# Final Report to MDHE ITQ Cycle 4

**Project Title:** Technology Enhanced Active Chemistry and Physical Science for 4-8 Teachers
**Lead Institution:** University of Missouri-Kansas City
**Date of Report:** July 30, 2007

**Project Directors, Titles, and Departments:**


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**Partnership Organizations:**

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University Academy (Charter)

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Lee A. Tolbert Com. Academy (Charter)

Nicole King, Principal
Kansas City Missouri School District
Scuola Vita Nuova (Charter)

Gerry Lutaska, Principal
Kansas City Missouri School District
Academy Lafayette (Charter)

**Grade-level focus:** grades 4- 8 science teachers
**Project area of focus:** Chemistry and Physical Science

**Number of Participants:** 30
**Total number of contact hours per project year:** 120
**Credit hours provided:** 6 Graduate

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## List of school districts

Participating High Needs School Districts (n=30)

| Participating School in PD Project | Number of Participants | High-Need |
|---|---|---|
| Academie Lafayette / French Charter school | 2 | **Yes** |
| Blue Springs R-IV | 3 | No |
| Center #58 | 1 | No |
| CSD #4, Grandview | 1 | No |
| Fort Osage R-1 | 1 | No |
| Harrisonville Cass R-9 | 1 | No |
| Kansas City Missouri School District | 8 | **Yes** |
| Lee's Summit R-7 | 3 | No |
| Lee A. Tolbert Academy | 2 | **Yes** |
| North Kansas City School District | 2 | No |
| Platte County R-III | 2 | No |
| Pleasant Hill School District | 1 | No |
| University Academy | 3 | **Yes** |

*As defined by MDHE in Appendix C of Cycle 4 Request for Proposals.

Ref: External Evaluators report. Corrections by Stoddard in bold.

## Description of project activities

Technology Enhanced Active Chemistry and Physical Science for (4-8) Teachers (TEACPS) has provided authentic experiences with scientific inquiry and technology applications to enhance critical thinking, problem solving, and process skills in physical science. Active laboratory investigations comprised the basis for instruction. Computer-based activities and models were used to help teachers prepare labs, reinforce lab activities and reflect the role of modeling in scientific explanations. Technology was also incorporated into data collection, analysis and presentation. Teacher - scientist teams developed and field tested instructional units that mirror active scientific inquiry and effective practices using technology to teach physical science. Computers played a critical role in facilitating communication, organization, and application of instructional units.

The project website allowed teachers to access all lessons and electronic resources utilized during the summer session. During the fall sessions teachers are uploading concept maps, lessons, activity materials and setup, and assessment items. A discussion site allows asynchronous communication and collaboration about uploaded materials which enhances the ongoing monthly in-person meetings. The teacher and scientist

collaboration continues as teachers integrate inquiry based physical science and technology into their school curriculum. In order to sustain TEACPS, all assessments, concept maps, computer models and instructional units are being cataloged and arranged by topic and standards addressed on the TEACPS website.

In detail, the participating teachers received education in physical science and student-centered teaching through this project in 2006. The project design included two required sessions which will be referred to as the summer and fall sessions.

The summer session was a two week intensive teacher institute which took place on a university campus. The session began with preassessments. Teachers were then instructed in the project's chosen pedagogy (the three-phase learning cycle followed by concept mapping) during the first two days of the institute. Over the following six days, science content material was taught by project personnel modeling the pedagogy. The teachers performed 24 inquiry-based, student-centered physical science lessons on the topics of mechanics, properties of matter, fluids, sound, energy, heat, electricity and magnetism, light, and the structure of the universe. Teachers were also provided materials which they could use to reproduce the lessons in their classrooms. During the last two days of the session, teachers developed curriculum for the fall implementation. At the close of the summer session teachers completed postassessments and the self-efficacy survey.

The fall session took place from August until December and consisted of five Saturday meetings on the UMKC campus and a two-week implementation period of in-classroom application of lessons and student assessment. At the August meeting, teachers discussed which instructional unit to perform during the implementation period. During September, teachers finalized the content boundaries of the instructional unit and created draft lessons. At the October meeting, finalized lessons were presented and selected for inclusion and draft content assessment items were created. At the November meeting, the content assessment was finalized and the teachers implemented their instructional unit using the content assessment and an attitude survey for pre- and post-testing for the two-week period. This data were collected and managed electronically on a secure project website. The results of the analysis of this data were reported by the teachers in a public presentation in December. Afterward, teachers again completed the self-efficacy survey.

## Completed project activities and accomplishments:

For the purposes of this progress report, recall the proposed project timeline:

| Timeline | Activities |
|---|---|
| Year 1<br>Feb 06-May 06 | **Recruitment/Selection** |
| Year 1 Summer 06, June 20-July 1 | **Summer Session (10 days)** |

| | |
|---|---|
| | • Introduction (1 day)<br>• Computer Skills (1 day)<br>• Properties of Energy and Matter (2 ½ days)<br>• Properties of Force and Motion (2 ½ days)<br>• Chemical Science (2 days)<br>• Wrap-up and Planning Conclusion (1 day) |
| Year 1<br>Sept 06-Dec 06 | **Develop Instructional Units /Field Test (10 days)**<br>• Define content boundaries of IU.<br>• Submit draft lessons.<br>• Finalize lessons and select lessons to include in units.<br>• Submit draft assessment items<br>• Finalize assessment items.<br>• Conduct pre-test<br>• Teach instructional unit.<br>• Conduct post-test.<br>• Report results |

The project has completed all work outlined above up to the teaching of instructional units. This includes:

- Teachers were recruited and selected (30 participants + a waiting list).
- Computer-based active physical science lessons were developed by TEACPS team (inquiry-based lessons, computer-based content supplement, and computer-based data collection).
- Concept mapping was introduced, modeled, and incorporated into curriculum.
- Learning Cycle and Inquiry pedagogy was introduced, modeled, and incorporated into curriculum.
- Lessons were modeled for teachers at 2006 Summer Institute.
- Project website was created including all lessons, computer models, pre- and post-tests, online data submission, and online data management for teachers.
- Teachers have been educated in use of their computers, necessary software (provided by TEACPS), computer-based lessons, and website.
- Teachers have been instructed and aided in designing their lessons for implementation.
- Teachers have been instructed and aided in creating assessment for implementation.
- Teachers have created lessons for their instructional unit.
- Teachers have performed pre-assessments of their students.
- Teachers have implemented instructional units.
- Teachers have performed post-assessments.
- Teachers have returned their data to the project directors electronically via a secure website.
- Teachers have presented analyzed data in a public presentation, 12-8-06.
- Project leaders have compiled results for publication and presentation.
- Project leaders presented results at AAPT 2006 meeting, submitted to present at NSTA (not accepted) for 2007 meeting

## Description of substantive modifications

The greatest change to this project relates to the graduate credit received by the participants. In years past, the participants have received graduate credit in the School of Education only. This year, each participant received three School of Education graduate credits and three science graduate credits from the College of Arts and Sciences. This is due to a Memorandum of Understanding sought by the investigators and approved by the Dean of the College of Arts and Sciences. This MOU provides reduced cost credits to in-service teachers pursuing professional development and has since been used by another project serving high school science teachers. In short, this development has paved the way for more science teacher professional development in the Kansas City area.

## List of state and additional project objectives

**State and project goals:**

**Objective 1**: To increase teacher participants' knowledge and understanding of key concepts in math and/or science as aligned with each project's content focus.

**Objective 2**: To improve teacher participants' practices in inquiry-based instruction.

**Objective 3**: To enhance participants' use of assessment data to monitor the effectiveness of their instruction.

**Objective 4**: To improve student achievement in math and/or science content areas.

**Objective 5**: To demonstrate a measurable impact on the preparation of pre-service teachers through improvements in math and/or science content and/or pedagogy courses.

**Objective 6**: To further the knowledge of the science education research community.

## Progress toward objectives

**Objective 1**: COMLETED PROJECT COMPONENTS THAT ADDRESS THIS OBJECTIVE INCLUDE:

- Summer content/pedagogy professional development.
- Ongoing real-time support during the school year.
- TEACPS physical science content has been derived directly from Show-Me Standards, Curriculum Frameworks, and Grade Level Expectations for grades 4-8.

**Objective 2**: COMLETED PROJECT COMPONENTS THAT ADDRESS THIS OBJECTIVE INCLUDE:

- All TEACPS content was taught using/modeling Inquiry/ (learning cycle model),
- All TEACPS content was taught using/modeling Concept Mapping.
- All TEACPS content was taught using computer models constructed by TEACPS to help teachers prepare labs, reinforce lab activities, and reflect the nature of science in that scientists build models to explain theories

**Objective 3**: COMLETED PROJECT COMPONENTS THAT ADDRESS THIS OBJECTIVE INCLUDE:

- Teachers have constructed and submitted assessment items based on the MAP model to the TEACPS website.
- Techers have refined and selected items via the TEACPS on-line discussion group.
- Pre-tests have been administered prior to applying instructional units.
- Post-tests have followed instructional unit application.

**Objective 4**: COMLETED PROJECT COMPONENTS THAT ADDRESS THIS OBJECTIVE INCLUDE:

- Teachers have implement best practice according to scientifically based research
- Teachers have constructed instructional units using the Learning Cycle, Concept Mapping, and Computer models,
- IU has been applied during the fall semester.

**Objective 5**: COMPLETED PROJECT COMPONENTS THAT ADDRESS THIS OBJECTIVE INCLUDE:

- Pre-service teachers were taught using lessons developed by TEACPS in Physics 140/140L “How Things Work” in Spring semester, 2007.

**Objective 6**: COMPLETED PROJECT COMPONENTS THAT ADDRESS THIS OBJECTIVE INCLUDE:

- Data was compiled and analyzed. Results of impact on teacher education curriculum, impact on teacher content knowledge, impact on teacher self-efficacy, and impact on students can be found in upcoming publications.

# Connection to Standards and GLEs

**Summer Session Components**

| June 19-June 30 2006 | Standards and Concepts Addressed |
|---|---|
| Introduction (1 day)<br>• Teacher pre-assessments; review content/concept standards, grade level expectations, and frameworks; Learning Cycle and Concept Mapping. | |
| Computer Skills (1 day)<br>• Basic computer skills; accessing & using the internet as a research tool; using spreadsheets to analyze data; basic statistical analyses | 7.1c-e, 8.1a, 8.2.a, 8.3.a-b |
| Science Content Session I (3 days)<br>• Physical Sciences A: Light: sources, transmission, interactions with matter; pinhole viewers; additive and subtractive colors with bubbles; diffraction grating colors; lenses and mirrors, building a telescope & microscope, structure of the solar system.<br>• Physical Sciences B: electricity, static electricity & electroscopes; construct circuits & use to test hypotheses; parallel and series circuits, resistance and heat loss; electric motors and generators<br>• Chemistry: Kinetic theory of matter: electrolysis of water, diffusion, heat, build a heat engine; conservation of energy, expansion/compression, phases of matter, chemical and physical changes, water cycle | 1.1a-e, 1.2a-c<br>2.2a, 5.1.b-e,<br>5.2.b,c,e,f, 5.3.a,b,<br>6.1.a-b, 6.2.a-c<br>7.1.a-e<br>8.1a, 8.2.a, 8.3.a-b |
| Science Content Session II (3 days)<br>• Physical Sciences A: motion, trajectories, velocities, acceleration, and force; elastic collisions (all using marbles); Galileo's inclined plane; circular motion and pendulum oscillation, sound, sound waves in air and helium<br>• Physical Sciences B: Simple machines, design and use to change direction of force & decrease applied force, decrease applied displacement; force, work, and energy<br>• Chemistry: Chemical energy, endothermic and exothermic reactions, heat transfer (conduction, convection, radiation), solutions, pressure, gas laws, sound | 1.1.d-e, 1.2a,c<br>2.1a, 2.2a-c, 5.1.c,d,<br>5.2.b, 5.3.a,b,<br>7.1a-e<br>8.1a, 8.2a, 8.3a |
| Curriculum and Pedagogy (1 day)<br>• Pedagogy reinforcement and recap<br>• Concept maps: comparison, assessment, and ideals<br>• Begin curriculum development | 7.1c-e, 8.1a, 8.2.a, 8.3.a-b |
| Wrap-up and Planning Conclusion (1 day)<br>• Teacher post-assessments; begin planning for fall session. | |

## Description of Dissemination

1. A paper is scheduled to be submitted to *Science Education* in August 2007. This paper will include compiled data relating to internal teacher assessments and correlations with student achievement and attitudes.

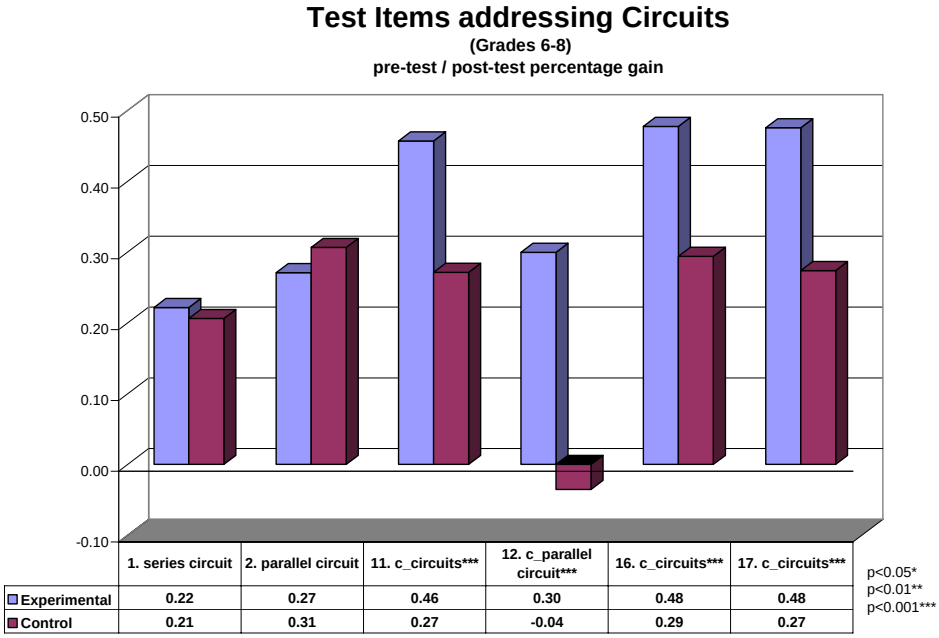
2. Stoddard will presented the preservice aspect of this work at the AAPT national meeting in Syracuse, 7-26-06.

3. Odom has submitted to present at the NSTA meeting in Saint Louis in 2007. The presentation was not accepted, however.

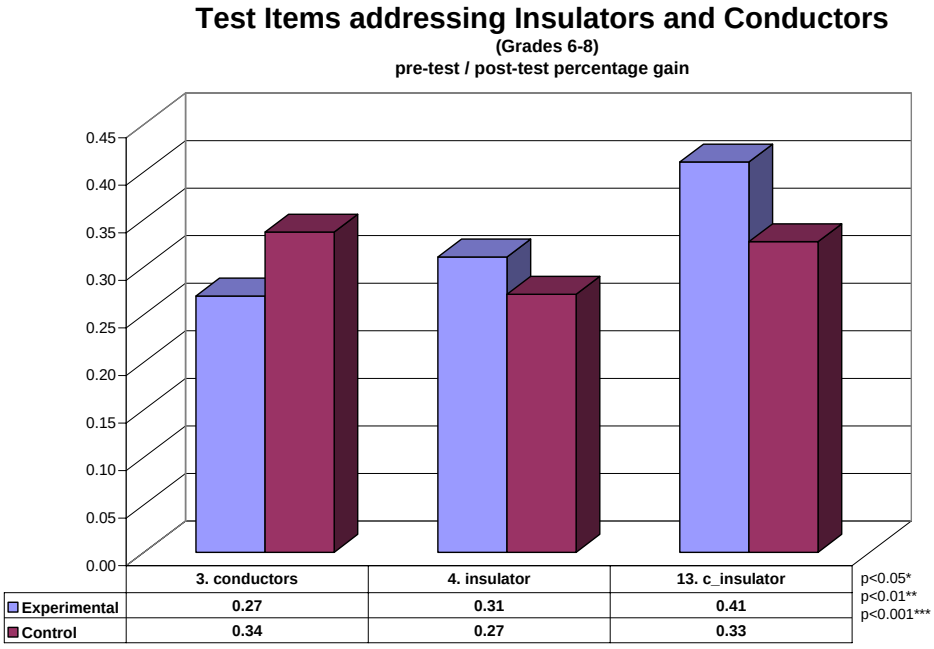
## Conclusion

Teachers participating in TEACPS were required to apply knowledge and skills gained during the summer session to their classroom during the fall semester. Teachers started by constructing concept maps to define the content of a unit plan on physical science addressing GLE. Elementary and middle school teachers formed 2 separate teams, Team Generator for $6^{th}$ – $8^{th}$ grade teachers and Team Newton for $4^{th}$ – $5^{th}$ grade teachers. After defining the content of the unit each team developed draft lessons and assessment items based on the MAP model. All lessons and assessment items were agreed upon by respective teams. This was followed by each teacher administering the pre test, teaching the unit, and administration of the post test. The tables below were created by participant teachers and represent pre-post test results for elementary and middle school students, respectively. (student n is approximately 1000)

The student outcomes data are as follows for team Generator:




| | 1. series circuit | 2. parallel circuit | 11. c_circuits*** | 12. c_parallel circuit*** | 16. c_circuits*** | 17. c_circuits*** |
|---|---|---|---|---|---|---|
| Experimental | 0.22 | 0.27 | 0.46 | 0.30 | 0.48 | 0.48 |
| Control | 0.21 | 0.31 | 0.27 | -0.04 | 0.29 | 0.27 |

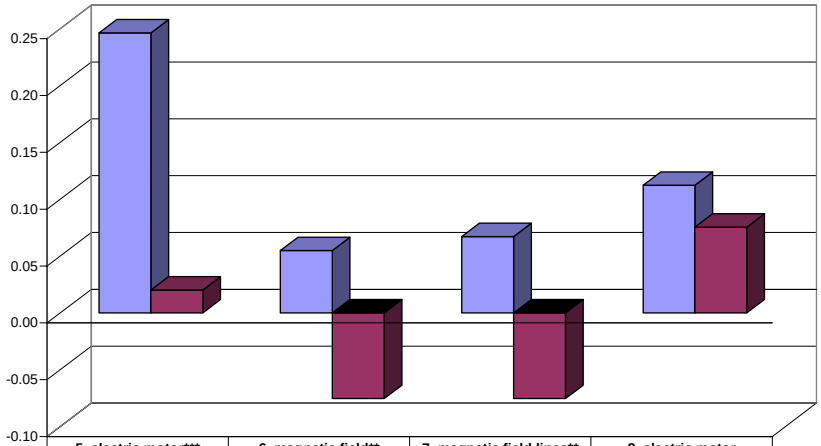



| | 3. conductors | 4. insulator | 13. c_insulator |
|---|---|---|---|
| Experimental | 0.27 | 0.31 | 0.41 |
| Control | 0.34 | 0.27 | 0.33 |

## Test Items addressing Motors and Magnetic Fields

**(Grades 6-8)**

**pre-test / post-test percentage gain**



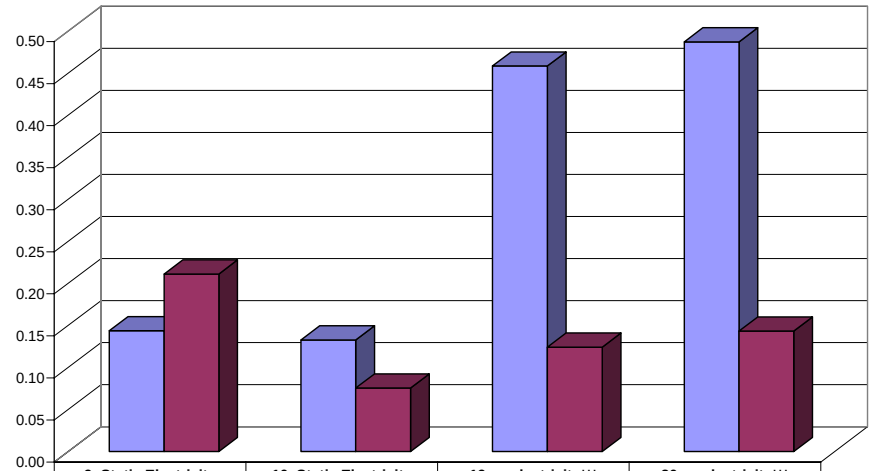

| | 5. electric motor*** | 6. magnetic field** | 7. magnetic field lines** | 8. electric motor |
|---|---|---|---|---|
| Experimental | 0.25 | 0.05 | 0.07 | 0.11 |
| Control | 0.02 | -0.08 | -0.08 | 0.08 |

p<0.05*
p<0.01**
p<0.001***

## Test Items addressing Electricity

**(Grades 6-8)**

**pre-test / post-test percentage gain**



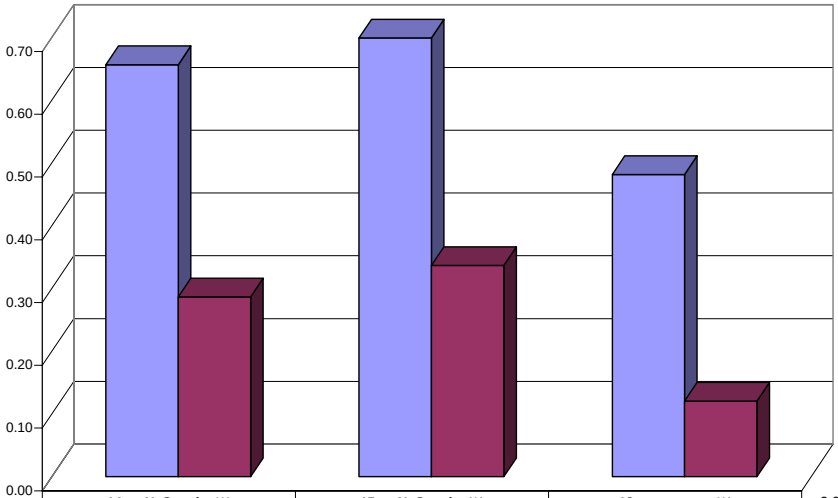

| | 9. Static Electricity | 10. Static Electricity | 19. p_electricity*** | 20. p_electricity*** |
|---|---|---|---|---|
| Experimental | 0.14 | 0.13 | 0.46 | 0.49 |
| Control | 0.21 | 0.08 | 0.12 | 0.14 |

p<0.05*
p<0.01**
p<0.001***

## Test Items addressing North/Sourh Poles and Compass

**(Grades 6-8)**

**pre-test / post-test percentage gain**




| | 14. c_N_S_poles*** | 15. c_N_S_poles*** | 18. c_compass*** |
|---|---|---|---|
| Experimental | 0.66 | 0.70 | 0.48 |
| Control | 0.29 | 0.34 | 0.12 |

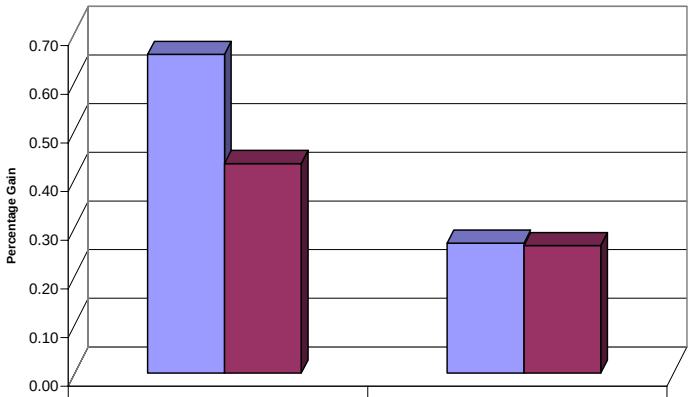
p<0.05*
p<0.01**
p<0.001***

## Overall Test***

p<0.05*
p<0.01**
p<0.001***

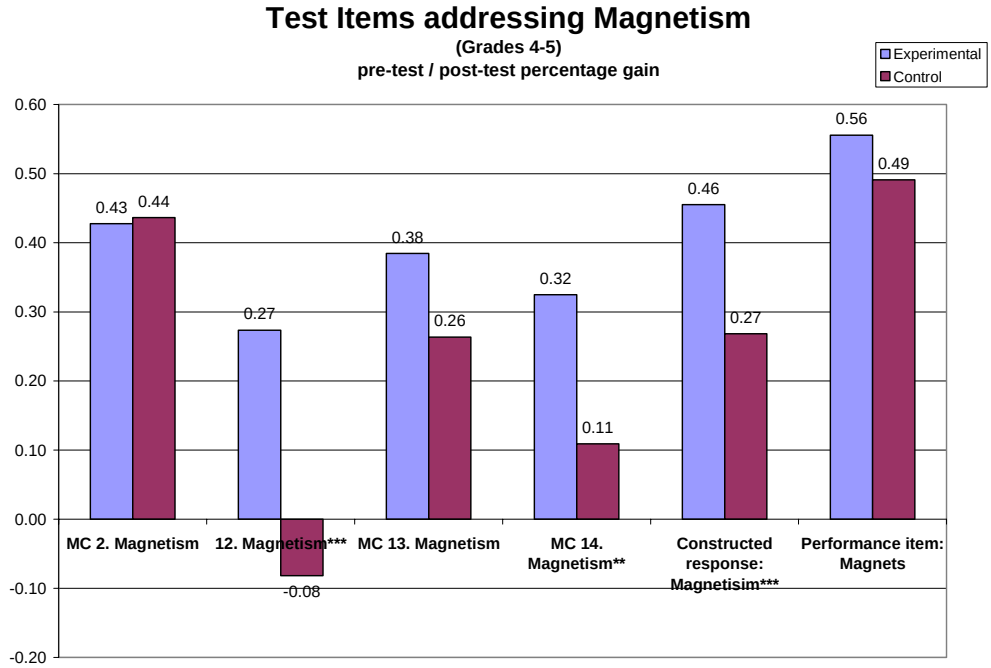
**(Grades 6-8)**

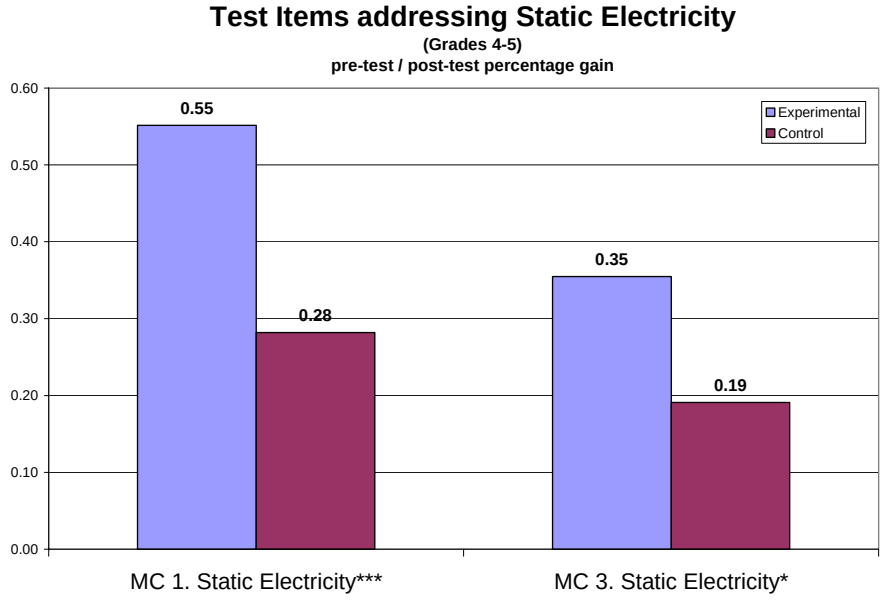
**pre-test / post-test percentage gain**

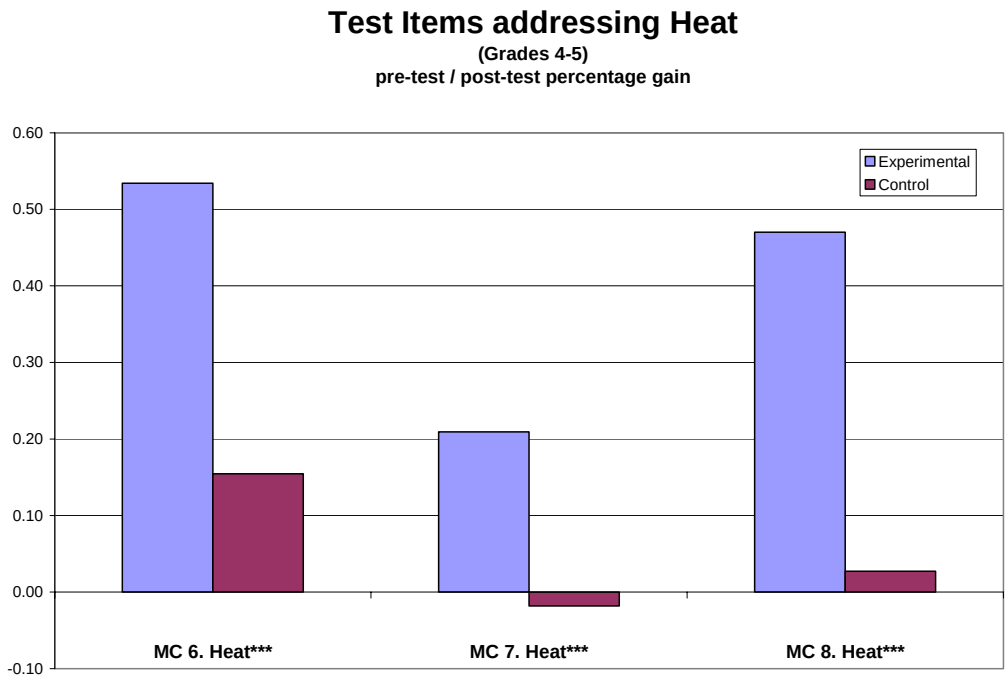


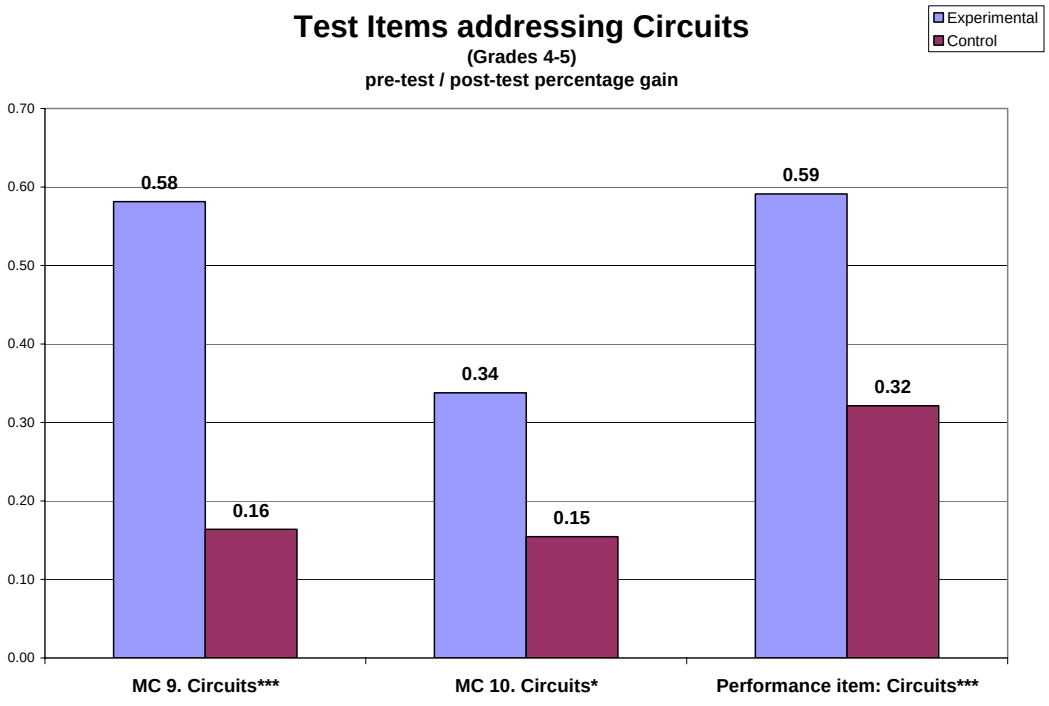

| | Post test | Pre Test |
|---|---|---|
| TEACPS Teachers | 0.65 | 0.27 |
| Control Teachers | 0.43 | 0.26 |

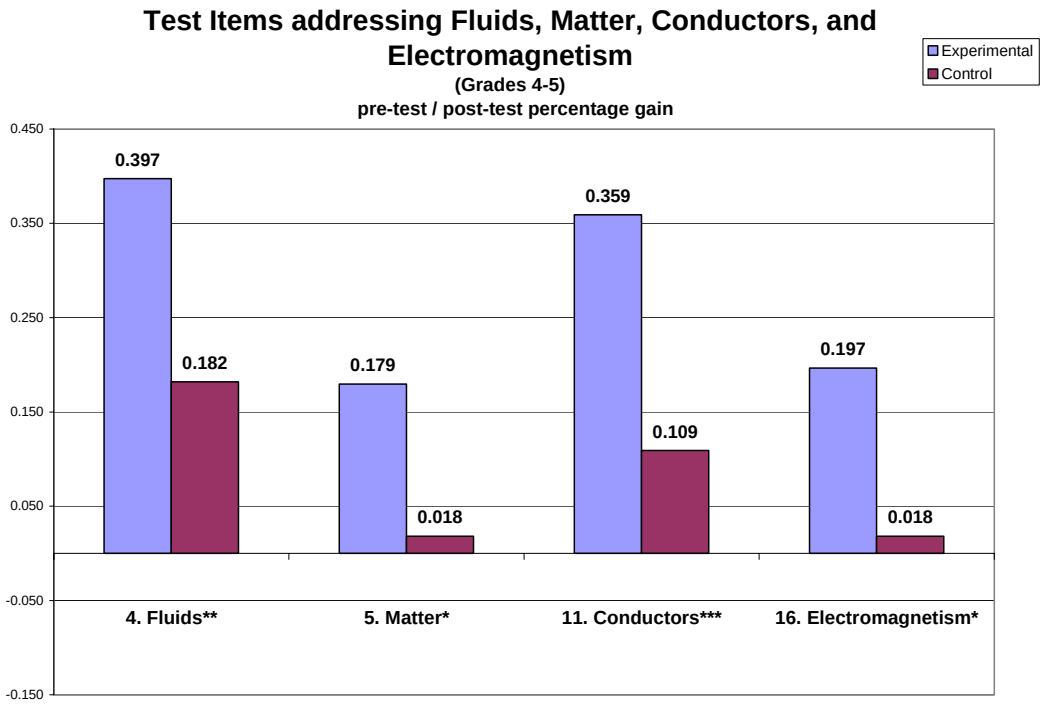
The student outcomes data are as follows for team Newton:

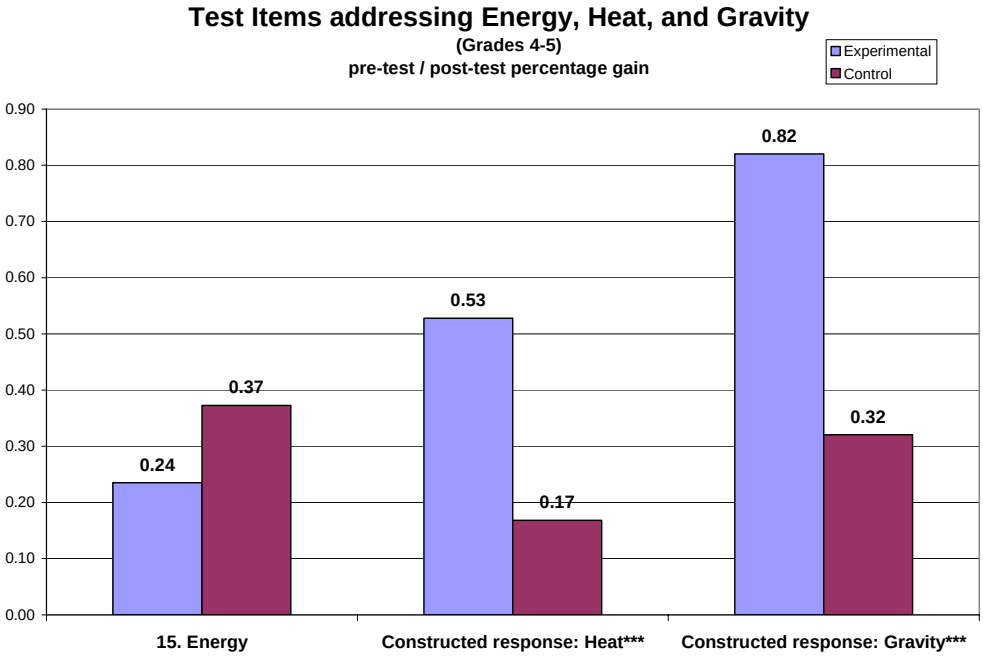


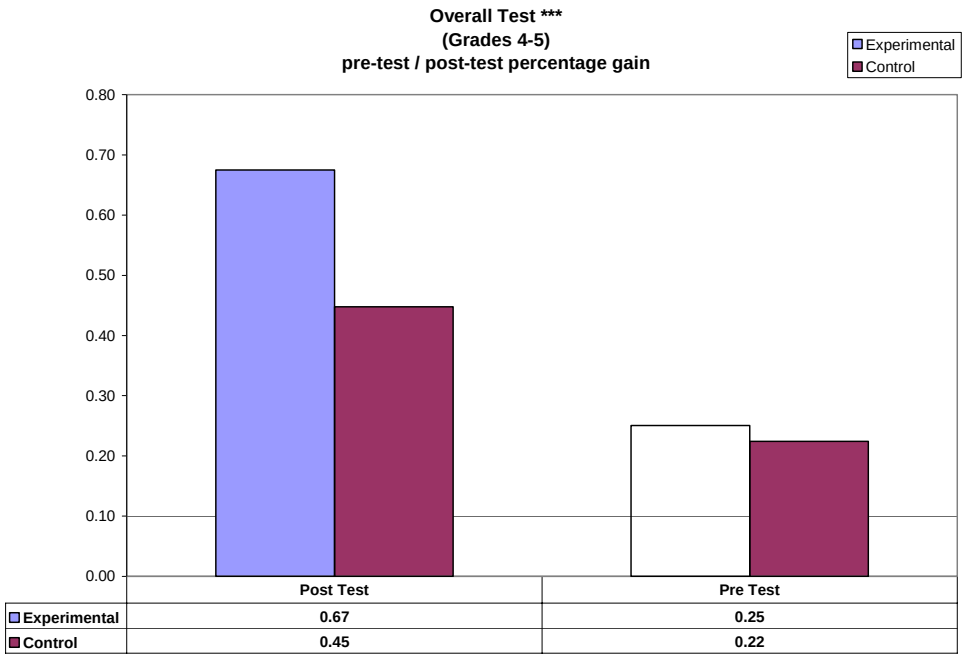




Test Items addressing Heat
(Grades 4-5)
pre-test / post-test percentage gain
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
Experimental
Control
MC 6. Heat***
MC 7. Heat***
MC 8. Heat***

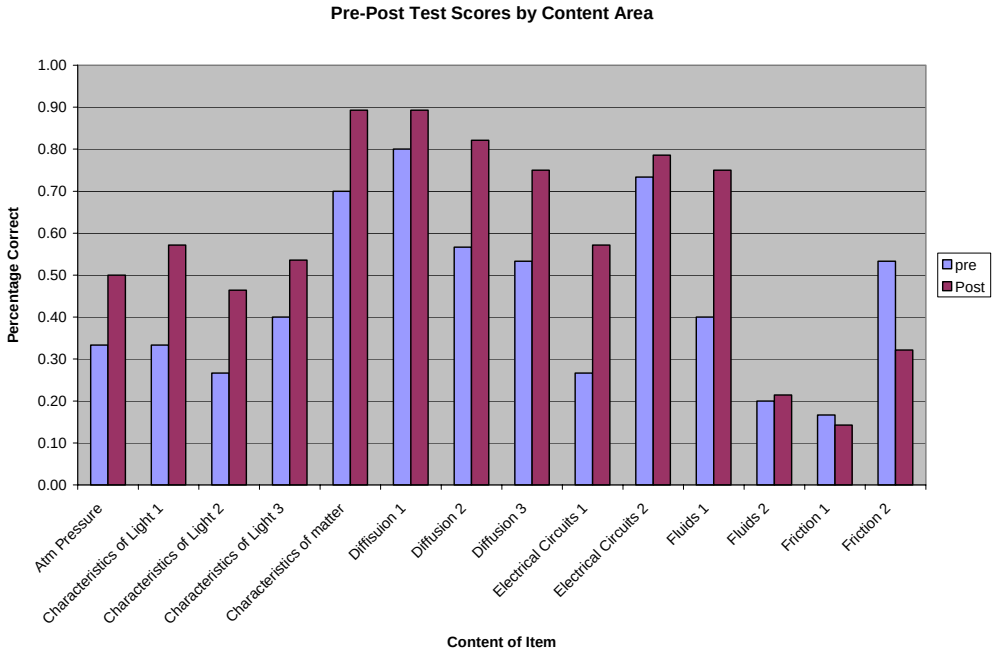

Test Items addressing Circuits
(Grades 4-5)
pre-test / post-test percentage gain
Experimental
Control
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.58
0.16
0.34
0.15
0.59
0.32
MC 9. Circuits***
MC 10. Circuits*
Performance item: Circuits***

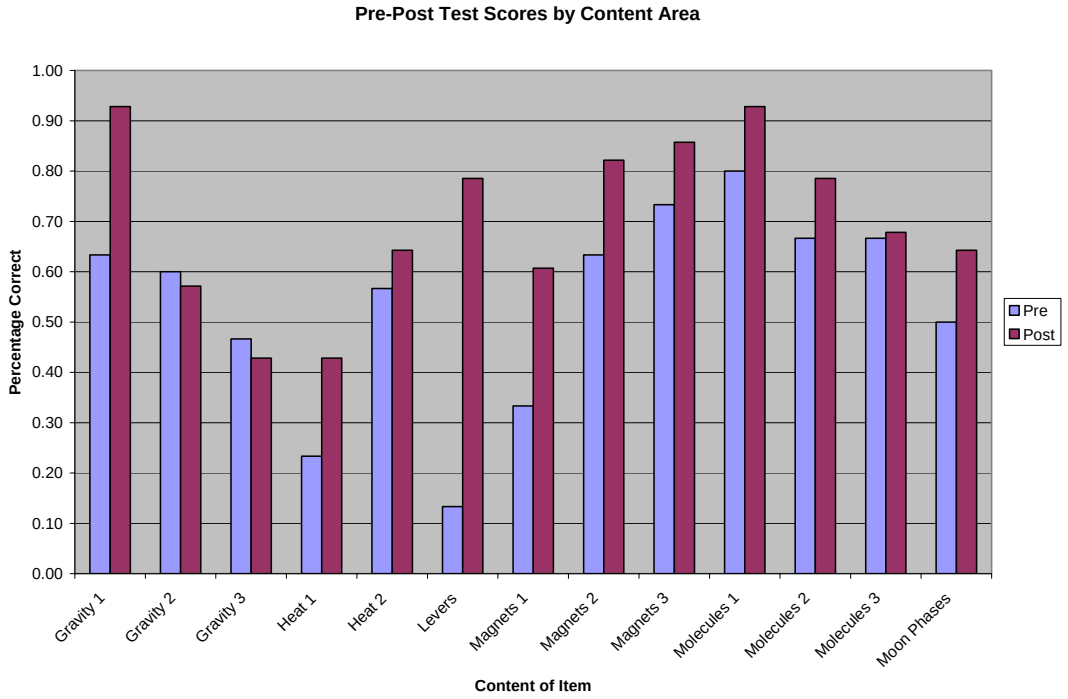

Test Items addressing Fluids, Matter, Conductors, and Electromagnetism
(Grades 4-5)
pre-test / post-test percentage gain
Experimental
Control
0.450
0.350
0.250
0.150
0.050
-0.050
-0.150
0.397
0.182
0.179
0.018
0.359
0.109
0.197
0.018
4. Fluids**
5. Matter*
11. Conductors***
16. Electromagnetism*

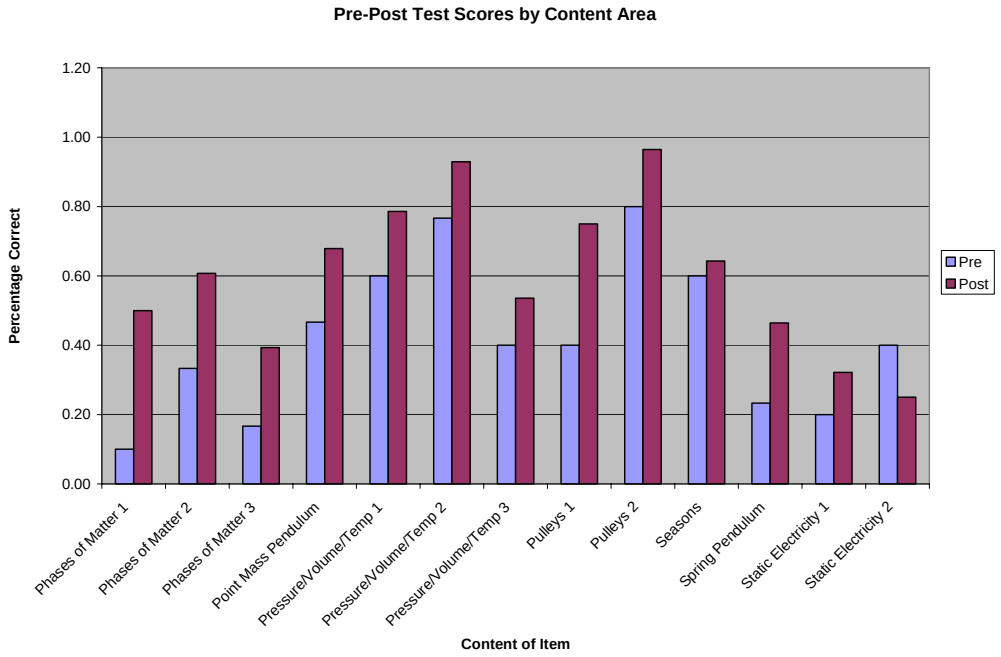

Test Items addressing Energy, Heat, and Gravity
(Grades 4-5)
pre-test / post-test percentage gain
Experimental
Control
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.24
0.37
0.53
0.17
0.82
0.32
15. Energy
Constructed response: Heat***
Constructed response: Gravity***




Finally, the aggregate data on teacher outcomes is as follows:






The greatest lesson learned in these projects continues to be to make very clear to teachers the rewards and responsibilities of participation in the initial application, including having teachers sign to their understanding that stipends will not be paid until responsibilities have been completed. By this design, a motivated and hard-working pool of participants self-selected, as is reflected in the impact of this project on their students.

# Attachments (Compliance Audit Checklist)

This form, signed by the Authorized Officer of the lead or custodial institution, will be returned with the **final request for funds** .

## MDHE Improving Teacher Quality Grant

**Compliance Audit Checklist**

This form, signed by the Authorized Officer of the lead or custodial institution, should be returned with the **final request for funds** during each project year. If "No" is checked for any item, a **full explanation** should be attached to this form.

Lead Institution: _____University of Missouri – Kansas City_____

Partnership Members: _____ UMKC,
University Academy KCMSD Charter School,
Lee A. Tolbert Academy KCMSD Charter School,
B. Banneker Academy KCMSD Charter School,
Scuola Vita Nuova KCMSD Charter School,
Academie Lafayette KCMSD Charter School ____

Project Title: ___ Technology Enhanced Active Chemistry and Physical Science for (4-8) Teachers_

| | Yes | No |
|---|---|---|
| 1. A copy of the institution's A-128 or A-133 audit has been submitted directly to the MDHE *Improving Teacher Quality Grant* Coordinator for each year in which the Title II grant funds were expended for this project. | __X__ | _____ |
| 2. All encumbrances were made after the authorized grant start-date, which was ____3-1-06_____. | __X__ | _____ |
| 3. All encumbrances for materials and supplies were made prior to the authorized grant end-date, which was _____6-30-07_____. | __X__ | _____ |
| 4. All services were completed and paid for prior to the authorized grant end-date. | __X__ | _____ |
| 5. The final request for funds was submitted no later than 30 days after the authorized grant end-date. | __X__ | _____ |
| 6. There is evidence that the MDHE *Improving Teacher Quality Grant* funds were used to supplement, and not supplant, nonfederal funds. | __X__ | _____ |
| 7. There is evidence that funds were expended in accordance with the MDHE *Improving Teacher Quality Grant* purposes and the approved application. | __X__ | _____ |

_____ _____
Signature of Authorized Officer Date

_____
Title