POLK STATE COLLEGE

Quality Enhancement Plan

Literature Review Supplement:

Teaching Mathematics – Best Practices

August 2010

Polk State College – QEP Literature Review: Best Practices

The QEP committee compiled a list of widely accepted best practices in teaching mathematics and analyzed each to determine its suitability for use within the QEP. The table below summarizes the literature on each of these best practices.

Active Learning Active Learning is "anything that 'involves students in doing things and thinking about the things they are doing'" (Bonwell & Eison, 1991, p. 2).	
Blair (2006)	• Today's students need active involvement to be able to learn
Prince (2004)	• Introduce activities into traditional lecture • Promote student engagement • Design activities around learning outcomes
Springer, Stanne, and Donovan (1999)	• Meta-analysis of learning practices in science, mathematics, engineering, and technology • Active learning increases: 1. academic achievement 2. favorable attitude toward subject 3. persistence in science, math, engineering, and technology classes
Bonwell and Eison (1991)	• Risk is greatest obstacle in faculty adoption of active learning strategies • Faculty may begin with low risk strategies and build incrementally • Professional development within an institution and department increases active learning implementation
Chickering and Gamson (1987)	• Active Learning is one of the Seven principles for good practice in undergraduate education
Assessment Assessment can be categorized as either 1. Formative: evaluation conducted while learning is in progress 2. Summative: final evaluation at completion of active learning period	
Suskie (2009)	Effective assessment: • Establishes clear, measurable, expected outcomes of student learning • Ensures students have sufficient opportunities to achieve those outcomes • Systematically gathers, analyzes, and interprets evidence to determine how well student learning matches expectations • Uses assessment results to understand and improve student learning
Cizek and Andrade (2009)	Formative assessment has proven to be extremely useful to: • Motivate students • Stimulate meta-cognition • Encourage students to monitor and adjust their learning strategies • Build rapport between students and instructors • Facilitate curriculum design

Martyn (2007)	• Student response systems, commonly called “clickers,” are effective formative assessment tools.
Blair (2006)	The American Mathematical Association of Two-Year Colleges recommends frequent assessment to: • Assess students’ progress • Assist instructors in adjusting instructional methods and materials
Angelo and Cross (1993)	Effective assessment is: • Learner-centered • Teacher-directed • Mutually beneficial • Formative • Context-specific • Ongoing • Firmly rooted in good practice
Learner-Centered Teaching Learner-centered teaching can be described as what and how the student is learning, under what circumstances learning takes place, and what the student is retaining and applying to facilitate future learning. Learner-centered teaching also transforms the role of the teacher from that of lecturer to a facilitator of knowledge (Weimer, 2002).	
Alsardary and Blumberg (2009)	• Students in a learner-centered upper-level mathematics (Discrete Mathematics) course incorporated coursework into class presentations and scored better than those students enrolled in traditional classes.
Bosch et al. (2008)	• Developed a framework to improve the learning climate by incorporating high performance expectations for teaching and student learning; by guiding design, development, and revision of course outlines and programs; and by guiding instructional facilities and implementation of instructional technologies.
Blumberg (2009)	Characteristics of student learning outcomes in a learning-centered instructional paradigm: • Student engagement increases • Student satisfaction increases • Student ability to apply content increases
Doyle (2008)	• Suggestions on how to get students to "buy in" to learner-centered environments so they can discover their own capacity as learners
Thompson, Licklider, and Jungst (2003)	• Merge active and collaborative learning environment • Pedagogical approach is used to incorporate best knowledge for learning • Classroom culture is cooperative, collaborative, and supportive
Weimer (2002)	Learner-centered teaching continually questions: • How is the student learning? • What conditions are present? • Is the student retaining and applying learning? • Is learning preparing the student for future learning?

Barr and Tagg (1995)	• Create environments and experiences to construct knowledge • Create opportunities to discover learning and solve problems • Continually improve learning for students
Learning Communities Learning communities seek to encourage student engagement by organizing a curriculum or course content structure around groups of students who progress through a curriculum, group of courses, or stated educational objectives together.	
Freeman, Alston, and Winborne (2008)	Students participating in the Learning Communities for STEM (science, technology, engineering, and mathematics) Academic Achievement initiative demonstrated positive influence in: • Attitude, learning experience, and intrinsic motivation in STEM
Scrivener et al. (2008)	First-year learning community study at Kingsborough Community College found that the program: • improved students' college experience. Students in the program felt more integrated and more engaged than students in the control group. • improved some educational outcomes while students were in the learning community program; effects diminished in subsequent semesters. Program-group students, for example, attempted and passed more courses and earned more credits during their 1st semester. • moved students more quickly through developmental English requirements. Students in the program group were more likely to take and pass English skills assessment tests required for graduation or transfer. • increased persistence results were mixed. Initially, the program did not change the rate at which students re-enrolled. In the last semester of the report's two-year follow-up period, however, slightly more program-group members than control-group members attended college.
Fischer and Sugimoto (2006)	• Learning and creativity are collaborative and interactive. • Today's lifelong learners need learning communities to prepare for workplace challenges.
Tinto (1998)	Students in learning communities: • learn to form supportive peer groups outside the classroom • become more actively involved in learning after the class is over • spend more time learning, which enhances their learning • develop their own "voice" in an academic setting
Tinto and Russo (1994)	Non-residential learning communities: • provide students with peers, alleviating fears of transition into college • provide a collaborative learning setting to transition the academic-social divide often seen in initial entrance to college

Learning Styles Learning style is the way in which each individual concentrates on, processes, internalizes, and remembers new and difficult academic information or skills.	
Bonham (2007); McClendon and McArdle (2002)	• Learning outcome fluctuations are leveled when students are placed in a learning modality compatible with their learning style.
Felder and Brent (2005)	• Offering a broad spectrum of learning styles strategies is more effective than traditional instruction.
Kolb and Kolb (2005)	• Learning style is hereditary, experiential, and environmental. • Learners adopt a particular style within a learning task in "patterned, characteristic ways."
Dunn and Dunn (1993)	• Although many students can master easy information in a style unsuited to them, they do so more efficiently and rapidly when they can capitalize on their learning-style strengths.
Mastery Learning Mastery learning presents subject content in units with clearly developed learning objectives. Students work with content, individually or collaboratively, until they are able to demonstrate mastery of each unit.	
Gusky (2007)	• Re-examines Bloom's work in mastery learning and further concludes that mastery learning fosters not only cognitive domains but also affective domains
Davis and Sorrell (1995)	• Generates research using Carroll's (1963, 1987) and Bloom's (1989) theories to implement mastery learning into the high school environment
Bloom (1985)	• Advances Carroll's theory to observe that a lack of variety in instructional methods inhibits learning • Recommends that self-paced learning and assessment methods be considered
Carroll (1963, 1989)	• Aptitude in learning is primarily relative to the measure of time it takes to learn.
Problem-Based Learning (PBL) PBL is "a curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem-solver confronted with an ill-structured problem that mirrors real-world problems" (Finkle & Torp, 1995, p. 1).	
Reynolds and Hancock (2010)	• In a comparison study using PBL and traditional instruction in biotech interdisciplinary courses, PBL students demonstrated greater achievement, greater problem-solving skills, and more positive attitudes.

Gijbels, Dochy, van den Bossche, and Segers (2005)	• In a meta-analysis of 40 studies from 1976-2000, PBL students performed better on knowledge tied to principles and better understood links between concepts.
Shore and Shore (2003)	• In a PBL study on introductory and intermediate algebra for students in health professions, PBL students performed higher than students in non-PBL sections in post-test measures of student performance.
Professional Development According to Bain (2004), professional development enables professors to keep abreast of new research or practices within a professional field while enriching and enhancing their knowledge with colleagues, experts, and professional organizations.	
Bain (2004)	• The best college teachers know how to create sustained learning in students; they prepare to teach, expect students to use the kind of thinking used in life, create a critical learning environment for students, treat students with decency, and consider themselves lifelong learners.
Blanton and Stylianou (2009)	• Faculty development engages in discipline-specific professional development through a community of practice and not through isolation.
Slavit, Bornemann, and Haury (2009)	• Mathematics teachers improve students' mathematical engagement, problem solving, and learning through professional learning communities and implementing collaborative teacher development models.
Harris and Cullen (2008)	• A shift from discipline-based structures to a new paradigm of implementing learner-centered principles.
Davys and Jones (2007)	• Peer observation with peer support and review can enhance improvements as a tool for continuing professional development.
Galbraith and Jones (2006)	• Successful teaching of mathematics is a combination of science and artistry for both the student and the teacher to bring about a meaningful, successful learning journey.
Van Eekelen, Boshuizen, and Vermunt (2005)	• Learning is accomplished through daily teaching experiences, usually in a non-linear way, by deliberately using self-regulated learning experiences.
Daley (2003)	Professional development strategies to support learner-centered approaches: • Examining beliefs about teaching and learning • Analyzing the career level of participating educators • Developing strategies to support knowledge construction and development of meaning
Neptune (2001)	• Identifies strategies to promote professionalism among mathematics faculty in regards to active professional organization memberships, information on national initiatives, and exchange of ideas.

Tinto (1998)	• Faculty must be encouraged to transition from a stand-alone discipline to broader intellectual communities across their fields and departments for shared learning with other faculty.
Student Engagement Student engagement is “participation in educationally effective practices both inside and outside the classroom” (Harper & Quaye, 2009, p. 2).	
Kuh, Kinzie, Schuh, and Whitt (2010)	The *Community College Survey of Student Engagement* (CCSSE) benchmarks for effective student engagement are: 1. Active and Collaborative Learning 2. Academic Challenge 3. Student-Faculty Interaction 4. Support for Learners 5. Student Effort
Harper and Quaye (2009)	• The old-fashioned notion that learning is the students’ responsibility no longer holds. Instructors and administrators must provide activities and instructional strategies that engage and stimulate students.
Pascarella and Terenzini (2005)	Beliefs about higher education have changed in recent years due to: • Rising numbers of community colleges • Increasing numbers of non-traditional students • A more complex understanding of learning As a result: • Colleges should apply more active and cooperative learning strategies. • Learning has to be relevant to the diverse student body found on campuses today.
Tinto (1994)	• Retention improves when students feel connected to academic and social communities on campus.
Study Skills Study skills "is the utilization of a number of skills that you already are using in other areas of your life that leads to a more successful and relaxed semester" (Cusimano, 1999, para. 35).	
Eades and Moore (2007)	• Professors can assist students in learning to take notes to increase student understanding and motivation.
Ross, Green, Salisbury-Glennon, and Tollefson (2006)	• Students use more study strategies when preparing for a test if instructors make cognitive processing demands inherent in assignments and when exams are explicit and mirror teaching practices.
Schwartz (2004)	Successful testing strategies include: • acquiring an overview of the material and content to be on the test • making index cards for each section that contain necessary definitions, theorems, and/or formulas

	• scanning the exam before starting • using a variety of strategies to solve problems • moving through the test • focusing on something positive to minimize anxiety • using a picture (ex. graph) for word problems • budgeting test time to allow for review • reflecting on strategies used for the next test
Cusimano (1998)	Successful test taking strategies include: • being physically and mentally organized • practicing realistic time management • setting goals and priorities • developing good note-taking skills and effective reading strategies • practicing using strong listening skills
Supplemental Instruction (SI) SI is "a peer-assisted academic support program that is implemented to reduce high rates of attrition, increase the level of student performance in difficult courses, and increase graduation rates" (Martin & Hurley, 2005, p. 308).	
Fayowski and MacMillan (2008)	• In a first-year calculus class pass/fail analysis, students participating in SI were 2.7 times more likely to succeed than non-participants.
Wright, Wright, and Lamb (2002)	• In a study of the effectiveness of SI in 90 developmental mathematics classes, SI initiatives made a positive difference in academic performance and retention rates.
Kenney and Kallison (1994)	Two studies exploring SI benefits to college-level calculus students found: • SI Appeared to help lower-achieving students most • SI Improved course grades • SI Decreased course withdrawals • SI Increased semester grade-point averages
Treisman (1992)	SI participation in mathematics classes over a six-year time period led to: • Increased student performance • Increased progression through subsequent courses in a sequence • Lowered academic indicators
Supportive Learning Environment A supportive learning environment is created by professors so that affective filters are lowered, and students feel safe enough to interact and take risks..	
Center for Community College Student Engagement (2009)	• Personal Connection is one of the principles facilitating student success.

Willis (2006)	• Students must feel safe before they can focus on academics • Results in reduction of affective filters and test anxiety
Briggs, Sullivan, and Handelsman (2004)	• Engaging students in a mathematics class may be more difficult than in other subject areas.
Neptune (2001)	Establish supportive learning environment through: • Organization • High standards • Mutual respect and caring • Enthusiasm
Technology-Enhanced Instruction Technology-enhanced instruction includes "the use of graphing calculators, student response systems, online laboratories, simulations and visualizations, mathematical software, spreadsheets, multimedia, computers or the Internet, and other innovations yet to be discovered" (Blair, 2006, p. 55).	
Martyn (2007)	• Students become more engaged when using student response systems. • Students perceive value in the use of student response systems and recommend their use in future classes.
McCabe (2003)	• The use of technology extends access to instruction, support services, and resources. • Technology-enhanced instruction is responsive to individual learning styles through various instruction modes and to different rates of learning through flexible timeframes.
Sutton and Krueger (2002)	• Internationally, as students' in-class calculator use increases, so does their performance on mathematical assessments. • Students using calculators perform better on mental computation and have better attitudes toward mathematics than non-calculator users.
Roueche and Roueche (1999)	• The use of a computer as a tutor in mathematics contributes to student success in remedial courses.
Kulik and Kulik (1986)	• The use of a computer to supplement regular instruction allows for more learning in less time and improves students' attitudes toward learning.