2006-2007 :: M.A.T. in Science Education

1. Mission Statement:

The long term mission of Science/Mathematics Education Department is to be and to produce leaders and practitioners in science and mathematics education at institutional, local, state, national and international levels by highlighting best practices and providing opportunities for cutting-edge research in science, technology, engineering and mathematics (STEM) education to current and future STEM education professionals. We also see to support the University in the recruitment and retention of high quality students in STEM disciplines.

2. Objectives:

2.1 Research and Critical Thinking:

Courses develop the independent research and critical thinking abilities of our students along with a familiarity with research-based developments in STEM teaching and learning and education reform efforts. Teachers will demonstrate an ability to critically think and independently conduct research in science teaching and learning and education reform efforts.

2.1.1 Related General Education Outcome Item(s): 11. Advanced Knowledge in Discipline(s); 12. Guided Research; 13. Independent Research; 14. Ongoing Research; 15. Research & Design; 16. Independent Thought

2.1.2 Related Strategic Plan Item(s):
I-1 Research Enterprise Initiative; II-1 The Education of Leaders; VI-1 K-16 Education; VI-4 Community Outreach; VI-5 University Village

2.1.3 Related Institutional Priority Item(s): CPT-3 Significantly improve quality of UTD's graduate students

2.1.4 Student Related Objective: Yes - This is a student related objective.

2.2 Content/Pedagogical Content Knowledge:

Courses facilitate the development of preK-16 classroom teachers into skilled educators with a depth of content knowledge and pedagogical content knowledge in the sciences and/or mathematics through best practices in science and mathematics education reflective of cutting-edge research and national STEM education reform initiatives. 2.1. Teachers will demonstrate an ability to analyze and select the best practices and methods associated with problem based science learning. 2.2. Teachers will obtain the depth of content knowledge of skilled educators in science and mathematics education reflective of cutting-edge research and national science education reform initiatives.

2.2.1 Related General Education Outcome Item(s): 10. Foundational Knowledge in Discipline(s); 11. Advanced Knowledge in Discipline(s); 12. Guided Research; 16. Independent Thought

2.2.2 Related Strategic Plan Item(s):
II-1 The Education of Leaders; II-3 Investment in People; V-2 Enhanced Quality of Life; VI-1 K-16 Education

2.2.3 Related Institutional Priority Item(s): CPT-3 Significantly improve quality of UTD's graduate students

2.2.4 Student Related Objective: Yes - This is a student related objective.

2.3 Universality of Knowledge:

Courses enable the development of understanding of the connections between college-level content knowledge in mathematics and science and content at the pre-college level to ensure the deep subject level knowledge required of successful teachers. Teachers will demonstrate an ability to connect the content of their high school level science with the content of college level science courses.

2.3.1 Related General Education Outcome Item(s): 11. Advanced Knowledge in Discipline(s); 16. Independent Thought

2.3.2 Related Strategic Plan Item(s):
II-1 The Education of Leaders; V-2 Enhanced Quality of Life; VI-1 K-16 Education

2.3.3 Related Institutional Priority Item(s): CPT-3 Significantly improve quality of UTD's graduate students

2.3.4 Student Related Objective: Yes - This is a student related objective.

2.4 Technology Application:

Courses allow for the familiarization, application and assessment of educational technology for use in teaching and learning. Teachers will demonstrate proficiency with educational technology for use in teaching and learning.

2.4.1 Related General Education Outcome Item(s): 11. Advanced Knowledge in Discipline(s); 16. Independent Thought

2.4.2 Related Strategic Plan Item(s): II-1 The Education of Leaders; VI-1 K-16 Education

2.4.3 Related Institutional Priority Item(s): CPT-3 Significantly improve quality of UTD's graduate students

2.4.4 Student Related Objective: Yes - This is a student related objective.

3. Measures & Findings:

3.1 Class Presentations/Papers:

Courses develop the independent research and critical thinking abilities of our students along with a familiarity with research-based developments in STEM teaching and learning and education reform efforts. Specifically, courses allow students to examine local, state, national and global issues in science and science education with an eye to how these impact the teaching of science and mathematics and ultimately our future leaders. (SCE 5301, SCE 8398) • Class presentations scored via rubrics assessing targeted content of core courses. • Course papers scored via rubrics assessing targeted content of core courses.

3.1.1 Assessment Timeframe: Throughout the courses

3.1.2 Success Criteria:

90% of students are able to: • Appraise and evaluate perceived solutions related to the various issues presented in terms of their validity or invalidity for economic and political issues, social and moral issues, and issues of technologic and scientific accuracy during class discussions and presentations. • Judge, formulate, and develop plans of action [lessons] for the age-group of their respective responsibilities to address, in an appropriate format, critical topics related to the subjects of discussion. • Select, and compare/contrast each of the critical issues as related to other areas of interest within the purview of their teaching responsibilities. • Compose valid arguments related to these critical issues, and relate them in varied evaluative formats, e.g., tests, exams, position papers, etc. • Provide valid arguments related to these critical issues, and relate them in varied evaluative formats such as exams, position papers, lesson plans, theses.

3.1.3 Related Objective(s): Research and Critical Thinking

3.1.4 Results Related To Success Criteria: No classes were taught this semester that support this objective.

3.2 Presentation, Papers, and Theses:

Courses develop the independent research and critical thinking abilities of our students along with a familiarity with research-based developments in STEM teaching and learning and education reform efforts. Courses also focus on evaluating, selecting, and conducting research for use in highlighting best practices to impact decisions affecting science and mathematics education. (SCE 5305, SCE 5308, SCE 8398) • Class presentations scored via rubrics assessing targeted content of core courses. • Course papers scored via rubrics assessing targeted content of core courses. • Thesis scored via rubric assessing research mastery. • Thesis defense scored via rubric assessing research mastery.

3.2.1 Assessment Timeframe: At the end of each course

3.2.2 Success Criteria:

90% of students are able to: • Appropriately search the current body of research literature. • Critically evaluate relevant research documents. • Formulate an independent research plan based on a formal review of literature. • Design and execute an independent research plan. • Report study results in science education research journal form. • Defend research conclusions in an electronic presentation to peers.

3.2.3 Related Objective(s): Research and Critical Thinking

3.2.4 Results Related To Success Criteria: Our criteria for success were that 90% of students are able to:

- Appropriately search the current body of research literature.
- Critically evaluate relevant research documents.
- Formulate an independent research plan based on a formal review of literature.
- Design and execute an independent research plan.
- Report study results in science education research journal form.
- Defend research conclusions in an electronic or oral presentation to peers.

Most students produced professional presentations and review of literature papers from the current body of published research that met the target performance level (90%). Those who (3 of 22) did not received a grade of incomplete, requiring them to re-do their work and submit it again.

3.2.5 Numerical Results:

Eighty-six percent of our students met the goals in the time period alloted. Thirteen percent are finishing their research and will submit their research within three weeks. At this point these three are meeting our criteria for the work they have completed.

3.2.6 Influencing Factors:

Most students showed adequate to excellent intellectual growth across the semester. However, students had difficulty receiving permission to complete data collection therefore were late with their research.

3.2.7 Achievement Level: Partially Met

3.2.8 Further Action: Yes

3.3 Class Presentations, Embedded Essay/Mulitple Choic: Courses facilitate the development of preK-16 classroom teachers into skilled educators with a depth of content knowledge and pedagogical content knowledge in the

sciences and/or mathematics through best practices in science and mathematics education reflective of cutting-edge research and national STEM education reform initiatives. Courses focus on problem based learning; problems are used as a vehicle for understanding and mastery of concepts. (SCE 5309, SCI 5321 SCI 5320, SCI 5326, SCI 5327, SCI 5331, SCI 5332, SCI 5333, SCE 5308) • Class presentations scored via rubrics. • Embedded essay questions assessing targeted content of courses. • Embedded multiple-choice benchmark item-sets assessing targeted content of courses. • Embedded problem sets assessing targeted content of courses. • Journal responses scored via rubrics.

3.3.1 Assessment Timeframe: Throughout the classes

3.3.2 Success Criteria:

80% of students are able to: • Transfer knowledge and strategies to new problem solving situations. • Creatively adapt knowledge and strategies to new settings • Solve challenging problems and adapt them for use in precollege classes • Compare the development and uses of mathematical and science concepts in precollege settings with the development and uses of analogous concepts in higher level courses.

3.3.3 Related Objective(s): Content/Pedagogical Content Knowledge

3.3.4 Results Related To Success Criteria: Our criteria for success require that 80% of students are able to:

- Transfer knowledge and strategies to new problem solving situations.
- Creatively adapt knowledge and strategies to new settings
- Solve challenging problems and adapt them for use in precollege classes
- Compare the development and uses of mathematical and science concepts in precollege settings with the development and uses of analogous concepts in higher level courses.

The majority of students (13 of 14) performed above the target level in most instances of the first attempt at essay questions given in journals and quizzes, which included both applications of content knowledge and adapting course content for use in pre-college classes. Concept questions, intended to challenge students' conceptual understanding, were given as multiple choice. Through group activity reports, students repeatedly demonstrated the ability to make connections between their own learning and pre-college content. Assisting students to reach target levels: Revisions were permitted on essay questions after initial scoring, allowing students to address missed concepts and incorrect uncertain applications. Questions missed by multiple students were discussed in class, and peer instruction was actively encouraged. Most individual students reached the target level after peer instruction and discussion. Less than a perfect score resulted in additional instruction and discussion either individually or as a class, as required.

3.3.5 Numerical Results:

Ninety-three percent of the students met the goal of mastery of the course materials. One student did not.

3.3.6 Influencing Factors:

Students responded well to peer-tutoring; they were able to apply their understanding of the concepts tutoring encompasses to new/different learning situations. Some students did not attend class regularly enough to maintain quality learning.

3.3.7 Achievement Level: Met

3.3.8 Further Action: Yes

3.4 Embedded Problem Sets/Essay/Multiple Choice: Courses facilitate the development of preK-16 classroom teachers into skilled educators with a depth of content knowledge and pedagogical content knowledge in the sciences and/or mathematics through best practices in science and mathematics education reflective of cutting-edge research and national STEM education reform initiatives. Courses stress improvement in content knowledge. (SCI 5321, SCI 5320, SCI 5326, SCI 5327, SCI 5331, SCI 5332, SCI 5333, SCI 5335, SCI 5328, SCI 5324, SCI 5322, SCI 5334, SCI 5325, SCE 5305, SCE 5308) • Embedded problem sets assessing targeted content of courses. • Embedded multiple-choice benchmark item-sets assessing targeted content of courses. • Embedded essay questions assessing targeted content of courses.

3.4.1 Assessment Timeframe: Throught the classes

3.4.2 Success Criteria:

90% of students are able to • Explain concepts in oral reports, papers, presentations, projects and exams. • Solve challenging problems illustrating the use of newly and previously learned concepts

3.4.3 Related Objective(s): Content/Pedagogical Content Knowledge

3.4.4 Results Related To Success Criteria: Our criteria for success require that 90% of students are able to

- Explain concepts in oral reports, papers, presentations, projects and exams.
- Solve challenging problems illustrating the use of newly and previously learned concepts

Students initially missing target levels for conceptual understanding on essay questions were asked to redo the questions until target level was reached. Concept questions (multiple choice) were addressed in class or individually until students demonstrated an understanding of the correct answer and the reasoning behind the incorrect distracters. Interactive discussions and journal entries reflecting problems and possible solutions were

utilized. Students were able to write scientific abstracts and convert these to Podcasts

3.4.5 Numerical Results:
Ninety-three percent of the students met the goal of mastery of the course materials. One student did not.

3.4.6 Influencing Factors:
Students were highly frustrated with UTD equipment (or lack of equipment) that was common in their middle and high schools, thereby making it difficult to obtain a high quality product. Some students did not attend class regularly enough to maintain quality learning.

3.4.7 Achievement Level: Met

3.4.8 Further Action: Yes

3.5 Class Presentations/Papers:
Courses enable the development of understanding of the connections between college-level content knowledge in mathematics and science and content at the pre-college level to ensure the deep subject level knowledge required of successful teachers. Courses model appropriate teaching behaviors for multiple grade levels. (SCE 5309, SCI 5321, SCI 5320, SCI 5326, SCI 5327, SCI 5331, SCI 5332, SCI 5333, SCE 5302, SCI 5335, SCI 5328, SCI 5324, SCI 5322, SCI 5334, SCI 5325) • Class presentations scored via rubrics • Course papers scored via rubrics

3.5.1 Assessment Timeframe: Throughout the courses

3.5.2 Success Criteria:
90% of students are able to find or develop appropriate teaching activities as demonstrated through peer teaching, or small group work.

3.5.3 Related Objective(s): Universality of Knowledge

3.5.4 Results Related To Success Criteria:
Our criteria for success requires that 90% of students are able to find or develop appropriate teaching activities as demonstrated through peer teaching, or small group work.
The major goal was to apply learning to the production of high quality teaching activities and behaviors. Students demonstrated an awareness of the applicability of concepts at different grade levels and the necessary modifications and/or simplifications required. Students modeled appropriate teaching methodologies. All but one student were able to reach this goal.

3.5.5 Numerical Results: Ninety-three percent of the student met the goal of mastery of the course materials.

3.5.6 Influencing Factors:
Students consistently demonstrated an awareness of the applicability of concepts at different grade levels and the necessary modifications and/or simplifications required.

3.5.7 Achievement Level: Met

3.5.8 Further Action: Yes

3.6 Embedded Essay/Problems Sets:
Courses enable the development of understanding of the connections between college-level content knowledge in mathematics and science and content at the pre-college level to ensure the deep subject level knowledge required of successful teachers. Courses integrate appropriate pre-college materials for student analysis. (SCE 5309, SCI 5320, SCI 5321, SCI 5326, SCI 5327, SCI 5331, SCI 5332, SCI 5333) • Embedded essay questions assessing targeted content of courses. • Embedded problem sets assessing targeted content of courses. • Class presentations scored via rubrics

3.6.1 Assessment Timeframe: Throughout the classes

3.6.2 Success Criteria:
90% of students are able to • Solve problems, use materials, report on strengths/weaknesses of materials. • Demonstrate how materials are used appropriately in classrooms • Report on the results of their use of materials with their students. • Analyze appropriateness of concept development in precollege materials

3.6.3 Related Objective(s): Universality of Knowledge

3.6.4 Results Related To Success Criteria: Our criteria for success require that 90% of students are able to
- Solve problems, use materials, report on strengths/weaknesses of materials.
- Demonstrate how materials are used appropriately in classrooms
- Report on the results of their use of materials with their students.
- Analyze appropriateness of concept development in precollege materials

Of the 24 students in these classes, all but one was able to reach this goal. Most students demonstrated an ability to evaluate course activities designed for pre-college for use in their own classrooms and those of peers teaching different grade levels or with varying demographically-based challenges in their classrooms. Students also demonstrated the ability to evaluate and adapt course concepts for students at different grade levels. Although individual student performance varied, the range was from outstanding to good. All students contributed ideas for

the production of materials that would illuminate the process of solving these problems.

3.6.5 Numerical Results: Ninety-three percent of the student met the goal of mastery of the course materials.

3.6.6 Influencing Factors:
Some students had difficulty applying what they learned in our classes to the learning environments for which they were responsible and/or had difficulty communicating how they had applied their knowledge.

3.6.7 Achievement Level: Met

3.6.8 Further Action: Yes

3.7 Embedded Essay/Presentation:
Courses enable the development of understanding of the connections between college-level content knowledge in mathematics and science and content at the pre-college level to ensure the deep subject level knowledge required of successful teachers. Courses emphasize the identification, analysis and use of appropriate pedagogy using educational technology. (SCI 5321, SCI 5320 SCI 5326 SCI 5327 SCI 5331 SCI 5332 SCI 5333, SCE 5302, SCI 5335, SCI 5328, SCI 5324) • Class presentations scored via rubrics • Embedded essay questions assessing targeted content of courses. • Embedded essay questions assessing targeted content of courses. • Embedded problem sets assessing targeted content of courses. • Class presentations scored via rubrics

3.7.1 Assessment Timeframe: Throughout the classes

3.7.2 Success Criteria:
90% of students are able to evaluate internet sites for correct content and application in educationally appropriate settings. • Analyze the use of appropriate technology as a possible tool in concept development

3.7.3 Related Objective(s): Universality of Knowledge

3.7.4 Results Related To Success Criteria: To reach this objective, 90% of students are able to evaluate internet sites for correct content and application in educationally appropriate settings.
• Analyze the use of appropriate technology as a possible tool in concept development
Group activity reports and journals provided a written evaluation of assigned technology. Students were able to demonstrate the ability to use equipment appropriately (as measured by instructor observations and completion of group work) and assess the strengths and weaknesses of the technology in classroom use at different grade levels, as well as the determination of appropriate applications. All of the students achieved this objective.

3.7.5 Numerical Results: One hundred percent of the students achieved this objective.

3.7.6 Influencing Factors:
Students were able to demonstrate the ability to use equipment appropriately and assess the strengths and weaknesses of the technology in classroom use at different grade levels, as well as the determination of appropriate applications.

3.7.7 Achievement Level: Met

3.7.8 Further Action: Yes

3.8 Embedded Essay/Problems Sets:
Courses enable the development of understanding of the connections between college-level content knowledge in mathematics and science and content at the pre-college level to ensure the deep subject level knowledge required of successful teachers. Courses extend the learning environment beyond the classroom (SCI 5320, SCI 5326, SCI 5327, SCE 5302, SCI 5331, SCI 5332, SCI 5333, SCI 5335, SCI 5328, SCI 5324) • Journal responses scored via rubrics. • Embedded problem sets assessing targeted content of courses. • Embedded essay questions assessing targeted content of courses. • Projects assessed via rubric.

3.8.1 Assessment Timeframe: Throughout the classes

3.8.2 Success Criteria:
80% of students are able develop a repertoire of problem-solving methods that they demonstrate in peer teaching, reports, and/or small group work. • Collect and report data from experiments carried out outside of the classroom.

3.8.3 Related Objective(s): Universality of Knowledge

3.8.4 Results Related To Success Criteria:
To meet this criteria, 90% of students are able to analyze the problem solving process from the student's and the teacher's point of view.
Students develop problem-solving techniques, an interest in extending learning through projects and essay-style questions, and an awareness of science in their everyday world, and its applicability to other parts of the regular pre-college curriculum. All but one student reached this criteria.

3.8.5 Numerical Results: Ninety-three percent of the students met this criteria.

3.8.6 Influencing Factors:

Almost all students demonstrated an ability to evaluate course activities designed for pre-college for use in their own classrooms and those of peers teaching different grade levels or with varying demographically-based challenges in their classrooms.

3.8.7 Achievement Level: Met

3.8.8 Further Action: Yes

3.9 Embedded Essay:

Courses enable the development of understanding of the connections between college-level content knowledge in mathematics and science and content at the pre-college level to ensure the deep subject level knowledge required of successful teachers. Courses accentuate meta-cognitive processes. (SCI 5321, SCI 5320, SCI 5326, SCI 5327, SCI 5331, SCI 5332, SCI 5333, SCI 5324, SCI 5335) • Journal responses scored via rubrics. • Embedded essay questions assessing targeted content of courses. • Projects scored via rubrics.

3.9.1 Assessment Timeframe: Throughout the classes

3.9.2 Success Criteria:

90% of students are able to analyze the problem solving process from the student`s and the teacher`s point of view.

3.9.3 Related Objective(s): Universality of Knowledge

3.9.4 Results Related To Success Criteria:

To meet this criteria, 80% of students are able develop a repertoire of problem-solving methods that they demonstrate in peer teaching, reports, and/or small group work.

• Collect and report data from experiments carried out outside of the classroom.

Students demonstrated the ability to reflect on their own learning and how to assess address common misconceptions in their own students. They suggested methods for solving the day-to-day issues of classroom management. All students met this criteria.

3.9.5 Numerical Results: One hundred percent of students reached this criteria.

3.9.6 Influencing Factors:

Extending the learning environment beyond the classroom helps students understand the scope and sequence of learning in K-12 classrooms.

3.9.7 Achievement Level: Met

3.9.8 Further Action: No

3.10 Embedded Problems:

Courses allow for the familiarization, application and assessment of educational technology for use in teaching and learning. Courses will appropriately integrate educational technology. (SCE 5305, SCE 5308, SCE 5309, SCE 8398, SCI 5320, SCI 5331, SCI 5332, SCI 5333, SCI 5326, SCI 5327, SCE 5302, SCI 5335, SCI 5328, SCI 5324, SCI 5322, SCI 5334, SCI 5325) • Embedded problem sets assessing targeted content of courses. • Course papers scored via rubrics • Journal responses scored via rubrics.

3.10.1 Assessment Timeframe: Throughout the classes and as summative assessments

3.10.2 Success Criteria:

90% of students are able to • Use graphing calculators to solve problems • Use digital data collection devices • Use computer software to produce presentation, papers, reports, assignments.

3.10.3 Related Objective(s): Technology Application

3.10.4 Results Related To Success Criteria: This criteria requires that 90% of students are able to

• Use graphing calculators to solve problems

• Use digital data collection devices

• Use computer software to produce presentation, papers, reports, assignments.

All students met the target performance of 90% in their use of the Internet, and software to produce assignments, presentations and reports as well as for communication/discussions. All students utilized the technology as required in the course, although some equipment (CBL probeware and graphing calculators) were more familiar to some students than others, and required additional instruction the use of that technology. They also made the transition from creation of mini-lessons on paper to creating their own Podcasts.

3.10.5 Numerical Results: One hundred percent of the students met this criteria.

3.10.6 Influencing Factors:

All students met the target performance of 90% in their use of the Internet, and software to produce assignments, presentations and reports as well as for communication/discussions. The professors need more training to keep up with the students.

3.10.7 Achievement Level: Met

3.10.8 Further Action: Yes

3.11 Class Presentations/Papers:

Courses allow for the familiarization, application and assessment of educational technology for use in teaching and learning. Courses emphasize the identification, analysis and use of appropriate use of educational technology. (SCE 5305, SCE 5308, SCE 8398, SCI 5320, SCI 5331, SCI 5332, SCI 5333, SCI 5326, SCI 5327, SCI 5322, SCI 5334, SCI 5325) • Embedded problem sets assessing targeted content of courses. • Class presentations scored via rubrics • Course papers scored via rubrics • Projects scored via rubrics.

3.11.1 Assessment Timeframe: Throughout the class and as summative assessments

3.11.2 Success Criteria:

90% of students are able to locate, evaluate and use Internet resources appropriately as evidenced by their projects, assignments and reports

3.11.3 Related Objective(s): Technology Application

3.11.4 Results Related To Success Criteria: This objective requires that 90% of students are able to locate, evaluate and use Internet resources appropriately as evidenced by their projects, assignments and reports.

All students met the target performance of 90% in their use of the educational technology, such as interactive applets, passive video files, and informational sites for use in pre-college classes through locating and evaluating research resources available through this medium. Through an assignment, students compared web-based resources with print resources.

3.11.5 Numerical Results: One hundred percent of the students reached this criteria.

3.11.6 Influencing Factors:

Instructor training on new, yet common, technology that is available to our students through their school districts is needed as is equipment that is at least equal to what teachers us in public schools.

3.11.7 Achievement Level: Met

3.11.8 Further Action: Yes

5. Closing the Loop:

5.1 Schedule adaptation: Rework schedule to help students complete the IRB

5.1.1 Related Objective(s): Research and Critical Thinking

5.1.2 Related Measure(s): Presentation, Papers, and Theses

5.1.3 Responsible Person: Instructor to work with IRB staff to modify/refine procedures.

5.1.4 Target Date: Spring 2008

5.1.5 Priority: High Priority

5.2 Peer-tutoring/attendance:

To close the loop in instruction, peers who understand the concepts are asked to peer-tutor those who do not; this is followed by students who were tutored explaining the concepts to other peer-tutors. This same technique is used to expand students' expertise with unfamiliar technology. Also, an attendance requirement will be implemented.

5.2.1 Related Objective(s): Content/Pedagogical Content Knowledge

5.2.2 Related Measure(s):

Class Presentations, Embedded Essay/Mulitple Choic; Embedded Problem Sets/Essay/Multiple Choice

5.2.3 Responsible Person: Instructors; teaching/research assistant

5.2.4 Target Date: The next semester the classes are taught

5.2.5 Priority: Medium Priority

5.3 Communication and tools:

Extending the learning environment beyond the classroom helps students understand the scope and sequence of learning in K-12 classrooms. More tools are needed to determine what misconceptions are present and how to address them. Students need examples of how to communicate their use of these tools with the instructors.

5.3.1 Related Objective(s): Universality of Knowledge

5.3.2 Related Measure(s):

Class Presentations/Papers; Embedded Essay/Problems Sets; Embedded Essay/Presentation; Embedded Essay/Problems Sets

5.3.3 Responsible Person: Instructors, NSM webmaster

5.3.4 Target Date: Next semester that courses are taught

5.3.5 Priority: Medium Priority

5.4 University support:

Support, through infrastructure funding and/or faculty enhancement funding, from the University to allow the faculty to upgrade their skills, to produce learning objects that would support K-16 education, and to create a dynamic resource for the University and the broader learning community.

5.4.1 Related Objective(s): Technology Application

5.4.2 Related Measure(s): Embedded Problems; Class Presentations/Papers

5.4.3 Responsible Person: University administration; instructors

5.4.4 Target Date: The next time the courses are taught

5.4.5 Priority: High Priority

6. Analysis:

6.1 Program/Unit Strengths:

6.1.1 Objectives/Outcomes Exceeded or Met: We were successful with objectives 2, 3, and 4 (specific criteria 3, 4, 5, 6, 7, 8, 9, 10 and 11)

6.1.2 Other Strengths:

Our faculty performs research that keeps our teaching current. Our students are, for the most part, committed to their education.

6.2 Program / Unit Weakneses:

6.2.1 Objectives / Outcomes Partially or Not Met: Objective 1 was partially met. Our students had great difficulty completing the IRB form, getting the approvals back, collecting and reporting on data within the semester timeline.

6.2.2 Other Weaknesses:

We do not have technology (both scientific and communications) that is at least as good as is in the public schools.

6.3 Other Areas Needing Improvement:

We need training in some of the latest technology communication tools as well as new computer programs for analyzing data.

7. Report:

7.1 Executive Summary:

Since we rarely offer the same class in subsequent semesters, analyses of data are based on classes not taught in the Fall, therefore we do not expect great changes in our students, only alternatives to our teaching performance. All students demonstrated an ability to evaluate course activities designed for pre-college for use in their own classrooms and those of peers teaching different grade levels or with varying demographically-based challenges in their classrooms. Students were able to demonstrate the ability to use equipment appropriately and assess the strengths and weaknesses of the technology in classroom use at different grade levels, as well as the determination of appropriate applications. All students met the target performance of 90% in their use of the Internet, and software to produce assignments, presentations and reports as well as for communication/discussions.

Our courses allow students to examine local, state, national and global issues in science, and science education through interactions with the research community. The courses focus on problem based learning; problems are used as a vehicle for understanding and mastery of concepts and content. Appropriate teaching behaviors for multiple grade levels are modeled allowing the students an opportunity to analyze pedagogy, educational technology, and pre-college state-required content. To assess students' achievement in these areas, both formative and summative data collection tools were employed. Along with class discussions, student-student and student-instructor interactions, the data collection methods were:

- Class presentations scored via rubrics assessing targeted content of core courses.
- Course papers scored via rubrics assessing targeted content of core courses.
- Embedded essay questions assessing targeted content of courses.
- Embedded multiple-choice benchmark item-sets assessing targeted content of courses.
- Embedded problem sets assessing targeted content of courses.
- Journal responses scored via rubrics.
- Projects assessed via rubric.

Because of the requirement for a quick turn-around in the data analysis, faculty members interacted through email to assess the program goals this semester. Measures were examined and evaluated for change to be implemented at the next offering of this semester's courses. In general the faculty found that students still have difficulty translating from undergraduate level to graduate level products. Explicit examples are needed as models for quality

of work expected. Peer review is needed to spur students to greater efforts to produce professional products. Some students had difficulty applying what they learned in our classes to the learning environments for which they were responsible and/or had difficulty communicating how they had applied their knowledge.

We will have to continue to monitor our teaching and our students' learning to maintain the goals/objectives we achieved this semester. For those goals that were partially met, samples of excellent products will be available for students to view. Student work will be on display for public viewing with an invitation to their peers, both inside and outside the class, to review the documents. To close the loop in instruction, peers who understand the concepts will be asked to peer-tutor those who do not; this will be followed by students who were tutored explaining the concepts to other peer-tutors. This same technique is used to expand students' expertise with unfamiliar technology. Also, an attendance requirement will be implemented. Extending the learning environment beyond the classroom helps students understand the scope and sequence of learning in K-12 classrooms. More tools are needed to determine what misconceptions are present and how to address them. Students need examples of how to communicate their use of these tools with the instructors. Finally, support, through infrastructure funding and/or faculty enhancement funding, from the University is needed to allow the faculty to upgrade their skills, to produce learning objects that would support K-16 education, and to create a dynamic resource for the University and the broader learning community.

7.2 Top 3 Program/Unit Accomplishments:

All of our goals were at least partially met. We interpreted this to mean that not all students achieved to our expectation level. However, most students showed adequate to excellent intellectual growth across the semester. Our fourth goal, that of allowing for the familiarization, application and assessment of educational technology for use in teaching and learning was met by all our students. Further, students consistently demonstrated an awareness of the applicability of concepts at different grade levels and the necessary modifications and/or simplifications required. Students responded particularly well to peer-tutoring; they were able to apply their understanding of the concepts tutoring encompasses to new/different learning situations.

7.3 Research Activities or Publications:

Faculty are active in acquiring extramural funding. Highlights of these efforts are listed below:

- Texas Regional Collaborative for Excellence in Science Teaching, TRC/TEA, $400,000, $105,000 and $100,000
- Texas Higher Education Coordinating Board $82,000
- University of Texas TeleCampus $79,435
- Tellabs Foundation, $100,000
- NASA, Office of Science EPO Supplement Program $44,907
- NSF, CCLI Grant Program $149,999

Faculty members are active in research and scholarly activities. This year we published in national and state peer reviewed journals and presented at national and state professional meetings. Examples of these activities are:

- Publications

o Geology, Resources and Environment of Latin America (GRELA): Incorporating earth systems science education in an undergraduate science service course. I. Pujana, R. J. Stern, & C. E. Ledbetter Journal of Geoscience Education, 54, 357-363.

o Arguing Evolution as a Defense: An Advanced Classroom Activity of Passion H. Montgomery The Texas Science Teacher 35(1) 30-35

o Improving Understanding and Exam Scores Five Minutes at a Time: Manipulative Activities in Class H. Montgomery and J. Palmer The Texas Science Teacher 35(2) 19-25

o Cross-Cultural Study of Immediacy and Preferred Learning Environments in Kenya and the U.S H. Montgomery and M. Openshaw, 23 pp Journal of Research in Science Education

o Cindi en el Espacio, a Spanish-language comic book Hairston, M. and M.L. Urquhart, University of Texas at Dallas January, 2006.

o Mini-CAST CINDI Resource CD-ROM, Urquhart, M.L., Science/Mathematics Department, UT Dallas, November 2006.

o Beyond Mnemonics: Pluto and the Nature of Science, Urquhart, M.L., The Texas Science Teacher, 32-36, October 2006.

o Identifying and Addressing Teacher Misconception Regarding Solar System Scale, Urquhart, M.L., American Association of Physics Teachers, July 2006

o Playground Physics in FMA Live, Urquhart, M.L. a NASA/Honeywell International physics education project, (Electronic Publication at http://www.fmalive.com/science/.)

- Conferences

o Penny Ante assessment: What do they know? C. Ledbetter & F. Fifer Conference for the Advancement of Science Teaching, Wichita Falls, TX (2006, October) 20

o What if Newton were alive today? Probing approaches for new views on old lessons C. Ledbetter & R. Nix Conference for the Advancement of Science Teaching, Wichita Falls, TX (2006, October) 43

o Pond-ering problem-solving: Incorporating Project WILD & Penny Ante Science into Texas-sized lessons R. Nix & C. Ledbetter Conference for the Advancement of Science Teaching, Wichita Falls, TX (2006, October) 52

o Hot hands and cold fingers: Using simple experiments to understand balanced living systems C. Ledbetter & R. Nix Conference for the Advancement of Science Teaching, Wichita Falls, TX (2006, October) 68

o Putting the cart before the horse! A new approach to making science education research relevant R. Nix & C. Ledbetter Conference for the Advancement of Science Teaching, Wichita Falls, TX (2006, October) 71

o Using science student perceptions of the classroom learning environment to evaluate a professional development program. R. Nix, C. Ledbetter, & B. Fraser American Educational Research Association San Francisco, CA. (2006, April) 185

o The Impact of Teacher Quality Grants on the Long-Term Professional Development of Science Teachers, Urquhart, M.L. and K. M. Bober, Proceedings of the 2005 Physics Education Research Conference, American Institute of Physics, 2006.

o Weather in Space? What's That?!? Urquhart, M.L., National Science Teachers Association Annual Meeting, Anaheim, California, April 2006.

7.4 Instructional/Training Activities (presented or received): Teaching is a high priority for our department. Therefore, two faculty teach undergraduate service courses for The Teacher Development Center and for Geosciences (Spring 2007, n = 124). Faculty members also supervise masters and doctoral students for Geosciences and for Physics departments (Spring 2007, n = 3). This semester three full-time faculty taught four graduate level classes (Spring, n = 35). Student evaluations from these courses rate our teaching as 'good' to 'excellent' on all measures.

7.5 Public Service:

Faculty from the Science Education department are heavily involved in service to professional groups, other educational entities, and the community. We function in many roles, some of which are listed below:

• Project director for ongoing professional development program for K-8 science teachers meeting one to two times per month

• Institute of Renewable Natural Resources and the Texas Geospatial Extension, and Lunar and Planetary Institute curriculum writer

• Treasurer, Sigma Xi

• External Evaluator, UNTHSC Project SCORE (NSF)

• Editor of The Texas Science Teacher (circulation 5,000 and online access via EBSCO Publishing)

• Board Member: Science Teachers Association of Texas

• Education and Public Outreach Co-Lead for the joint NASA/Air Force/UT Dallas CINDI project.

• Reviewers for NASA Planetary Geology and Geophysics Program, Journal of Research in Science Teaching, Meteoritics and Planetary Science Journal, and Journal of Geophysical Research

• Member of the NASA Pre-Service Teaching Advisory Panel (Invited Position)

• Provider of space science workshops and short courses for teachers at national, statewide and local science educator conferences.

• Kindergarten Science Outreach Program

• First Grade Science Outreach Program

• Assisted UTD graduate students and faculty with science club and science night events at their schools.

• Brought space science activities to nearly 2000 students in Allen and Dallas ISDs in April 2006.

• Science Fair Judge at Herbert Marcus Elementary, Dallas ISD

• Science advisor for Boon Elementary, Allen ISD

7.6 Other External Activities:

Drs. Ledbetter and Montgomery are active internationally. Dr. Ledbetter regularly hosts the visit of Dr. Barry Fraser, Director of the Curtin University of Technology and the Science-Mathematics Education Centre. This association is undertaken to alumni from UT Dallas a viable option for the pursuit of their doctoral degrees. Dr. Ledbetter serves as a member of the doctoral committees for Ms. Katheryn Skinner and Mr. Richard Plott at Curtin University of Technology, Australia.

Dr. Montgomery is actively conducting research in Africa, as well as participating in international conferences. His work includes:

• Memetics Predicts the Future of the Intelligent Design Debate. Oxford Round Table, Oxford University, U.K. (Jul 23-27)

• Radiolarians, Red Cherts, and Ridges: Rethinking the Origin of La Desirade. International Research Conference, Geology of the area between North And South America, with focus on the origin of the Caribbean Plate H. Montgomery and C. Hopson International Research Conference, Geology and Origin of the Caribbean Plate Siguenza, Spain (May 28-Jun 2)

7.7 Contributions to UTD: Contributions to the Institution:

The four faculty in Science Education (one Assistant Professor, two Associate Professors and one Senior Lecturer) are active contributors to the well being of the University. These duties include:

Department Level

Advisor for Graduate Program in Science Education

Science/Mathematics Education Department Associate Chair
Center for Science/Mathematics Education Research Director
SACS Assessment Coordinator
Development and maintenance of C-SER website
Head of Departmental Self Study
Science Education Program Admissions Committee member
Supervisor for Science/Mathematics Education Teaching Assistants
School Level
Natural Science and Mathematics Committee for Graduate Recruitment
Evaluate and recommend current and prospective students for scholarships and fellowships.
Promotion of outreach programs for specific NS&M programs
Science/Mathematics Education department chair search committee member
Mentor for graduate and undergraduate students in Teacher Development, Geology, and Physics
Faculty Sponsor for Women in Physics, including summer physics camps for middle school girls
University Level
NS&M dean search committee member
Chair, Faculty Mentoring Committee
Faculty Senate Members (2 representatives)
Directors, UTeach Dallas

7.8 Top 3 Program / Unit Challenges:

Again this semester, students were highly frustrated with UTD equipment (or lack of equipment) that was common in the middle and high schools in which they teach, thereby making it difficult to obtain a high quality product. This equipment includes laptops with appropriate software, physics equipment (CPO, sensors, probeware), video capture equipment (podcast, video camera, digital microphones) and the like. Some students did not attend class regularly enough to maintain quality learning. We have very high expectations that are sometimes foiled by our lack of providing examples of products that live up to our expectations.

7.9 Detailed Resources Needed to Improve and Fulfill Mission: For all of our classes we need the support of teaching/research assistants, equipment, materials, and consumables. Our departmental budget is not large enough to allow us to purchase equipment, materials and consumables that are at least equal in quality and quantity of those same items that are currently found in public school classrooms.

The long term vision of Science/Mathematics Education Department is to be and to produce leaders in science and mathematics education at institutional, local, state, national and international levels by highlighting national science, technology, engineering and mathematics (STEM) education reform initiatives in order to support the development of best practices and provide opportunities for participation in cutting-edge research to current and future STEM education professionals. To accomplish this goal we need the following:

• Web mediated educational community space with a person (within the department such as a research/teaching assistant) to moderate the discussions and post student/faculty work.
• Our own server on which to house this educational community and products produced by faculty/students.
• Departmental sets of laptops with podcasting capabilities.
• Video camera with sound to produce higher quality teaching tools.
• Funding to replace consumable laboratory materials and repair/replace laboratory equipment.
• An educational technology course designer to help us with instructional videos designed to show our students how to appropriately use technology.
• Laptops and specialized software for use by students.
• Instructor training on new, yet common, technology that is available to our students through their school districts.
• Equipment that is at least equal to what teachers use in public schools.