

APPENDIX 2.1

SAMPLE TEACHER PARTNERSHIP APPLICATION/AGREEMENT

OVERVIEW

PRISM is a National Science Foundation Graduate Teaching Fellows in K–12 Education (NSF GK–12) project that awards 12-month Fellowships to eligible graduate students and K–12 Teachers. Each PRISM Teacher partners with a PRISM Fellow to develop and implement compelling, inquiry-based science lessons. Our Fellows are science or math Ph.D. students from Emory or Clark Atlanta University who are studying to become scientists/mathematicians, and college professors. Together, each Fellow–Teacher team attends a two-week Summer Institute to learn about problem-based learning (PBL) and investigative case-based learning (ICBL) pedagogy. You will spend time together at the Institute and over the summer developing original problems and cases, and adapting existing materials for use in your classroom. Your graduate student partner will assist you in implementing the cases in your class, spending an average of about 10 hrs/wk at your school (actual time spent in the classroom will typically fluctuate from week to week, but you will collaborate to make specific plans).

PRISM is an intense yearlong partnership with a graduate student and requires a significant commitment of time, including a two-week summer institute (June 6–17) and four planning days (one each in July, September, January, and June). Teacher participation also requires an average of 2 hrs/wk during the summer, fall and spring outside of class time to plan with your graduate student, develop and revise lessons, and complete monthly reports. Ultimately, you will gain significant practice in the development and implementation of problem-based learning lessons and you will publish your materials on CASES Online (<http://www.cse.emory.edu/cases>), sharing your work with educators around the world.

IMPORTANT APPLICATION DATES

Feb 15, 2011	Information Session (optional, but recommended) 4:30pm, Center for Science Education, 1399 Oxford Road
Mar 4, 2011	Application Deadline
mid-March	Group Interviews, Center for Science Education, 1399 Oxford Road
Apr 1, 2011	Award Notification
Apr 15, 2011	Deadline for Acceptance of Award

SOURCE: EMORY UNIVERSITY

ELIGIBILITY

PRISM is open to science and mathematics Teachers in middle schools and high schools within Atlanta Public Schools, City Schools of Decatur, DeKalb County Schools, and Fulton County Schools. Previous experience with PBL is not required. Former PRISM Fellows are not eligible, but may apply for the PRISM/CFNM Fellowship (see FAQ below). Applicants must have the experience and skills to mentor a novice educator in classroom management and student assessment. Applicants must have permission of their principal to participate. We prefer applicants from schools that have other current applicants or former PRISM Fellows (i.e., a team of PRISM Teachers at the same school). Teachers who are participating in summer school or have other lasting summer obligations are strongly discouraged from applying because PRISM is so time-intensive.

AWARD INFORMATION

All PRISM Teachers receive a \$4,000 stipend for full participation. The stipend is distributed in three payments: August 2011 (40%), December 2011 (30%), and May 2012 (30%). Failure to participate in project activities or meet the responsibilities listed in this document may result in an adjustment of stipend at the discretion of project administrators.

FREQUENTLY ASKED QUESTIONS

1. For what kind of Teacher is PRISM looking?

The PRISM Fellowship is ideal for Teachers who want to spend the time and energy to reflect on and improve their teaching practices. We are looking for critical eyes, innovative spirits, and open minds. We want Teachers who are willing to try student-centered teaching techniques that give more responsibility for learning to the student. We need Teachers who welcome the opportunity to work with a Fellow inside and outside the classroom. We want someone who is willing to mentor the Fellow in classroom management, lesson planning, and assessment of student learning. We want someone who will be available for all PRISM professional development days, and who will meet with his/her Fellow weekly throughout the summer, fall and spring to plan collaboratively. We prefer applicants from schools that have other current applicants or former PRISM Fellows (i.e., a team of PRISM Teachers at the same school).

2. In this partnership, what are the roles of the Teacher and the graduate student?

The Teacher will serve as a mentor to the Fellow with regard to teaching, curriculum planning, and classroom management. The Fellow will provide content expertise and serve as an enthusiastic role model of a young scientist/mathematician to your students. It is important to note that the PRISM Fellow is not a student-Teacher nor a tutor. Fellows may or may not have had prior teaching experience, and they are not studying to become K–12 Teachers. PRISM Fellows are enrolled in Ph.D. projects in a variety of science and mathematics disciplines (e.g. Chemistry, Biological Sciences, Mathematics, Physics, Psychology). They are participating in PRISM to become better scientists and more confident professors by practicing and improving their teaching, communication, and research-dissemination skills.

3. How will the PRISM Teacher Fellowship benefit me?

The PRISM Teacher Fellowship will provide you with an opportunity to develop and implement innovative science and math lessons to engage your students in the science behind real world phenomena. Your students will become motivated investigators, self-directed and life-long learners, critical thinkers and keen problem-solvers. There is no one-size-fits-all solution to reach this goal, but PRISM gives you the time, the training, and the resources (including your stipend, Fellow partner, and a professional learning community of other PRISM Fellows) to develop what works best for you and your students. You will have the opportunity to present your work at regional conferences, publish your cases online and in scholarly journals, and lead your colleagues in implementing this exciting pedagogy. You will become a key component in the bridge we are building between K–12 schools and universities. In partnership with graduate students, faculty, and staff from Emory University and Clark Atlanta University, you will join a cadre of dedicated science educators who are transforming K–12, undergraduate, and graduate science education to ensure a scientifically literate public.

4. What is the PRISM/CFNM Fellowship?

Chemistry and physics Teachers may also be interested in the PRISM/CFNM Fellowship, which combines PRISM with a 6-week summer research experience in nanoscience.

Overview: The PRISM project has partnered with Clark Atlanta University’s Center for Functional Nanoscale Materials (CFNM), a National Science Foundation Center of Research Excellence in Science and Technology, to offer joint PRISM/CFNM Teacher Fellowships in nanoscience research and problem-based learning curriculum development. PRISM/CFNM Teachers participate in most components of the PRISM project and in guided research experiences in Clark Atlanta’s nanoscience labs, and ultimately translate the CFNM’s nanoscience research into problem-based learning (PBL) curriculum materials.

The PRISM/CFNM Teachers attend the 2-week PRISM Summer Institute at Emory and work together to begin creating lessons on nanoscience topics. Teachers then spend the following six weeks in Clark Atlanta labs, working on a variety of nanoscience research projects alongside CFNM graduate students and faculty. Weekly seminars provide time to discuss and make presentations on various nanoscience topics including biosensors, nanotubes, nanofibers and the ethical use of nanotechnology. Teachers also complete weekly journals to document their lab experiences and to reflect on: a) their own personal and professional development through the project; b) how they might translate their experiences into meaningful learning experiences for their students; and c) their thoughts/concerns/ideas/hopes relevant to science education, nanoscience research, PBL, student engagement, curriculum development, etc. Teachers and graduate students meet weekly to discuss their experiences and to work together on PBL case development.

5. How is the PRISM/CFNM Fellowship different from the regular PRISM Fellowship?

PRISM/CFNM Fellows do everything that PRISM Fellows do with the following exceptions:

- PRISM/CFNM Fellows attend a 6-week summer research experience at Clark Atlanta.
- PRISM/CFNM Fellows create 4 of the 8 required PBL lessons on nanoscience and research topics.
- PRISM/CFNM Fellows partner with Clark Atlanta graduate Fellows who work with them over the summer and during the school year for 5 hrs/wk (as opposed to 10 hrs/wk for regular PRISM Graduate Fellows).
- PRISM/CFNM Fellows receive an \$8000 stipend, paid out in August (50%), December (25%), and May (25%).

- PRISM/CFNM Fellows receive an \$800 supply budget to support nanoscience lessons in their classrooms.
- High School chemistry or physics Teachers (including former PRISM Teacher Fellows) and community college instructors are eligible for PRISM/CFNM Fellowships.

FOR MORE INFORMATION

Visit our website at <http://www.prism.emory.edu>. For questions about PRISM or the application process, contact John Doe at ###-###-#### or john.doe@uni.edu

APPLICATION PROCEDURE

Part A: Online Survey

Complete the survey available at <http://www.prism.emory.edu/app/Teacher.cfm>

Part B: Teacher Materials

1. Résumé or curriculum vitae
2. Written Statement - In a 2–4 page, double-spaced, typed statement, please include the following:
 - a. What makes you a good PRISM applicant?
 - b. Why you are interested in the PRISM Fellowship, how you will benefit from participation in PRISM, and how PRISM will benefit from your participation.
 - c. Your experiences working with others in curriculum development or other educational projects, and your reflections on those experiences (i.e., what worked? what didn't? how did/would you change it next time?).
 - d. Any other information that might help us to choose you.
 - e. Your name and school in the document header.

Assemble all Part B items together in a single DOC or DOCX file and email it to Jane Doe jdoe@email.edu. Name the file "YourlastnamePRISM11.doc" (e.g., my file would be called DoePRISM11.doc).

Part C: Letter of Support

1. Signed Cover Sheet
2. Letter of Support

Ask your principal to complete these materials and submit them directly to Jordan Rose at the Center for Science Education by the PRISM application deadline. The Cover Sheet must be signed by the applicant and the principal. The Cover Sheet is available at <http://www.prism.emory.edu/app/Teacher.cfm>.

All application materials must be received by 5pm on March 4, 2011. Applications are not considered complete until all parts have been received. Late applications will not be reviewed. Contact Jane Doe (###-###-####) to check on the status of your application.

FELLOWSHIP RESPONSIBILITIES AND ACTIVITIES

Overview:

- Mentor graduate student partner during curriculum development and classroom implementation of problems and cases.
- Meet weekly* with your graduate student partner outside of class time to develop cases, plan implementation, reflect and develop case notes, etc. (at least 1 hr/wk). *These meetings must be face-to-face meetings or phone conversations; emailing is not sufficient.
- Spend at least 1 hr/wk for independent work, including case preparation, completion of evaluation instruments, and monthly reflections (see below).
- Submit Monthly Progress Reports (2-page forms outlining work accomplished and reflecting on experiences).
- Develop, implement, and submit ≥8 Cases for publication on our CASES Online website, which serves as a resource to educators in Georgia and across the world.
- Attend one Reflection & Planning Session each semester with PRISM staff during planning periods or after school.
- Attend events listed below and additional project meetings as needed.
- Summer Institute. June 6–17, 2011. 8:30am–4:30pm.
- Summer Planning Day. July 29, 2011. 9am–4pm.
- Fall Planning Day. September 2011. 9am–4pm.
- Spring Planning Day. January 2012. 9am–4pm.
- Demo Day. June 2012. 9am–4pm.

Pre-Fellowship Events

- School visits. We will arrange for your Graduate Fellow partner to visit your school.
- Kickoff Picnic (date TBA). This is a social event that occurs prior to the official commencement of the Fellowship. Payment will not begin until summer 2011.

Summer Specifics:

- Attend the Summer Institute from 8:30am–4:30pm, Monday–Friday June 6–17, 2011. Some evening work is necessary (readings, team meetings, brief tasks).
- Meet weekly with Graduate Fellow to continue case development and planning.
- Develop Fall Implementation Plan outlining when and how cases will be implemented.
- Attend Summer Planning Day (July 29, 2011) and submit current versions of case materials.

Fall Specifics:

- Attend Fall Planning Day (September) and update Fall Implementation Plan.
- Develop Spring Implementation Plan outlining when and how cases will be implemented.
- Submit current versions of case materials (December).

Spring Specifics:

- Attend Spring Planning Day (January).
- Make 10-minute presentation giving a brief overview of cases implemented, example of successful case including student products, and reflections on the PRISM experience to faculty, school administrators, next year's PRISM cohort, and guests at Demo Day (May/June).
- Submit final versions of case materials (May).

What you can expect from PRISM:

- Meals, beverages, and/or snacks at PRISM meetings, as appropriate.
- Support for classroom implementation of curricula, including additional facilitators, technical support, supplies, etc.
- Professional development in job application process, teaching philosophy development, etc.
- Feedback from PRISM staff on progress and materials.
- Stipend distributed in August 2011 (40%), December 2011 (30%), and May 2012 (30%).

APPENDIX 3.1

APPLICATION FOR GK-12 FELLOW

GEORGIA TECH STUDENT AND TEACHER ENHANCEMENT PARTNERSHIP (GT-STEP)

Applicant (print name) _____

E-mail address _____ Phone _____

Anticipated Final Degree _____

Date began Graduate School at GT _____

Please check one: US Citizen US National US Permanent Resident

Home School/Department _____

Major _____

Advisor _____

Advisor's Home School/Department _____

Expected Term for Degree Completion _____

Undergraduate Degree _____

Undergraduate institution _____

In what section of the Atlanta area do you now live?
(This will not affect your chance of placement in the project—it is just used for school assignment purposes.)

Briefly state why you want to be a STEP K–12 Fellow.

SOURCE: GEORGIA TECH UNIVERSITY

APPENDIX 3.2

GK–12 FELLOW APPLICATION

UNIVERSITY OF IDAHO WATERS OF THE WEST

Copy and paste this document into a word processor and complete. Then email it as an attachment to the GK–12 project manager John Doe at doe@univ.edu. Provide as much information as you want. Please attach a current short resume along with the completed application. Thanks for your interest.

Name: _____

Department: _____

Are you a participant in Waters of the West “Water Resources”, Environmental Science, or Environmental Engineering projects? Yes No (if yes, please indicate which one)

Degree seeking: MA MS PhD

Year in degree project: (as of Fall 2012) _____

Have you talked with your faculty advisor about your possible participation in the project? Yes No

Who is your faculty advisor? _____

Your undergraduate degree (include area of emphasis if applicable): _____

Your MS degree (if applicable): _____

Your current research topic (if applicable): _____

Contact information for applicant: _____

Email: _____

Phone: _____

Briefly explain why you are interested in participating in this project. What insights, ideas, expertise, and passion are you contributing to the project? What do you hope to gain from the experience? A paragraph is sufficient, but candidates often write more.

SOURCE: UNIVERSITY OF IDAHO

APPENDIX 3.3

SAMPLE GRADUATE FELLOWSHIP APPLICATION/AGREEMENT

OVERVIEW

PRISM is a National Science Foundation Graduate Teaching Fellows in K–12 Education (NSF GK–12) project that awards 12-month Fellowships to eligible graduate students. Each PRISM Graduate Fellow partners with a middle or high school Teacher to develop and implement compelling, inquiry-based science lessons. Fellows and Teachers participate in a two-week Summer Institute on problem-based learning (PBL) and investigative case-based learning (ICBL) pedagogy. Together, each Teacher–graduate student team spends the summer writing original problems and cases and planning for classroom implementation the following school year. Graduate Fellows spend approximately 12 hrs/wk during summer, fall, and spring, participating in PRISM activities including case development and implementation, planning, evaluation, and reflective teaching practices. This time will include approximately 10 hrs/wk in the K–12 classroom. Days actually spent in the classroom will vary according to placement, and Fellows may not be in the classroom every week. Participation in PRISM requires a time commitment that typically fluctuates from week to week, but will average 12 hrs/wk, and include a two-week summer institute (June 6–17) and four planning days (one each in July, September, January, and June). More details below.

IMPORTANT APPLICATION DATES

Feb 15, 2011	Information Session - 4:30pm, Center for Science Education, 1399 Oxford Road
Mar 4, 2011	Application Deadline
mid-March	Group Interviews, Center for Science Education, 1399 Oxford Road
Apr 1, 2011	Award Notification
Apr 15, 2011	Deadline for Acceptance of Award

ELIGIBILITY

PRISM is open to doctoral students in the following projects and departments: Emory’s Anthropology, Behavioral Sciences and Health Education, Biomedical Engineering, Biostatistics, Chemistry, Epidemiology, all Graduate Division of Biological

and Biomedical Sciences projects, Mathematics, Physics, Psychology; and Clark Atlanta’s Chemistry and Biology projects. Previous experience in K–12 classrooms is not required. Applicants must:

- be full-time students in good standing in their graduate project
- have permission of their mentor to participate
- NOT be enrolled in any courses during the Fellowship year
- NOT participate in any teaching assistantships during the Fellowship year

All Fellows are expected to devote themselves full time to their PRISM and research activities during the Fellowship year and hence may not undertake other coursework or teaching opportunities, without approval from PRISM administrators. Emory Fellows who receive offers for other awards should contact the Graduate School and PRISM to determine whether the two awards may be held concurrently.

AWARD INFORMATION

All PRISM Graduate Fellows receive a \$30,000 stipend* plus an allowance for tuition, fees, and health insurance. Failure to participate in project activities or meet the responsibilities listed in this document may result in an adjustment of stipend at the discretion of project administrators.

** Stipends for Emory PRISM Fellows are compiled from multiple sources (see table below), including Emory’s National Science Foundation (NSF) Graduate Teaching Fellows in K–12 Education (GK–12) grant, Emory’s Office of the Provost, the Emory Graduate School, and a contribution from the graduate students’ faculty mentor, department, or other sources that would permit the students’ participation in the PRISM project. The Emory Graduate School will receive approximately \$4,666 in tuition, fees, and health insurance for each Fellow.*

SOURCES OF EMORY PRISM FELLOW STIPEND	
PRISM Award (NSF & Emory Sources)	\$18,500
Mentor/Dept. Contribution	\$11,500
Total Stipend	\$30,000

One PRISM Fellow each year will be selected from doctoral students in biology and chemistry at Clark Atlanta University. The stipend for the Clark Atlanta

Fellow comes from our NSF GK–12 project subaward to Clark Atlanta and will be paid to the Fellow through Clark Atlanta. The subaward includes an allowance of \$10,500 for tuition, fees, and health insurance.

FOR MORE INFORMATION

Visit our website at <http://www.prism.emory.edu>. For questions about PRISM or the application process, contact John Doe at ###-###-#### or john.doe@univ.edu

APPLICATION PROCEDURE

Part A: Online Survey

Complete the survey available at <http://www.prism.emory.edu/app/grad.cfm>

Part B: Student Materials

1. Emory Graduate School Fellowships Application Cover Sheet
2. Curriculum vitae
3. Written Statement - In a 2–4 page, double-spaced, typed statement, please address the following:
 - a. Why you are interested in the PRISM Fellowship, how you will benefit from participation in PRISM, and how PRISM will benefit from your participation.
 - b. Preferred K–12 grade level and subject (e.g., high school chemistry, middle school physical science).
 - c. In 1–2 paragraphs, illustrate one way you might use an active learning method to teach a specific science concept for the grade level and area chosen above.
 - d. In a single paragraph, explain your research (current and/or future) as if you were speaking to a typical high school student.
 - e. Brief statement of any prior experience and interest in working with K–12 Teachers or students. This could include volunteer work, tutoring, or other experience. (NOTE: prior experience is NOT required - if you have little experience, emphasize your interests and rationale for applying).
 - f. Brief statement of science background (baccalaureate and post-baccalaureate coursework, research, or other experience) and teaching experience (if any).

Assemble all Part B items together in a single PDF file and email it to Jane Doe at jdoe@email.edu. Name the file “YourlastnamePRISM11.pdf”. Download the Cover Sheet and guidance on creating PDF files from the right-hand margin of http://www.gs.emory.edu/resources/financial.php?entity_id=18

You may also use the Woodruff Library or other office to scan and email the file as a PDF.

Part C: Mentor Support Materials

1. Signed Cover Sheet
2. Letter of Support

Ask your faculty advisor /research mentor to complete these materials (Cover Sheet available at <http://www.prism.emory.edu/app/grad.cfm>) and submit them to Jane Doe at the Center for Science Education.

All application materials must be received by 5pm on March 4, 2011.

FELLOWSHIP RESPONSIBILITIES AND ACTIVITIES

Overview:

- Graduate Fellows should spend an average of 12 hrs/wk on PRISM activities:
 - Spend approximately 10 hrs/wk planning, developing, and implementing problems and cases with K–12 Teacher partner. During the school year, Graduate Fellows should spend no more than 10 hrs/wk in the K–12 classroom.
 - Spend approximately 2 hrs/wk for independent work, including readings, case preparation and research, completion of evaluation instruments and progress reports (see below).
- Meet weekly with your K–12 Teacher partner (face-to-face or by phone).
- Submit Monthly Progress Reports (2-page forms outlining work accomplished and reflecting on experiences).
- Develop, implement, and submit Case Materials for publication on our CASES Online website, which serves as a resource to educators in Georgia and across the world.
- Attend Reflection Sessions every other week with PRISM staff (a regular time will be coordinated to best fit everyone’s schedules).
- Attend events listed below and additional project meetings as needed.
 - Summer Institute. June 6–17, 2011. 8:30am–4:30pm.
 - Summer Planning Day. July 29, 2011. 9am–4pm.

- Fall Planning Day. September 2011. 9am–4pm.
- Spring Planning Day. January 2012. 9am–4pm.
- Demo Day. June 2012. 9am–4pm.

Pre-Fellowship Events

- School visits. We will arrange for you to visit your Teacher–partner’s school.
- Kickoff Picnic (date TBA). This is a social event that occurs prior to the official commencement of the Fellowship. Payment will not begin until June 2011.

Summer Specifics:

- Attend the Summer Institute from 8:30am–4:30pm, Monday–Friday June 6–17, 2011. Some evening work is necessary (readings, team meetings, brief tasks).
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Fall Specifics:

- Attend Fall Planning Day (September) and update Fall Implementation Plan.
- Develop Spring Implementation Plan outlining when and how cases will be implemented.
- Submit current versions of case materials (December).

Spring Specifics:

- Attend Spring Planning Day (January).
- Make 10-minute presentation giving a brief overview of cases implemented, example of successful case including student products, and reflections on the PRISM experience to faculty, school administrators, next year’s PRISM cohort, and guests at Demo Day (May/June).
- Submit final versions of case materials (May).

What you can expect from PRISM:

- Meals, beverages, and/or snacks at PRISM meetings, as appropriate.
- Support for classroom implementation of curricula, including additional facilitators, technical support, supplies, etc.
- Professional development in job application process, teaching philosophy development, etc.
- Feedback from PRISM staff on progress and materials.
- PRISM stipend distributed in equal monthly installments from June 2011 through May 2012.

APPENDIX 4.1

SAMPLE GK–12 PROJECT RESOURCES

Description	For Further Information (Full citations in Chapter 4)
GK–12 WORKSHOPS, INSTITUTES, AND COURSES	
Course in teaching methods for science graduate students	Baumgartner 2007
Integrating pedagogical training into the graduate project	Tanner and Allen 2006
Example of a GK–12 partnership training model	Stamp and O’Brien 2005
Integrating teaching and research for graduate students	Trautmann and Krasny 2006
Protocol for Assessing Scientists’ Presentation Skills	Kaser et al. 2012
SCIENCE PARTNERSHIP PROJECTS	
Assessment of Teacher–scientist partnership related to wind energy	Caton et al. 2000
GK–12 partnership model focused on ecology	McBride et al. 2011
Project SERVE: reflections on the experience of scientists in the K–12 classroom	Gilmer et al. 2005
EXAMPLES OF CURRICULA AND TEACHING STRATEGIES	
Peer Perspectives Volume II: A Novel Approach to Quality GK–12 Interactions	Sanchez et al. 2010
Problem-based learning “how-to” guide	Duch et al. 2001
Problem Based Learning Clearinghouse	University of Delaware 2012
Handbook for Culturally Responsive Science Curriculum	Stephens 2003
Using inquiry to improve pedagogy through K–12/university partnerships	Huziak-Clark 2007
Discussion on achieving scientific literacy	Bybee 1997a and b
Using concept maps in instruction	Novak 1998
Using the 5E model in teaching	Tanner 2010
Teaching in the elementary school science classroom	Beichner and Dobey 1994
A scientific approach to curriculum development and assessment	Handelsman et al. 2007
ASSESSMENT AND REFLECTIVE PRACTICE TOOLS AND APPROACHES	
Using rubrics as tools for making learning goals and evaluation criteria explicit	Allen and Tanner 2006
Review of assessment practices and theory in the areas of assisting learning, individual achievement, and project evaluation	NRC 2001
LEARNING THEORY	
How people learn from infancy through adulthood	Eshel 2007
Theory and practice on how people learn	NRC 2000

APPENDIX 4.2

CONTRACT BETWEEN THE UNIVERSITY OF MONTANA AND THE GK-12 FELLOW

This Contract confirms the understanding between the University of Montana (herein called UM) and GK12 Fellows selected to participate in the ECOS Project.

1. Scope of Work. Duties and responsibilities of PhD Fellows, as outlined in the grant funded by the National Science Foundation, are attached. NOTE: Montana law requires that all regular volunteers and Teachers undergo a criminal background check before they can work in academic institutions. The ECOS project will coordinate and pay for this background check.
2. Period of Project. The period of work covered by this agreement shall begin on _____ and shall terminate on _____.
3. Fiscal Arrangements. UM agrees to pay the GK12 Fellows \$ _____ for 12 months (divided into 12 equal payments) provided that the Fellow has completed the work requirements and required hours for the month. Checks will be mailed to the Fellow's mailing address. UM also agrees to pay tuition and fees of up to \$ _____ for the academic year (not including the summer session). In the unusual circumstance that a Fellow cannot continue participation in project activities, monthly payments will be prorated to cover only such time as the Fellow met the ECOS Project requirements.
4. Meeting Obligations of the Fellowship. If the ECOS staff, partner Teachers, or graduate advisor has concerns that a Fellow is not fulfilling the required obligations for his or her work as a Fellow or graduate student, the ECOS Director, _____, will be notified. S/he, or a designee, will work with the Fellow to clarify expectations and develop a plan for remediation. If the problem is not corrected, the Fellow's academic advisor will be contacted for a conference with the director and Fellow to determine an appropriate course of action. If the Fellow still cannot meet project obligations, his or her Fellowship may be terminated.
5. Conditions That May Lead to Early Termination. This agreement can be terminated upon two weeks' written notice by the Director if a Fellow fails to comply with project requirements. Fellows may be terminated immediately for illegal activities conducted at a school site or that involve minors. Fellows may terminate participation in the ECOS Project with two weeks' written notice to the Director. However, payment of the stipend will terminate at that time.

I have read about and agree to the duties and responsibilities listed in these documents:

ECOS PhD Fellow Signature: _____ Date: _____

Director/PI Signature: _____ Date: _____

PhD Advisor Signature: _____ Date: _____

Committee Members Signatures: _____ Date: _____

SOURCE: UNIVERSITY OF MONTANA

ECOS Project PhD Fellows' Duties and Responsibilities

The duties and responsibilities of ECOS Fellows are summarized below. Support of the advisor and Committee is required for the listed duties (advisors and Fellows sign the attached agreement and initial each page). This Fellowship is intended to support Fellows, much like having a TA or RA, as they make good progress toward degree requirements. Because of the potentially negative influence on making progress toward graduation, the ECOS project leaders discourage Fellows from holding additional positions in addition to this Fellowship.

1. Fellows are ambassadors of the University of Montana. As such, Fellows are expected to dress in accordance with professional standards at the school, and interact in a respectful manner with partner Teachers, school staff, and students.
2. Fellows are expected to meet all deadlines for project and information gathering activities. When delays cannot be avoided, Fellows are expected to notify the ECOS staff and negotiate a new deadline. Failure to participate in reporting may lead to an early termination of the Fellowship.
3. Project activities begin on _____. Summer activities will include developing a plan for the _____ academic year. The Fellowship ends _____.
4. PhD Fellows are required to write a chapter in their Dissertation about the ECOS Fellowship outcomes and experience, and to submit a manuscript from this chapter for publication in an appropriate teaching journal. Time spent working on this chapter is considered part of the dissertation research and may NOT be counted toward the 15 hour work requirement of the ECOS Fellowship.
5. Fellows will all work together as a team of two graduate students and two Teachers. Fellows are expected to work on ECOS activities for 15 hours per week during the Fellowship. This obligation is met through a combination of planning time, research and investigation planning, and working with Teachers in their classrooms.
6. The lead Teacher(s) and Fellows will work in partnership in the schools. During the school year, the Fellows will rotate their activities between different schools and classrooms, according to the needs they identify during weekly planning.
7. According to Montana law, a Teacher must be present in the classroom whenever the Fellow is in the classroom. The Teacher will guide the Fellow's interactions with students in the classroom, and provide him or her constructive and timely feedback. Teachers are responsible for all classroom discipline.
8. The Fellow must provide one reliable form of contact that he or she will check on a daily basis (email, home phone number, school phone number, cell phone number) to the ECOS Director and Team Fellows.
9. Fellows will be required to take BIO/FOR 595 for 1 credit per semester. This time will be used for coordination with ECOS leaders and for "whole project" planning.
10. The Fellow will work with other ECOS Fellows and lead Teachers to present workshops for scientists and/or Teachers at meetings and conferences as appropriate (e.g., ESA, MSTA, etc.). He or she will also work together to create newsletters, inquiries, and other materials to disseminate and plan for project sustainability. This will be an important activity during this academic year.
11. The Fellow will complete and deliver assessment instruments and/or participate in interviews as part of project evaluation.

APPENDIX 4.3

SAMPLE ADVISOR FEEDBACK SURVEY TOOL

As an advisor of a graduate student who received a Fellowship, we would like to get your feedback on the benefits and drawbacks of having your student participate in this Fellow–Teacher–school partnership project.

1. Please rate the following potential benefits of the Fellowship:

	A major benefit	A minor benefit	Not a benefit
Provided student with valuable teaching experience			
Provided student with valuable community service experience			
Provided financial support for student			
Provided student with opportunity to do research for a dissertation chapter			
Other (please describe):			

2. Please rate the following potential drawbacks of the Fellowship:

	A major drawback	A minor drawback	Not a drawback
Required student to take time away from dissertation			
Required student to take time away from other research responsibilities			
Required student to spend time on activities not related to their discipline			
Other (please describe):			

3. Would you recommend another of your students for a Fellowship? Yes No

4. What other comments or suggestions do you have about the Project and Fellowships?

Please feel free to add additional pages as needed.

SOURCE: UNIVERSITY OF MONTANA

APPENDIX 4.4

UNIVERSITY OF MONTANA SAMPLE CURRICULUM UNIT TEMPLATE



To use this template, fill in the required information for each element after the colon. You may wish to cut and paste information from another file. Feel free to insert diagrams as necessary (be sure to provide a reference for any diagrams created by other people).

1. Contributors' Names:
2. Name of Unit/Investigation:
3. Goals and Objectives:
 - a. Inquiry Questions:
 - b. Science Theme(s):
 - c. General Goal:
 - d. Specific Objectives:
 - e. Grade Level:
 - f. Duration/Time Required:
 - Prep time
 - Implementing Exercise During Class
 - Assessment
4. Science Context:
 - a. Background (for Teachers):
 - b. Background (to present to Students):
5. Motivation and Incentive for Learning
6. Vocabulary:
7. Safety Information:
8. Materials List (including any handouts or transparency masters):
9. Methods/Procedure for students:
 - a. Pre-investigation work:
 - b. Investigation work:
 - 1) What evidence (data, samples) do students collect?
 - 2) How do students present the evidence (data)?
 - 3) What conclusions are drawn from the evidence students collect?
 - 4) Include examples of data sheets.
10. Assessment:
11. Extension Ideas:
12. Scalability
13. References:
14. List of Experts and Consultants
15. Evaluation/Reflection by Fellows and Teachers of how it went:

SOURCE: UNIVERSITY OF MONTANA

APPENDIX 4.5

GK–12 PEER OBSERVATION FEEDBACK TOOL

GK–12 TEAM INSTRUCTION PEER OBSERVATION				
GK–12 Team: _____				
Peer Observer: _____			Date of Review: _____	
CONTENT AND SKILLS	Very Evident	Somewhat Evident	Somewhat Lacking	Not Evident at All
1. Were students given an overview of the topic prior to the teaching session?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Was the significance/importance of information to be learned provided?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Did the content link to previous instruction, building on previous skills and knowledge?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Was the unit illustrated with real life examples, models, and/or analogies?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were students given time to assimilate the new skills and knowledge during the instructional period?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DELIVERY				
6. Was the session well organized?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Was there evidence of active, hands-on student learning?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Was the presentation made at an appropriate pace, stopping to check student understanding and engagement?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Were instructional aids (e.g., visuals, props, handouts, equipment) prepared and appropriate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Were students given time to ask questions and clarify the new skills and knowledge they were developing?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Were students treated respectfully?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
STUDENT ENGAGEMENT				
12. Was there evidence of students actively listening and participating?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Was there evidence of students being passive or inattentive?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Were a variety of instructional strategies used to keep students attentive and involved?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Did the instructor(s) hold the attention and respect of students and practice effective classroom management?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INTEGRATION WITH RESEARCH				
16. Were examples of graduate student STEM research included to illustrate the application of skills and knowledge?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Were specific potential research topics/questions identified within the skill and knowledge contexts of the unit?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Were students specifically encouraged to further explore the skills and knowledge they were learning/gaining?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Strengths: What were the strengths of the instruction and unit?				
Weaknesses: How can the instruction and unit be further enhanced?				

SOURCE: UNIVERSITY OF MONTANA

APPENDIX 5.1

GK–12 BEST PRACTICES AND POTENTIAL PITFALLS (OR.... HOW TO AVOID THE LATTER SO YOU CAN HAVE MORE OF THE FORMER)

Session Objective

Identify common pitfalls or roadblocks on the road to a successful GK–12 project and share ideas to avoid or solve problems that arise.

Session Leaders:

Carol Brewer and Dave Oberbillig (Univ of Montana ECOS GK–12 project), facilitated by Kevin Swanson, NSF GK–12 Einstein Fellow.

Carol and Dave started the session with a team-told story that embodied the evolution of their own project, some of the unexpected challenges they ran into in having their Fellows fully utilized by cooperating teachers and how the quiet perseverance and professionalism of individual Fellows won the teachers over.

The 45 session participants were individuals with different roles in their respective GK–12 projects. The format of the session was to break into working groups of 5–6 people, with participants from one GK–12 project dispersing into separate groups. Each group selected a scribe (to capture all ideas that were articulated and complete the group handout), poster maker (to create a poster of pitfalls encountered and navigational strategies to share) and a spokesperson (to moderate the group, bring consensus and report out the small group’s story to the large group).

The Discussion Decree given to the small groups was to identify:

1. Pitfalls – the 2 most common across projects and the 1 most unusual “out of nowhere” surprise; and
2. Strategies for Success – 2 that can be generalized to GK–12 projects and 1 most unique idea.

The reporting-out comments from the individual groups are summarized here in the section titled “GK–12 Lore: If I only knew then....” and information recorded by the groups is tabulated under the column headings Consensus Pitfalls and Success Strategies. A reflective summary section is included below the table. While no template

for success exists that will encompass the varied nature of GK–12 projects, it is hoped that this document provides a resource that can help new projects anticipate and proactively plan for some of the operational challenges that inevitably arise during the life cycle of a GK–12 project.

The most common themes for “pitfalls” related to communication across the project organization, establishing boundaries and expectations for Teachers and Fellows, identifying appropriate matches between Fellows and cooperating Teachers, coordination of project activities, time management for participants (especially Fellows), teaching skills/concepts at an age appropriate level, problematic actions by some school administrators, cultural differences (K–12 and university) and sustainability.

Common ideas for success strategies included designing effective training for Fellows and Teachers, creating strong professional partnerships between Fellows and Teachers, clear communication, designing engaging learning activities, using technology effectively, providing professional development credit to facilitate “buy-in” from teachers, using written contracts to define and clarify respective roles and responsibilities for Teachers and Fellows, using follow-up workshops through the school year for Fellows and Teachers, Fellows making videos about their own research to show the students, utilizing Fellows with teaching experience to inform the program, requiring research advisors to share the experience of their Fellow and increasing attendance at meetings by offering food.

Some of the surprises reported while working with K–12 schools were the need to have Fellows fingerprinted for background checks, dealing with emergency evacuations of schools, a “dangling” Fellow who found himself without a class when the scheduled class was dissolved, and that Fellows shouldn’t be left alone (without a licensed teacher) in the classroom with the students.

The following section attempts to capture the themes emerging from the final reporting out from the small groups to the large group.

GK-12 Lore: If I only knew then that

- Communication is essential and sometimes breaks down; (Was what I think I said; what he/she thought she/he heard?)
- I have to get them together once in a while [Fellows, Fellows and Teachers] and feeding them really helps.
- Fellows and Teachers like free food—feed them and they will come.
- Others might have expectations that are different than mine.
- Other’s goals may not be my/our goals.
- Things besides lessons happen in schools (e.g. fire drills, lockdowns, TB shots and fingerprinting for Fellows).
- SOMEONE needs to coordinate everything, even the little things.
- I can’t fit all the science equipment in my car trunk (by a Fellow trying to bring equipment to use at a school, because there was very little at the school).
- Running things would take so much time.
- K–12 students work from different levels.
- Schools have standardized tests (which might significantly affect what learning activities can be implemented).
- Dangling Fellows need rescuing (Fellow was left dangling without cooperating Teacher due to changes at the school).
- School administrators may “forget” to follow through and might stop talking to us (or returning e-mails).
- Tuition-free college credits look like free chocolate to teachers (i.e. college course credits for work related to GK–12 activities are translated into additional salary compensation from the district to the teachers; designing project training and development activities so that cooperating teachers can earn tuition-free credit might increase their stake in the project and entice them to contribute additional thought, effort and creativity to their participation).
- Teachers may see the Fellow’s classroom role differently than the project management team does (and I need to take steps to make sure everybody is on the same page in this regard to help ensure a positive experience for participants).
- Research advisors are good arm wrestlers and some have a tendency to arm-wrestle for a Fellow’s time.
- Researchers are from Venus and Teachers are from Mars (i.e. we come from different personal cultures and I will need to keep this in mind to achieve the results I want).
- GK–12 Fellows are from Venus and research advisors are from Jupiter (i.e. potentially conflicting goals and expectations need to be understood).
- Gravity acts in stairwells (by a Fellow in a school where a Teacher was pushed down the stairs by a student—the project needs to be aware of the disturbing realities in some of the schools).
- Maybe I should share ownership of parts of this project.
- Some graduate students will be better fits as GK–12 Fellows than others.
- “Getting to know you” takes time (i.e. the first day of school is way too late for Fellows to meet their cooperating teachers).
- “Communicate” means different things.
- Written documents are important.
- Communication is affected by the trust of the community (of project participants).
- “Bull” happens and some people are better at drilling through it than others.
- People have different personalities.
- It is not easy to write a good people-to-people contract.
- Humans are fallible, flawed creatures that create messes to clean up (this wasn’t said verbatim but is a synopsis of the overarching context of some of the spontaneous discussion remarks generated during the reporting out from working groups to the larger group).
- If you’re not falling down once-in-a-while you’re not learning to ski better. Consider risk–reward balance and be willing to try things like having students collect rattlesnakes (really, it was reported that one Teacher was willing to have her students try this with snakes. NSF does not promote or endorse rattlesnake collecting by K–12 students. The projects are responsible for evaluating what is reasonable risk, but you get the idea).
- The GK–12 web site should be a resource for stuff (like contracts).
- Not all Teachers will perceive this (my) project as the best thing since sliced bread

[Note- Session participants displayed significant energy around the topic of communication. Perspectives about what communication should look like:

- It's a 2-way street; or more like a communication web between all the project participants;
- It should be early, often, consistent and appropriate. (How often was a point of some debate. Frequency of communication meetings needs to be balanced with other time demands. Frequent meetings just to meet without perceived value-added by meeting time can be frustrating.)
- Consistency of communication was perceived as essential to support project success. One Fellow indicated receiving conflicting answers to a question from the PI and the project manager.
- Participants felt that there needs to be a clear chain of command in the project to ensure consistency of communication. They suggested that project management needs to have a "communication hub" – someone designated as a point of contact to go to with operational questions and that there needs to be one person who "knows where everything is" in the project.

Individual Small-Group Newsprint Synopses

In the table on the following page, **bold** items are those identified by groups as the unique SHOCKER (or "super Pitfall" as described by some groups) or UNIQUE strategy (not all groups identified one).

Summary Comments:

Challenges in K–12 education may look different to those working outside "the K–12 system" than to those working inside. Many GK–12 Fellows report a transformation in their perception of what K–12 education looks like and the challenges within the system after they have worked in the schools with the Teachers and students. Many GK–12 project senior personnel (STEM researchers) may not initially have a deep familiarity with the day-to-day K–12 school schedule structure and other non-curricular operational and liability elements that are associated with being legally responsible for large numbers of minors. Given this situation and cultural differences between research worlds and K–12 education worlds, it is important that GK–12 project management attempt to listen carefully for concerns which Teachers and other school personnel may express and be prepared to adjust where needed to increase the probability of success.

It was apparent during the session that the

most common recurring issue was the importance of building a positive and collaborative working relationship between the Fellow and cooperating Teacher, especially in those projects which use a one Fellow–one Teacher pairing model. Building this relationship, the filter through which the work of the Fellow with the K–12 students occurs, takes time and intentionality on the part of the project management and an understanding that GK–12 projects bridge different cultures that speak different languages. Clarifying expectations, defining respective roles and responsibilities in the classroom and creating a sense that the Fellow and Teacher are equal project stakeholders with different areas of expertise helps foster a positive working environment that increases the quality of the project experience and professional growth for both the Fellow and Teacher. It also lays the groundwork for positive benefits to the K–12 students.

The above transcribed lore and articulation of potential pitfalls and success strategies represent the collective experiential wisdom of 45 GK–12 participants from multiple projects from across the United States, as brainstormed and shared during one Annual Program meeting breakout session. It does not constitute a final recipe that can be transferred to each and every individual GK–12 project. However, it is hoped that it will help provide a "heads up" for oncoming potholes and detours as well as potential strategies to help GK–12 project management navigate down their own GK–12 highway.

Transcribed by Kevin Swanson 2007-08 Albert Einstein Distinguished Educator Fellow assigned to NSF GK–12 Program.

Consensus Pitfalls	Success Strategies
<ul style="list-style-type: none"> - Unresponsive school administrators and lack of coordination with school administration - Lack of clarity about roles and allowing assumptions to lead the way - Balancing GK–12 time with research – while meeting all expectations 	<ul style="list-style-type: none"> - Create teacher “buy-in” through paid credits for teachers during the program planning process - Contracts between constituents and open communication - Require research advisors to share experience with their Fellows
<ul style="list-style-type: none"> - Clarity of roles not always explicit - Breakdown in communication both within and across levels (PI’s, Fellows, Teachers) - Interference from high stakes testing and unforeseen complications in the schools 	<ul style="list-style-type: none"> - communication, communication, communication - Articulating boundaries/roles across levels - Feed the Fellows (and teachers too) and they will come [to the project meetings]
<ul style="list-style-type: none"> - Thinking what we proposed was actually what we were going to do! - Cultural differences - Don’t give all the \$\$ out at summer workshop 	<ul style="list-style-type: none"> - Extend deadlines (for applications) to increase pool of [Fellow] applicants (but be careful...) - Bring back your best Fellows ... even though it’s best to share the love
<ul style="list-style-type: none"> - Lack of understanding of roles and expectations (and lack of prior knowledge of each other), i.e. what a “middle schooler” was like and what a graduate student is - Bureaucracy – school districts/administration, schools, university, classrooms (difficulty with field trips) - Teacher leaves due to injury, no substitute, class is dissolved and students spread out to other classes = no classroom classes for Fellow – what do you do? 	<ul style="list-style-type: none"> - Make clear roles and expectations = communication = “job descriptions” in writing - contract with Fellows and teachers (co-ownership to define roles) - Formal Application and Interview process = in person to assess accurately (not clear if this was referring to Fellows, teachers or both) - Bring back at least 2 fellows to help train new Fellows (use your best options)
<ul style="list-style-type: none"> - Sustainability - Lack of coordination (at all levels) - Time - Resources (equipment) [in the classrooms] - Student skills and background knowledge - Standardized testing needs and emphasis [in the K–12 classrooms and how it might affect available options for Fellows’ activities in classrooms – varies from place to place] 	<ul style="list-style-type: none"> - Planning prior to the school year - Hands-on activities - Successful collaborations - Creating trust and mutually respectful Teacher–Fellow partnerships - Technology in classrooms (having it available)
<ul style="list-style-type: none"> - Teacher–Fellow selection and matching criteria (or lack thereof) - Unclear expectations (communicate your expectations: teachers need to be voluntary; otherwise there are misguided expectations) - Unpredictability in the classroom (TB tests and fingerprinting for Fellows, bomb scare in school) 	<ul style="list-style-type: none"> - Clarify Fellow’s role in the classroom (you’re scientists, not teachers) - Not leaving Fellows alone in the classroom (not a strategy, just a rule [with potential legal implications if not followed and something happens]) - Constant communication (with all participants) - Having a graduate student with previous teaching experience inform the project
<ul style="list-style-type: none"> - Development of clear expectations - Poor communication and flow of information across organization 	<ul style="list-style-type: none"> - Finding the best method of communication (meetings, team-building exercises) - Fellow video to students (re: research work)
<ul style="list-style-type: none"> - “This is the first job (Fellow) I’ve had where I got in trouble for working too much” (i.e. need to balance Fellowship time and research time – a goal of graduate school is to graduate) - Not replacing the project manager who moved on after 2.5 years 	<ul style="list-style-type: none"> - Team building for equal partners with the grad student as “science expert” and the teacher as “science teaching expert” - Intensive training institute with workshops through school year - Pedagogy training that leads to products (curricular materials, teaching philosophy, publication, professional CV, etc.) - Create lasting infrastructure and artifacts (e.g. effective web site, green houses, native plant gardens, curriculum material, local field guide) - Paying close attention to our assessment feedback, the project has an expert and we have to learn from our data and adjust where necessary

APPENDIX 6.1

EXAMPLES OF INTEGRATING RESEARCH IN THE CLASSROOM

INSPIRE GK–12, MISSISSIPPI STATE UNIVERSITY

Technology

A Fellow studying mechanical engineering and computer projecting created a semester-long project for a robotics course for 11th- to 12th-grade students at a math and science academy. Students began by learning basic projecting of Lego® Mindstorms® through guided activities. They were then assigned to small student teams and challenged to develop a computer project to create a functioning robot. The culminating task was a competition among the teams at a Robot Olympics. The Robot Olympics had a variety of competition tasks, including putting a ball in a designated cup, recognizing colors, and dancing to music, to name a few. Students were excited and engaged throughout the entire process.

A Fellow in a middle school science classroom used technology to teach a lesson on microscopes and “what cannot be seen with just the human eye.” He demonstrated the use of a benchtop scanning electron microscope to observe objects selected by the students and led a discussion of the features of the objects that were surprising to the students. The Fellow connected this activity to his own research on soil microorganisms, which can be seen only through microscopes.

A Fellow who studies the impacts of meteorology on agriculture conducted a lab in which middle school science students used handheld weather meters to collect weather data and predict weather patterns for the next day. Students collected data from various locations around the grounds of the school to compare differences in temperature, humidity, wind speed, and barometric pressure.

Hands-on activities

A Fellow who studies industrial engineering in the field of ergonomics of working environments and the human interface with equipment created an activity for a high school geometry class which allowed students to design a chair that could bear the most weight on the basis of their knowledge of which geometric shapes provide the most support. Students hypothesized which shapes would be the best form of support to use in their chair design and

then used popsicle sticks to build the chair and test their hypotheses.

A Fellow who studies inorganic chemistry and metal reactivity showed several samples of metals in solution to eighth-grade science students who were studying metals in the periodic table. The students conducted a lab that involved flame testing a variety of known metals and observing the color produced in the flame. The students were then given unknown samples to determine, on the basis of their earlier observations, the type of metal in the solution and its location in the periodic table.

Demos

A Fellow who studies hydrogeology used toilet paper as a time line to demonstrate the expanse of geologic time to eighth-grade students. The students were led to the hallway by the Fellow, and the toilet paper was rolled out into segments while the Fellow described each geologic period, with each piece of toilet paper representing a grouping of years. By the end of the lesson, the students had walked the entire length of the hallway and toured the geologic timescale.

A Fellow who studies inorganic chemistry invited the local fire station to give high school chemistry students a lesson in fire safety as part of the laboratory safety unit. In the lesson, a firefighter demonstrated how to use a fire extinguisher, before allowing students to practice on a controlled fire on the school grounds. The lesson was followed by safety demonstrations conducted by the Fellow regarding the dangers of acid. The Fellow projected a cow’s eyeball onto a large screen in the classroom and inundated the eyeball with acid. The students saw a reaction quickly take place. The demonstration illustrated how fast acid can cause damage and brought home the point to the students that they need to wear safety glasses in the laboratory.

Didactic

A Fellow who studies invasive species of Australian pine and their acidic impacts on the soil introduced seventh-grade science students to the practice and importance of making observations in field research along with keeping copious notes on their observations and findings in a lab notebook. The

Fellow provided images of her field research in a PowerPoint presentation and then had the students share what they noticed about the surrounding environment of the invasive species as shown in the images. The Fellow also provided her field notebook for the students to see examples of the type of observations and data collection she made. The Fellow then related this lecture to the students' upcoming lab experiences.

STATE UNIVERSITY OF NEW YORK COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

Games

A Fellow who studies nutrient cycles in grasslands introduced her environmental science students to the topic of the nitrogen cycle by developing a game in which the students work together to act out the steps of the cycle in the classroom. The “legume” and “symbiotic rhizobia” students linked arms and worked together frantically to cut apart the paper nitrogen (N₂) molecules. Then they passed the nitrogen atoms (N) on to the “soil,” who passed it on to the “plants,” and so on. This simple game got students excited and engaged in the topic. Building on that experience, the class then worked together to create a flow diagram of the nitrogen cycle. Finally, the Fellow gave a PowerPoint presentation that linked the nitrogen cycle to current global events related to agriculture, fossil fuels, and food security.

Didactic/Technology

Another Fellow who works on mosquito-borne diseases traveled to her field site in the tropics for a few weeks during the school year. While she was in the field, she emailed her high school students regular updates of her work, posted photos of her site online, and responded to student questions. When she returned, she talked about her



State University of New York GK–12 Fellow guides environmental science students through an activity.

experiences and shared photos and video, using a PowerPoint presentation.

EAST TENNESSEE STATE UNIVERSITY

Hands-on activities

A GK–12 Fellow incorporated her research on microbiology into a two-week unit on the basics of bacteria for a fourth-grade class. The unit was set up as a science experiment in which the students investigated the research question “Where in the classroom do the most bacteria grow?” In the first week, the Fellow facilitated a discussion that led the students to develop their own hypotheses about the location at which they thought the most bacteria would be found. Students then tested their hypotheses by swapping locations with one another and growing the bacteria in a petri dish. In the second week, the students gathered data by sketching the patterns of bacterial growth they observed under a microscope. Then they analyzed their data by ranking the bacterial growth between locations. On the basis of their analyses, they were able to make conclusions about their hypothesis and answer the research question.

OPIHI (OUR PROJECT IN HAWAII’S INTERTIDAL), UNIVERSITY OF HAWAII MANOA

Technology

Fellows developed inquiry-based projects and lessons to teach middle and high school students research skills. Students learned how to gather data on the various species of invertebrates (see photo below) found in Hawaii’s rocky intertidal, data that can inform scientists about environmental changes. The data were entered into an online database used by other scientific researchers and the public. Students were then involved in various activities, such as science fair projects and creating brochures and posters, to communicate and share their findings.



Brittle Star (*Ophiocoma erinaceus*) studied by the University of Hawaii GK–12 Teachers and students.

APPENDIX 6.2

LESSON PLAN: ENGINEERING COST ANALYSIS BY DESIGN OF A WATER FILTER

GRADE LEVEL

It is targeted for grade 6.

SUBJECT AREA

Math, Science

KEYWORDS

Activated carbon, cost analysis, design, engineering, filter, food coloring, greywater, particulates.

LEARNING OBJECTIVES

This activity serves two purposes. The first is to reinforce topics that the students will be familiar with such as addition, multiplication and sales tax calculation. The second objective is to introduce the engineering design concept of proper material selection and the impact that material costs have on a design. The students will build a water filter using various materials with an assigned cost. Colored water will be run through the filter with the goal of filtering the color from the water. Student designs will be evaluated by two criteria. The first will be to visually inspect the filtered water and determine if the color was removed. The second will be to compare the cost of the water filter. The best class design is determined by comparing filtration capability and lowest design cost.

ENGINEERING/SCIENCE CONNECTION

One of the steps utilized in treating greywater is to filter it to remove larger particles. Various degrees of filtration of water exist. The level of filtration depends on the intended use of the end product. Removing fine particles through the filtration process is required if the end goal is obtain water for consumption. Engineers involved in water purification/treatment are involved in engineering processes or machinery that can perform the proper filtration. One of the constraints an engineer encounters in the design process is the constraint of cost. As an engineer, he/she is tasked with designing a process or product within a certain cost. It is possible to develop a product that accomplishes the same task but may vary in cost. In this activity students learn how to design

and build a basic water filter. The students will have the freedom to design their filter as they choose and will calculate the cost to build their filter.

TIME REQUIRED

The activity can be completed in 1hr 50 minutes. This includes an introduction to the activity (10 mins.), instructions (10 mins.), performing the activity and completion of the “Water Filter” worksheet (90 mins.).

GROUP SIZE

Group size is between 1 and 3 students. Material availability and class size will usually dictate group size.

EXPENDABLE COST PER GROUP

Cost for a group size of 20 to 25 students is approximately \$20.

EDUCATION STANDARDS

Sixth Grade Standard 6.b. (Sales tax calculation)

MATERIALS LIST

Materials List:

1. Activated carbon: A 16oz container would be needed for a class of approximately 20–25 students. This item can be purchased at www.amazon.com for approximately \$7.00, keyword: Black Diamond Activated Carbon. This item can be reused.
2. Cotton rounds, 240 count. This item can be purchased at www.walgreens.com for approximately \$4.50, keyword: Cotton round
3. Cotton balls, 100 count. This item can be purchased at www.walgreens.com for approximately \$1.50, keyword: Cotton balls
4. Clear Plastic Cups, 50 count. This item can be purchased at www.partycity.com for approximately \$6.00, keyword: Clear plastic cup, 10oz, 50ct. This item can be reused.
5. Water bottles. This item should not be purchased but should be collected prior to the activity and recycled or reused.

6. Water Filter Worksheet. One worksheet per student would be required.

PREREQUISITE KNOWLEDGE

To be successful, the student should have knowledge of basic arithmetic and sales tax calculation.

ACTIVITY BACKGROUND AND CONCEPTS FOR TEACHERS

This activity will introduce the basic operation of a water filter. It will also expose the students to consider the impact that their design decisions have on the cost of their design. Students will learn that particles can interfere with bacteria inactivation. From the introduction of the activity, discussed later, the students should know that the UV light does not kill the bacteria but instead prevents them from reproducing.

The teacher should have a basic understanding of water filtration and its role in the water treatment process. A filter, as shown in Figure 1, functions by preventing predefined particle sizes from passing through the filter material. A filter is selected to remove particle sizes up to a specified size.

Activated carbon (Figure 2) is known by other names such as activated charcoal or activated coal. Activated carbon is used in various forms some of which include powder, granulated, granular and extruded. For this activity we use the granulated form. Activated carbon is used in water treatment because each granular piece of carbon is very porous and has a large surface area for removing water impurities. Activated carbon is used in commercial water filters to purify water for drinking.

The teacher should have a basic understanding of what ultraviolet light is. The basic concepts are that ultraviolet light is part of the electromagnetic spectrum that has a wavelength between 10nm and 400nm. The unit of measure for the different wavelengths in the spectrum are measured in

nanometers, nm. A nanometer is 10^{-9} meters, which is 1 billionth of a meter. UV light can't be seen by the human eye. In comparison, the portion that can be seen by the naked eye is between 380nm and 750nm. Figure 3 shows the electromagnetic spectrum. The different types of light that make up the electromagnetic spectrum are measured in wavelengths.

INTRODUCTION/MOTIVATION

The following is a guide as to how the lesson can be introduced to the class.

Research is being conducted to study the effects that ultraviolet light produced from light emitting diodes has on greywater pathogens. The idea is to be able to treat greywater so we are able to reuse it. Before we continue let's define a few words. Ultraviolet light is a type of radiation. We experience UV radiation every time we step into the sun. Has anyone ever been sunburn? If you have, the sunburn was caused by ultraviolet lights. Has anyone seen businesses where you can get a tan? They use UV lamps to get people tanned. UV light is nice for tans, but it can also be bad if we get too much. It can cause negative effects like cancer. This is why it's important to wear sunblock. Research into UV light was conducted because it was identified as causing harmful bacteria and viruses to stop reproducing. This is why UV light is used in water treatment. Light emitting diodes or LEDs are small sources of light that can artificially create UV light. Until recently, lamps were used to create artificial UV light but LEDs use less energy and last approximately 10 times longer. Greywater is water that comes from our homes. It's defined as any water that comes from our sinks, bathtubs, washing machines or similar sources except from the toilet. Water that comes from our toilets is called black-water. Researchers are investigating how they can treat this greywater that we produce daily in our homes so we can reuse it. If the bacteria and viruses that are found in greywater were removed using UV light, it would be safer for people to reuse. Has anyone seen a commercial about water droughts? This is a serious issue. As the cities and our population grow, we use more water. If we don't do something about it we can run out and that would be very bad. What is one way we can do our part to help? (Answers: Using less water, recycling) What if we could reuse all the water we use for showering, washing dishes and washing our clothes? Do you think that would help us conserve

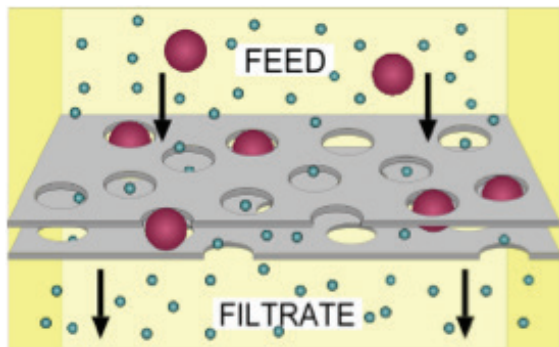


Figure 1: Filtration Operation

water? Wouldn't it be great to use this water again and not have to use clean drinkable water instead? What are some uses you think we can reuse this water, that doesn't include drinking it? (Answers: Washing our cars, watering the lawn, flushing our toilets). A goal researchers have is to determine if the greywater can be treated to ensure it is safe for us to reuse.

In this activity we will design our own filtration systems. The filtration systems are important because they remove large particles from the greywater before being treated further. You will get into groups of two and be given certain materials. Each material has an assigned cost to it. You will design your filtration system and determine the total cost to build and operate it. This is a real world situation. Products that are designed have to be designed with cost in mind.

VOCABULARY/DEFINITION

1. Activated Carbon: This is a form of carbon that is defined by very fine pores. It is used to absorb gases and solutes. It's main uses are in purification, deodorization and decolorization.
2. Filtration media (Filter): A substance, usually porous, through which liquid is passed to remove suspended particles or impurities.
3. Ultraviolet (UV) light/ray: Ultraviolet light is part of the electromagnetic spectrum that has a wavelength between 10nm and 400nm. It is not visible by the human eye.
4. Greywater: Water from residential sources such as sinks, bathtubs, washing machines but excludes sources such as toilets.
5. Black water: Water from sources such as toilets or other sources containing human/animal waste.
6. Bacteria: single celled organisms that are



Figure 2: Activated Carbon

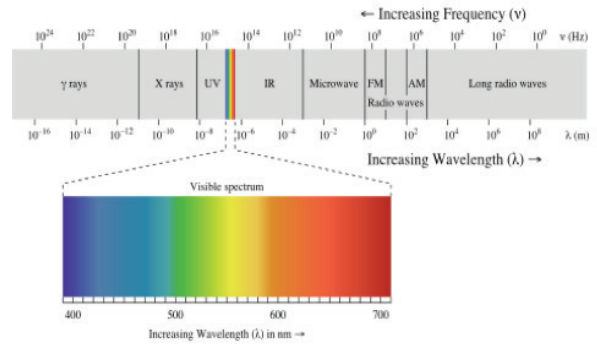


Figure 3: Electromagnetic Spectrum

typically spherical, rod-shaped or spiral shaped. Bacteria are part of the process in fermentation, infectious diseases, nitrogen fixation and putrefaction.

7. Virus: A microscopic agent that is typically infectious. It reproduces itself within the cells of other living hosts like bacteria, plants and animals.
8. Disinfection: To get rid of microorganisms that are potentially harmful.
9. Particle: A piece, fragment or minute portion. It is considered a tiny or small portion. Example: A particle of dust.

(NOTE: Definitions paraphrased from Dictionary.com)

DESIGNING A WATER FILTER

Procedure

Step 1: Introduce the activity. Use the guide of how to introduce the activity from the “Introduction/Motivation” Section. The students should know they will be designing and building a water filter. They should know that they will be allowed to select the materials to use in the filter but that each material has a fixed cost.

Step 2: The instructor should prepare the colored water ahead of time. Each group should receive a 16 ounce bottle of colored water. Food coloring should be used. Green food color is recommended but other colors can be substituted if needed. The teacher should also prepare the water bottles needed for the students' filters prior to commencing the project. The bottom of a 16 oz water bottle should be cut-off. For a class of 36 students 18 water bottles should be used. Group the students in pairs. Instruct the students that they should plan and design their design prior to building the filter.

Step 3: Conducting the Activity

Pass out the worksheet, “Designing a Water Filter”. Read the worksheet to the students. The worksheet explains the procedure the students must take to complete the activity. Inform the students that as they purchase the materials they must record the quantity they purchase and compute the subtotals. (Note: Students should not be allowed to use only the activated carbon.)

(Note: This activity involves the use of water. Make sure to have napkins available for possible spills that may occur.)

Step 4: When the student(s) complete the design and build their filter, allow them to cycle the colored water through their filter. Make sure they place their filter inside the clear plastic cup as shown in Figure 4. They should see a reduction in the color of the water. If they choose to cycle the water again have the student use a second clear cup and place it under the water filter and use the water in the cup and filter it. The students can filter the water as many times as they want. Let them know that each time the water is cycled, it will cost them the predefined amount. After the students are satisfied with the outcome of the water, the total cost should be computed.

Step 5: The teacher should compare how each group’s filter and costs compare to one another. If desired, a top overall design can be selected.

SUPPLEMENTARY MATERIALS

Water Filter Worksheet

ASSESSMENT

The following pre and post questions should be asked for assessment purposes:

Pre-Activity Assessment:

1. Why is it important to have drinking water without any particles of dirt or other particles in it? Answer: The particles may cause us harm if we drink them and/or make us sick.
2. Is it important to consider cost when designing a product? Would you buy a bottle of water if it cost \$10. Answers: Probably not. We would drink tap water if bottled water were that expensive.
3. Is selecting the proper materials to design a product important or is it more important to design a product no matter the cost? Answer: Allow students to give their answers. Ask this question again after the activity.

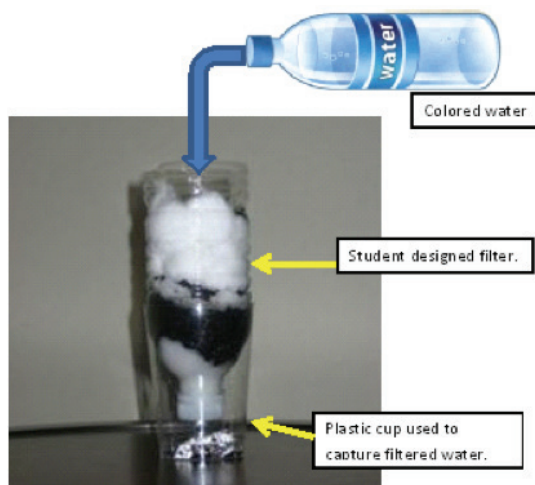


Figure 4: Water filter built from water bottle, cotton balls and activated carbon.

Post-Activity Assessment:

1. What material was most effective in removing the color from the water? Answer: There is no right and wrong answer as this depends on the student’s design.
2. What design changes would you make to improve your design? Would you use more materials to improve the filtration performance or less material to reduce costs? Answer: There is no right and wrong answer to this question.

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Water Filter Worksheet

Objective

A preliminary filtration system will be important in a water treatment system. Preliminary filtration removes large particles such as dirt or gravel from the water. This is important in a water treatment system that uses ultraviolet light for secondary treatment since any large particles in the water will prevent bacteria from being treated.

Your goal is to perform a preliminary filtration on the provided greywater. Greywater is a term for residential water that comes from any source other than toilet water. Examples would be shower water, dishwater or laundry water. You will design and build a portable filtration system. The system you design will be used to filter and clean the water as much as possible. You may cycle the water through your system as many times as needed to obtain your desired filtration. The colored guide, Figure 1, can be used to determine the level of filtration achieved.

It would be nice to design and develop the filtration system without worrying about costs but since we live in the real world we need to take costs into consideration. The total cost of filtering the greywater will depend on the materials you use to build your filtration system and the number cycles used. Use the following table to document the materials used and the number of cycles used to filter the greywater and calculate the total cost of filtration.

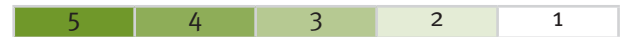
Materials:

- Water Bottles: \$5.00/each
- Cotton Balls: \$.50/each
- Cotton Rounds: \$2.00/each
- Activated Carbon: \$10.00/spoonful
- Cups: \$1.00/each
- Cost per cycle: \$15.00/cycle

Costs			
Materials	Qty	Price	Subtotals
Water Bottles			
Cotton Balls			
Cotton Rounds			
Activated Carbon			
Cups			
Cycles			
Total			
9.75% Tax			
Total Cost + Tax			

(Note: Can't buy only activated carbon.)

Figure 1: Color Guide



APPENDIX 6.3

LESSON PLAN: SIEGE THAT CASTLE

Lesson Title	Projectile lab “Siege that castle!”
Length of Lesson	1 day
Created By	Henry Stauffenberg IV, William Funderburk
Subject	Physics
Grade Level	9–12 (Physics)
State Standards	Physics:1a,b,c,d,e,f;2a,b,c
Depth of Knowledge (DOK) Level	Physics: 3
DOK Application	Create, inquire, hypothesize, organize, collect, interpret, investigate, connect, explain, prove, draw conclusions, graph, predict, regress
National Standards Graduate	9–12 A: Inquiry; B: Physical Science;
E: Science and Technology	
Research Element	Working with Excel for statistical analysis and presentation of data collected and drawn from experimentation. Creation of range table and improving it, using applied knowledge of basic calculus and physics. Importance of experimental design and development of critical Excel skill set.

Student Learning Goal:

The purpose of this lesson is to re-create a medieval range table and learn the importance of experimental design and Excel application and analysis. Students will utilize the range table (graphing through Excel) to regress a quadratic equation that describes the accuracy of a projectile; in other words, students will use the power of math to knock down a castle wall. The goal is to get students thinking about nonlinear multidirectional motion and to expand upon what they have learned about vectors, velocity, and acceleration due to gravity.

Mississippi State Standards

Physics: 1: (a) Use current technologies, such as CD-ROM, DVD, the Internet, and online data searches, to explore current research related to a specific topic; (b) clarify research questions and design laboratory investigations; (c) demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations; (d) organize data to construct graphs, draw conclusions, and make inferences;

(e) evaluate procedures, data, and conclusions to critique the scientific validity of research; (f) use logic and evidence to formulate and revise scientific explanations and models; 2: (a) Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies; (b) analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion; (c) Analyze real-world applications to draw conclusions about Newton’s three laws of motion.

National Science Education Standards of Content 9–12

A: Inquiry: Identify questions and concepts that guide scientific investigations:

- Students should formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding the hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base, and a conceptual understanding of scientific investigations.

B: Physical Science—motion and forces:

- Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated from the relationship $F = ma$, which is independent of the nature of the force. Whenever one object exerts a force on another, a force equal in magnitude and opposite in direction is exerted on the first object.
- Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is inversely proportional to the square of the distance between them.

E: Science and Technology—understanding about science and technology:

- Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations.

Many scientific investigations require the contributions of individuals from different

disciplines, including engineering. New disciplines of science, such as geophysics and biochemistry, often emerge at the interface of two older disciplines.

Materials Needed (supplies, handouts, resources):

Pasco spring-operated projectile launcher, plastic or wooden balls of standard size and mass, grid paper, carbon paper, meterstick, computer and Excel program, cup or equivalent object to represent castle tower or wall.

Lesson Performance Task Assessment:

- Demonstrate ability to use Pasco equipment and create range tables
- Demonstrate ability to design and work in a lab, using available materials
- Demonstrate ability to create graphs and regression equations in Excel
- Show work, using carbon and graph paper and good note taking
- Demonstrate ability to use equations to hit an object placed at a set measured distance
- Complete a lab write-up

Relevance of Lesson to Performance Task and Students:

- To practice experimental design, using specialized Pasco equipment
- To understand the importance of experimental design by completing a range table, a graph with Excel, and a regression of a quadratic equation to meet the objective of knocking down the opponent's wall with one calculated shot
- To gain insight into medieval times (learn a bit of history) and into the importance of projectile motion and the rise of physics
- To apply what the students have learned, such as the concept and equations of projectile motion, and to connect, compare, and contrast what they have learned with previously learned linear motion (free fall of objects affected by gravity)

Capture Interest:

Sitting at each class table is a barbarian horde (or Celtic/Germanic tribe) that recently “appropriated” a Roman catapult. Your reigning warlord demands that you, the engineers, investigate and document the capabilities of this new siege weapon of war. Unfortunately, the last pillaging and burning

destroyed the range table created by the Romans. You will have to re-create this table through testing and documenting results. Being the clever engineers that you are, you realize the power of math and figure that you can improve upon the table and one up the Romans by graphing it and regressing an equation for calculating the precise placement of a projectile. If you are successful, you will have revolutionized siege warfare, making seizing and pillaging territories far more efficient.

After the class creates a graph: Your warlord has grown tired of your restless barbarian neighbors and wishes to test your siege weapon on them in order to destroy the competition. Your neighbors wish to do the same to you, so every shot counts, as this looks like war. One shot, one kill—the last barbarian encampment standing wins. It's time to put your range table and equation to the test: The global conquest of the physics classroom begins!

Historical Note:

Castles and siege weaponry were at their height during the medieval era shortly after the collapse of the Roman empire; however, neither the Greeks nor the Romans utilized or pioneered siege weapons such as the ballista or the grapeshot catapult. During the 1300s, trebuchets and the use of range tables remained the primary method of siege warfare, and they did so for hundreds of years afterward, until calculus was applied to physics to replace the range table. The application of calculus to physics during World War II was revolutionary, enabling the calculation of shell trajectories aimed at battleships and precise artillery bombardment of enemy targets, thereby contributing to the Allies' victory during World War II.

Guided Practice:

Show how to use a projectile launcher safely, and demonstrate how to load the launcher, set the spring, and adjust the angle. Make it clear that the student is to click only into the first spring setting. Then show how to measure the horizontal distance up to the graphing paper (in centimeters) with a carbon sheet laid over the top. Launch a ball and have it hit carbon paper, leaving a mark on the graph paper. Make it clear that the student is to lift the carbon paper and label each shot. Each table will fire five shots at a wide range of angles, to avoid clustering of data. Each shot is done in triplicate (fired at the same angle and recorded

three times in a row). Explain the importance of triplicate recording by connecting graduate research with averaging and the accuracy of data. Make it clear that the only measurements the students will be recording on the table (after the shot is fired) is the horizontal distance the projectile travels and the angle of attack. Students should choose how to organize their tables; however, giving a sample table for triplicate work is recommended, as students may be working with Excel for the first time. After the tables are created, walk through a class demonstration creating a graph with Excel and regressing a quadratic equation from the data. Explain briefly how the formula can be used to calculate the angle or horizontal distance when one variable is known. For the war scenario, explain that each team will place its cup (castle) at any linear distance from the catapult. The team operating the catapult will measure the distance to the castle and insert the measured value into its equation. If the equation is good, the projectile should hit the cup on the first shot; however, it most likely will take a few shots because of other variables at play.

Either before or after generation of the range table, explain to the students that they will also calculate the muzzle velocity (initial horizontal velocity) of their projectile launcher. They must set it to zero degrees, record the horizontal distance the projectile travels, and record the vertical distance from the floor to the middle of the barrel. Give them the two projectile equations to calculate the travel time and the initial velocity in the horizontal direction. Explain that they will manipulate the first equation so as to substitute time into the second equation. That way, they won't have to know the time, and they can insert their vertical and horizontal measured distances into the appropriate equation to calculate the initial muzzle velocity. This exercise will be homework, because the creation of the range table is more important, especially if they are to compete in the war scenario described earlier.

Independent Practice:

Calculation of the muzzle velocity and other components of projectile motion if needed, such as a change in vertical direction or vertical initial velocity.

Enrichment:

Ask for students' calculated vertical projectile components, using their horizontal data. Have students further explain and connect applied

concepts to the lab they have just completed. Have them use equations to hit more difficult targets.

Check(s) for Understanding:

- Successful completion of range table and quadratic equation
- Ability to use equation to hit target castle
- Correct calculation of muzzle velocity
- Ability to explain in a report what they did and why it was important and ability to connect together the material they learned in previous lectures about projectile motion, free fall, Newton's laws of motions, and the effect of gravity

Closure:

Mention the historical note stated previously, or end with a class discussion on Newton's laws of motion and other material that the class will be moving into beyond projectile motion.

Possible Alternative Subject Integrations:

Calculus: Regression models, line equations, and formulas using algebraic calculations

Teacher Notes:

Pick an open room, place launchers in areas that will avoid potential damage to computers and other breakables, and do not use ammunition that has a lot of bounce to it. Keep an eye on the students, because they can hurt themselves if safety procedures are not followed.

APPENDIX 6.4

LESSON PLAN: SUPERHYDRO-WHAT? MEASURING ANGLES AND SEGMENTS

Student Learning Goal:

Students will observe how water droplets interact with various surfaces and will learn the concept of surface wettability. They will learn the difference the smoothness of a surface makes when water droplets come in contact with the surface. For example, smoother surfaces or superhydrophobic surfaces tend to have higher contact angles and are considered less wettable. Protractors will be used to measure the contact angle of a water droplet on a variety of surfaces. Students will use the Proscope to see better and will make conclusions about the smoothness of the surface. Students will use rulers to measure the spread of the droplet in contact with the surface and the height of the droplet as it sits on the surface.

Materials Needed (supplies, handouts, resources):

Water, surface samples, droplet dispenser, 2–3 Proscopes, 2–3 computers and projectors, protractors, rulers

Lesson Performance Task/Assessment:

After seeing the demonstration of water droplets striking various surfaces and after observing the difference between superhydrophobic, hydrophobic, and hydrophilic surfaces, students will learn the definitions of contact angle, spread, and height. Students will work in small groups and will use the Proscope (with supervision) to observe

water on two or three different surfaces. Using a ruler and protractor, they will measure the contact angle, spread, and height to scale. By holding a rule up to the picture on the screen, they will realize that the picture is not to scale. In order to measure it to scale, the measuring device must be observed next to the droplet and viewed within the Proscope.

Lesson Relevance to Performance Task and Students:

Students will understand that not all surfaces are the same. This understanding will help them realize that not all surfaces can be used on aircraft wings if ice is to be prevented. They will also learn to use measuring devices in a real-world research setting.

Anticipatory Set; Capture Interest:

Without offering any explanation, the instructor will demonstrate water striking three different surfaces. Students may expect to see the same results on each surface, but will observe that water does not interact with each surface in the same way. This demonstration should pique the students' curiosity, and a discussion will be prompted with the following questions:

- Which surface repels water the most?
 - Explain wettability
 - Is the surface that repels water more or less wettable?

Lesson Title	Superhydro-what?! Measuring Angles and Segments
Length of Lesson	50 minutes
Created by	Emily Burtnett
Subject	Geometry
Grade Level	9th, 10th, 11th, 12th
State Standards	4b
DOK Level	2
DOK Application	Solve real-world applications and mathematical problems to find missing measurements in right triangles by applying special right-triangle relationships, geometric means, or trigonometric functions.
National Standards	Understand measurable attributes of objects and the units, systems, and processes of measurement that apply to them.
Graduate Research Element	Apply appropriate techniques, tools, and formulas to determine measurements. Measure contact angles of droplets on various surfaces.

SOURCE: INSPIRE GK–12, MISSISSIPPI STATE UNIVERSITY

- Which surface should be used if you do not want ice to build up on your aircraft?

The instructor will use the Proscope to show a close-up of a water droplet on one of the surfaces.

- What kind of measurements can we make to describe the droplet on this surface such that we can use these measurements to compare the droplets with droplets on other surfaces? (contact angle, spread, and height)

Guided Practice:

The instructor will define contact angle, spread, and height. Students will work in three groups and rotate among three stations. At each station will be a Proscope set up to observe a droplet on a superhydrophobic, hydrophobic, and hydrophilic surface. The instructor will guide the students how to measure the three variables, and the students will collect and record the data at each station on their own. The instructor will assist as needed. Once the students have collected the data, the instructor will ask them what observations they made about each station and how their data compared. The instructor will conclude with the definitions of superhydrophobic, hydrophobic, and hydrophilic surfaces and ask students to try to classify the sample at each station. Superhydrophobic surfaces generally have contact angles greater than 150° , hydrophobic surfaces demonstrate contact angles of $\sim 120^\circ$, and hydrophilic surfaces can have contact angles of up to 90° .

Independent Practice:

Students will work independently at each station to measure and collect their data on each droplet. The teacher will walk around and assist as needed. Students will be asked to discuss their data with each other.

Remediation and Enrichment:

If the Proscopes aren't working in the classroom or the image isn't of good quality, the instructor will have handouts of a picture of a droplet on each surface available for students to use to measure. Individual IEPs will be supported. For enrichment, or if there is extra time, the students can use surfaces in the room on which to observe and collect data. These surfaces could include desktops of various roughness, chairs, textbooks, glass, etc. They can compare data taken from these surfaces with the data collected at the stations

and can then make conclusions about the various surfaces.

Check(s) for Understanding:

Students will be asked to classify the surfaces as superhydrophobic, hydrophobic, and hydrophilic. They will be asked for examples of where and why an engineer might want to use a hydrophilic surface rather than a hydrophobic surface, and vice versa.

Closure:

The instructor will conclude with the definitions of superhydrophobic, hydrophobic, and hydrophilic surfaces and will ask students to try to classify the sample at each station. Students will apply their understanding of each surface to a real-world application—for example,

- Why would an engineer want to use a superhydrophobic surface versus a hydrophilic surface?

Possible Alternative Subject Integrations:

Use physics to explain effects of densities, viscosity, and velocity.

Teacher Notes:

Show students pictures through a PowerPoint presentation. Make sure that there is an instructor at each station to monitor the usage of Proscopes.

APPENDIX 9.1

SAMPLES OF GK–12 EVALUATION INSTRUMENTS

GK–12 FELLOWS PROGRAM EVALUATION (FELLOW)

Name _____ Date _____

School _____ Lead Teacher _____

Please evaluate your experience in the GK–12 Fellows Program by rating your agreement with each of the statements listed below according to the scale provided.

Agreement Levels

1=Strongly Disagree...5=Strongly Agree

<p>Classroom</p> <ul style="list-style-type: none"> Shadow Teachers for 1 month Assess technology capabilities; plan for connecting classes to project website 	<ul style="list-style-type: none"> Teach ecological concepts related to schoolyard labs Develop curricula and link to standards Work as tutors for student projects
---	--

Overall GK–12 Program Evaluation	AGREEMENT				
Integration:					
I was perceived as a role model by students and faculty in my school.	1	2	3	4	5
Students viewed me as a teacher more than a scientist or mathematician.	1	2	3	4	5
I served as a school-wide resource.	1	2	3	4	5
Many activities included math and science principles regardless of the class in which they were presented.	1	2	3	4	5
Inquiry learning was increased in my classroom due to my activities.	1	2	3	4	5
PEER modules were presented in my classroom.	1	2	3	4	5
I increased and improved the use of technology in my classroom.	1	2	3	4	5
Team Contact:					
I provided a useful link between my lead teacher and university faculty.	1	2	3	4	5
University faculty conducted a presentation in my classroom.	1	2	3	4	5
I involved my faculty mentor when questions arose regarding their area of expertise.	1	2	3	4	5
My students benefited from my contact with university faculty.	1	2	3	4	5
PEER Web resources, such as virtual scientist visits and interviews, were presented in my classroom.	1	2	3	4	5
I involved other RM/Rs in my classroom activities.	1	2	3	4	5
My students were influenced by TAMU employees other than myself.	1	2	3	4	5
Interaction Results:					
I improved my lead teacher’s content knowledge.	1	2	3	4	5
I have a better understanding of education principles because of working with my lead teacher.	1	2	3	4	5
My activities improved students’ learning of state standards.	1	2	3	4	5
I used my entire budget for classroom supplies.	1	2	3	4	5
I provided supplies that my lead teacher will be able to use next year.	1	2	3	4	5

SOURCE: GK–12 FELLOWS INTEGRATE SCIENCE/MATH IN RURAL MIDDLE SCHOOLS, TEXAS A&M UNIVERSITY.

*Agreement Levels**1=Strongly Disagree...5=Strongly Agree*

Program Organization:					
I spent at least 8 hours working directly with students each week.	1	2	3	4	5
At least 1 hour was spent planning for upcoming events with the lead teacher weekly.	1	2	3	4	5
Distance Learning Community requests involved my area of expertise.	1	2	3	4	5
Time spent with Distance Learning Requests is reasonable and worthwhile.	1	2	3	4	5
It is important for professionals in my field to contribute to K–12 math and science education.	1	2	3	4	5
Spending 10 hours per week in a middle school classroom interfered with my other obligations as a graduate student.	1	2	3	4	5
The GK–12 program has influenced how I will contribute to public education in the future.	1	2	3	4	5
I have learned about needs and difficulties of public education through my involvement in this program.	1	2	3	4	5
I am more organized due to my involvement in this program.	1	2	3	4	5
I was able to participate in the GK–12 program and still perform scholarly duties expected of a graduate student.	1	2	3	4	5
I have gained communication skills through the GK–12 program.	1	2	3	4	5



BAYLOR COLLEGE OF MEDICINE

SETAKIST* TEACHER EVALUATION

Please indicate the degree to which you agree or disagree with each of the following statements by circling the appropriate number to the right of each statement.

* Self Efficacy Teaching and Knowledge Instrument for Science Teachers

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. When teaching science, I usually welcome student questions.	1	2	3	4	5
2. I feel I have the necessary skills to teach science.	1	2	3	4	5
3. I am typically able to answer students' science questions.	1	2	3	4	5
4. Given a choice, I would encourage the principal to evaluate my science teaching.	1	2	3	4	5
5. I feel comfortable improvising during science lab experiments.	1	2	3	4	5
6. I feel that I am able to teach science as well as I teach most other subjects.	1	2	3	4	5
7. After I have taught a science concept once, I feel confident teaching it again.	1	2	3	4	5
8. I find science a relatively easy topic to teach.	1	2	3	4	5
9. I know the steps necessary to teach science concepts effectively.	1	2	3	4	5
10. I can explain to students why science experiments work.	1	2	3	4	5
11. I am continually finding better ways to teach science.	1	2	3	4	5
12. I generally teach science effectively.	1	2	3	4	5
13. I understand science concepts well enough to teach science effectively.	1	2	3	4	5
14. I know how to make students interested in science.	1	2	3	4	5
15. I feel comfortable when teaching science content that I have not taught before.	1	2	3	4	5
16. I feel I have a good understanding of the science concepts I teach.	1	2	3	4	5

SOURCE: BAYLOR COLLEGE OF MEDICINE GK-12

STUDENT INTEREST SURVEY: SCIENCE PRETEST

School Name: _____

Teacher's Name: _____

Resident Scientist's Name: _____

Your Student Number: _____ Grade: _____ Gender: **M** or **F** (please circle)

The following statements relate to beliefs and interests in science. Check the box that most closely matches how you feel about each statement.

Beliefs about Science	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. I enjoy science class.					
2. I think I could be a good scientist.					
3. I like to find answers to questions by doing experiments.					
4. I get to do experiments in my science class.					
5. Being a scientist would be exciting.					
6. Science is difficult for me.					
7. I like to use the science book to learn science.					
8. Science is useful in everyday life.					
9. Studying hard in science is not cool.					
10. Scientists help make our lives better.					
11. Being a scientist would be boring.					
12. I want to take more science classes.					

Interest in Science	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
13. I think science is important only at school.					
14. I like to use computers to learn about science.					
15. Science tests make me nervous.					
16. I like to use science equipment to study science.					
17. I usually don't try my best in science class.					
18. The things we study in science are not useful to me in daily living.					
19. I like to work in a small group in science class.					
20. Science class activities are boring.					
21. Finishing high school is very important to me.					
22. I get better grades than most of my classmates in school.					
23. I always give my best effort on my school homework.					
24. I like being in school.					
25. My family cares about the grades I get in school.					
26. I like science more than all other subjects in school.					
27. My friends and I compete for the highest test scores in science class.					
28. I will definitely go to college someday.					

SOURCE: GK-12 FELLOWS INTEGRATE SCIENCE/MATH IN RURAL MIDDLE SCHOOLS, TEXAS A&M UNIVERSITY

29. List five words that describe a Scientist: _____

30. What are three things Scientists do when they are doing science? _____

31. Do you think you could become a Scientist? Why? _____

GK–12 FELLOWS PROGRAM EVALUATION (FACULTY MENTOR)

Name _____ Date _____

Department _____ Fellow _____

Please evaluate your experience in the GK–12 Fellows Program by rating your agreement for the Graduate Fellow section and the Overall GK–12 program section, using the scale provided.

Sample Content Workshop Topical Areas

- Unifying Ecological Themes
- Forming Partnerships with Scientists
- Developing School Ecology Outdoor Laboratories
- Tools and Techniques for Ecological Sampling
- Authentic Assessment for Science

Graduate Fellow Program Evaluation	Agreement				
My graduate fellow was able to participate in the GK–12 program and still perform scholarly duties expected of a graduate student.	1	2	3	4	5
Spending 10 hours per week in a middle school classroom interfered with the other obligations of my graduate fellow.	1	2	3	4	5
My graduate fellow often asked for help when questions arose in the classroom involving my area of expertise.	1	2	3	4	5
I am a good resource for middle school teachers through my graduate fellow.	1	2	3	4	5
The activities presented at the semester retreat were a good use of time for my graduate fellow.	1	2	3	4	5
My graduate fellow has gained communication skills through the GK–12 program.	1	2	3	4	5
My graduate fellow is better organized due to involvement in this program.	1	2	3	4	5
The amount of time and effort expected from faculty mentors of graduate fellows is realistic.	1	2	3	4	5
The amount of time and effort expected from my graduate fellow is unrealistic.	1	2	3	4	5

Fellow Training (Jan—May)

- Teaching Science
- GK–12 Seminar

Overall GK–12 Program Evaluation	Agreement				
The Southwest Regional NSF GK–12 Conference allowed me to see the worth of this program.	1	2	3	4	5
I have reviewed several requests for the Distance Learning Community.	1	2	3	4	5
I will continue to serve as a mentor for graduate fellows in the GK–12 program.	1	2	3	4	5
I will recommend that other graduate students apply for this fellowship.	1	2	3	4	5
Middle school students have benefited from my involvement in this program.	1	2	3	4	5
It is unimportant for professionals in my field to contribute to K–12 math and science education.	1	2	3	4	5
I have learned about needs and difficulties of public education through my involvement in this program.	1	2	3	4	5
Distance Learning Community requests rarely involve my area of expertise.	1	2	3	4	5
Time spent with Distance Learning Community requests is reasonable and worthwhile.	1	2	3	4	5
The amount of time and effort expected from faculty mentors of graduate fellows is realistic.	1	2	3	4	5

SOURCE: GK–12 FELLOWS INTEGRATE SCIENCE/MATH IN RURAL MIDDLE SCHOOLS, TEXAS A&M UNIVERSITY.

