

Annual Report for Period:07/2008 - 06/2009

Submitted on: 07/02/2009

Principal Investigator: Raineri, Deanna M.

Award ID: 0338215

Organization: U of Ill Urbana-Champaign

Submitted By:

Raineri, Deanna - Principal Investigator

Title:

TRACK 2, GK-12: EdGrid Graduate Teaching Fellows Program

Project Participants

Senior Personnel

Name: Raineri, Deanna

Worked for more than 160 Hours: Yes

Contribution to Project:

D. Raineri is PI of this award, makes all final decisions, oversees grant reporting and budget expenditures, coordinates efforts to build campus sustainability for GK-12, reviews reports from the coordinator (Bievenue), reviews all evaluation activities and IRB evaluations, attends all group meetings and training sessions, attends weekly graduate seminars, recruits advisors and mentors, and leads the selection process for new fellows. Her involvement is supported by UIUC College of LAS.

Name: Jakobsson, Eric

Worked for more than 160 Hours: Yes

Contribution to Project:

E. Jakobsson (Integrative Biology) is a co-PI and faculty mentor who is also involved in the selection process for new fellows. In year three of Track 2 he mentored fellow Chris Whalen. He was also the PI of the UIUC Track 1 grant. His involvement is supported by UIUC.

Name: Bruce, Bertram

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Bruce (Library and Information Science) advises project evaluation and supervises one graduate student evaluator. Dr. Bruce also participates in summer orientation by providing information on both evaluation and inquiry-based learning, including use of iLabs (www.inquiry.uiuc.edu). His involvement is supported by UIUC.

Name: Burton, Orville

Worked for more than 160 Hours: Yes

Contribution to Project:

V. Burton (History Department) is co-PI and GK-12 mentor for social science students. In the first year of Track 2 he mentored two history fellows (DuRocher-Wilson and Holmes), and also participated by co-mentoring two geography fellows. In the second year Dr. Burton played less of a role but mentored two undergraduate fellows (Taylor and McFarland) and was consistently supportive at large group meetings. In year three he mentored history fellow Troy D. Smith. Dr. Burton served on the selection committee during each year of the award. His involvement is partially supported by this award and partially by UIUC.

Name: Braatz, Richard

Worked for more than 160 Hours: Yes

Contribution to Project:

R. Braatz (Chemical Engineering) is a co-PI and faculty mentor who has been actively involved since the start of the Track 1 award. Each year he mentors at least one fellow, often two. In the first year of Track 2 he mentored Chemical Engineering fellow Karulkar, in the second year he mentored Chemical Engineering fellows Karulkar and Younker, and in the third year he mentored Chemical Engineering fellow Younker. He regularly attends group meetings, and often attends seminars. He has also served on the selection committee during the first two years of the Track 2 award. His involvement is supported by UIUC.

Name: Rhoads, Bruce

Worked for more than 160 Hours: Yes

Contribution to Project:

B. Rhoads (Geography) is a faculty mentor. He mentored 2 fellows in year 1 of Track 2 (Metcalf and Whiting). He was on

sabbatical during year 2. His involvement is supported by UIUC.

Name: Hubler, Alfred

Worked for more than 160 Hours: Yes

Contribution to Project:

A. Hubler (Physics) is a faculty mentor. During year 1 of Track 2 he mentored 3 undergraduate fellows (Hornig, Carnate and Dunlau) and 1 graduate fellow (Sandrik). During years 2 & 3 he was the partnering teacher for fellow Vlastic in a middle school Algebra classroom (Home Hi). He also regularly attends group meetings. His involvement was partially supported by this award, partially by Campus Middle School (previously Home Hi Middle School for Girls), and partially by UIUC.

Name: Hsui, Albert

Worked for more than 160 Hours: Yes

Contribution to Project:

A. Hsui (Geology) was a faculty mentor for 1 graduate fellow (Jackson) in year 1 of Track 2. He also regularly attended group meetings. He is now retired from UIUC. His involvement was partially supported by this award.

Name: Hug, Barbara

Worked for more than 160 Hours: Yes

Contribution to Project:

B. Hug is faculty in the UIUC College of Education and presents at graduate seminars on topics related to inquiry-based science education and educational research. Her involvement is supported by this award.

Name: Trofanenko, Brenda

Worked for more than 160 Hours: Yes

Contribution to Project:

B. Trofanenko is faculty in the UIUC College of Education and presents at graduate seminars on topics of social science education and the use of technology. Her involvement is supported by this award.

Name: Wilson, David

Worked for more than 160 Hours: Yes

Contribution to Project:

Faculty mentor for geography GK-12 fellows (Whiting). Started participating in 2005. He regularly attends group meetings and also served on the selection committee for year 3 fellows. His involvement is partially supported by this award.

Name: Kieffer, Susan

Worked for more than 160 Hours: Yes

Contribution to Project:

S. Kieffer (Geology) is a faculty mentor for geology GK-12 fellows (Clark). She started participating in 2005 and regularly attends group meetings. Her involvement is partially supported by this award.

Name: Hanks, Lawrence

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Hanks was a faculty mentor for fellow Matthew Richardson.

Name: Gruebele, Martin

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Gruebele was a faculty mentor for fellow Sharlene Denos.

Post-doc

Name: Kelly, Ryan

Worked for more than 160 Hours: Yes

Contribution to Project:

R. Kelly (Ph.D. Student, Plant Biology) is a fellow (08-09) who partnered with high school teacher Susan Camasta (Hinsdale South High School). They collaborated on several environmental science curriculum units covering topics that included the carbon cycle

and global warming, all of which will be available at <http://gk12-uiuc.net>.

Graduate Student

Name: DuRocher-Wilson, Kristina

Worked for more than 160 Hours: Yes

Contribution to Project:

K. DuRocher-Wilson (Ph.D. student, History) is a fellow (03-05). Her first year as a fellow was the 3rd year of the UIUC Track 1 award. Both years she partnered with History teacher John Naisbitt at Hinsdale Central High School. Together they developed a wealth of interactive, technology-infused, curriculum units for both American and World History. These units can be found at <http://www.centralhistory.com>. Kris was instrumental in updating some parts of their curriculum and brought a new focus to history...the doing of history, the research and construction of ideas (as opposed to the reading and memorizing of history). Her involvement was entirely supported by this award.

Name: Holmes, Kwame

Worked for more than 160 Hours: Yes

Contribution to Project:

Kwame Holmes (Ph.D. student, History) is a fellow (04-05) who partnered with 8th grade social studies teacher David Collins at Franklin Middle School. Kwame was very involved in developing new units on early American history, African American History, government, and current events. He was particularly adept at provoking deep thought and rich discussions among the students. Kwame was also involved with other fellows' projects include History Fellow DuRocher-Wilson and Geography fellows Metcalf and Whiting. He also worked with other fellows (e.g., Karulkar) to develop a simulation of the multiple factors that led to the Civil War. His involvement was fully supported UIUC.

Name: Lustofin, Katrina

Worked for more than 160 Hours: Yes

Contribution to Project:

K. Lustofin (Ph.D. student, Entomology) is a fellow (03-05). In year 3 of the Track 1 award she partnered with Chemistry teacher Susan Camasta at Hinsdale South High School. They collaborated on several curriculum units that featured demonstration of chemical concepts using insects. In year 1 of the Track 1 award she partnered with physics teacher Sheila Ashbrook and biology teacher Joan Campagnolo at Home Hi Middle School. She developed several activities, including a comprehensive unit on Tsunamis and a student designed evolution game (see <http://gk12-uiuc.net>). Her involvement was entirely supported by the two GK-12 awards.

Name: Karulkar, Mohan

Worked for more than 160 Hours: Yes

Contribution to Project:

M. Karulkar (Ph.D. student, Chemical Engineering) is a fellow (04-06) who has for both years partnered with Chemistry teacher Susan Camasta at Hinsdale South High School. Together they developed a wide array of curriculum units, all available at <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/>. Mo has been instrumental in developing progressively more interactive and student-centered visualization and modeling web-based tools and activities. In year 2 Karulkar and Camasta have been collecting student assessment data, pre- and post-tests, as well as observations, and developed a paper on their experiences (see Publications-Journals). They have each presented their work at conferences as a paper and a poster. Mo is also very involved in supporting other fellows with his expertise in developing web-based flash modules, as well as web design. He was also responsible for editing and publishing the GK-12 newsletters in years 1 and 2. His involvement was entirely supported by this award.

Name: Jackson, Ryan

Worked for more than 160 Hours: Yes

Contribution to Project:

P. Ryan Jackson (Ph.D. student, Civil/Environmental Engineering) was a fellow from July 1, 2004 through June 30, 2006. For his first year he worked with a geology teacher, Rob Johnson, at Danville High School. Ryan and Rob collaborated on several geology curriculum units, all posted at <http://gk12-uiuc.net>. This team showed the most change of any GK-12 team...Rob was computer-phobic at first, hesitant about another adult in the classroom, and he mostly lectured with no visual artifacts whatsoever. By the end of the year students were making comments that indicated they were excited to come to class (generally made up of lower-achieving students), Rob was mixing a variety of activities, including computer visualizations, with his lecture materials, and Rob and Ryan also worked together to completely overhaul all of his overhead slides into dynamic powerpoint presentations mixed

with visualizations, movies, and interactive web sites.

In Ryan's second year he worked with a 7th grade science teacher, Gary Apfelstadt, in a 'WaterWorks' class at Urbana Middle School. They collaborated on many field trips and curriculum projects, all viewable at <http://www.usd116.org/waterworks>. As a result of this 2nd year project Ryan expanded his experience to more of a community approach to outreach, learning to bring together a variety of resources and agencies to provide a rich learning experience for the students.

The source of support for all of Ryan's work was this GK-12 award. Each of the teachers also received support from the GK-12 award, as well as administrative support from their respective schools.

Name: Metcalf, Sara

Worked for more than 160 Hours: Yes

Contribution to Project:

S. Metcalf (Ph.D. student, Geography) is a fellow (04-05) who worked with geography teacher Paul Hohulin at Centennial High School. Sarah and Paul frequently co-developed ideas and curriculum units with fellow Whiting and teacher Topel (also geography). Their materials can be found at <http://gk-12-uiuc.net>. Their most successful project was the 'Grain Game' which has now been featured in posters and presentations at several conferences. They are planning to package and distribute it freely. Sarah was also successful at integrating modeling ideas and software tools into the geography curriculum (e.g., modeling countries' economies with Stella). Her involvement was fully supported by this award.

Name: Sandrik, Suzannah

Worked for more than 160 Hours: Yes

Contribution to Project:

S. Sandrik (Ph.D. student, Aerospace Engineering) is a fellow (04-06) who partnered with science teacher Shelley Barker at Danville High School in a newly formed 'Principles of Engineering' course. The course is part of the Project Lead the Way initiative to introduce engineering at the high school level. Since Mrs. Barker does not have a background in engineering and only limited experience in physics education, Suzy was instrumental in developing materials and course structure. The lesson activities Suzy developed can be found at <http://gk12-uiuc.net>. Her involvement was entirely supported by this award.

Name: Whiting, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

R. Whiting (Ph.D. student, Geography) is a fellow (04-06) who worked with geography teacher Heather Tope at Central High School. Rob and Heather frequently co-developed ideas and curriculum units with fellow Metcalf and teacher Hohulin (also geography). Their materials can be found at <http://gk-12-uiuc.net>. Their most successful project was the 'Grain Game' which has now been featured in posters and presentations at several conferences. They are planning to package and distribute it freely. Rob also worked to develop some important thematic ideas into the curriculum (e.g., Networks - Why Were There Pirates in the Carribean?, as well as communication and transportation networks). In year 2 Rob also developed U.S. Government activities (e.g., redistricting and gerry-mandering). His involvement was entirely supported by this award.

Name: Vlastic, Andrew

Worked for more than 160 Hours: Yes

Contribution to Project:

A. Vlastic (Ph.D. Student, Mathematics) is a fellow (05-07) who partnered with Professor Alfred Hubler, who also teaches math at Campus Middle School for Girls in Urbana. Vlastic has developed a series of lessons in mathematical logic and proofs to promote critical thinking; these will be available at <http://gk12-uiuc.net>. The environment in which he is working is somewhat unconventional, being a private middle school for girls with above average and highly motivated students. Hubler and Vlastic also designed an on-line tool for creating mathematical proofs (<http://www.how-why.com>; login required). His involvement is entirely supported by UIUC College of LAS, Mathematics Department.

Name: Younker, Jennifer

Worked for more than 160 Hours: Yes

Contribution to Project:

J. Younker (Ph.D. Student, Chemical Engineering) is a fellow (05-07) who partnered with chemistry teachers Sarah Boesdorfer and Rick Pavinato. S. Boesdorfer taught at Danville High School in 2005-2006 and at Mt. Zion High School (Mt. Zion, IL) in 2006-2007. Rick Pavinato teaches at Homewood-Flossmoor HS (Homewood, IL). They have collaborated on several curriculum units, including the 'Nomenclature Game' and an Introduction to Nanotechnology, which can be found at

<http://gk12-uiuc.net/jyounger/Lessons.html>.

Name: Clark, Scott

Worked for more than 160 Hours: Yes

Contribution to Project:

S.K. Clark (Ph.D. student, Geology) is a fellow (05-06) partnering with Chris Midden at Unity Point School in a 5th grade classroom on earth science topics. Scott also works with Rob Johnson at Danville High School helping to coordinate geology field trips. His involvement is entirely supported by this award.

Name: Rosu, Luisa

Worked for more than 160 Hours: Yes

Contribution to Project:

L. Rosu is a graduate assistant working on project evaluation. She started participating in year 2 of Track 2 and started a university leave of absence in January of year 3. She is supported by this award.

Name: Davis, Rita

Worked for more than 160 Hours: Yes

Contribution to Project:

R. Davis is a graduate assistant working on project evaluation. She began her participation in year 2 of Track 2 and is supported by this award.

Name: Richardson, Matthew

Worked for more than 160 Hours: Yes

Contribution to Project:

M. Richardson (Ph.D. Student, Ecology and Evolutionary Biology) is a fellow (06-08) who partnered with middle school teachers Jan Hari (Urbana Middle School) and Joan Campagnolo (Campus Middle School for Girls) in 06-07 and with Hari and Greg Conn (LeRoy Jr. High School) in 07-08. They collaborated on several curriculum units covering topics that included biodiversity, biomes, adaptation, and evolution, all of which will be available at <http://gk12-uiuc.net>.

Name: Denos, Sharlene

Worked for more than 160 Hours: Yes

Contribution to Project:

S. Denos (Ph.D. Student, Biophysics) is a fellow (2006-08) who partnered with biology teachers Shelley Barker, Katherin Hafner (Danville High School), Matt Kirkpatrick (Neuqua Valley High School, Naperville, IL), Kevin Kuppler and Bryan Foli (Edison Middle School). At the high school level, they collaborated on several curriculum units which focus on molecular visualization, bioinformatics, genetics, and evolution. At the middle school level Denos designed and presented several hands-on labs demonstrating various concepts related to their current unit. Materials will be made available at <http://gk12-uiuc.net>.

Name: Cummins, Desmond

Worked for more than 160 Hours: Yes

Contribution to Project:

D. Cummins (Ph.D. Student, Mathematics) is a fellow (2006-08) who partnered with physics teacher Mike Smith at Pittsfield High School and mathematics teacher Jonathan Ramirez at Edison Middle School. Cummins and Smith developed an approach to teach mathematical reasoning using the subject matter of relativity. Cummins also created an on-line challenge problem activity in which students work to solve logic problems on their own and then teach the solution to classmates; the entire class receives credit when one randomly chosen student correctly solves the problem in front of the class. Cummins and Ramirez developed several critical thinking challenges for 7th graders, and also formed an after-school math club. Cummins was supported by the UIUC Mathematics department both years.

Name: Whalen, Christopher

Worked for more than 160 Hours: Yes

Contribution to Project:

C. Whalen (Ph.D. Student, Neuroscience) is a fellow (2006-08) who partnered with biology teacher Matt Kirkpatrick and psychology teacher Jennifer Schmauderer, both at Neuqua Valley High School, Naperville, IL. Whalen and Kirkpatrick developed and implement a neuroscience-based theme for honors biology, including units on brain imaging, neuro-transmitters, neurological diseases, and sheep's brain dissection. Whalen and Schmauderer developed and implemented neuroscience units in psychology classes, including units on perception, neurological diseases, and statistical analysis. All materials will be available at

<http://gk12-uiuc.net>.

Name: Smith, Troy

Worked for more than 160 Hours: Yes

Contribution to Project:

T. D. Smith (Ph.D. Student, History) is a fellow (2006-08) who partnered with history teacher Bill Sutton at University High School. They collaborated on several curriculum units covering topics that include Indian removal, the Civil War, and race riots, all of which will be available at <http://gk12-uiuc.net>. During his first year, he was supported by UIUC College of LAS and by this award in his 2nd year.

Name: Laskowski, Katie

Worked for more than 160 Hours: Yes

Contribution to Project:

K. Laskowski (Ph.D. Student, Animal Biology) is a fellow (08-09) who partnered with high school teacher Kathy Hafner (Danville High School). They collaborated on several biology curriculum units covering topics that included biodiversity, adaptation, and evolution, all of which will be available at <http://gk12-uiuc.net>.

Name: Maddox, Joseph

Worked for more than 160 Hours: Yes

Contribution to Project:

J. Dylan Maddox (Ph.D. Student, Ecology and Evolutionary Biology) is a fellow (08-09) who partnered with high school teacher Brad Allen (St. Joseph-Ogden High School). They collaborated on several biology curriculum units covering topics that included biodiversity, adaptation, and evolution, all of which will be available at <http://gk12-uiuc.net>.

Name: Goshorn, Crystal

Worked for more than 160 Hours: Yes

Contribution to Project:

C. Goshorn (Ph.D. Student, Food Science & Human Nutrition) is a fellow (08-09) who partnered with high school teacher Rick Pavinato (Homewood-Flossmoor High School). They collaborated on several chemistry curriculum units covering topics that included organic chemistry and molecular structures, all of which will be available at <http://gk12-uiuc.net>.

Undergraduate Student

Name: Mudarth, Melanie

Worked for more than 160 Hours: Yes

Contribution to Project:

M. Mudarth is an undergraduate fellow (04-05) and geology major who worked with several fellows (geology, environmental science, and geography) to develop curriculum units. Since Mudarth is also working toward a teaching certificate she facilitated structured lesson plans and age appropriate materials. Her involvement is entirely supported by this award.

Name: Rampalli, Krystal

Worked for more than 160 Hours: Yes

Contribution to Project:

K. Rampalli (Undergraduate Student, Molecular and Cellular Biology) is a fellow (04-07) who has aided a variety of teachers (Apfelstadt, Campagnolo, Topel, Ohulin) and graduate fellows (Jackson, Lustofin, Whiting, Metcalf) in a variety of subject areas (geology, environmental science, geography, chemistry) throughout her tenure as an undergraduate fellow, and most recently partnered with teacher Gary Apfelstadt at Urbana Middle School in his Waterworks course. Rampalli took the lead on developing activities with the Intel Showing Evidence Tool (<http://www.intel.com/education/showingevidence>). Rampalli also assisted with field trips, hands-on labs, and curriculum unit development. She was also involved in group conference presentations and seeks to apply for a GK-12 fellowship as a graduate student (even to the point that her choice in graduate schools will be affected by the opportunity). Her involvement is entirely supported by this award.

Name: Carnate, MaryJoy

Worked for more than 160 Hours: Yes

Contribution to Project:

M. Carnate is an undergraduate fellow (04-05) majoring in mathematics who worked with several graduate fellows to integrate mathematics into science curriculum units. Since Carnate is also working toward a teaching certificate she facilitated structured

lesson plans and age appropriate materials. Her involvement is entirely supported by this award.

Name: Horng, Jeanette

Worked for more than 160 Hours: Yes

Contribution to Project:

J. Horng is an undergraduate fellow (04-05) majoring in mathematics who worked with several graduate fellows to integrate mathematics into science curriculum units. Since Horng is also working toward a teaching certificate she facilitated structured lesson plans and age appropriate materials. Her involvement is entirely supported by this award.

Name: Dunklau, Dannette

Worked for more than 160 Hours: Yes

Contribution to Project:

D. Dunklau is an undergraduate fellow (04-05) majoring in physics who primarily worked with A. Hubler (faculty mentor) on developing age appropriate web-based interactive materials and problem-sets for middle school level physics. Her involvement was entirely supported by this award.

Name: Taylor, Brandon

Worked for more than 160 Hours: Yes

Contribution to Project:

Undergraduate fellow, majoring in Anthropology, working with history faculty and water science and geography fellows on RiverWeb. Started February, 2006. His involvement is entirely supported by this award.

Name: McFarland, Matthew

Worked for more than 160 Hours: Yes

Contribution to Project:

M. McFarland is an undergraduate fellow (06-), majoring in Molecular & Cellular Biology, working with history faculty and water science and geography fellows on RiverWeb. His involvement is entirely supported by this award.

Technician, Programmer

Other Participant

Name: Bievenue, Lisa

Worked for more than 160 Hours: Yes

Contribution to Project:

L. Bievenue is project coordinator, coordinating all activities of the program. She coordinates meetings, seminars, application/selection processes, dissemination (e.g., conference presentations), and campus publicity. She observes fellows in the classroom, reviews their materials development, and guides their work throughout the year. She recruits new fellows and teachers each year. She administers teacher stipends, reimbursements for classroom materials, and trouble-shoots any problems. Her involvement is entirely supported by this award.

Name: Curtis, David

Worked for more than 160 Hours: Yes

Contribution to Project:

I. Gabler and D. Curtis (Engaged Minds) led the 2004 and 2006 summer teaching methodology workshop. Their focus is on inquiry-based, student-centered learning. Specific topics included brief theory on constructivism, questioning strategies, lesson plan development structures (e.g., inductive), setting student expectations, and assessment. Their involvement was entirely supported by this award.

Name: Gabler, Ina

Worked for more than 160 Hours: Yes

Contribution to Project:

I. Gabler and D. Curtis (Engaged Minds) led the 2004 and 2006 summer teaching methodology workshops. Their focus is on inquiry-based, student-centered learning. Specific topics included brief theory on constructivism, questioning strategies, lesson plan development structures (e.g., inductive), setting student expectations, and assessment. Their involvement was entirely supported by this award.

Research Experience for Undergraduates

Organizational Partners

Unity Point School

Unity Point School has been a site for a GK-12 Fellow/Teacher partnership (2005/06). Two teachers (Midden and Fuller) and one fellow (Clark) are involved. Fellows used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Campus Middle School for Girls

Campus Middle School has been a site for three GK-12 Fellow/Teacher partnerships (2000-2007). In Track 2, two teachers (Hubler, Camagnolo) and three fellows (Vlasic, Lustofin, Richardson) were involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Danville High School

Danville High School has been a site for a GK-12 Fellow/Teacher partnerships (2000-2009). In Track 2, three teachers (Barker, Boesdorfer, Johnson, Hafner) and five fellows (Jackson, Sandrik, Clark, Younker, Denos, Laskowski) are involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Hinsdale Township High School District 86

Hinsdale School District has supported two sites for GK-12 Fellow/Teacher partnerships (2001-2009). In Track 2, two teachers (Naisbitt and Camasta) and four fellows (DuRocher, Lustofin, Karulkar, Kelly) were involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Champaign Community Unit School District #4

Champaign School District has supported four sites for GK-12 Fellow/Teacher partnerships (2002, 2004-08). In Track 2 six teachers (Collins, Franklin Middle School; Hohulin, Champaign Centennial HS; Topel, Champaign Central HS; Kuppler, Foli and Ramirez, Edison Middle School) and five fellows (Holmes, Metcalf, Whiting, Denos, Cummins) were involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Urbana School District 116

Urbana School District has supported two sites for GK-12 Fellow/Teacher partnerships (2000-2002, 2005-2008). In Track 2 two teachers (Apfelstadt and Hari) at Urbana Middle School have worked with two graduate fellows (Jackson and Richardson) and one undergraduate fellow (Rampalli). They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Homewood-Flossmoor High School

Homewood-Flossmoor High School has been a site for a GK-12 Fellow/Teacher partnerships (2006-2009). In Track 2, one teacher (Pavinato) and two fellows (Younker, Goshorn) have been involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Mt. Zion High School

Mount Zion High School has been a site for a GK-12 Fellow/Teacher partnerships (2006-07). In Track 2, one teacher (Boesdorfer) and one fellow (Younker) have been involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Pittsfield High School

Pittsfield High School has been a site for a GK-12 Fellow/Teacher partnerships (2006-08). In Track 2, one teacher (Smith) and one fellow (Cummins) have been involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

LeRoy Junior High School

LeRoy Junior High School has been a site for a GK-12 Fellow/Teacher partnerships (2007-08). In Track 2, one teacher(Conn) and one fellow

(Richardson) have been involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

University High School

University High School has been a site for a GK-12 Fellow/Teacher partnerships (2006-08). In Track 2, one teacher (Sutton) and one fellow (Smith) have been involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

St. Joseph-Ogden High School

St. Joseph-Ogden High School has been a site for a GK-12 Fellow/Teacher partnerships (2008-2009). In Track 2, one teacher (Allen) and one fellow (Maddox) are involved. They used school facilities to conduct their work. Together they conducted research on their activities, as well as cooperate with project evaluators.

Other Collaborators or Contacts

The Engaged Minds(SM) Program (www.engaged-minds.net) provided professional development on inquiry-based student-centered teaching methods for the teachers and fellows.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Findings: (See PDF version submitted by PI at the end of the report)

Training and Development:

Summer Orientation. Each summer we have 4-6 days of orientation and workshops depending on the needs of the fellows and teachers. The program usually begins with a 2-day orientation workshop in July for teachers and fellows; mentors are also encouraged to attend. The purpose of the orientation is to

- a) share the program goals,
- b) establish the roles and expectations for fellows, teachers and mentors,
- c) begin instruction on inquiry-based teaching methods,
- d) share ideas for curriculum resources and integration of mathematics,
- e) share tools for modeling and visualization, and
- f) plan activities for the upcoming school year (in teacher/fellow teams).

Each summer the agenda of this orientation is different as it is designed around the fellow and teacher population, some of whom may be attending for a 2nd or 3rd time. Sample summer agendas for this orientation follows.

GK-12 Orientation Meeting

July 12-13, 2004

Agenda

Monday, July 12

8:30 am Introductions

8:45 am About the GK-12 Program (Deanna and Lisa)

9:30 am About the GK-12 Program Evaluation (Sharon Comstock and Jim Buell)

10:00 am Inquiry, the Inquiry Page, and iLabs (Sharon Comstock, Jim Buell, et. al.)

Noon Lunch (in Lucy Ellis Lounge)

1:00 pm Engaged Minds (David Curtis and Ina Gabler)

Reflective Discussion Methods

Questioning Strategies

3:00 pm Team Meetings

Tuesday, July 13

8:30 am Curriculum Resources (Lisa Bievenue)

9:30 am Integrating Mathematics and Science (Bridget Arvold)

11:00 am Modeling Resources (Mike Kandianis)

Noon Lunch

1 pm Team Meetings

Students and teachers then met in small groups several more times during the summer to plan projects for the school year.

GK-12 Orientation II Meeting

July 12, 2005

8:30 am Team Planning Time

10:00 am GK-12 Program Evaluation, iLabs/Inquiry Page,

12:00 LUNCH

1:00 pm Instructional Design

1. From the Tyler Rationale to contemporary 'backwards design' models
2. Integrating constructivist-based approaches activities into the overall instructional design models
3. Share and critique homework assignment using inquiry model

2:30 pm Alternative/Authentic Assessment

1. Conventional vs alternative
2. Writing good multiple choice questions
3. Developing good rubrics
4. Participant Activity: practice writing multiple choice questions, create a rubric

July 13

8:30 am Modeling Lab: Netlogo, Model-It

12:00 LUNCH (2-hour Team Lunch)

2:00 pm Incorporating Technology

1. Specific Types and Uses of Technology: Information Sources (Typical vs. Accessing Data Bases, Authentic Documents), Various Types of Web-Based Inquiry, Simulations and Models, Information Exchange Projects and Modes, Teacher Resources and Instructional Support, Support for Student Reports and/or Presentations, etc.
2. Participant Activity: critique various types of instructional or instructional support websites.

GK-12 Summer Orientation Meeting Agenda

August 1-2, 2006

Illini Union, Room 407

AUGUST 1, TUESDAY

8:00 am Optional individual team meetings, breakfast available in ILLINI ROOM A

9:30 am Introductions, Orientation to GK-12 Program

10:30 am Engaged MindsSM Teaching Methods: Questioning Strategies

Led by Ina Claire Gabler and David Curtis

12:30 pm Lunch (ILLINI ROOM A)

1:30 pm Engaged MindsSM Teaching Methods: Questioning Techniques Practicum

5:15 pm Dinner Break

7:00 pm Computer Lab (338 Davenport Hall) - Modeling and Visualization Explorations

AUGUST 2, WEDNESDAY

7:45 am Breakfast available in Room 314

8:00 am Breakout Sessions ? Teachers only / Fellows only

9:00 am Scheduling of all-day meetings

9:30 am Engaged MindsSM Teaching Methods: Inductive Concept Method

Led by Ina Claire Gabler and David Curtis

? Introducing the Inductive Concept Strategy

? Inductive Concept Strategy Demo, Technology Integration, & Discussion

11:05 am Break

11:20 am Engaged MindsSM Teaching Methods: Inductive Concept Method Practicum

12:15 pm Lunch (ROOM 314)

1:30 pm Practicum (continued)

GK-12 Summer Orientation Meeting Agenda

August 14-15, 2006

Illini Union, Room 314

AUGUST 14, MONDAY

8:00 am Optional individual team meetings, breakfast available

9:30 am Introductions

10:00 am Engaged MindsSM Teaching Methods: Assessment & Evaluation

Led by Ina Claire Gabler and David Curtis

? Discussion on Readings

? Hands-on #1: Completing an unfinished rubric for a sample lesson

12:00 pm Lunch

1:00 pm Engaged MindsSM Teaching Methods (continued)

? Hands-on #2: Creating your own rubric for your own lesson

2:30 pm GK-12 Program Evaluation (Meet the Evaluation Team)

3:30 pm iLabs Tutorial (338 Davenport Hall)

5:00 pm Team Planning Time (338 Davenport Hall)

AUGUST 15, TUESDAY

7:45 am Breakfast available

8:30 am Dissemination of Materials, GK-12 Website

9:30 am Engaged MindsSM Teaching Methods: Resocializing

Led by Ina Claire Gabler and David Curtis

? Discussion: What is resocializing? Why resocialize? Who benefits from resocializing and why?

? Activity: Hands-On Resocializing Plan & Critique

12:00 pm Lunch

1:00 pm Team Meetings (with Faculty Mentors)

UIUC GK-12 Summer Workshop

July 30-31, 2007

Illini Union, Room 314

Day One

7:30?8:30 Pre-meeting planning time, refreshments

8:30?9:00 Announcements, agenda overview

9:00?9:50 Let's play Pictionary

9:50?10:20 Debrief: How could you use this in your subject matter as an assessment?

Discussion: What do we mean by assessment?

? Why do we assess?

? Kinds of assessments

? -Summative

? -Formative

? -Performance based or authentic

? -Alternate assessment; can we give kids choices?

? What are the characteristics of a good assessment?

? What are the characteristics of a great assessment?

(do you think everyone agrees on this?)

10:20?10:30 Break

10:30?10:41 Video: (~11 minutes)

10:41?10:51 Mountlake Terrace High School

www.edutopia.org/node/2937

& discussion [see this website for other cool stuff]

10:51?11:20 Write

11:20?12:00 Share

On newsprint, teacher/fellow workgroups

? What are your overarching goals for 07-08? What enduring understandings are you teaching towards?

? What have you planned so far?

? How will you assess?

? What do you need help with?

12:00?1:00 Lunch

1:30?3:00 Overview of performance based assessments that are also formative or summative

--The assessment, handout, grading?

3:00?4:00 Time to create

4:00?5:00 Share with the group

Day 2

7:45?8:30 Refreshments

8:30?9:00 Announcements, review agenda

Video: Assessment overview (9 minutes)

www.edutopia.org/node/2975

Do you recognize the 'big names' interviewed? What do they promote? Agree? Disagree? (Linda Darling-Hammond, Howard Gardner, Hugh Price, Grant Wiggins. Also consider Eeva Reeder, Ann Cook and Pat Bola?os and what they have to say.)

9:00?9:55 Fellow/teachers discuss homework.

Each group gets 5-10 minutes, let's help one another, sharing ideas and expertise.

9:55?10:05 Break

10:05?11:30 Understanding by Design ? The 'Big Ideas'

(1) Identify desired results,

(2) Determine acceptable evidence &

(3) Plan learning experiences & instruction

Each group gets to add to their project with above three points for their collaborations in 07-08.

11:30 ? 12:00 GK12 Action Research - Chris

12:00?1:00 Lunch

1:00 ?1:45 Reflections of GK12 Fellows: Year in Review

1:45?2:00 Details for 2007-08 academic year?.professional mtgs, etc.

2:00?3:00 Fellow/ teacher planning work time

3:00?4:00 Sharing: each group gives some summary of detail they've added to their newsprints created Monday

Fellow Seminar Series.

In year one, all fellows (graduate and undergraduate) participated in bi-weekly 3-hour seminars in the fall semester and weekly 1.5-hour seminars in the spring. In the fall, seminars were conducted by the Engaged MindsSM Professional Development Program, which introduces secondary level teachers to a range of seven constructivist, student-centered methods and assessment techniques. Published in two texts by Allyn and Bacon (2003) for both preservice and inservice teachers, Engaged MindsSM methods are applicable across the K-12 curriculum, including science, math, social studies, English, and the arts. These standards-based, field-tested methods are designed to stimulate and strengthen students' critical thinking skills in active-learning environments. GK-12 Engaged MindsSM seminars focused on modeling how to integrate constructivist pedagogy with content and provide techniques for orienting fellows, teachers and students to active learning. Topics focused on development of inquiry-based and student-centered teaching methods

? directed discussion method (including questioning strategies)

? inductive concept method

? reflective discussion (including driving questions and role-play)

? exploratory discussion

? interactive presentation (including advanced organizers)

Other seminars in the fall and spring included

? 'Learning circle' discussions in which fellows shared classroom experiences

? A discussion on integrating technology to promote inquiry in science and social studies classrooms, led by College of Education faculty Barbara Hug (science)

? A discussion on integrating technology to promote inquiry in science and social studies classrooms, led by College of Education Brenda Trofanenko (social studies)

? A mini-workshop on visualization software, led by NCSA staff

In years two, three and four, all fellows participated in bi-weekly 1.5-2.0 hour seminars. In the fall, topics focus on inquiry-based projects, technology integration, lesson plan development, and assessment. In the spring, topics focused on technology integration, dissemination and publication. Barbara Hug (College of Education) presented and led a discussion on education research, especially qualitative methods. In year

five, fellows participated in weekly one-hour seminars on similar topics, but with emphasis in teaching methodology, action research, learning theory, and curriculum standards.

Teacher Professional Development Meetings.

October 29, 2004; October 11, 2005; October 3, 2006; October 2, 2007; October, 2009 ? lesson planning clinic, peer and expert critiques of fellows' lesson plans

October, 2008 ? action research clinic

November 7-8, 2009 ? Regional GK-12 meeting at Purdue

November 20, 2004; December 3, 2005; December 2, 2006; February 21, 2008; February 27, 2009 ? mid-year review, fellows presented their projects

February 21, 2005; February 8, 2006; March 13, 2007; November 27, 2008 ? Mini-workshops on technology topics, including modeling with MS Excel, Inspiration concept modeling software, Stella modeling software, multi-media topics, internet searching, MS Powerpoint, Adobe Photoshop, and

March, 2005 ? Team meetings, teachers and fellows met in small groups to plan a final project;

May 6, 2005; April 29, 2006; April 28, 2007; April 22, 2008; August 10-11, 2009 ? Final meeting, fellows presented their projects

Outreach Activities:

All GK-12 teams participated in three presentations at the 2005 Chicago regional meeting of the National Science Teachers Association. The primary group presentation was 'Bringing new scientists, new technologies, and new science into the classroom with a university collaboration'. Two other presentations were given by individual teams (high school chemistry and middle school physics).

Six fellows presented posters at the 2006 Illinois Technology Conference for Educators (March 2-3, St. Charles, IL).

Suzannah Sandrik (fellow in 04-05 and 05-06) was a panelist at the Project Lead the Way Counselors Conference in Springfield, IL, on October 17, 2005: 'How the PLTW Program Enhances Student Success in a College Engineering Curriculum.'

Two fellows (Yunker and Rampalli) presented a Flash Workshop, 'Using Macromedia Flash to Create Interactive Materials for the Classroom,' at the 2007 Illinois Technology Conference for Educators (February 22 - March 3, St. Charles, IL). Rampalli also assisted with another workshop, 'Technology tools to promote scientific inquiry at the Middle School level.'

One fellow (Richardson) presented a paper about one of his GK-12 projects, 'Outreach programs in GK-12, a biodiversity project,' at the Midwest Ecology and Evolution Conference at Kent State University, March 9-11, 2007. He also presented 'Building ecological complexity in GK-12 classrooms: ideas for outreach' at the same conference in Athens, OH, March 8, 2008.

Four fellows (Cummins, Denos, Richardson, Whalen) presented a poster (Whalen) and papers (Cummins, Denos, Richardson) at the 100th Annual Meeting of the Illinois State Academy of Science, April 4-5, 2008. Titles of the presentations were 'Here's how you prove stuff: an approach to introducing high school students to mathematical proof techniques using basic computability theory,' 'Molecular Visualization in High School Biology: My Favorite Protein,' 'Neuroscience in High School Biology Classrooms: A Year-Long NSF GK-12 Intervention,' and 'Demonstrating how abiotic factors influence the distribution of animals.'

Also, the UIUC GK12 program sponsored a field trip to the University of Illinois for over 100 7th graders from Edison Middle School in Champaign, IL, on April 29, 2008. Students visited the Insectary and an Ant lab, participated in several 'fun'chemistry labs, learned about perception using prism goggles and played a statistical logic game.

In 2008-2009 alumnus fellow Sharlene Denos initiated an outreach program with her department (biophysics) in which other graduate students developed lessons for high school classrooms and presented those materials at Danville (IL) High School.

Journal Publications

Gabric, K., Hovance, C., Comstock, S., & Harnisch, D. L., "Scientists in Their Own Classroom: The Use of Type II Technology in the Science Classroom", *Computers in the Schools*, p. 77, vol. 22, (2005). Published,

Camasta, S., Karulkar, M., Comstock, S., & Harnisch, D. L., "Collaborative Inquiry and Participatory Design: A Case Study in Technology Development and Application in a High School Science Classroom", *Proceedings of the Annual Meeting of the Society for Information Technology in Teacher Education*, p. 1, vol. , (2006). Published,

Hubler, A.W., Vlastic, A.Y., Steigler, E., Bievenue, L., Raineri, D.M., "Interactive Middle School Courseware on Abstract Reasoning Skills", *Proceedings of the Annual Meeting of the Society for Information Technology in Teacher Education*, p. 1, vol. , (2006). Published,

Richardson, Matthew and Hari, Jan, "Teaching Students About Biodiversity by Studying the Correlation Between Plants & Arthropods", *American Biology Teacher*, p. 217, vol. 70, (2008). Published,

Richardson, Matthew and Hari, Jan, "Building ecological complexity in the classroom using pea aphids and components of their community", *Journal of Biological Education*, p. , vol. , (2008). Submitted,

Matthew L. Richardson, "Using an exploratory Internet activity and trivia game to teach students about biomes", *Science Activities*, p. 19, vol. 46, (2009). Published,

Matthew L. Richardson and Janice Hari, "Building ecological complexity in the classroom using pea aphids and components of their community", *The American Biology Teacher*, p. 261, vol. 71, (2009). Published,

Matthew L. Richardson and Janice Hari, "Teaching students about biodiversity by studying the correlation between plant and arthropod biodiversity", *The American Biology Teacher*, p. 217, vol. 70, (2008). Published,

Books or Other One-time Publications

Kirkpatrick, M., Camasta, S., Harnisch, D.L. & Comstock, S.L., "Teachers coaching scientists: Beyond metaphor to modeling meaningful inquiry.", (2009). Conference Proceedings, Published
 Editor(s): C. Crawford et al.
 Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2009
 Bibliography: Chesapeake, VA: AACE.

Camasta, S., Harnisch, D.L. & Comstock, S.L., "Generational impact: Growing a teacher community of practice in science education.", (2009). Conference Proceedings, Published
 Editor(s): C. Crawford et al.
 Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2009
 Bibliography: Chesapeake, VA: AACE.

Whalen, C., Kirkpatrick, M., Harnisch, D.L. & Comstock, S.L., "Making it real: Students assess technology and teaching in high school biology.", (2009). Conference Proceedings, Published
 Editor(s): C. Crawford et al.
 Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2009
 Bibliography: Chesapeake, VA: AACE.

Harnisch, D.L. & Comstock, S.L., "Evaluation of next generation technology integration in the sciences: An eight-year case study.", (2009). Conference Proceedings, Published
 Editor(s): C. Crawford et al.
 Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2009
 Bibliography: Chesapeake, VA: AACE.

Harnisch, D.L., "Improving student-centered learning with advances in learning, teaching and technology.", (2009). Newsletter, Accepted Collection: Center for English Teaching Excellence (CETE) in Georgia Republic Newsletter.

Bibliography: in press.

Harnisch, D.L., "Building sustainable collaborative inquiry with technology in K12 classroom: An eight-year study in Illinois.", (2009). Conference Proceedings, Published

Collection: Proceedings of American Association for the Advancement of Science (AAAS) International Conference 2009.

Bibliography: Chesapeake, VA: AACE.

Harnisch, D.L. & Comstock, S.L., "The Impact of the GK12 Program on its Participants. Symposium entitled, The NSFGK12 Program: Insect-based Curriculum, Impact and Extension.", (2008). Conference Proceedings, Published

Collection: Proceedings of 2008 Annual Meeting of Entomological Society of America.

Bibliography: unknown

Rosu, L., Harnisch, D., Bruce, B. & Davis, R., "Challenges and Opportunities in Forming Collaborative Partnerships in Higher Education.", (2007). Conference Proceedings, Published

Editor(s): Crawford et al.

Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2007

Bibliography: (pp. 2451-2453). Chesapeake, VA: AACE.

Camasta, S., Karulkar, M., Comstock, S. & Harnisch, D., "Collaborative Inquiry and Participatory Design in High School Science: A Case Study in Technology Development and Application.", (2006). Conference Proceedings, Published

Editor(s): C. Crawford

Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2006

Bibliography: pp. 3957-3970. Chesapeake, VA: AACE.

Buell, J., Harnisch, D., Bruce, B., Comstock, S. & Braatz, R., "New Tools Supporting New Partnerships: Technology Development within the NSF GK-12.", (2004). Conference Proceedings, Published

Editor(s): C. Crawford

Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2004

Bibliography: pp. 4614-4618. Chesapeake, VA: AACE.

Gabric, K., Comstock, S., Moore Jr., S., Harnisch, D., Shope, R., Bruce, B. & Buell, J., "What Science and Technology Mean to the High School Learner", (2004). Conference Proceedings, Published

Editor(s): C. Crawford

Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2004

Bibliography: pp. 4643-4650. Chesapeake, VA: AACE.

Harnisch, D., Comstock, S., Bruce, B. & Buell, J., "Development of Professional Learning Communities: Factors within the NSF GK-12 Program.", (2004). Conference Proceedings, Published

Editor(s): C. Crawford

Collection: Proceedings of Society for Information Technology and Teacher Education International Conference 2004

Bibliography: pp. 2887-2891. Chesapeake, VA: AACE.

Web/Internet Site

URL(s):

<http://gk12-uiuc.net>

Description:

This is the main web site for the UIUC GK-12 project. Fellow projects, activities, and materials are linked from this site.

Other Specific Products

Contributions

Contributions within Discipline:

A variety of educational materials have been developed as a result of this project, including the following.

Chemistry:

- Using Models and Visualization <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/viz/>
- Naming Compounds <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/naming/>
- Reaction Types <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/rxns/>
- What is a Mole? <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/moles/>
- Calculating Avogadro's Number <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/avogadro/>
- What is a Quantum Model? <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/quantum/>
- The Quantum Atomic Model Explorer http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/model_explorer/
- Spectrometry <http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/qualitative/>
- Periodic Table and Nomenclature
<http://gk12-uiuc.net/jyounger/Lessons.html>
- Balancing Equations
<http://gk12-uiuc.net/jyounger/Lessons.html>
- Nuclear Chemistry
<http://gk12-uiuc.net/jyounger/Lessons.html>
- Polymer Chemistry
<http://gk12-uiuc.net/jyounger/Lessons.html>

History:

All the following lessons are at <http://www.centralhistory.com>

- Colonial Growth
- Revolutionary War
- Growth of the Nation
- Civil War
- Late Nineteenth Century
- Early 20th Century
- World War I
- World War II
- Modern America
- Helpful Handouts
- Online Resources
- AA History, 1900-1940
- Civic Projects
- Material Culture Project

Geology (see Community/Geology at <http://gk12-uiuc.net>)

- Topography - Geology Resources on the Internet
- Plate Tectonics - Did Pangea really exist?
- Earthquakes and Plate Boundaries
 - Tracking Earthquakes Around the World Using the Internet
 - New Madrid Fault Assignment
 - Frequency of Earthquakes and Plate Boundaries Assignment
 - Magnitude of Earthquakes and Plate Boundaries Assignment
 - Depth of Earthquakes and Plate Boundaries Assignment

Engineering (see Community/Engineering at <http://gk12-uiuc.net>)

- Mechanical Advantage Activity
- Matchstick Rockets

Geography (see Community/Geography at <http://gk12-uiuc.net>)

- Networks (Why Were the Pirates in the Caribbean)

- Grain Game (How Chicago Replaced St.Louis as the Midwest Hub)
- Population Modeling with Netlogo
- Population Modeling with Stella

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Several former GK-12 fellows are now scientists and faculty members across the United States; all of them contribute regularly to outreach within their organization. For example, P. Ryan Jackson is a senior scientist at the U.S. Geological Survey; Kris DuRocher is history faculty at Moorehead State University; Katie Lustofin is biology faculty at Marietta College.

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Conference Proceedings

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Product

Contributions: To Any Other Disciplines

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering

Any Conference

The GK-12 program (2001-2009) at the University of Illinois at Urbana-Champaign (UIUC), currently administered by the College of Liberal Arts and Sciences in partnership with the National Center for Supercomputing Applications (NCSA), has involved 43 teams in 21 middle and high schools geographically distributed in Illinois. Annually, GK-12 teams comprised of advanced graduate students in science, mathematics, engineering, and social sciences work with educators to integrate the use of computer-based modeling and scientific visualization. Key to the program's success at UIUC has been the use of inquiry-based learning methodologies to inspire authentic—and exciting—learning opportunities. The UIUC program focuses on using computer-based modeling and visualization to explore the quantitative aspects of science and social science, especially in fields that have recently begun to rely more heavily on quantitative methods (e.g., biology, environmental science, geography, geology, and history).

Major research and education activities corresponded to our goals for the UIUC Track 2 GK-12 program:

- Expand to new disciplines. In the UIUC EdGrid Track 1 GK-12 program participating departments included Chemical Sciences, Life Sciences, Animal Sciences, Physics, Mathematics, Computer Science and Library and Information Science; with fellows selected from each of those departments. Additional departments in the renewal program include Anthropology, Atmospheric Sciences, Geology, Geography, History and Sociology. *Selected* fellows in Track 2 have come from Chemical Sciences, Life Sciences, Mathematics, Geology, Geography, History, Civil Engineering, Aerospace Engineering, and Neuroscience. The multidisciplinary nature of our GK-12 EdGrid Program has meant responding to diverse work styles, expectations, perceptions (especially concerning prioritization of project goals), methodologies adopted and basic world views. Although such varied visions have sometimes led to delays, the multidisciplinary nature of our GK-12 project has undoubtedly lent it a dynamic richness that we want to sustain. See below for specific activities in each discipline represented during the 2004-05, 2005-06, 2006-07, 2007-08, and 2008-09 school years.
- Expand to other campus outreach programs. In the Track 1 GK-12 program fellows joined existing EdGrid (www.edgrid.org) teams, such as ChemViz and Biology Student Workbench, which provided a stable support network, as well as a variety of existing materials that the fellows could adapt for their use working with teachers in the classroom. This arrangement facilitated efficient and effective integration into the educational system and helped the fellows to get a running start. In track 2 we encourage fellows to identify similar scientific tools that could be used in K-12 classrooms; Sharlene Denos identified VMD (Virtual Molecular Dynamics) and it was very well received by her partner teachers (Barker and Hafner) and also another Biology teacher (Matt Kirkpatrick at Neuqua Valley HS). During 2008 and 2009 we broadened campus involvement in GK-12 activities by incorporating fellows into other campus K-12 outreach programs, such as the Science Olympiads, a summer neuroscience workshop for teachers (led by Professor Barbara Hug in the College of Education), and a biophysics K-12 outreach project initiated by former fellow, Sharlene Denos.
- Emphasize interdisciplinary projects. One of the things we noticed in the Track 1 GK-12 program is that some of the most rewarding projects were interdisciplinary in nature. One computer science fellow worked with a biology teacher. Another biology fellow worked with a chemistry teacher. This was instructive for both the fellows and the K-12 teachers and students. The K-12 teacher and students began to understand that “science” is not divided into neat categories of biology, physics, and chemistry. The fellows applied their knowledge in new areas, often discovering new ways of thinking about their own research. There is also significant cross-fertilization among the fellows. When the fellows meet to discuss their projects they learn from each other, and have applied

principles from another discipline to their own work. In the first year of the Track 2 project we emphasized these kind of interdisciplinary connections wherever possible. For example, the civil engineering and the chemical engineering fellows contributed to a water management project led by the geography fellows. One geography fellow participated in one class of a history fellow. The engineering fellows all collaborated on an engineering project that led to the high school students winning an undergraduate engineering design competition at the UIUC Engineering Open House. Each of these interdisciplinary projects were rewarding for all teachers and students involved. One teacher commented that it was one of the most educational activities she had participated in. In years 2 and 3 there were fewer opportunities for interdisciplinary projects due to the disciplines and classrooms involved, but fellows continued to strive to interact and develop interdisciplinary units, such as geology and water science field trip collaborations, and geography and geology collaboration that further developed the “Grain Game.” In years 3 and 4, one fellow/teacher team developed and implemented a neuroscience theme for the first-year biology course at Neuqua Valley High School. More than simply sprinkling neuroscience topics into the biology course, the fellow worked to use the interdisciplinary nature of neuroscience to emphasize the importance of applying many kinds of knowledge and tools to application areas such as neuroscience.

– **Emphasize inquiry-based learning methods.** Many experts and recent national reports concur that inquiry-based projects successfully facilitate learning. One report on technology and inquiry has suggested that inquiry-based instruction “allows students to engage in practices of scientists and to construct their own scientific knowledge through investigation rather than memorization” (Linn, Slotta, and Baumgartner, 2000, p. 2). However, getting teachers interested and familiar with inquiry is challenging (Thakkar, Bruce, Hogan, and Williamson, 2003). To address such challenges, we focused on developing inquiry-based materials with GK-12 fellows and teachers for use in their classrooms. A tool we use to support this effort is the Inquiry Page (<http://www.inquiry.uiuc.edu>) and iLabs (<http://ilabs.inquiry.uiuc.edu>). The Inquiry Page is a free, web-based resource and online community of and for teachers/learners who use inquiry-, problem- and project-based methods, developed by Prof. Bertram Bruce at UIUC. Its particular utility is in its facilitation of inquiry-based lessons or “units” that can be shared with other teachers/learners. Guided by the principles of participatory design, it has grown to serve educators internationally.

The fellows. Year One, Track 2.

Eight GK-12 graduate fellows were selected at the University of Illinois at Urbana-Champaign (UIUC) for the 2004-05 school year, six funded by NSF grant #0338215, and 2 funded by the UIUC College of Liberal Arts and Sciences (LAS). Graduate students in the School of Chemical and Life Sciences, and the Departments of Anthropology, Geography, Geology, History, Mathematics (all in the College of LAS) were especially encouraged to apply, but students in the College of Agriculture....and Engineering were also eligible to apply. Twenty-five students applied; eight were selected as follows: Aeronautical Engineering, Chemical Engineering, Civil Engineering, Entomology, Geography (2), History (2). Four fellows were women, 1 African American. The eight fellows worked with 7 faculty mentors and 9 teachers as follows.

Fellow	Department	Mentor	Teacher	School	Course(s)
Kris DuRocher-Wilson	History	Burton, History	John Naisbitt	Hinsdale Central HS	American History
Kwame Holmes	History	Burton, History; Rosenblatt, Mathematics	David Collins	Franklin Middle School, Champaign	American th History (8 grade)

Mohan Karulkar	Chemical Engineering	Braatz, Chem. Engr.	Susan Camasta	Hinsdale South HS	Chemistry
Ryan Jackson	Civil Engineering	Hsui, Geology	Rob Johnson	Danville HS	Geology
Katy Lustofin	Entomology	Berenbaum, Entomology	Joan Campagnolo, Sheila Ashbrook	HomeHi Middle School, Urbana	Physics, Biology
Sara Metcalf	Geography	Rhoads, Geography	Paul Hohulin	Champaign Centennial HS	Geography
Suzy Sandrik	Aeronautical Engineering	Hubler, Physics	Shelley Barker	Danville HS	Engineering
Rob Whiting	Geography	Rhoads, Geography	Heather Topel	Champaign Central HS	Geography, American Govt.

Two of the graduate fellows (DuRocher-Wilson and Lustofin) were also fellows the previous year as part of the UIUC Track 1 grant. DuRocher-Wilson continued with the same teacher and Lustofin moved to a different school. All fellows were selected by mid-April (2004) and they attended the final group meeting of the 2003-04 GK-12 group on May 1st. At this meeting departing fellows presented their work for the year and new fellows gave a short presentation about their research (as if they were relating it to a K-12 classroom) and how they perceived they may be able to contribute in a K-12 classroom. Teachers and administrators from partnering schools were invited to the full day meeting and time was provided for teachers and administrators to chat with returning and incoming fellows about possible projects they might work on for the following year. After this meeting fellows were matched with teachers and encouraged to make contact before the fellowship officially started on July 1, 2004.

The fellows. Year Two, Track 2.

Seven GK-12 graduate fellows were selected at the University of Illinois at Urbana-Champaign (UIUC) for the 2005-06 school year, six funded by NSF grant # 0338215, and 1 funded by the UIUC College of Liberal Arts and Sciences (LAS). Graduate students in the School of Chemical and Life Sciences, and the Departments of Anthropology, Geography, Geology, History, Mathematics (all in the College of LAS) were especially encouraged to apply, but students in the Colleges of Engineering and Agricultural, Consumer and Environmental Science were also eligible to apply. Sixteen students applied; seven were selected as follows: Aeronautical Engineering, Chemical Engineering (2), Civil Engineering, Geography, Mathematics. Two fellows were women. The seven fellows worked with 5 faculty mentors and 9 teachers as follows.

Fellow	Department	Mentor	Teacher	School	Course(s)
Mohan Karulkar	Chemical Engineering	Braatz, Chem. Engr.	Susan Camasta	Hinsdale South HS	Chemistry
Ryan Jackson	Civil Engineering		Gary Apfelstadt, Jan Hari	Urbana MS	Geology
Suzy Sandrik	Aeronautical Engineering	Hubler, Physics	Shelley Barker	Danville HS	Engineering
Rob Whiting	Geography	Rhoads, Geography	Heather Topel	Champaign Central HS	Geography, American Govt.

Scott K. Clark	Geology	Kieffer, Geology	Chris Midden Rob Johnson	Unity Point, Danville HS	5 th Grade Earth Science, Geology
Andrew Vlasic	Mathematics	Uhl, Mathematics	Alfred Hubler	Home Hi	Algebra
Jennifer Yunker	Chemical Engineering	Braatz, Chem. Engr.	Sarah Boesdorfer	Danville HS	Chemistry

Four of the graduate fellows (Karulkar, Jackson, Sandrik, Whiting) were also fellows the previous year. Karulkar, Sandrik and Whiting continued with the same teacher and Jackson moved to a different school.

All fellows were selected by mid-April (2005) and they attended the final group meeting of the 2004-05 GK-12 group on May 6th. At this meeting departing fellows presented their work for the year and new fellows gave a short presentation about their research (as if they were relating it to a K-12 classroom) and how they perceived they may be able to contribute in a K-12 classroom. Teachers and administrators from partnering schools were invited to the full day meeting and time was provided for teachers and administrators to chat with returning and incoming fellows about possible projects they might work on for the following year. After this meeting fellows were matched with teachers and encouraged to make contact before the fellowship officially started on July 1, 2005.

The fellows. Year Three, Track 2.

Seven GK-12 graduate fellows were selected at the University of Illinois at Urbana-Champaign (UIUC) for the 2006-07 school year, five funded by NSF grant # 0338215, and 2 funded by the UIUC College of Liberal Arts and Sciences (LAS) – the Dean’s office and the Department of Mathematics. Graduate students in the School of Chemical and Life Sciences, and the Departments of Anthropology, Geography, Geology, History, Mathematics (all in the College of LAS) were especially encouraged to apply, but students in the Colleges of Engineering and Agricultural, Consumer and Environmental Science were also eligible to apply. Sixteen students applied; seven were selected as follows: Biophysics (1), Chemical Engineering (1), Ecology and Evolutionary Biology (1), History (1), Mathematics (2), Neuroscience (1). Two fellows were women. The seven fellows worked with 5 faculty mentors and 9 teachers as follows.

Fellow	Department	Mentor(s)	Teacher(s)	School	Course(s)
Andrew Vlasic	Mathematics	Uhl, Mathematics	Alfred Hubler Jim Dockery	Campus MS for Girls, Pittsfield HS	8 th grade Algebra, Calculus
Jennifer Yunker	Chemical Engineering	Braatz, Chemical Engr.	Sarah Boesdorfer, Rick Pavinato	Danville HS, Homewood- Flossmoor HS	Chemistry
Desmond Cummins	Mathematics	None	Mike Smith	Pittsfield HS	Physics
Sharlene Denos	Biophysics & Computational Biology	Martin Gruebele, Barbara Hug	Shelley Barker	Danville HS	Biology

Matthew Richardson	Ecology & Evolutionary Biology	Larry Hanks	Jan Hari, Joan Campagnolo	Campus MS for Girls	8 th grade, 7 th grade
Troy Smith	History	Vernon Burton	William Sutton	University HS	US History
Chris Whalen	Neuroscience	Eric Jakobsson	Matt Kirkpatrick, Jennifer Schmauderer	Neuqua Valley HS	Biology, Psychology

Two of the graduate fellows (Vlasic, Younker) were also fellows the previous year. Both continued with the same teacher, although Younker's teacher moved to a new school (Mt. Zion HS). Both also worked with an additional teacher and school: Younker with Rick Pavinato at Homewood-Flossmoor HS and Vlasic with Jim Dockery at Pittsfield HS.

All fellows were selected by mid-April (2006) and they attended the final group meeting of the 2005-06 GK-12 group on April 29th. At this meeting departing fellows presented their work for the year and new fellows gave a short presentation about their research (as if they were relating it to a K-12 classroom) and how they perceived they may be able to contribute in a K-12 classroom. Teachers and administrators from partnering schools were invited to the full day meeting and time was provided for teachers and administrators to chat with returning and incoming fellows about possible projects they might work on for the following year. After this meeting fellows were matched with teachers and encouraged to make contact before the fellowship officially started on July 1, 2006.

The fellows. Year Four, Track 2.

Five GK-12 graduate fellows were selected at the University of Illinois at Urbana-Champaign (UIUC) for the 2007-08 school year, four funded by NSF grant # 0338215, and 1 funded by the UIUC College of Liberal Arts and Sciences (LAS) – the Department of Mathematics. Graduate students in the School of Chemical and Life Sciences, and the Departments of Anthropology, Geography, Geology, History, Mathematics (all in the College of LAS) were especially encouraged to apply, but students in the Colleges of Engineering and Agricultural, Consumer and Environmental Science were also eligible to apply. Sixteen students applied; five were selected as follows: Biophysics (1), Ecology and Evolutionary Biology (1), History (1), Mathematics (1), Neuroscience (1). One fellow was female. The five fellows worked with 4 faculty mentors and 9 teachers as follows.

Fellow	Department	Mentor(s)	Teacher(s)	School	Course(s)
Desmond Cummins	Mathematics	None	Mike Smith Jonathan Ramirez	Pittsfield HS Edison MS	Physics Mathematics
Sharlene Denos	Biophysics & Computational Biology	Martin Gruebele, Barbara Hug	Kathy Hafner Kevin Kuppler Bryan Foli	Danville HS Edison MS Edison MS	Biology 7 th grade
Matthew Richardson	Ecology & Evolutionary Biology	Larry Hanks	Jan Hari Greg Conn	Urbana MS LeRoy Jr HS	8 th grade 7 th grade
Troy Smith	History	Vernon Burton	William Sutton	University HS	US History
Chris Whalen	Neuroscience		Matt Kirkpatrick Jennifer Schmauderer	Neuqua Valley HS	Biology Psychology

All of the graduate fellows were also fellows the previous year. In order to broaden their experience, three fellows worked with new teachers. Smith and Whalen did not work with new teachers, and instead focused on developing, assessing, and fine-tuning a year-long set of materials for their respective courses.

The fellows. Year Five, Track 2.

Four GK-12 graduate fellows were selected at the University of Illinois at Urbana-Champaign (UIUC) for the 2008-09 school year. Graduate students in the School of Chemical and Life Sciences, and the Departments of Anthropology, Geography, Geology, History, Mathematics (all in the College of LAS) were especially encouraged to apply, but students in the Colleges of Engineering and Agricultural, Consumer and Environmental Science were also eligible to apply. Sixteen students applied; five were selected as follows: Animal Biology (1), Plant Biology (1), Food Science and Human Nutrition (1), and Natural Resources and Environmental Sciences (1). Two fellows were female. The four fellows worked with 4 faculty mentors and 4 teachers as follows.

Fellow	Department	Mentor(s)	Teacher(s)	School	Course(s)
Crystal Goshorn	Food Science & Human Nutrition	Richard Braatz	Rick Pavinato	Homewood-Flossmoor HS	Chemistry
Ryan Kelly	Plant Biology	Tom Jacobs	Susan Camasta	Hinsdale South HS	Environmental Science
Kate Laskowski	Animal Biology	Alison Bell	Kathy Hafner	Danville HS	Biology
Dylan Maddox	Natural Resources & Environmental Science	Patrick Weatherhead	Brad Allen	St. Joseph-Ogden HS	Biology

All fellows were new to the program this year and knew they would not have the option of a full second year due to funding constraints. Thus, all fellows vigorously pursued every opportunity and benefited from past fellows' work and advice.

Undergraduate fellows. Year One, Track 2.

In addition to the eight graduate fellows, five undergraduate fellows were selected in the fall to support various aspects of the program and fellow/teacher projects. In this first year of the UIUC Track 2 program we experimented with undergraduate fellows on a limited basis. Three fellows participated for just one semester (due to other commitments they had); two for a full year. Because undergraduates' schedules typically do not afford them blocks of time to spend in a K-12 classroom we decided to experiment with undergraduate fellows who could support the graduate fellows' work. The undergraduates would then be part of a team, but not have any responsibility beyond their ability to commit on a month-to-month basis. We paid them on an hourly basis so as to accommodate students' various levels of time commitment with which they were comfortable. Three of the undergraduate fellows were pre-service teachers; their role was to assist the graduate fellows with lesson plan writing, research, and additional support for special classroom projects and field trips. Two of the undergraduate fellows were also mathematics majors and assisted with integrating mathematics into the science and social science lesson plans and projects. One undergraduate fellow's major was biochemistry; she especially assisted Lustofin and Karulkar. Another undergraduate fellow's major was geology; she especially assisted Jackson. The fifth undergraduate fellow's major was physics; she worked on a project with mentor Hubler on physics lessons for

middle school girls.

Undergraduate fellows. Year Two, Track 2.

Two undergraduate students from year one continued into year two (Mudarth and Rampalli). Both assisted on projects as needed and contributed to the newsletter. Two additional undergraduate fellows joined the program in February, 2006. Taylor (Anthropology major) and McFarland (Molecular and Cellular Biology major) joined with Burton (History) to develop “RiverWeb” resources for geography and geology projects, and also future history projects. Taylor also taught a Photoshop workshop at the February 21st “Mini-workshop” day.

Undergraduate fellows. Year Three, Track 2.

Two undergraduate students from year two continued into year two (Taylor and Rampalli). Taylor is mainly responsible for developing “RiverWeb” resources for geography and history projects. Rampalli, in her third year of the program, was treated as a graduate fellow. She worked with middle school teacher Gary Apfelstadt at Urbana Middle School in the Waterworks class.

Summary of Fellows by School, Tracks 1* and 2. School/District	Number of Teachers Involved	Years of Participation	Total Unique Fellows	Total Fellow-years
Champaign Centennial HS	4	2003-2005	2	2
Champaign Central HS	1	2004-2006	1	2
Franklin MS, Champaign	1	2004-2005	1	1
Edison MS, Champaign	3	2007-2008	2	2
Champaign Unit 4 School District	9	2003-2005 2007-2008	6	7
Urbana High School	1	2000-2002	1	2
Urbana Middle School	2	2005-2007	3	3
Urbana Unit 116 School District	3	2000-2002, 2005-2007	4	4
Danville High School	7	2000-2009	7	9
Hinsdale Central High School	4	2000-2006	4	6
Hinsdale South High School	2	2001-2009	4	5
Hinsdale School District #186	6	2000-2007	7	10
Unity Point School, Carbondale, IL	2	2005-2006	1	1
Campus Middle School for Girls (previously known as Home Hi Middle School), Urbana, IL	3	2004-2007	3	3
Mt. Zion High School	1	2006-2007	1	1
Homewood-Flossmoor High School	1	2006-2007	2	2
Pittsfield High School	2	2006-2008	2	3
Neuqua Valley High School	2	2006-2008	1	2
University High School	1	2006-2008	1	2
LeRoy Jr. High School	1	2007-2008	1	1
St. Joseph-Ogden High School	1	2008-2009	1	1
TOTAL	39		38	48

*Track 1 data is only included for schools who also participated in Track 2.

Project Descriptions.

Following are representative fellow/teacher projects.

Engineering (2005-2007)

Graduate Fellow Suzy Sandrik and teacher Shelley Barker are leading a new class called "Principles of Engineering" at Danville High School. The class provides twenty freshman and sophomore students with several opportunities that are rarely encountered in high school:

- to learn about different types of engineering
- to study engineering subjects they will revisit in college if they pursue engineering
- to design, build, and test engineering projects like the mousetrap cars and the marble sorter
- to work in teams
- to present the results of their efforts to the class and to other audiences, including at Engineering Open House
- to speak with practicing engineers
- to practice writing technical reports

The two largest projects of the fall term were engineering field reports and mousetrap cars. The reports required each student to choose an engineering field, conduct research on what engineers in that field do, interview an engineer in that field, find schools that offered majors in or relating to it, and identify what high school background those schools would require to consider the students for admission. As the engineering fellow, Suzy presented a brief overview of different types of engineering and different functions that engineers have in the work force. She set up interviews between the students and practicing engineers and attended the students' presentations.

For the mousetrap car project, the students worked in teams of three. Leading up to the project, Suzy and Shelley presented information and activities on engineering drawing and mechanical advantage. Each group had to produce design sketches before they were given their mousetrap. The mousetraps were provided, and the materials for building the cars were to come from whatever the students found around their homes. The mousetrap cars were tested over two days, which gave the students time to make adjustments. By the second day of testing, all of the cars moved, and some were very successful.

A short but popular project near the end of the fall semester was the construction and launching of matchstick rockets, tiny one-inch rockets made of match heads and aluminum foil. The students were studying thermodynamics and using heat to accomplish work. They answered questions regarding the science behind the rockets and the engineering aspects of what they tried that worked, what didn't work, and what they changed to try to fix problems. Before the activity, Suzy and Shelley viewed the lack of consistently good launches in their own preparatory tests as a negative aspect of this project, but the fact that they were difficult to make actually encouraged the students; they had just enough success to take it as a challenge and worked on them voluntarily for homework. They succeeded too - the second day (which was not planned, but requested by the students), everyone had a successful launch.

This spring, the students studied open and closed loop controls. They used *Fischertechnik*s and the corresponding software program Lucky Logic to build a machine that sorts marbles according to color. The students spent half the semester working on this project and presented their completed

marble sorters at the Engineering Open House on March 11th, 2005, winning their division of engineering design.

History (2003-2005)

Graduate Fellow Kris DuRocher Wilson (History) is collaborating with John Nasibitt, history teacher at Hinsdale Central High School. Although most of their work is focused on the two classes of United States history, smaller lessons and skills are being developed for the four classes of Advanced Placement European History.

For American History, their goals have been to make history come alive for students by allowing them to become active participants in the past. Primary sources and student-centered lessons encourage students to become historians, to look at the artifacts of the past, to think critically about them, and to make connections between events in the past and their own lives. In the fall of 2004, this was done through a combination of large and small projects.

Smaller projects include skill-based lessons on how to examine primary sources, how to use geography to make historical hypotheses, and how to think historically. Other smaller lessons included the “truth” behind the first Thanksgiving, which examined the travels of Squanto as he was enslaved, traveled around Europe, and learned to speak English. Squanto returned to his village in time to discover all other members had been wiped out by disease. He thus, threw his lot in with the Pilgrims. This lesson raised questions about why we choose to remember history in certain ways. (Indeed Thanksgiving was not a holiday until Lincoln declared it so during the Civil War to boost morale). Another “behind the scenes” lesson included looking at the life of Andrew Jackson, who is often praised as a man of the people. His life and presidency offer an interesting contradiction, which results in students discussing the difference between the myth and the man.

Larger units combine skill-building exercises with thematic and historical problems. One unit examines how revolutionary the Revolutionary War was. It begins by teaching students how to evaluate not only primary sources from the time, such as excerpts from Abigail Adam’s letters to her husband and Thomas Paine’s *Common Sense*, but also images such as political cartoons and stylized paintings. Students are required to take on the role of historians in making an argument about the nature of the revolution. They argue whether it was truly novel or simply the removal of England’s presence, leaving the same elite white men in power as before. Students write a short essay supporting their argument with examples from the primary sources.

One web-based lesson examined presidential elections through time. Here students had more freedom to pursue their own interests and interact with a partner. Through a website designed for this project (<http://www.freewebs.com/hinsdalecentralelectionslesson/index.htm>) students listened to Lincoln’s campaign songs from the 1860’s, watched commercials for the candidates in the 1960’s election, and downloaded web-based advertisements for the 2004 election. Students, after viewing all of the material, considered the audience, agenda, context, tone and feel of these campaigns. In the lively discussion that followed the assignment, students made many connections between all three campaigns, noting that the emphasis on morality remains a constant. Students also noticed connections about America’s place in the world between the 1960 and 2004 campaign advertisements.

Our examination of the antebellum United States included a unit on slavery. This began with students reading two accounts of slavery, one positive and one negative, and then exploring the audience, agenda, and context of each. Doing so revealed a twist – both accounts were told by the same woman three months apart. Understanding the reason for this, as well as the unreliability of primary sources was a springboard into a lesson on slave historiography (the history of how historians have looked at slavery). This lesson combined this knowledge with a note-taking skill, requiring students to be concise in their note taking, taking notes in specific areas of a 8 x 8 piece of paper. At the conclusion of the lesson, this paper was turned into a “fortune teller” an origami shape which allowed students to choose a date and then examine the materials by lifting a flap. This was then used to take a quiz. Our fall semester concluded with a Civil War historical discussion that focused on students understanding material and then synthesizing it. After doing that, they formulated questions to ask the fellow during a class discussion. This allowed students to be impressed with the fellow’s knowledge of the Civil War (!) but also to see how one goes about formulating and answering historical research questions.

For the spring of 2005, European history worked on advanced web searching. United States history examined cultural imperialism, the home front during World War I and II, an oral history interview, and the rise of material culture.

Geology (2004-2005)

Graduate Fellow Ryan Jackson and Undergraduate Fellow Melanie Mudarth are collaborating with Danville High School geology teacher Robert Johnson to integrate technology into the classroom help to prepare high school geology students for the transition to the college classroom. Due to the inherent spatial complexity in geology, a goal of the collaboration is to develop a set of exercises, labs, and visual aides that allow the students to better visualize the complex nature of geologic features and processes. Spatial recognition and the ability to think and design in three dimensions is a valuable skill for scientists and engineers, but it is also a transferable skill that can be used outside of the fields of science and engineering. Additional goals of the team include updating the lab exercises of the course to complement university level labs and utilize new advances in technology, integrate technology into the classroom by utilizing the computer and associated resources during lecture and labs, and give the students a broader knowledge base in geology and general science.

Major projects completed during the fall semester include a unit on topography, a unit on earthquakes, and a unit on mineralogy. The topographic unit involved the integration of the computer into the traditional lecture through the use of Microsoft PowerPoint presentations with interactive animations allowing the visualization of complex topography in 3-D with the ability to rotate the view of an ordinary topographic map to virtually any perspective. The animations were part of a suite of geology education materials developed by Steve Reynolds in the Department of Geology at Arizona State University. Further work included building a 3-D computer model of a 2-D topographic map made by the students during a lab exercise. The model served as a visual aide for the students while they created their maps in three dimensions given a set of elevation data. Finally, the topography unit concluded with a field mapping exercise that took the students through the entire map-making process from data collection to building a 3-D map on the computer using the processed data. During this exercise, the students were introduced to many methods of field mapping from ancient methods to modern surveying using total stations.

The earthquake unit was centered on a computer lab that allowed the students to use interactive data mapping tools to examine the correlation between the location of the earth's tectonic plates, volcanic activity, and seismic activity. Using a number of internet resources, students were able to choose the data to plot based on the magnitude, the depth, and the time period of the quakes. Combining the numerous maps generated for various sets of data with a map of volcanic activity and the location and type of the tectonic plates, students formed independent conclusions about the correlation between the locations of various types of quakes and the plate boundaries. Following this exercise, the students were asked to use the resources available on the internet and in the library to write a report on the New Madrid fault. This assignment personalized the topic due to the close proximity of the fault to the school and allowed role-playing as the students were asked to write from the perspective of a seismologist working for the local homeowners. At the end of the report, students were asked to synthesize the information they collected into a professional opinion on whether or not to recommend earthquake insurance to the homeowners of Carbondale, Illinois.

Finally, the semester concluded with a unit on minerals. Ryan led a discussion in class on the everyday uses of minerals in an attempt to broaden the perspective of the class and generate interest in the subject. In classes following the discussion, the students were assigned several common minerals and asked to research the everyday uses of their minerals. They were given time to complete their research in the computer lab and limited instruction on the building of a scientific poster. Each group member was assigned a role associated with various tasks and given the associated responsibility (coordinator, visual aides, informative text). The students were instructed to include such information as the uses in industry, in their home, in cosmetics, in food and food production, in sports, in medicine, and in society in general.

The spring semester included a term project on the career paths of geologists, a 3-D stratigraphy model lab to accompany a sedimentary geologic history of the earth report, a fossil report in the form of a children's book, posters and oral presentations on the various time eras and planets in the solar system, and a project in which the students will create game show parodies with a meteorological theme. The career term project involved the students choosing from among 46 various careers in geology and finding (with the help of the fellows) a contact in the field, completing an interview, and writing a report, a poster, or a pamphlet. The unit will end with a geology career fair. The fossil report lesson involved the students preparing a report on the origin of a fossil, but presented in the form of a children's book complete with illustrations and age appropriate text. The books will be donated to an elementary school in Rantoul, Illinois for use in the classroom.

Chemistry (2004-2006)

Graduate Fellow Mohan Karulkar worked with chemistry teacher Susan Camasta at Hinsdale South Highschool in Darien, IL, in two Chemistry classes of about 25 students, aged 15-16. The main goals were:

- exposing students to real-world scientists and engineers in a context consistent with their curriculum,
- providing students with a source of experience and knowledge that extends beyond the an educational setting, and
- supplementing students' educational experience with new and engaging technologies.

Mohan's lessons fall into three broad categories: Discussions, Labs, and Web/Technology-based Lectures.

Discussions typically involved introducing or wrapping-up a concept, or unit by assessing students' prior knowledge of the subject, drawing on topics discussed earlier, and giving real-world examples

of the topic at hand. Examples include:

- A discussion on the real-world uses of radioactive isotopes, including dating, toxicity screening, and food irradiation. This was a wrap-up to an atomic-structure unit.
- A discussion about models and visualizations that drew on Mohan's personal and work experience in modeling and creating visualizations. The difference between the two concepts was stressed and examples were given in this web-based activity. A discussion about everyday models and visualizations was held, and an introduction to several historical models of the atom was given. (<http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/viz/>)

Lab-based lessons typically serve as post-lab activities, reinforcing concepts introduced in the lab. These typically involve a technological aspect to keep students engaged while providing a change in venue. Examples include:

- A follow-up discussion to a lab designed to help students learn how to name compounds. The activity was an internet-based set of animations showing the lab's reactions from a molecular perspective. (<http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/naming/>)
- A follow-up discussion to a lab intended to demonstrate different types of reactions. The activity featured animations designed to give a molecular perspective of the reaction types (<http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/rxns/>) while referring to reactions seen earlier in the year
- A Flash-based animation introducing the concept of the Mole, discussed after a lab which covered some of the same topics. The animation featured questions that the class discussed as a whole, and was available online for later review. (<http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/moles/>)
- A flash-based, wholly online lab activity for calculating Avogadro's Number using meaningful, physical data. Many stopping points for discussion were included, along with an answer key available after completion of the lab. The benefits of having the lab online were that it was reviewable after class, had built-in pacing, clear instructions, and no safety issues. Also, the availability of an online answer key gave students the chance to check their work while it was fresh in their minds. (<http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/avogadro/>)
- The Quantum Atomic Model explorer is a tool designed to help students understand the difference between traditional visualization of atomic structure and actual, accepted atomic theories. This tool could easily be built into a lab, or a lab built around it. It is interactive, visual, and provides outside links for the inquisitive student. (http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/model_explorer/)

Web/technology-based lectures were lessons done in the computer lab, with Mohan leading the discussion with a projected PC, and students following along on their own PCs. These web-based lessons typically had links to outside sources, places to pause for questions, and interactive elements like small Flash demonstrations. Examples include:

- A web-based introductory lecture on Quantum models provided examples of several different models, interactive components, and a chance for students to follow along with Mohan as he reviewed with new ideas. (<http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/quantum/>)
- A web-based lesson on Spectrometry helped introduce quantitative/qualitative data. The lesson provided colorful examples and several stopping points for question and analysis, including real mass spectrometry data and AFM images that students were asked to interpret. (<http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/qualitative/>)

Neuroscience – Biology & Psychology (2006-08)

Graduate Fellow Christopher Whalen worked with biology teacher Matthew Kirkpatrick and psychology teacher Jennifer Schmauderer at Neuqua Valley High School in Naperville, IL, in five freshman biology classes of about 25 students each, aged 13-14, and 3 psychology classes of about 25 students each, 1 AP (mostly seniors) and 2 introductory (sophomores and juniors). The main goal was to integrate neuroscience topics into both psychology and biology courses in a way that was seamless and strengthened each course. Specific objectives included:

In Biology:

- Present the Nervous System as a Model System to demonstrate various levels of Biology – molecular, cellular, and macroscopic
- Develop Visuals, Software, and Hands-On activities that demonstrate the relevant concepts
- Employ an interdisciplinary approach using the application of neuroscience to bridge science disciplines
- Generate Lessons with Longevity: Retention and Perseverance of Skills and Knowledge

In Psychology:

- Draw connections between psychology and biology
- Demonstrate psychology as an experimental science

In addition fellow Whalen conducted some self- and classroom-assessments based on the following research questions:

General Research Questions

- Was I as a fellow successful at integrating my specialization onto the traditional discipline framework?
- Was I successful at using my skills and expertise to help students explore “outside the box” while still meeting curriculum goals?
- Does exposure to the fellow alter and redefine “What it mean to be a scientist” in the minds of the students? If so, in what ways and in what directions?
- How does the GK-12 program potentially change the educational trajectory of children?
- What is the long term impact of my GK-12 lessons? Are they more memorable, enhance conceptual change, strengthen retention, or enrich the mind forever more than the alternative lesson that the students would have been exposed to?

Biology

- How does in depth understanding of one human biological system, the nervous system, allow for integration of scale and application of science at various levels (i.e. molecular, cellular, systems, organismal, population, evolutionary) and transfer of information to and from other disciplines of science and mathematics?

Psychology

- Do students view psychology in a more biological light as a result of my presence?

Lesson topics:

Biology

- Introduction – GK-12 mission, goals, my research
- Stroop Task (computer activity) – Scientific Method
 - Experiment Design, Data Analysis using Excel
- Neurotransmitters (hands-on) – Biomolecules
 - Building Neurotransmitters using Molecular Models (3d hands-on)

- Internet Research (computer activity)
- Biomolecule Class and Origins: (comparison to biomolecules particularly amino acid)
- Psychological Function (video clips) - on depression, bipolar, addiction, etc.
- Neurotransmitter Fun Fact Treasure Hunt
- Visual Molecular Dynamics (computer activity) – Protein Structure and Function
 - Visualizing Proteins: RNA polymerase, ATPase, dopamine receptor, Complex V
 - Active Site Detection
- Macroscopic Evolution (computer activity)
 - Artificial Selection – Dog breeding
 - Bug Hunt – interactive predator/prey game how traits evolve in a population. Graph interpretation
 - Genetic Drift – many traits are not adaptations!
- Molecular Evolution (computer activity)
 - BLAST - comparing species by brain genes neural genes to other species using
 - All traits are not adaptations!
- Neurons (interactive lecture) – Cell Structure & Function
 - Neuron as a specific cell with departure from prototype
 - Microscope Viewing of Neuron
- Action Potential (interactive lecture) –
 - Cell Signaling & Communication (video clips)
 - Transmembrane Proteins, Ions, Electrical Gradients, Concentration Gradients
- Brain to Muscles – Animalian Movement (interactive lecture)
 - Brain → Axons → Neurotransmitters → Muscle Cells
 - Anatomy of a Muscle Cell
 - Electrical Signaling of Muscle Cells
 - Visualizations (Prof. Cheng’s Animation Videos)
- Diseases, Disorders, Lesions, and Impairments in the Brain
 - Alzheimer’s, Huntington’s, Addiction, Depression
- Brain Anatomy (hands on)
 - Human Brain Station
 - Sheep Brain Dissection – major features and function
 - Comparative Brain Anatomy – Human vs. Sheep vs. Rat
- Functional Neuroimaging (computer activity)
 - fMRI/EROS – application of all neuroscience knowledge and scientific method investigation to brain activity with real functional activation maps
 - Ask Student’s what additional tools could you use to investigate this further.
 - Generate Lab report

Psychology

- Introduction –
 - Who I am. Why I’m here. My research
 - Memory Experiment – basic data calculations
- Brain Imaging Techniques (interactive lecture)
 - X-ray, CT, MRI, fMRI, ERP, PET, EROS
- Brain Anatomy Stations (hands-on, computer)
 - Human brains, sheep brains, MRI, MSU website, quiz yourself
- Stress: Biological and Psychology (interactive lecture, readings, jigsaw student teaching and discussion)
 - What is the purpose of stress?

- Stress Hormones
- Readings
- Psychological Stress Experiment (PBS video clip: Larry Cahill)
- Perception (interactive lecture, video clips)
 - Top Down vs. Bottom Up, Gestalt – neural recordings, Attention, Memory, Past Experiences.
 - Daniel Simon's Videos and others to lead discussion
- Motivation (interactive lecture)
 - What drives behavior? What is the purpose of our motivations?
 - What does neuroscience tell us about motivation?
 - Studies: Olds and Milner, fMRI, Addiction.
- Statistics Lesson (computer activity) – analyzing memory project data
 - When to believe a study's results did not occur by chance?
 - Mean, Median, Mode, Standard Deviation, t-score, p-value
- Memory & Cognition –
 - Video Clips: Unknown White Male (video clip), amnesia, aphasia, ataxia, apraxia (youtube, psych CD)

Formative Evaluation Recommendations (2005-2006).

The following are not offered as a prescription but rather as a list of points to ponder. Those who are more acquainted with the GK12 Program and more aware of all the parameters will have to balance these ideas with their broader knowledge base. The GK12 Program should consider:

1. More time and care invested in making better matches between the teachers and the fellows will result in smoother acclimation of the fellow to the classroom. Critical to this process is ensuring “teacher buy-in”—that is the full commitment of the teacher to the program.
2. Developing an involved and detailed process to communicate clear expectations and requirements for the classroom collaboration before and during the school year would reduce frustration and enable stronger partnerships.
3. The spring presentations of the Fellow’s Spring Projects should continue as it promotes highly successful experiences in the classrooms.
4. An emphasis on technology as a means to an end should be encouraged. Schools vary in their capacity to support technology. Technology should support learning not replace it.
5. The changes the fellow undergoes as scientist should be examined in greater detail. The potential for further impact of the program may very well be a direct result of this transformation.
6. Teachers and Fellows create a unique collaboration based on the school, the courses, the fields, and the personalities of each pairing. Fostering this collaboration with models and, especially, mentoring should be of highest priority.
7. The influence of the Fellows on the classroom curriculum to increase beyond being additions to existing courses did not occur easily. Exploring ways to integrate the Fellow’s contributions into the educational mission of the classroom remains a need.
8. At the end of the school year, I had firmly established one key understanding. The GK12 fellows were outstanding scholars and people. The selection of the fellows had obviously developed into a “science.”

Formative Evaluation Recommendations (2006-2007).

The evaluation is based on the following research questions.

1. Given the different levels of autonomy each fellow has in the classroom, is it possible to investigate the initiative of the fellow?
2. Does the collaboration between the fellow and the teacher equal?
3. Do fellows bring significant technology into the classroom?
4. Can the fellow use their research in the classroom?
5. Does the degree of collaboration affect the level of technology integration?
6. Are the contributions of the fellows integral to the curriculum or additions?
7. Can the fellows communicate effectively with the teachers, students, administrators?
8. If the fellows are engaged in visual modeling, are the students observers or participants?

The following are not offered as a prescription but rather as a list of points to ponder. Those who are more acquainted with the GK12 Program and more aware of all the parameters will have to balance these ideas with their broader knowledge base. The GK12 Program should consider:

1. The classroom teacher must be fully committed to the program in order to participate.
2. The managers should review and promote ways to have the fellow become fully integrated into the classroom culture.
3. There should be recognition of the particular challenges to include technological resources in older buildings and additional support should be provided.
4. The recommendations of School Year 05/06 remain pertinent (see above).

References

- Linn, M.C., Slotta, J., and Baumgartner, E. (2000). Teaching High School Science in the Information Age: A Review of Courses and Technology for Inquiry-based Learning. <http://www.mff.org/pubterms.taf?file=http://www.mff.org/pubs/HSscience.pdf>
- Thakkar, U., Bruce, B. C., Hogan, M. C., & Williamson, J. (2003). Extending literacy through participation in new technologies. *Journal of Adolescent and Adult Literacy*, 45(3).

Summary of Major Findings.

Based upon data thus far gathered, and similar to findings in the UIUC Track 1 GK-12 program, we are seeing certain themes emerge across research sites: (1) commitment to excellence, (2) role of collaborations, (3) community building, (4) meaningful technology integration, and (5) facilitation of inquiry- and problem-based learning. The meaningful integration of technology to promote inquiry and student-centered learning is key at each of the sites, and differs in each K-12 environment.

Across these sites inquiry- and problem-based learning are being uniquely implemented. Data is initially indicating that the greater the communication, the more supported a teacher feels in his/her classroom, and the more collaborative the Fellow-teacher team, the more likely inquiry- and/or problem-based learning is employed.

While still under data analysis, we have found some evidence of

- (1) how participatory design principles employed by teacher-fellow teams represent a successful model for how visualization tools are developed and used in the science classroom;
- (2) how collaborative inquiry can inspire and exemplify critical scientific literacy for learners; and
- (3) how students' views of the sciences change as a result of tasks given by the course and tools integrated.

Some fellow and student statements are included below, and others are still being processed, but we can identify strands of knowledge and learner impacts on which we are building case studies.

Learner centered, collaborative, inquiry-based model for integrating visualization tools:

- Integration of modeling technologies into the school classroom supported authentic inquiry, engaging students in significant synthesis of ideas
- Students were able to use the tools to generate and/or manipulate real data, and use these applications in independent problem solving in collaborative teams
- Students demonstrated an increased ability to make connections between class work and larger world--between subject and its uses--when using visualization/modeling tools
- Tools themselves went beyond facilitating inquiry to being the inquiry; inspiring participatory design

Impacts on learner:

- Students overcome anxiety of technology when faced with a clear objective
- Heightened participation levels in the classroom and outside "after hours" on students' own free time demonstrate increased responsibility for their learning
- Evidence of more complex thinking and problem solving skills
- Improved latent information literacy skills (search/retrieve, evaluate, apply)
 - Increased awareness—and interest—in subject

Identified elements that contribute to learner successes:

ENVIRONMENT:

- Teaching-learning cultures at sites are *collaborative*
- Teacher is facilitator and co-learner
- Student relationship to subject reframed
- Subjects (biology, chemistry, history, mathematics, geology, etc.) "re-visioned" as dynamic—not static—disciplines. This extended to student perceptions of scientists, engineers, and social scientists.
- Student-technology relationship allowed to change
- Time given to overcome challenges
- Authentic problem-solving encouraged

INQUIRY AND TECHNOLOGIES

- “T-3” Toy → Tool → Transformation
- Facilitation of inquiry as well as being an object of inquiry itself
- Learner a producer and participant, not merely a consumer and recipient

Statements made by the fellows indicate an acknowledgement of what kinds of activities motivate students and promote student-centered learning:

IN GEOLOGY.... "Just today I had a student speak out in the middle of a lab 'I love Geology!' He followed this by 'I didn't like it yesterday and I won't like it tomorrow, but I love it today'. I spent a great deal of time putting together an earthquake tracking lab for the computer classroom with excellent mapping resources online and access to massive earthquake data sets.... This made all my prep work on the geology lab worth it."

IN CHEMISTRY... "I bring a lot of visualizations and software specific to our curriculum because I've built them around the syllabus. The students have a say in the types of tools that they use."

IN ENGINEERING... "The students get to see an actual engineer on a regular basis, have someone closer to their own age to ask questions of, have someone familiar with engineering and engineering school to ask questions of."

Students' views:

"It helped save time and make information clearer to me. It also gave me visuals for things that I wouldn't have been able to picture from just reading about. It helped me understand."

"...it helps me to understand what we are talking about by seeing rather than hearing what happens."

2008-2009 Findings

Summary. The 2008-2009 GK-12 Program at UIUC can best be described by one word: "transformative." Nearly every aspect of the GK-12 this year has been the culmination of an evolutionary process, and participants associated with the GK12 Program all concurred it was "the best year of the whole program." Changes made based on formative and summative evaluation reports of previous years were successfully implemented. Program administration was tightened, streamlined, and made more accountable to the Fellows' own professional growth experiences; challenges Fellows faced at their individual school sites were addressed more quickly; Fellow selection was as rigorous as past years, however a more homogenous group of student-scientists was formed, allowing for greater collaboration and teaming between Fellows; selection of partner teachers was also more judicious, placing Fellows only with master teachers with years of experience in order for there to develop a mentor partnership between Fellow and teacher. Problems of the previous years: administrative inconsistency, lack of communication of expectations for Fellows (for publication, time spent in the classroom, roles relative to their being scientists in the classroom), too much emphasis on educational pedagogy that was superfluous; time management: all were addressed this year to a positive effect. Overall themes witnessed in past years were deepened this year.

(1) Collaborative teaming is necessary for sustainable change in the classroom and for the Fellow: mentoring of scientist-fellows by resident teachers is necessary, and sharing of professional expertise must be mutual to be transformative;

(2) Inquiry emerges when teachers, Fellows, and students all are given both the scaffolding and the containment in which to construct meaningful inquiries for themselves. For the Fellows this meant constructing their own “action research plan” that taught them how to constructively solve communication and pedagogical questions not ordinarily encountered in the scientific community;

(3) Technology integration must be directly related to the emerging inquiries. This year, the Fellows had even greater freedom to select and implement only technologies and tools that contributed to sense-making for their disciplines and in the context of the curriculum (e.g., student response systems, visualizations and modeling that took into account the students’ growing understanding; students designing their own “technologies” as part of their experiments);

(4) A culture of sustainability was deepened this year, where generations of past teachers have now “grown up” in the GK-12, becoming leaders in their districts, state, or nationally. Fellows from previous years have gone on to draw on their experiences as Fellows to contribute to their professions (e.g., one fellow hosted a symposium for the Entomology Society of USA describing the GK12 program from the Fellow and teacher perspectives and how their experience impacted their professional scholarship. Nearly 100 attended this popular session, and much interest in the NSF GK-12 Program overall was generated and discussed).

Overall, the GK12 Fellows this year benefitted from past years challenges: these Fellows, under the guidance of an energized project coordinator (who was a past fellow himself), learned much more quickly how to focus on learners, improve their communication and feedback to learners and within teams, reflect on their practices and implement new solutions, and strengthen their professional identities as scientists. All Fellows noted that they feel more confident communicating their respective disciplines to those outside of it. All Fellows noted how supported they felt. The only challenge that was consistent across each was lack of time: the Program does take time, yet no Fellow felt any changes were necessary. This is the first year Fellows did not have more significant suggestions to improve their program experience, and this may be attributed to the intuitive and natural response of the project coordinator, Chris, who took a mentoring/coaching position to each fellow-teacher team.

Stories of Transformation: Professional Identities of a Scientist-as-Educator

From the online surveys and Learning Logs of Fellows, site observations, and interviews with the Project Coordinator, teachers, and PI, it became clear that this year was the most efficient in bringing new Fellows to a level of enhanced confidence and skill. Particularly successful this year has been helping Fellows wrestle with the key problem that all scientists and educators have: how to communicate complexity to non-scientists and learners of all levels; and furthermore, how to inspire this audience to such a degree that they take not only an interest, but adopt a position of inquiry or “scientific thinking” themselves (be they teachers or students, other fellows outside of their disciplines or conference attendees at AAAS). One Fellow, who considered himself already proficient as an educator in undergraduate programs grew significantly in his awareness of how to improve beyond his previous limits:

“Teaching methodology (has been the greatest growth area). I've also gained a fair amount of information on what type of teaching works best. Additionally, it's been very useful to teach high school students, because (1) they are truly a captive audience, so you have to be more engaging than you would with college students, (2) you have to explain complex concepts to students that likely have very little background knowledge and frankly may not be capable of understanding unless every detail is explained in ways that they can understand.... I've learned a great deal regarding what I think will work and what won't work.... It's invaluable. As I've said above, I've had essentially no experience developing my own curriculum as a TA. Neither have any of my peers. Thus, I am already more marketable than most graduate students and even some postdocs.”

Action Research Plans: Fellows Learn Pedagogy by Doing

The GK-12 Program this year adopted an embedded approach to pedagogical training, adapting reflective practitioner techniques in order to support each individual Fellows' own unique classroom culture and discipline. Each Fellow was asked to create an “action research plan” that cast the classroom as a learning lab in its own right. Fellows could then ask themselves, “What do I see as my own objectives in the classroom this year relative to what I want to both contribute and learn from the experience?” Within this framework, Fellows matured by responding to weekly meetings with the former fellow/Project Coordinator who created dynamic and trusting environments in which the Fellows could brainstorm, discuss, and problem solve with a clear focus on professional improvement. This shift was significant this year, de-emphasizing the role of pedagogical training in the past.

Reflective Thinking. Use of reflection was key this year. Fellows chronicled their experiences in what one Fellow called his “Dear GK-12 Diary”. All Fellows demonstrated improved ability to focus their attention on their own professional understanding of teaching and learning in the context of being a scientist. As an example of this progression, we shared excerpts from one Fellow who was having a very difficult time at the beginning of the year with her school site. This Fellow expressed frustration, and took it upon herself to visit other Fellows and school sites to better understand what high school cultures are like. When posed with the challenge of creating an action research question/inquiry to solve her disconnect in the classroom, she embraced it. As she said in an interview, she decided, “I’m going to solve this. I’m going to treat this like a scientific problem.” Her progression from being frustrated by K-12 learners and the sometimes chaotic environment to actually building a collaborative community with her teacher, other educators, and Fellows

REFLECTION CAPTURES PROGRESSION

During this fellowship I have felt like I am **spinning my wheels** a bit. I like the open and flexible nature of the program but I would also like to have someone to bounce ideas off more often. When I interviewed I was told that I thought I would have more interaction with the teacher.

I have been waiting to hear from (the teacher) to firm up our schedule. I had been working on a lesson plan for the AP class but (the teacher) was wrong about his days so **now I am not sure what lesson I am giving.** I am trying to have two different lessons ready because I am not sure which one I am giving.

I am constantly amazed at how willing people are to work with you in the field of education. Scientists in different labs don't have nearly this much collaboration.

was a significant indicator of transformation for this Fellow. Included here is a slide of her process that was presented at the NSF GK-12 Annual Meeting 2009 to Evaluators on the power

of reflective journaling as evaluation tool.

Technology in Practice:

This year, as in years past, an emphasis has been on the adoption of tools that directly expanded upon the curriculum or enhanced the learners' interest in science. As one Fellow put it regarding technology's use in the classroom: "It's not just desirable, it's a necessity....Some concepts are just not amenable to develop hands-on projects. It's difficult to visualize many biological processes, so computer simulations provide visual stimulation that just is not possible any other way. Also, I think it's important not to use technology just for the wow factor." Use of student response systems such as iClickers engaged students in one school site, for example, and the Fellow was able to secure them for the school for future use.

Another Fellow, based on the chemistry curriculum for a titration lab, introduced (and later earned the site license) for virtual lab software used with undergraduates. She said it's important that the students use tools that help them see chemistry because they "can't see it on paper". (Her partner teacher pointed out that some teachers never do the titration lab because burettes are expensive and it takes time to set up. He said this is the first time the students have actually touched the burettes, and they are able to have control *because* of the pre-lab the Fellow created and the virtual lab they did. He will now continue to do this lab because of her. Furthermore, her background in food science and use of non-dangerous chemicals such as Tang and grape juice makes it scientifically valid, but safer).

Other technologies were developed within the context of students creating their *own*. In an honor's chemistry classroom students wrestled with a year-long project based on a relevant and germane question facing society today: what are the effects of CO²? Conceived during a summer GK12 workshop prior to the start of the school year, the Fellow-Teacher team posed this ambitious question to the students, supporting the students for the year. The students drafted, peer reviewed, and then agreed on their experiment design to study the effect of CO² on the growth of plants. All questions in the inquiry were left open in an extended problem-based immersion in the scientific method. Students, for example, had to build and test their own apparatus that would allow for experimentation. CO² tablets? Baking soda reactions? Type of containers? Yeast? The overall success of the project rested on how the students learned to pose inquires and test them, along with traditional observational data gathering. The Fellow reflected most upon the nature of how questions are even posed and how young adults solve problems in creative ways he would not have imagined. This was a potentially overwhelming project, yet the teacher was able to do it with the support of the Fellow as a scientist-expert who could demonstrate the uncertainty of doing real science. As the teacher put it, the program "allows the teacher to implement activities she couldn't do on her own (with an emphasis and support) regarding content and processes." The Fellow shared his sense of success: "(it) turned out particularly well as we envisioned it would as the first experimental design lesson. We had a whole-class discussion on how we might design our CO² enrichment experiments, potential pitfalls, things to keep in mind, good/bad ideas, etc. Then we broke up into groups, and each group continued to brainstorm on their own. The initial discussions were quite successful in themselves, with students naturally arriving at most of the main points I wanted to cover without much guidance on my part. The group brainstorming then followed very naturally, and each group tended to come up with their own, often creative plans, clearly based on the class

discussion but unique and thoughtful. This is exactly what (we) were hoping for, but I was a little surprised at how well it worked out in practice.”

Enthusiastic Learning: Questioning Strategies

Exposing students and teachers to the technologies used in the lab to solve problems is important; but in some schools it's less about the tools and more about how questions ignite student passions. A biologist fellow working with aquatic populations (sticklebacks) enhanced the curriculum significantly in her partner school in a small city in Illinois. Open-ended problem solving was noted as a significant risk in this school that has been working to achieve NCLB standards. Yet, the fellow was able to build a cooperative and creative relationship with her teacher who noted (almost with surprise), “Students learned as much from failures as from successes. They did a lot of very original thinking. We had the regular bio class work on genetic crosses!”

The Fellow enthused about her love of her research, and said it was working with the students that gave her the most energy: “My AP students were conducting their own experiments last semester where they were measuring the effects of different stressors on the fish's breathing rate. They really got in to it! At the end of the actual experiment, I had one group of boys stay through lunch and ask if they could test another stressor. It was pretty cool, I remember them standing in the back of the classroom huddled around the beaker with the fish in it having a very intense discussion about which stressor to pick and how exactly to do it. They clearly were very interested in what they were doing! Sometimes when I come in (the teacher) will have "Let's ask Miss (fellow)" questions for me. Apparently when I'm gone, if the kids have a really interesting question about science, they'll ask (the teacher) to remember it to ask me when I come in. I like that because it makes me realize that the kids must respect me as some sort of authority on science and also that they're thinking about me even when I'm not there. For my freshman bio classes, I asked them to create a board game about the behavior of the fishes we've been studying. I gave them an outline of the behaviors they needed to include, but beyond that they were on their own. The games I got back were amazing! It was clear some of the students were really excited about it. Not only were some of them very well done artistically, but most of them went above and beyond by including other behaviors or details of behaviors that I hadn't expected them to know.”