

THE IMMUTABILITY OF BEST PRACTICE

Robb Sinn

North Georgia College & State University

Abstract

Best practice frameworks distill the foundations of scientific learning research into strategies for developing high quality learning formats. A best practice framework is proposed based upon authentic discovery, collaboration and communication (ADCC). Vignettes demonstrate how implementation of the ADCC framework might influence classroom learning at the university level. Best practice frameworks are grounded in science but allow for individualization and guide innovations. Many high-quality learning formats have been fixtures since the dawn of formal education, and modern educators have even more tools with which to build. The essay is a call for university academics to develop personalized frameworks to inform and enhance learning outcomes in collegiate education.

THE IMMUTABILITY OF BEST PRACTICE

Effective pedagogy is the confluence of science and intuition, an inchoate mixture of personal style and professional understanding. The fulcrum of this essay is a best practice framework devised to guide instructional innovation based upon three core strategies: authentic discovery, collaboration and communication (ADCC). Vignettes demonstrate how ADCC can effectively guide university level learning. Excellence demands informed innovation.

Surrounded by tectonic advances in learning and cognition research, some core strategies for effective pedagogy hold time-honored places. Dewey and Piaget advocated active learning and collaborative- and inquiry-based methods (Phillips, 2000). Socrates focused students' inquiry with questions. The fables of Aesop and the parables of Jesus are didactic mind puzzles that stick in the memory and provoke thought. Whether termed progressive or constructivist, the distillates of modern learning theory will experience a continued permanence.

Best Practice and Constructivism

The science of learning and cognition explain why a learning format works well. Best practice distills science into suggestions. The correct fusion of best practice principles is an individual choice given course requirements, student needs and available assets. This essay takes constructivist learning theory as given: learners must actively construct new knowledge by affixing it to prior personal schemata. These constructions occur in social contexts. This essay is a call for thoughtful collegiate instruction informed by best practice frameworks based on learning theory and invigorated by the creativity of the instructor.

Framework and Definitions

The ADCC framework suggests three core strategies: authentic discovery, collaboration and communication. *Authentic discovery* indicates inquiry-based learning with vital connections

to real-world activities. *Collaboration* suggests a community of learners that investigates variously in groups and as a class. Learners engage in a conversation informed by the luminaries who have established modern understanding within the discipline. *Communication* refers to written and oral presentations across disciplines, technological formats, settings and groups. These three components share the feature that when more of the component is added, learning outcomes nearly always improve. None of the core strategies is controversial in the learning literature, whether progressive or constructivist (Matthews, 2000), and their implementation allows for incredible variation in the look and feel of the learning environment.

The Learning Literature

A brief glance at learning theory research establishes the core strategies of the framework as viable scientifically. The review of literature is limited to best practice strategies for typical classroom settings where a single instructor interacts with approximately thirty students. A broader view of learning formats is included in the discussion.

Researchers have found that apprentice learning, a modality wherein students complete real-world mathematics in authentic settings, develops better conceptual understanding as well as better transference of knowledge to non-mathematical and non-school settings (Boaler, 1998). Yesilcay (2000) used case-study methodology to evaluate a real-world, project-based approach to learning statistics and found that students learned more from the project than from any other instructional component of the course. He further reports improvements in student motivation. In a review of the literature surrounding motivation to learn mathematics, Middleton and Spanias (1999) reported that careful design of instruction can strongly influence student motivation for mathematics achievement, which increases the likelihood students will choose to take future mathematics courses. “Students must understand that the mathematics instruction they receive is

useful Use of ill-structured, real-life problem situations, in which the use of mathematics facilitates uncovering important and interesting knowledge, promotes this understanding” (p. 81). Researchers have found college statistics courses based on constructivist models have improved student attitudes toward statistics and that personal relevance is important for successful learning (Mvududu, 2003).

Education researchers have repeatedly underscored the value of communicating across the curriculum for mathematics outcomes. Arguing from a constructivist model of learning outcomes during cooperative mathematics inquiry, Ball and Bass (2000) detail how the communication of mathematical concepts elucidates shared meanings, contrasts different understandings and helps develop what they term “the base of public [mathematical] knowledge” (p. 201). Collaboration and communication are essential for inquiry-based learning, and all three core strategies necessitate active learner engagement. Researchers have found that reading forms an essential component of inquiry-based learning in mathematics (Siegel, Borasi, & Fonzi, 1998). If the learning of a quantitative discipline is enhanced by peer discussion, writing, reading and presenting, then the benefits of communication across the curriculum for other disciplines should not be in doubt.

The ADCC framework offers improved affective outcomes including enhanced student motivation and interest. Researchers performed a meta-analysis of 113 mathematics education studies and found attitude toward mathematics significantly influence achievement in mathematics (Ma & Kishor, 1997). Mounting evidence demonstrates instructors can positively affect the intrinsic motivation of students which has been linked to high quality learning. Educators can encourage creative task engagement by providing interesting and optimally challenging learning activities and promoting student choice (Deci, Koestner, & Ryan, 2001).

Utilizing the ADCC Framework

Practical suggestions for constructing high-quality learning experiences using the ADCC framework will focus on authentic learning simulations. College professors can add real-world quality to learning experiences with authentic simulations conducted in blended educational environments that include online discussions combined with in-class presentations. The vignettes that follow are designed to foster thought about a constructivist-inspired approach. The multidisciplinary aspects of liberal arts courses are especially intriguing.

Vignettes

Ecology. Students enter the classroom on the first day to find a miniature gas pump and car sitting on the teacher desk, a projected image of a nuclear power station and a structural diagram of a complex molecule on the white board. The professor informs of the class of their task: to develop a plan for building a new nuclear power facility a few miles from campus. Discussion ensues, and a student mentions her reticence. Is nuclear power safe? Does it affect the environment? Another student inspired by the models to consider recent gas prices asks how the use of nuclear power would affect the price and availability of other energy sources.

By the end of the class period, three groups have formed. One will perform an environmental analysis. A second will develop a cost-benefit analysis upon the use of energy. A third will construct a proposal for the reactor to include an analysis of costs, safety and estimated impact on the community's energy usage. The groups meet online, posting hyperlinks and comments to small group discussions. Different projects are assigned to different groups who collect information and file reports. Class discussions of course objectives are peppered with student questions and laced with the developing ideas from different groups.

By the end of the semester, the cost-benefit group has divided into a political wing and one representing the energy sector. The proposal group has inculcated safety and environmental reforms into their development plan and argues strenuously for its adoption. The environmental group splits into teams that advocate public health, community development, environmental safety and lessened human dependence on energy. The final two weeks of the semester are filled with student presentations to the class where science, politics, business interests and community ideals collide and inspire thought. The digital portfolios of the various groups are placed online where the entire class can view the debate. The final exam is an essay wherein each individual must take a position either for or against the proposed nuclear reactor and base their reasoning upon class lectures, labs, student presentations, the course text, related readings and the web-based discourse.

Political Science. Students on their first day of class feel the professor is odd. He talks about an alien planet to be colonized jointly by Xylons, Krylons Vylons and Pylons. A twenty-page handout describes the natural resources available along with the needs and proclivities of each alien race. That evening, they read the United States Constitution wondering what ideas from the document could frame their colonization effort.

After a week, students are assigned to three-person groups representing different alien species. Each species has a personalized handout that describes their group objectives and desires for a constitutional process. Xylons are a tiny minority consisting of one pair of students, apparently an afterthought when the class roster did not divide evenly by three. Krylons are also a minority species with two groups representing them. Vylons are the majority race but reproduce slowly, and Pylons are a quickly growing minority.

Students attempt to ratify a version of the United States' Bill of Rights, but Xylons object to freedom of religion. Their species abhors superstition in all forms. Pylons practice passivism and object to the right to bear arms. Vylons have evolved beyond vocal cords and demand a reformulation of freedom of speech. The debate quickly moves to issues of community representation, group power sharing, the question of a bicameral parliamentary body and the role of the judiciary. The executive branch is fraught with debates about offices, structures and responsibilities. Except for species-specific profiles, class debates appear online where various constitutional committees form to negotiate articles of the new planet's constitution.

About midterm, a terrorist assault by rogue Krylons kills off several Pylons and Vylons (oddly coinciding with the W-day). An energetic Vylon response angers community Krylons who feel that they are being maligned. Readings and class discussions have recently touched on the constitutional processes in Afghanistan and Iraq, and students find themselves researching the growth of democratic government in the Middle East to inform their projects.

Final projects are presented by teams each of which has developed an article of the new constitution. The students present both their constitutional article and their alien-group justifications for it. They then relate their work to historic and current trends within government. The final exam is typical for a political science course: essays about theories, histories and ideals. Few students can resist quoting the alien constitution in their responses, and no penalty is attached when demonstration of traditional course content is obvious.

Literature. Students each read from a collective syllabus of classics from different periods and genres. Selecting a genre, students complete projects where they investigate a certain period of literature, read several of its important works and write an essay. So far, all seems normal. About midterm, the professor surprises them. Now that they are experts, they

must each write a short story or essay that exemplifies their genre. They choose period, topic and style, but they must mirror the ideas and constructions of the genre. The role play taxes student creativity enormously. The works are collected, graded, revised and bound in a publication handed out to students on the last day of class. Three works are entered in a statewide undergraduate writing contest, one of which wins a prestigious award.

Mathematics. Students in an upper-division math course hear their professor ridicule traditional mathematics instruction as lecture-lecture-quiz, lecture-lecture-test. He derides it as “parrot-math.” By the second week, they find themselves with a faculty handbook. They are research mathematicians from three different fictional universities. There is a research conference that the universities take turns hosting. Conference presentations share the results of investigations into course-related problems.

The course web blog has five “journals,” and students who write excellent papers become the editors of the journals. Students can present solutions to problems as “research” only if an entire class of problems is discussed complete with examples, extensions and connections. Each class meeting begins with a student host welcoming participants to the class conference and introducing guest speakers. Each speaker uses PowerPoint to display equations, problems and ideas. At the end of the meeting, the conference organizer collects all of the digital presentations which are then posted on the course blog site.

Students find that nearly half of their final grade is based on points earned in the categories of scholarship (writing papers), teaching (conference presentations) and service (organizing conferences, refereeing papers, and editing journals). At the end of the course, each passing student earns faculty rank, but top performers in the simulation earn tenure and even full professor status (along with an A). The “career simulation” helps students learn what an

academic or research career is like, promotes active engagement, rewards creativity, demands hard work and promotes student interest. The future mathematics teachers gain experience presenting mathematics to others, and all students find the communication of ideas contributes to their own understandings.

Statistics. In teams, students collect data for a project of their choosing. The first topic of the course is correlation which allows for a myriad of (nearly) scientific investigations. The instructor assigns teams providing each with its own chat room on the university's courseware site. They upload survey ideas, questions and data for their teams to view. Athletes, commuters and non-traditional students appreciate the blended format which avoids inconvenient on-campus meetings for their collaborative work.

The students spend six weeks learning how to frame appropriate questions, analyze demographics, compute descriptive statistics to ensure representative samples and perform regression analyses. They turn in their work digitally and receive feedback on their team chat page. Just before the midterm, each group presents its findings to the class. Presentations incorporate PowerPoint with graphics and calculations imported from Excel. Written reports follow, uploaded to the courseware site.

The final four weeks of the semester are consumed by a project, this time comparing subgroups to the overall population. The population parameters are considered to have been established by the data from the previous correlation studies. Students find themselves being drawn into their peers' creativity, studying everything from whether increased trips to Wal-Mart influence reported stress levels to how confident students are speaking to members of the opposite sex while at the beach. More serious students investigate the attitudes of campus groups toward interracial dating. One group analyzes handwriting for neatness and compares it

to grade point average finding a significant correlation. In the meta-analytic component of their reflection essays, students repeatedly state their most significant learning occurs while doing the projects rather than during class or while studying for tests.

Implications for Instruction

The ADCC framework has three consequences for high quality learning: improved student outcomes especially in the affective domain, an indigenous format for including new technologies and a need for varied assessment practices. The activities proposed by the vignettes prompt students to understand basic course objectives, but they inject democracy and student creativity into the course. The Internet opens informational doors to young researchers not available a decade ago. This can elevate student motivation by providing a glimpse of real-world application to what can easily be viewed as a sterile academic exercise.

Student Outcomes. A valuable exercise to evaluate learning is suggested in *Teaching with Your Mouth Shut* (Finkel, 2000). Finkel asks his readers to think of something they learned well, something momentous now locked permanently into memory. The outcome of this exercise in Finkel's repeated experience is that people—even academics—rarely find that their most significant learning happened in a classroom and especially not during a lecture. If the key is student outcomes, high quality learning is easily understood. What do students retain from a learning experience after a month, a year, or a decade? Little or nothing is the unfortunate response, if one asks the question about traditional, lecture-based methods of classroom instruction, especially for mathematics (Dubinski, 1998). The ADCC framework intentionally alters instructional strategies to favor long-term retention of essential learning objectives.

Perhaps the quintessential demonstration of constructivist learning is how children best learn the basic algorithms of arithmetic. Constructivist educators building on a Piagetian

foundation advocate providing blocks and manipulatives to allow children to concretely experience addition, subtraction, multiplication and division. After many concrete operational experiences, children are invited to invent their own pencil-and-paper strategies for computation. The children's invented algorithms are rarely the traditional ones and are typically not efficient, but an interesting phenomenon occurs. Once children have invented their own computational strategy, they quickly and permanently comprehend other algorithms including the "best" algorithms. The rate of their learning is laborious at first but increases rapidly as more constructive opportunities are afforded them. A review of the research demonstrates that over time constructivist-based instruction deepens comprehension and enhances retention (van de Walle, 2004).

The mathematics vignettes described above were developed as the author utilized the ADCC framework. Alternative assessments (for mathematics) were needed to evaluate student understanding in these novel settings. The results of utilizing authentic simulations repeatedly have demonstrated increased student interest and motivation, deepened learning and improved communication skills.

Historical Foundations. The author wishes the ADCC framework or the idea of authentic discovery simulations were unique in either their conception or implementation, but that is certainly not the case. While this particular framework and formulation is the author's, the principles are in widespread use and have been so for centuries. Professional schools make particular use of authentic simulations. Case studies performed by MBA students (often in groups) utilize authentic corporate data and confront real marketplace issues. The Socratic discourse in Ivy League law schools is supplemented by the ultimate legal simulation activity: Law Review. Students work as editors and reviewers of the scholarly work presented by peers

and professors. These legal briefs are essentially the work required of first year associates in law firms, federal court clerks and litigation specialists filing court documents.

Medical school gross anatomy courses include dissection of a human cadaver in a lab setting, a quite authentic way to discover anatomy. Third and fourth year medical school students spend most of their time in rotations through various disciplines, watching and helping practitioners at work and studying late at night on specific procedures recently seen in their rounds. Similar clinical education occurs to some degree in nearly all health science disciplines.

Authentic discovery is not limited to simulation activities. Service learning derives from an application of the ADCC framework just as easily. The same gains should be expected when implemented thoughtfully. Learning communities contextualize discovery within the communication and collaboration of groups.

The myriad of possibilities described in this essay argue for a learning-theoretic framework that is simple, malleable and foundationally sound. High quality learning occurs when girded by principles proven effective by science and experience. Modern learning theory confirms the viability of many sound pedagogical practices and offers insights into new educational formats.

Technology. This essay argues strongly in favor of the use of new technologies when those innovations adhere to core constructivist principles. Thanks to technology, ADCC-based instruction can happen in combinations never before possible. In a study of a technology-based mathematics instruction, implementations most influenced by constructivist ideals showed the highest gains in student achievement, math concept and interest in mathematics (Hickey, Moore, & Pellegrino, 2001). When researchers performed a meta-analysis of cooperative, technology-based learning, they found significant gains from the social context of learning for groups,

especially pairs, that also improved individual student achievement and affective outcomes (Lou, Abrami, & d'Apollonia, 2001).

Technology can be used ineffectively, as well. A review of the literature on using computer simulations to generate data sets and examples in introductory statistics courses found little current evidence they improve student outcomes (Mills, 2002). Effective demonstrations of mathematics principles are vital, but students learn best when they get messily involved with data, for example, by collecting it themselves. Technology can assist when used well, and the ADCC framework can be a guide for selecting and implementing effective digital enhancements to the curriculum.

University Teaching. The word “teach” begs a misunderstanding of the very process described. The reader will benefit enormously by mentally exchanging it for “lead the learners” whenever it is encountered. Socratic leaders of learners while considering science must not forget the inspirational role personal intuition plays when developing a learning forum. Studies of human learning and cognition inform an educator’s personal framework, but the resulting instruction can have a variety of hues and flavors best suited to the competencies and concerns of the instructor. Evidence suggests academics interested in improving student outcomes often have little or no formal basis for developing innovative instruction included in their graduate school experiences (McClay, 2005). Further, the article suggests much evidence exists that even in education colleges, academics are not implementing the strategies they advocate.

Few professors invest time in developing a research-based framework or the intuition that derives from attempting innovations. In their critical review of the research literature surrounding the teaching beliefs and practices of university academics, Kane, Sandretto and Heath (2002) suggest that academics should be encouraged to examine their theories-in-use in

light of espoused theories and intentions. They further note that academics rarely have received learning-theoretic instruction in teaching and that staff development projects at the university level focused on instructional practices have been underutilized and understudied. Because these issues have received copious attention at the primary and secondary levels, these researchers suggest academics would profit by basing future investigations upon the groundwork already laid by researchers who have studied K-12 outcomes extensively.

One warning about the use of intuition to guide innovation is needed. Intuition in this essay means an elemental understanding of how young people learn. Academics all too often project their own modes of learning onto their students even though the way students learn is often markedly different. There is a fatal flaw in orienting instruction toward the way gifted mathematicians and scientists once grasped their subjects. This is like suggesting Carl Lewis ought to be consulted about how to teach a high school phys-ed class. While an Olympian who has always oozed athleticism and loved physical exertion would be the perfect keynote at an exercise physiology conference, what could he be expected to know about teaching thirty whining couch potatoes who have more interest in X-Box than exercise?

Systemic Change. What do researchers know about what works in education? It is the contention of this essay that a great deal is known about what works when a teacher and thirty students meet in a classroom setting. The systems and structures of education are just beginning to be studied. Distance learning is one area of expanded focus, but distance learning researchers often attempt emulate the typical classroom structures with a digital environment. Other permutations are possible, and structural research should expand its boundaries.

When corporate research and development models are applied to education, analysts suggest educational research is under-funded at the national level (Whittle, 2005). The analysis

ignores educational research not funded by federal and state agencies but is especially valid when considering major systemic reforms. Little is known about how radically altering the current paradigm of education could benefit learning. Chatterji's (2002) analysis of the research foundations supporting standards-based reform movements in education over the past fifteen years found that little account of systemic qualities has been taken by reformers or evaluators.

Creative options for reconfiguring campuses, courses, and systems need to be investigated. For example, the University of Montana-Western has implemented block-scheduled courses where students immerse themselves in one or two courses at a time over a period of weeks rather than a traditional semester. The block design is a larger scale version of the "mini-mester" in use at many universities. Can a multiplicity of courses be traded for depth of insight into a single course? Researchers should investigate. The "math-mester" at the University of Nebraska-Lincoln takes the four math courses needed by elementary education majors and combines them into a single, twelve-hour course taught jointly by mathematicians and mathematics-education faculty. This NSF-funded intervention has produced marked gains in preservice teachers' understanding of both content and pedagogy (Lewis, 2004). A performance bonus program (opposed by the local teacher's union) was launched in an urban Arkansas school with impressive results for standardized test scores (Henninger, 2005).

What other systemic changes could affect learning? Researchers should be encouraged to investigate beyond the traditional classroom systems and partisan political preferences. Would radical systemic changes improve learning outcomes? Learning theory debunks many traditional learning formats and can inform systemic advances.

Conclusion

The vignettes demonstrate an adherence to what might be termed the “mainstream” constructivist principles of learning. The most radical forms of constructivism are hotly debated in scientific education (Matthews, 2000), but constructivism here indicates a moderate position in Phillip’s (2000) constructivist continuum where objective reality influences knowledge but where acquisition is shaped and informed by subjective factors. The ADCC framework is based on widely accepted cognitive research. Modern scientific understanding has not significantly altered many traditionally valuable pedagogies but instead explains their continued effectiveness.

Mathematics educators are grateful for the work of learning theorists, cognitive researchers and educational psychologists who routinely use mathematical settings to measure learning gains. The foundation of this argument for best practice is a mathematics-informed understanding of learning theory and student outcomes. Does this approach diminish the widespread applicability of the framework? Not necessarily. Phillips (2000) argues that if constructivist ideals succeed in science and mathematics education, they can succeed anywhere, for (radical) constructivism is not as controversial in the arts, literature and social sciences.

Scientific study of educational outcomes defies perfect analysis. Experimental designs require that all other variables be held constant, a nearly impossible standard for classroom-based research. Independence across groups and homogeneity of the groupings is a fine objective technically but difficult to practice. Instructor effectiveness and enthusiasm problematically mediate learning outcomes.

The largest problem facing educational researchers, however, is one of ethics. Suppose a new way of teaching is being evaluated in a treatment versus control setting (an educational research modality disputed on ethical grounds in the first place). The new method shows marked

gains in student achievement half way through the trial. The ethical researcher halts the study and offers the better method to all students. This difficulty was faced recently by HIV researchers who conducted a study in African nations comparing the HIV transmission rates between groups of males who were circumcised compared with an uncircumcised group (Schoofs, Leuck, & Phillips, 2005). The researchers found enormous differences in HIV transmission rates favoring the circumcision group. Given the raucous debate about circumcision in the public health literature, science begs for an extensive comparison over time. Humanity demands exactly what the researchers did: halt the study to publish initial findings.

The intractability of the problem should not discourage researchers who have and will continue to develop sound educational practices and improved theories of learning and cognition and who will soon experiment with systemic changes. The very difficulty facing scientific analysis of educational outcomes should embolden educators to exercise individual freedom in developing personalized frameworks and strategies. If the framework is founded on solid learning research, the personal intuition of the instructor will likely yield outstanding results.

Academicians can, with a few weeks of concerted effort, develop a rudimentary understanding of the science of cognition. With time for reflection, best practice frameworks can be established to guide the evaluation and development of learning forums. The increasingly competitive field of higher education owes its constituency a concerted effort toward understanding learning and innovating classroom practice. In the traditional classroom, professors can rely upon the immutability of best practices from bygone eras and an increasingly scientific understanding of what makes a pedagogy effective. The continued payment of escalating educational costs by future learners is not immutable, however, especially if university academics continue to teach the unexamined course.

References

- Ball, D. L., & Bass, H. (2000). Making belief: The collective construction of public mathematical knowledge in the elementary classroom. In D. C. Phillips (Ed.), *Constructivism in education: Opinions and second opinions on controversial issues* (pp. 193-224). Chicago: University of Chicago Press.
- Boaler, J. (1998). Open and closed mathematics: Student experiences and understandings. *Journal for Research in Mathematics Education*, 29(1), 41-62.
- Chatterji, M. (2002). Models and methods for examining standards-based reforms and accountability initiatives: Have the tools of inquiry answered pressing questions on improving schools? *Review of Educational Research*, 72(3), 345-386.
- Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research*, 71(1), 1-27.
- Dubinski, E. (1998). Understanding Calculus. Paper presented at the Mathematics Colloquium of the University of Cincinnati Mathematics Department.
- Finkel, D. L. (2000). *Teaching with your mouth shut*. Portsmouth, NH: Cook Publishers.
- Henninger, D. (2005, October 14). Pay for performance: How an Arkansas school found a way to measure success. *The Wall Street Journal Online*.
- Hickey, D. T., Moore, A. L., & Pellegrino, J. W. (2001). The motivational and academic consequences of elementary mathematics environments: Do constructivist innovations and reforms make a difference? *American Educational Research Journal*, 38(3), 611-652.
- Kane, R., Sandretto, S., & Heath, C. (2002). Telling half the story: A critical review of the research on the teaching beliefs and practices of university academics. *Review of Educational Research*, 72(2), 177-228.
- Lewis, J. (2004). Mathematicians and mathematics education. Presentation at Project NExT Professional Development Seminar sponsored by the Mathematical Association of America.
- Lou, Y., Abrami, P. C., & d'Apollonia, S. (2001). Small group and individual learning with technology: A meta-analysis. *Review of Educational Research*, 71(3), 449-521.
- Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education*, 28(1), 26-47.

- Matthews, M. R. (2000). Constructivism in science and mathematics education. In D. C. Phillips (Ed.), *Constructivism in education: Opinions and second opinions on controversial issues* (pp. 161-192). Chicago: University of Chicago Press.
- McClay, W. M. (2005, October 28). Teaching the teachers. *The Wall Street Journal Online*.
- Middleton, J. A., & Spanias, P. A. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education*, 30(1), 65–88.
- Mills, J. D. (2002). Using computer simulation methods to teach statistics: A review of the literature. *Journal of Statistics Education*, 10(1).
- Mvududu, N. (2003). A cross-cultural study of the connection between students' attitudes toward statistics and the use of constructivist strategies in the course. *Journal of Statistics Education*, 11(3).
- Phillips, D. C. (2000). An opiated account of the constructivist landscape. In D. C. Phillips (Ed.), *Constructivism in education: Opinions and second opinions on controversial issues* (pp. 1-16). Chicago: University of Chicago Press.
- Schoofs, M., Leuck, S., & Phillips, M. (2005, July 5). Study says circumcision reduces AIDS risk by 70%. *The Wall Street Journal*, p. A1.
- Siegel, M., Borasi, R., & Fonzi, J. (1998). Supporting students' mathematical inquiries through reading. *Journal for Research in Mathematics Education*, 29(4), 378-417.
- van de Walle, J. A. (2004). *Elementary and middle school mathematics: Teaching developmentally*. Boston: Pearson Education.
- Whittle, C. (2005, November 4). S.O.S. (Save our schools). *The Wall Street Journal*, p. A14.