise more as the source of knowledge than students in psychology.

In concluding their study examining the epistemological beliefs of college students across domains of study, Paulsen and Wells (1998) stated that, "it seems unlikely that substantial differences in epistemological beliefs across domains would persist in studies of faculty or other more advanced experts," (p. 380). This statement of Paulsen and Wells regarding experts implies the existence of an upper limit or ceiling effect in epistemological beliefs as delimited by expertise across domains. While Hofer and Pintrich (1997) have noted that, "it is unclear where the process of epistemological understanding begins" (p. 122), the researcher contends that it is

equally unclear where the process of epistemological understanding ends except perhaps as associated with the achievement of expertise as an outcome. An examination of differences in the epistemological beliefs of *any* group of experts however has yet to be studied, thus the existence of an expert ceiling effect in these beliefs has not been substantiated either way by any empirical evidence despite its significance to the study of epistemological understanding and the development of expertise.

Expertise has been defined as, “the capacity either to offer expert opinions or to demonstrate one or more skills in a domain,” (Weinstein, 1993, p. 59). There are some fundamental differences between novices and experts beyond just capacity in a particular content area or skill. Experts are not only more knowledgeable and more capable at doing the same things that a novice may do yet they do these same things quite differently than novices do involving processes that are multi-level, highly interrelated, and quite complex (Bereiter & Scardamalia, 1986; Palmer & Marra, 2004). As such, expertise is highly relative to one’s area of expertise given such accompanying complexity of the processes of experts. The term, *relative experts* has been used to describe to this group, as a whole, of highly skilled and highly knowledgeable persons (*ibid.*, p.11). This relative nature of expertise indicates both the specificity of content and novelty of problem-solving that an expert may invoke. Experts as a whole are relevant for study. As while much literature discusses how novices and experts differ, there is little research discussing how experts are similar as a whole, where research is restricted to the study of particular expertise in isolation to one another (e.g. Berliner, 1986 & Sternberg & Horvath, 1995 in re expert teachers; Lichtenberg, 1997 for counseling psychologists; Rolfe, 1997 for nurse practitioners; Tanaka & Curran, 2001 studying recognition capabilities of bird and dog experts; Wood, 1999 in re visual expertise of radiologists). Defining the characteristics of experts, beyond extensive knowledge in a particular content area, are important to determine so educators can begin to move learners in the direction of expertise regardless of the particular knowledge or skill set desired. To know for instance, that experts as a whole have highly sophisticated and similar epistemological beliefs would inform educators, especially teacher educators, of the importance of the development of epistemological beliefs as associated with the development of expertise later on.

Faculty members are ostensibly experts in their respective fields of knowledge (Paulsen & Wells, 1998; Wineburg, 1991). As faculty members are considered experts in their fields of study, differences in epistemological beliefs are unlikely to occur as a matter of background variables such as educational level given the uniformity of this variable across faculty. Research does appear to suggest that the epistemological beliefs of faculty members may of course differ as a matter of background variables such as gender, age, and academic discipline as has been discerned by the aforementioned literature and even in controlling for these variables (e.g. Schommer-Aikins, Duell, & Barker, 2004). The purpose of this study is to discern whether there are differences in the epistemological beliefs of faculty members as a matter of gender and academic discipline while controlling for years of experience in higher education. Controlling for years of experience in higher education was important given that the development of expertise and years of experience in one’s field of study should logically be correlated thus a confounding variable in examining differences in epistemological beliefs. To achieve this purpose, the researcher will examine:

- Whether differences in the epistemological beliefs of faculty members exist as a matter of instructor gender while controlling for years of experience in higher education?
- Whether differences in the epistemological beliefs of faculty members exist as a matter of discipline classification while controlling for years of experiences in higher education?

From examining these research questions, the researcher endeavors to discern whether Paulsen and Wells' (1998) implicit hypothesis of a ceiling effect in the epistemological beliefs among experts can be supported for the sample of faculty studied.

Methods

Participants

An online survey was sent to a sample of faculty members in a large, public university located in the Southwestern United States iteratively over the course of a six-month period. Of these faculty members, 228 volunteered to complete the online survey by following a link contained in a recruitment e-mail message. The majority of the participants identified themselves as European American (85.4%, $N = 193$) with 54.6% ($N = 124$) reporting as male. A total of 46 different academic departments were represented contained within the sixteen colleges and schools at the university studied.

Measures

To measure the epistemological beliefs of faculty, the Epistemic Belief Inventory (EBI) was employed. The EBI is a 28-item, five point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Schraw, Bendixen, & Dunkle, 2002). The researcher summed the score for each individual while omitting any individuals who did not complete the instrument from analysis thus not including any missing values. Examples of a positively-scored item and a negatively-scored item to be reversed are provided respectively:

- Absolute moral truth does not exist.
- Really smart students don't have to work as hard to do well in school.

Higher scores on this instrument indicate more sophisticated epistemological beliefs while lower scores indicate less sophisticated, more naïve epistemological beliefs. The EBI has five dimensions or subscales based upon those categories outlined by Schommer (1990): omniscient authority; simple knowledge; certain knowledge; fixed (innate) ability; and quick learning. According to Schommer (1990, 1993a, 1993b), epistemological beliefs are characterized by a multidimensional set of more or less independent beliefs meaning that person can have more sophisticated in one dimension and less sophisticated beliefs in another dimension. The reported internal consistency of this instrument was $\alpha = .83$ (Schraw et al., 2002). For this study, the internal consistency of the EBI was acceptable with $\alpha = .74$.

For the variable of academic discipline, the different academic departments were categorized as either a *hard* or *soft* discipline according to Biglan's classification system (Biglan, 1973a & 1973b). In surveying 168 faculty representing 36 different academic disciplines, Biglan (1973a) asked faculty to classify each academic discipline, "on the basis of the similarity of the subject matter," (p. 196) as deemed by the faculty members studied. The categorization of a discipline as *hard* or *soft* refers to the degree of paradigmatic development of a field (Biglan, 1973a & 1973b). Disciplines such as chemistry, biology, and mathematics for example were categorized as *hard* while disciplines such as political science, psychology, and fields in the fine arts were categorized as *soft*. The distribution of *hard* versus *soft* disciplines was sufficient with 98 departments classified as *hard* and 126 departments classified as *soft*. The distribution of *pure* versus *applied* disciplines was also sufficient with 94 departments classified as *pure* and 129 departments classified as *applied*. If a department could not be classified according to Biglan's system, the response was removed from the discipline phase of the analysis, which resulted in five responses being omitted from analysis.

Procedure

Participants were solicited by requesting individual departmental and college administrators to forward the recruitment e-mail message to their respective listservs of faculty members. The researcher did not have access to any of the e-mail addresses contained in these listservs. The researcher also posted a similar recruitment message that was distributed via a university-wide faculty e-mail listserv system after university administrative approval. After collected, data were recoded and reversed per instrument instructions. The data were collected online via Microsoft Excel and readied for analysis using SPSS (v.12) statistical software package. Participants who did not complete the instrument in its entirety were removed from the analysis.

Analyses

A three-way analysis of covariance was performed with instructor gender, *hardness* of discipline, and purity of discipline as the independent variables with self-reported epistemological beliefs as the dependent variable, and years of experience in higher education as the concomitant variable or covariate. The assumption of homogeneity of slopes was met as the interaction of the covariate with each of the independent variables was not statistically significant. The first research question was answered by the main effects of gender and discipline classification (as either *hard* versus *soft* or *pure* versus *applied*) on self-reported epistemological beliefs. The second research question was answered by the main effects of gender and discipline classification on self-reported epistemological beliefs by dimension.

Results

Differences in the epistemological beliefs of faculty did not emerge as a matter of instructor gender, $F(1, 201) = 1.26, p = .263$, hardness of discipline, $F(1, 201) = 0.28, p = .600$, or purity of discipline, $F(1, 201) = 1.02, p = .313$ while controlling for years of experience in higher education. Table 1 indicates the estimated cell and marginal means and standard

deviations for epistemological beliefs while controlling for years of experience in higher education as a matter of each of the independent variables. On a subscale level, differences in epistemological beliefs of faculty did not emerge as a matter of instructor gender, hardness of discipline, or purity of discipline for any of the dimensions of epistemological beliefs. For the dimension of omniscient authority, significant differences in the epistemological beliefs did not emerge as a matter of instructor gender, $F(1, 201) = 3.10, p = .08$, hardness of discipline, $F(1, 201) = 0.164, p = .686$, or purity of discipline, $F(1, 201) = 0.007, p = .939$ while controlling for years of experience in higher education. As for the dimension of simple knowledge, significant differences in the epistemological beliefs did not emerge as a matter of instructor gender, $F(1, 201) = 0.08, p = .777$, hardness of discipline, $F(1, 201) = 1.33, p = .251$, or purity of discipline, $F(1, 201) = 1.62, p = .204$ while controlling for years of experience in higher education. As for the dimension of certain knowledge, significant differences in the epistemological beliefs did not emerge as a matter of instructor gender, $F(1, 201) = 0.25, p = .620$, hardness of discipline, $F(1, 201) = 0.37, p = .543$, or purity of discipline, $F(1, 201) = 0.64, p = .424$ while controlling for years of experience in higher education. Regarding the dimension of innate ability, significant differences in the epistemological beliefs did not emerge as a matter of instructor gender, $F(1, 201) = 1.64, p = .202$, hardness of discipline, $F(1, 201) = 0.84, p = .36$, or purity of discipline, $F(1, 201) = 0.01, p = .981$ while controlling for years of experience in higher education. Regarding the dimension of quick learning, significant differences in the epistemological beliefs did not emerge as a matter of instructor gender, $F(1, 201) = 0.487, p = .486$, hardness of discipline, $F(1, 201) = 0.25, p = .618$, or purity of discipline, $F(1, 201) = 2.39, p = .124$ while controlling for years of experience in higher education.

Table 1. Estimated Marginal and Cell Means

<i>Hard</i>	<i>Soft</i>	<i>Pure</i>	<i>Applied</i>	Total
$M = 74.12$	$M = 72.13$	$M = 72.74$	$M = 73.75$	$M = 73.30$
$SD = 7.53$	$SD = 9.24$	$SD = 7.97$	$SD = 8.60$	$SD = 8.30$
$n = 65$	$n = 46$	$n = 50$	$n = 61$	$n = 111$
$M = 72.04$	$M = 69.21$	$M = 70.17$	$M = 69.87$	$M = 69.99$
$SD = 7.66$	$SD = 7.78$	$SD = 8.28$	$SD = 7.56$	$SD = 7.81$
$n = 25$	$n = 66$	$n = 36$	$n = 55$	$n = 91$
$M = 73.54$	$M = 70.41$	$M = 71.66$	$M = 71.91$	$M = 71.81$
$SD = 7.58$	$SD = 8.49$	$SD = 8.15$	$SD = 8.32$	$SD = 8.23$
$n = 90$	$n = 112$	$n = 86$	$n = 116$	$N = 202$

Discussion

The results of this study lend support to the statement of Paulsen and Wells (1998) that it is, “unlikely that substantial differences in epistemological beliefs across domains would persist in studies of faculty or other more advanced experts,” (p. 380). Evidence from this study further lends support for the hypothesis of an upper limit or ceiling effect in the sophistication of epistemological beliefs among experts given that the researcher empirically studied the self-reported epistemological beliefs of faculty members across forty-six academic disciplines represented. No other study to date has examined the epistemological beliefs of experts across

such a variety of disciplines. The overarching significance of this study is that (1) a ceiling effect in the epistemological beliefs among experts can be supported and (2) that we can determine an important characteristic of experts in general as having highly sophisticated and similar epistemological beliefs.

For teacher education programs, the goal is to move teachers in the direction of becoming not only competent teachers yet expert teachers. The existence of an expert ceiling in epistemological beliefs suggests an innovative way for teacher educators to both augment and assess the progression of their preservice teachers. Future research should further determine the characteristics that expert teachers demonstrate in regards to their epistemological beliefs and seek to reinforce these beliefs in preservice teachers. An emphasis on reinforcing epistemological beliefs among preservice teachers can be justified as a movement towards the development of expertise in teaching given that, from the results of this study, experts across a variety of domains or fields of study have highly sophisticated and similar epistemological beliefs. Thus, if novice, preservice teachers are to become expert teachers, these teachers must develop more and more sophisticated epistemological beliefs at some point as these highly sophisticated and similar epistemological beliefs are associated with expertise.

Previous research has suggested that the sophistication of epistemological beliefs may formulate in a developmental stage model (Hofer, 2000). As every expert begins as a novice, this developmental stage process of epistemological beliefs may have some corollaries as to the developmental process of becoming an expert. Future research should consider creating linkages between the development of epistemological beliefs and the process of becoming an expert in one's field of knowledge as one manner of studying complex, personal epistemologies (Palmer & Marra, 2004). For instance, as a novice progresses towards becoming an expert how are their epistemological beliefs characterized as they develop their expertise in their respective fields. This future research could be achieved within a teacher education program by measuring the epistemological beliefs of students at specified intervals as they complete certain requirements of their certifications. The most ideal sample for study would be undergraduate students enrolled in a combined bachelors/masters program often offered in Accounting and Engineering programs. In this manner, researcher could examine the epistemological beliefs of novices in a certain domain over a longer period of time than a teacher certification program takes to complete. The longitudinal nature of epistemological belief development is worthy of study outside of the academic domain also as experts in non-academic domains may offer new insights into the development of epistemological beliefs and expertise. An understanding by faculty members as to how they are epistemologically different from their students given evidence supporting an expert ceiling in these beliefs can only improve faculty's understanding of how their students may best learn. A faculty member knowing for instance that their students' beliefs about knowledge are generally more naïve or less sophisticated in nature permits faculty members to be sensitive to the epistemological development of their students and to scaffold and differentiate appropriately.

Viewed on its face, the results of this study lend support to the idea of epistemological beliefs being domain general as there were no differences in epistemological beliefs across academic disciplines among faculty members. However, to borrow from the first line of Tolstoy's *Anna Karenina*, "Happy families are all alike; every unhappy family is unhappy in its

own way," (p.1), all experts may think alike yet every novice thinks differently in their own way. For instance, novice, first year physics students may explain the phenomenon of gravity through a vast, myriad of incorrect arguments (all the while getting the correct answer: what goes up must come down) whereas a group of experts can explain the same phenomenon using a limited and similar number of correct arguments. The researcher proposes that epistemological beliefs may be considered domain general among faculty members as experts given the sophistication of their beliefs while the epistemological beliefs of novices may be more domain specific as they are less sophisticated in that there may be more various ways in which epistemological beliefs may be characterized as less sophisticated and less various ways in which epistemological beliefs may be characterized as more sophisticated. Future research should not only examine how epistemological beliefs differ in their sophistication but the diversity of these beliefs within levels of sophistication.

In this study, the researcher is assuming that (1) faculty members are experts, (2) as experts have more sophisticated epistemological beliefs than most and finally (3) that we are measuring epistemological beliefs in a reliable and valid manner for experts. Each of these assumptions presents limitations to the generalizability of findings which the researcher will discuss. First, the researcher relies on the uniform application of all faculty members being considered *de facto* experts in their respective fields of study. Not all faculty members however may be considered experts in their fields of study given their point in their careers yet the researcher attempts to safeguard against this nuisance variable by controlling for years of experience in higher education as amount of experience would appear to be highly associated with level of expertise. Secondly, the existence of an expert ceiling in epistemological beliefs relies on evidence from the examination of faculty members, which the researcher is assuming to have more sophisticated epistemological beliefs than most. This hypothesized, expert ceiling effect may of course be more of a faculty plateau effect in epistemological beliefs. Future research should compare the epistemological beliefs of faculty members to another group of persons, which may be more or less considered experts such as forensic experts used in criminal investigations. The study of self-anointed experts should be avoided in favor of some external criteria, though it should be noted that *who* is recognized as an expert is directly related to *what* problems are considered worth investigating (Namenwirth, 1986). Finally, the researcher assumes that we are measuring epistemological beliefs in a reliable and valid manner for a sample considered as experts. All previous instruments measuring epistemological beliefs including the one used in this study were normed and validated from convenient samples of college students, generally not considered experts in a domain or field of study. Thus, evidence supporting the existence of an expert ceiling in epistemological beliefs may be deceptive as current measures may not distinguish differences among experts given that norming samples consisted of non-experts.

References

- Baxter Magolda, M. B. (1992). *Knowing and reasoning in college: Gender-related patterns in students' intellectual development*. San Francisco: Jossey Bass.
- Bereiter, C. & Scardamalia, M. (1986). Educational relevance of the study of expertise. *Interchange*, 17(2), 10-19.
- Berliner, D. C. (1986). In pursuit of the expert pedagogue. *Educational Researcher*, 15(7), 5-13.
- Biglan, A. (1973a). The characteristics of subject matter in different areas. *Journal of Applied Psychology*, 57(3), 195-203.
- Biglan, A. (1973b). The relationship between subject matter characteristics and the structure and output of university departments. *Journal of Applied Psychology*, 57(3), 204-213.
- Dweck, C. S. & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95, 256-273.
- Hofer, B. K. (2000). Dimensionality and disciplinary differences in personal epistemology. *Contemporary Educational Psychology*, 25, 378-405.
- Hofer, B. K. & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 67(1), 88-140.
- Jehng, J. J., Johnson, S. D., & Anderson, R. C. (1993). Schooling and student's epistemological beliefs about learning. *Contemporary Educational Psychology* 18(3), 23-35.
- Lichtenberg, J. W. (1997). Expertise in Counseling Psychology: A Concept in Search of Support. *Educational Psychology Review*, 9(3), 221-238.
- Namenwirth, M. (1986). Science seen through a feminist prism. In R. Bleier (Ed.), *Feminist Approaches to Science* (p. 18-41). New York: Pergamon Press.
- Palmer, B. & Marra, R. M. (2004). College student epistemological perspectives across knowledge domains: A proposed grounded theory. *Higher Education*, 47, 311-335.
- Paulsen, M. B. & Feldman, K. A. (1999). Epistemological beliefs and self-regulated learning. *Journal of Staff Programming and Organizational Development*, 16, 83-91.
- Paulsen, M. B. & Wells, C. T. (1998). Domain differences in the epistemological beliefs of college students. *Research in Higher Education*, 39(4), 365-384.
- Ricco, R. & Rodriguez, P. (2006). The Relation of Personal Epistemology to Parenting Style and Goal Orientation in College Mothers. *Social Psychology of Education*, 9(2), 159-178.

- Rolfé, G. (1997). Beyond expertise: theory, practice and the reflexive practitioner. *Journal of Clinical Nursing*, 6(2), 93-107.
- Schraw, G., Bendixen, L. D., & Dunkle, M. E. (2002). Development and validation of the Epistemic Belief Inventory (EBI). In B.K. Hofer and P.R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.
- Schommer-Aikins, M. A., Duell, O., & Hutter, R. (2005). Epistemological beliefs, mathematical problem-solving beliefs, and academic performance of middle school students. *The Elementary School Journal*, 105(3), 289-304.
- Schommer-Aikins, M. A., Duell, O., & Barker, S. (2003). Epistemological beliefs across domains using Biglan's classification of academic disciplines. *Research in Higher Education*, 44(3), 347-366.
- Schommer, M. A. & Walker, K. (1995). Are epistemological beliefs similar across domains? *Journal of Educational Psychology*, 87, 424-432.
- Schommer, M. A. (1993a). Comparisons of beliefs about the nature of knowledge and learning among postsecondary students. *Research in Higher Education*, 34, 355-370.
- Schommer, M. A. (1993b). Epistemological development and academic performance among secondary schools. *Journal of Educational Psychology*, 85, 406-411.
- Schommer, M. A. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82, 498-504.
- Sternberg, R. J. & Horvath, J. A. (1995). A prototype view of expert teaching. *Educational Researcher*, 24(6), 9-17.
- Tanaka, J. W. & Curran, T. (2001). A neural basis for expert object recognition. *Psychological Science*, 12(1), 43-55.
- Tolstoy, L. (2000). *Anna Karenina*. New York: Random House.
- Weinstein, B. D. (1993). What is an expert? *Theoretical Medicine*, 14, 57-73.
- Wineburg, S. S. (1991). Historical problem solving: A study of the cognitive processes used in the evaluation of documentary and pictorial evidence. *Journal of Educational Psychology*, 83(1), 73-87.
- Wood, B. P. (1999). Visual expertise. *Radiology*, 211, 1-3.

