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Aligning Paradigms, Standards, and Assessment: A Higher-Education Application for Instruction in Science and Mathematics

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Abstract

Disciplines of science and mathematics are essential for 21st century life and progress of our nation. To strengthen the effectiveness of education in the state of Georgia and to address emerging and enduring issues in 21st century life, the state adopted Georgia Performance Standards (GPS). Designed for children enrolled in kindergarten through grade twelve, the GPS promote the general skills of inquiry, communication, problem solving, and critical thinking (Georgia Department of Education, 2005). To meet the standards in science and mathematics in Georgia classrooms, programs of teacher preparation and educational leadership in higher education institutions across the state must support and develop pre-service and in-service teachers and leaders able to effectively incorporate standards and assessment consistent with this paradigm shift. Student leadership teams at Columbus State University were instructed in the use of a matrix alignment process as a learner-centered paradigm and effective assessment strategy to promote student achievement in P-12 education.

Introduction

The disciplines of science and mathematics are essential for 21st century life and progress of our nation. It is, therefore, crucial that all children learn skills to gather, synthesize, and analyze information in these disciplines. However, much research has questioned the efficacy of American education in science and mathematics (Schmidt, McKnight, & Raizen, 1996; Stigler & Hiebert, 1999; U. S. Department of Education, National Center for Educational Statistics, 1998). To strengthen the effectiveness of education in the state of Georgia and to address emerging and enduring issues in 21st century life, the state has adopted the Georgia Performance Standards (GPS). Designed for children enrolled in kindergarten through grade twelve, the GPS promote the general skills of inquiry, communication, problem solving, and critical thinking (Georgia Department of Education, 2005). To meet the standards in science and mathematics in Georgia classrooms, programs of teacher preparation and educational leadership in higher education institutions across the state must support and develop pre-service and in-service teachers and leaders able to effectively incorporate standards and assessment consistent with a paradigm shift...
A Comparison of Paradigms

The traditional higher education methods for teacher and leader preparation in science and mathematics have incorporated a teacher-centered paradigm. In this paradigm, knowledge is dispensed by a single-discipline professor to passive students. In a competitive and individualistic culture, students are considered to be learners focused on obtaining the “right” answers. Teaching and assessing are viewed as separate processes, with assessment, whether formal or informal, monitoring learning. Objectively scored examinations are the primary method used to monitor student learning (Huba & Freed, 2000).

Despite the pervasiveness of the teacher-centered paradigm, it has been found less effective at promoting learning than a learner-centered paradigm (Kellogg Commission on the Future of State and Land Grant Universities, 1997; Tenenzenini & Pascarella, 1994). A learner-centered environment is one in which careful attention is given to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting while building onto their conceptual and cultural knowledge (University of Southern California, 2006). In a learner-centered paradigm, students are actively involved in the construction of knowledge using the general skills of inquiry, communication, problem solving, and critical thinking. A professor serves as a coach and facilitator in a collaborative, supportive environment. Teaching and assessing are interdependent with direct assessment through performances, papers, projects, and portfolios (Huba & Freed, 2000). The shift from the teacher-centered paradigm to a learner-centered paradigm has been endorsed by the American Association for Higher Education, the American College Personnel Association and the National Association of Student Personnel Administrators (Joint Task Force, 1998).

Georgia Performance Standards

The new Georgia Performance Standards (GPS) require teachers and leaders to adopt a more learner-centered approach. Each performance standard consists of four components: a content standard, an illustrative task, student work, and a commentary. No longer are students expected just to know; they are expected to do. Student learning is the focus of the GPS, and standards are expected to be integrated and not taught in isolation. Assessments are used to guide instruction, and the effectiveness of the instruction is judged by whether students meet the components of the standards. The performance standards in science and mathematics have been designed to emphasize conceptual understanding, skills and problem-solving (Georgia Department of Education, 2005).

Teachers and leaders are being forced to shift from a traditionally teacher-centered paradigm to more learner-centered instruction. With this dramatic paradigm shift comes great responsibility for schools of higher education. Many signs point to the need to develop teachers’ and leaders’ capacity to address the new learner-centered approach to science and mathematics for the successful implementation of the GPS. The Georgia Partnership for Reform in Science and Mathematics (PRISM) is an initiative by the University of Georgia designed to increase science and mathematics achievement for all P-12 learners. One goal of the PRISM Institute is to engage higher education faculty from across colleges in discussions to improve teaching and learning in college level science and mathematics courses. Professors from the arts and sciences are engaging in collaborative conversations with professors in education. More university instructors are becoming aware of and knowledgeable about the GPS. Collaborative conversations designed to enhance understanding and encourage university faculty to effectively incorporate standards and assessment of student performance are encouraged. Conversations touting the merits and disadvantages of a more learner-centered program are beginning across campuses of many colleges and universities. Thus, standards-based instruction in higher education is being debated and discussed (Board of Regents, University System of Georgia – PRISM, 2007).

The PRISM Higher Education Institute also decided to include more professional learning in the teaching of standards-based instruction for higher
ALIGNING PARADIGMS

Education faculty who prepare new teachers and leaders. The PRISM Institute has awarded numerous small grants for college faculty to implement new teaching and assessment strategies to improve student learning and continues to encourage higher education to increase its responsiveness to the needs of P-12 schools (Board of Regents for the University System of Georgia – PRISM, 2007).

Assessment Strategies

In Georgia, the state curriculum is determined by the GPS; and standards for science and mathematics are established for grades P-12. To promote student learning in science and mathematics, effective classroom assessment must be utilized. Continuous assessment and the resulting adjustments are necessary for optimum learning by students (McTighe & O’Connor, 2005).

Effective assessment practice reflects an understanding of student learning, requires attention to learning outcomes, incorporates multiple measures, provides feedback to the learner, and is ongoing or continuous (Huba & Freed, 2000). The connection of assessment strategies to the GPS within a learner-centered paradigm is crucial to promote student achievement in science and mathematics.

Continuous assessment within programs of higher education is vital. Such ongoing evaluation serves to identify program strengths and weaknesses, helps plan and improve instruction, reveals instructional needs, supports teacher quality, and monitors student achievement over time (Airasian, 2005).

A Higher-Education Consolidation

To best meet the needs of Georgia students in science and mathematics, it is necessary to craft a consolidation of a learner-centered paradigm, the GPS, and effective assessment strategies. In an attempt to improve student achievement in science and mathematics for P-12 schools in the west central Georgia and east Alabama region, the Educational Leadership program at Columbus State University (CSU) devised a curriculum alignment matrix. The matrix was created as a systematic framework for aligning educational leadership program curriculum with paradigms, standards, and assessment.

The importance of training highly qualified leaders and administrators, along with the importance placed by CSU Leadership faculty on educational accountability, facilitated changes to the Education Leadership program at the university. Curriculum alignment was deemed the foundation of this initiative as a way to enhance effectiveness of leaders. Academic leaders are equipped with the tools to fully implement school and system change, including teachers, to improve student achievement in science and mathematics.

The curriculum improvement process is complex by nature and requires ongoing program evaluations (Drake & Burns, 2004). A systematic and comprehensive approach is a necessary requirement for successful program adaptations and applications; therefore, the Educational Leadership faculty at CSU designed a wall-sized taxonomy matrix framework for analyzing and aligning the Educational Leadership Program Curriculum. The alignment was done for the Masters’ and Specialists’ degrees at two separate levels.

The first alignment level was external and required a review of curriculum standards, principles, instruction, and assessment. Improvements were made by aligning the program with the external standards from Standards for Advanced Programs in Educational Leadership (SAPEL) and with national testing objectives. The second alignment level was internal and required a review of curriculum goals and objectives, instructional strategies, syllabi, class content (validity studies), and curriculum-embedded assessment instruments.

All members of the Educational Leadership faculty team met weekly to study alignment data presented visually on the wall-sized taxonomy matrix framework. Item analysis changes were made by moving data slips from one matrix cell to another matrix cell included within the framework. Topics for consideration and discussion were
determined weekly with follow-up as needed. Program evaluations were ongoing and reiterative. Assessment measures were designed as indicators for changes to the program; and input from students, faculty, community leaders, standards commissions, and candidates were encouraged. The Educational Leadership faculty team worked cooperatively to interpret and use assessment data, research, and professional expertise when making decisions regarding curriculum alignment. The wall-sized taxonomy matrix framework facilitated the process of curriculum alignment by providing a visual representation of the information to be assessed. Movement of data and information was visually evident when changes were made by moving information from one cell to another. The wall-sized taxonomy matrix framework for analyzing and aligning curriculum provided visual documentation of standards and the program content to be evaluated. Additionally, changes made by the Educational Leadership team were easily viewed by other faculty, administrators, or by interested community members.

**Application for Science and Mathematics**

To facilitate the efficacy of a standards-driven curriculum within its service area, the faculty team from the Educational Leadership Department of CSU utilized the curriculum alignment matrix with current graduate students enrolled in the leadership cohorts to analyze courses in science and mathematics offered by the Muscogee County School District. The leadership student teams selected GPS S7CS4 (Science, 7th grade, Co-Requisite—Characteristics of Science Standard 4) for alignment: Students from Muscogee County will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities. To effectively scrutinize the standard in alignment with the science courses being offered in the middle school, the faculty team inspected the local curriculum for the alignment of standards, looked at science test data for information, identified the needs within the classroom, and developed a plan for collaboration. The team considered the course textbook for its discussion and application of the scientific method, reviewed the classroom arrangement, and suggested the addition of pertinent tools and materials for the science laboratory at the middle school. To assist in meeting the requirements of GPS S7CS4 in one classroom lesson, the team adopted the instructional strategy of creating a poster or flow chart of the steps and tools used to measure, manipulate, and observe the scientific method. The learners were required to work in collaborative groups to create and illustrate the posters or flow charts. Assessment of student learning would entail the representation of student work samples using those artifacts for evaluation. The artifacts, posters or flow charts were assessed in conjunction with an oral presentation or demonstration that explained the components of the scientific method.

The leadership student team also selected GPS M7D1 (Mathematics, 7th grade, Data analysis and Probability Standard One) for alignment: Students will pose questions, collect data, represent and analyze the data, and interpret results. To effectively scrutinize the standard in alignment with the mathematics course being offered in the middle school, the team reviewed the local curriculum for the alignment of standards, looked at mathematics test data for information, identified the needs within the classroom, and developed a plan for collaboration. The team considered changing the textbook, adjusting the classroom schedule for mathematics to include more time on the subject, revamping the classroom arrangement, and/or adding additional resources for the learners.

To assist in meeting the requirements of GPS M7D1, the team adopted the instructional strategy of formulating questions and collecting data from a census of objects and from samples of varying sizes. For one classroom lesson concerning GPS M7D1, the learners were required to select a topic and develop a question to determine the height of 7th grade girls and boys in 3rd period math class. Assessment of student learning would entail the representation of data in various forms with artifacts used for evaluation. The artifacts included the creation of an Excel descriptive data chart or spreadsheet that arranged the class height in order from
the tallest to the shortest. Students then worked to create a correlation equation concerning student heights and created a class diorama as an important artifact for assessment.

Therefore, the selection and alignment of GPS S7CS4 and M7D1 assisted in making important decisions concerning science and mathematics instruction at the middle school level. By implementing the matrix alignment process, the student leadership team at Columbus State University utilized a learner-centered paradigm and effective assessment strategies to promote student achievement in P-12 education. The matrix alignment process offers encouragement for those leaders and teachers seeking to aligning paradigms, standards, and assessment in a higher-education application for instruction in science and mathematics.

References


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