PROGRESS
REPORT

The University of New Mexico

GK-12 Optics & Photonics Education Project

2006-2007 School Year

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Abbreviations

A&S	Arts and Sciences, University of New Mexico
APS	Albuquerque Public Schools
CETP	Collaboratives for Excellence in Teacher Preparation
COE	College of Education, University of New Mexico
COP	Classroom Observation Protocol
GK-12	NSF Graduate Teaching fellows in K-12
ISEF	International Science and Engineering Fair
ISR	Institute for Social Research, University of New Mexico
K-12	Kindergarten through 12th Grade
NSF	National Science Foundation
OPE	Optics & Photonics Education Project
SCIAD	Science Advisors Program
SNL	Sandia National Laboratories
SOE	School of Engineering, University of New Mexico
STEM	Science, Technology, Engineering, and Mathematics
UNM	University of New Mexico

Preface

We decided it was important to chronicle the project in this manner from inception to now. ISR was not involved in the project until the third year, since we missed the beginning; we relied on the original project proposal and a brief report by the College of Education to describe the first two years of the project. This Progress Report brings the reader up to date. At the time of printing, the project received a one-year extension on the original grant. ISR will complete a Final Report of the project at the end of the 2008 school year.

Overview of the Graduate Teaching Fellows in K-12 Optics and Photonics Project

In 2003, the faculty of the School of Engineering (SOE), the College of Arts and Sciences (A&S), and the College of Education (COE) at the University of New Mexico (UNM) in partnership with the Albuquerque Public Schools (APS), proposed a graduate teaching project to the National Science Foundation (NSF). In 2004, they received funding from NSF for the project. The objective of the project was to improve math, science, and engineering education at the K-12 level, using the existing strengths in optical science and engineering education, research, and training in New Mexico, and emphasizing the interdisciplinary field of modern optics and photonics.

The overarching vision for the project was to increase K-12 achievement in math and science by creating exciting new curricular enrichment modules in optics and photonics, which would be supported by hands-on learning via optics and photonics experiments and direct contact with GK-12 Graduate fellows. The GK-12 Optics and Photonics Education project (OPE) sought to increase the pool of students who are interested in and knowledgeable about photonics, and engineering. The project also hoped to strengthen the partnership between the local school district, Department of Engineering faculty, and College of Education faculty, and boost the content knowledge for math and science teachers. The focus of the project was to use local optics and photonics resources to enrich the science and math curriculum in a few local public schools. The stakeholders modeled the project on a similar program carried out by Sandia National Laboratories, in which technical staff from the labs worked with elementary and middle schools in central and northern New Mexico during the 1990s.

Needs Addressed by the Project

The project was implemented at a cluster of schools within the Albuquerque Public School District. The district is divided into 11 clusters comprised of a high school and the elementary and middle schools which feed into that high school. The project stakeholders selected the West Mesa Cluster as the focus of the project. West Mesa is one of the most diverse of the APS clusters and includes the elementary and middle schools with the highest Native American populations in the district. Every school in this cluster has a large Hispanic population, ranging from 56% to just over 90% of the student population.

As minority students represent more than half of the APS student population, the disparity in scores between white and minority students is a major concern. The math and science results for school year 2002-2003 for schools in the West Mesa Cluster were consistently below the district averages, thus focus on improving student achievement in these content areas was an important goal for this cluster.

GK-12 Goals

The project addressed the four goals of the National Science Foundation (NSF) GK-12 program, and an additional fifth goal set by the project stakeholders:

1. Providing Graduate Teaching fellows supervised by UNM faculty to enhance K-12 education in optics and photonics, and strengthen the existing partnership between the university and the local school district.
2. By involving practicing teachers and education faculty in conducting workshops for the Graduate Teaching fellows, the project provides STEM graduate students with opportunities to learn new effective teaching methods and to improve their communication skills.
3. By teaming the Graduate Teaching fellows with K-12 math and science teachers, the project will create an environment in which teachers can improve their knowledge of modern optics and photonics while graduate students in STEM disciplines can improve their pedagogical skills.
4. By being an active presence in K-12 classrooms, the Graduate Teaching fellows will serve as role models to K-12 students with whom they can relate, and will directly contribute to enhanced knowledge of ubiquitous applications of optics and photonics in the modern world.
5. A fifth goal of the project was to develop an assessment and evaluation to produce evidence-based outcomes that contribute to the understanding of how students effectively learn science, engineering, and mathematics. An effort would be made by UNM and participating K-12 schools to establish a baseline for formative assessment of the program. Formative assessment would include "before" and "after" quizzes in the classroom, and term- and year-end evaluations by all major participants, i.e. GK-12 fellows, K-12 teachers, and K-12 students. The results of the formative evaluation would be used to monitor the project, take corrective actions as necessary, and ensure the project achieved its expected outcomes, specified in Goals 1 through 4.

Project Activities

According to the project proposal, during the first year of the project, stakeholders at APS and administrators in the West Mesa Cluster identified lead contact teachers at each school site in the cluster. Fellows were to work with a team of interested teachers at each school site. Each individual school would identify those teachers who would work with the fellow and would identify those activities that met the needs of the individual school in achieving its goals in STEM and in meeting district and state standards in mathematics and science.

To assign fellows to schools and classes, a model developed in UNM's College of Education was used. Fellows chose four schools to visit in teams of two during the project orientation session. The fellows observed classrooms of teachers who would be participating in the project. After the visits, the teachers and fellows met to ask additional questions. At the end of the orientation, the fellows and teachers submitted requests for placement. Stakeholders matched the requests and assigned fellows.

The GK-12 fellows worked with their teacher or teachers to enhance the existing curricula and optics and photonics demonstrations in the classroom. Fellows were to learn the teachers' objectives for STEM and at the same time address state and local standards. Additionally, the fellows were to work with the teachers to modify existing instructional materials to improve the level and quality of inquiry-based experiences and to develop new learning modules. The fellow and the teacher were to agree on the amount of time the fellow would spend on classroom instruction. The GK-12 fellow was not to act as a substitute teacher and the teacher would be present in the classroom together with the fellow.

Fellows also worked with teachers in science-related activities occurring outside of the traditional school day, which could improve communication about science in the broader school community. Such activities included family science events, existing or new science clubs, and school-wide science expositions that would include student-developed experiments, demonstrations, models, and collections. All of these "outreach" activities were to have an optics/photonics focus.

New GK-12 fellows were recruited into the program at the beginning of each Spring semester. To ensure a wide dissemination of information about the GK-12 fellow positions, several attempts were made to recruit fellows, e.g., information was placed on the web sites, printed posters were also sent to universities with large populations of minority undergraduate students, stakeholders attended minority student meetings and career fairs, and department graduate coordinators were also advised about the project. A GK-12 Committee consisting of representatives of the School of Engineering and the College of Arts and Sciences identified the best candidates for the fellowships. Candidates had to satisfy the NSF criteria, namely, they had to be:

- citizens, nationals, or permanent residents of the United States at the time of application; and
- Full-time students enrolled in a STEM graduate program at UNM.

Additionally, consideration was given to student's academic records and to their potential as a role model in the classroom. Efforts were made to recruit underrepresented minorities (preferably bilingual), women, and persons with disabilities into the GK-12 fellowships.

The GK-12 fellowships were awarded contracts for 12-month periods. Fellows were given very lucrative salaries to attract high-quality candidates in competition for traditional graduate Research Assistant, Teaching Assistant, or other fellowships. The committee's goal was that participation in the GK-12 program, should enrich the fellow's communication skills and knowledge of pedagogy but should not result in a longer time to graduation compared to other students. Fellows spent a minimum of 10 hours each week providing direct assistance to K-12 teachers and 5 hours a week preparing outside the classroom.

According to the project proposal, fellows were to participate in a training and orientation workshop one week before the beginning of the Fall semester, as well as in an on-going seminar. The project's Principal Investigator and co-Investigators were to organize and lead the workshop each year. A goal of the training was to give fellows the tools to work effectively in the schools. Fellows learned about the school district, the resources available for science, math, and technology instruction, procedures and legal matters for working with children in public school, basic child development, and effective pedagogy with diverse populations.

The fellow spent a brief period observing the classes of the participating teachers to understand better the instructional approaches, resources, and climate of the school. Together with the participating teacher or teachers, the fellow was to develop a work plan tailored to the needs of the school and abilities of the fellow. The fellows planned to work with the teachers and Faculty Mentors to develop new learning modules.

The project incorporated an on-going training and support session for the fellows in the form of a bi-weekly seminar. Initially, led by the project PI and later led by the APS project coordinator, all fellows were required to attend the bi-weekly seminar. Most seminar sessions focused on improved pedagogy and planning upcoming activities. Teachers were invited but rarely attended. The seminars were held beyond the teachers' contracted duty day. Seminars provided an opportunity for the fellows to strengthen their network by discussing challenges and successes they are experiencing, sharing resources they located or developed, and report on their progress in developing the learning modules. Fellows shared how they made connections between existing curricula and optics and photonics instruction. Time was allocated to deepen their understanding of the teaching and learning process, as well as address other needs identified by the fellows or the APS project coordinator.

The project proposal anticipated yearly summer workshops at UNM, where teachers would meet with Faculty Mentors for preliminary training in optics and photonics concepts. During the Summer of 2007, the fellows and project coordinator anticipated joining an initiative sponsored by Sandia Labs to develop a workshop for a select group of teachers on the topic of "Water Resources." This effort did not materialize and the fellows spent the summer developing a demonstration DVD of their best presentations and experiments for classrooms.

An important proposed outcome of the project was to be a series of new learning modules for novice learners, created in the process of implementing the project. The Principal Investigators envisioned the project as a novel model for creating modern learning modules developed jointly by the teachers, the GK-12 fellows, their disciplinary Faculty Mentors specializing in different applications of optics and photonics, and the experts from the College of Education who were to assist in preparing unique instructional aids. These additional materials would focus on specific approaches teachers could use to introduce scientific inquiry-based learning in their classrooms, with hands-on investigation and student-directed learning, and examples of tests that could be used during the instruction, all in the specific context of a particular classroom activity. The modules were to include simple but innovative experiments that integrate recent advances in optics and photonics to present fundamental concepts in physical science, chemistry, or biology, and encourage critical thinking about the impacts of technology on the environment and the implications of advanced scientific research on human lives. During Year 1, existing optics and photonics education kits available commercially were to be used to develop learning modules. In Years 2 and 3, new modules would be developed based on the unique combinations of skills of the project participants. The new learning modules would be made available to other teachers nationwide via the project website. This approach would ensure the widest possible dissemination and transfer of the knowledge acquired during this project for other school districts in New Mexico and the nation, and contributes to a wide use of effective teaching styles.

Original Assessment and Evaluation Plan

The project stakeholders proposed an assessment and evaluation tool to produce evidence-based outcomes to highlight the success of the project. The main objectives of the evaluation would be:

- Assess enriched learning by K-12 students;
- Evaluate improvements in communication and teaching skills among GK-12 fellows;
- Evaluate content gain and professional development opportunities for teachers;
- Evaluate how the project affects career decisions made by middle-and high-school students; and,
- Document project outcomes to inform others of the impact of GK-12 project.

The PI's used an evaluation design used by a previous science teacher/mentor program, SCIAD (Science Advisors Program) and modified it to match the GK-12 project's goals and objectives. The evaluation was designed to employ several different sources of data including surveys, semi-structured interviews, classroom observations, and a review of relevant documents. GK-12 fellows and their Faculty Mentors, teachers, principals, students, and parents would be informants for the evaluation. A Ph.D. graduate student from UNM's College of Education was to collect data and conduct the analysis, while gathering material for a dissertation. Monitoring the overall evaluation plan and taking corrective actions was to be the responsibility of the project's management team. Demographic data would be collected on the GK-12 fellows as well as on teacher and student participants. Surveys were designed to collect information from each participant group at each school site. The instruments were to be designed based on themes and issues identified from the SCIAD program. Multiple measures would be used to determine the effects of the GK-12 project on the different categories of participants (see Table 1). Initial, baseline data would be collected whenever appropriate. Data would be collected at the end of each school year to show impacts over each year and over the three years of the project. If any of the fellows chose to participate in the project for more than one year, their effectiveness over multiple academic years would be observed.

Table 1 Proposed Project Evaluation Matrix

Project Evaluation Matrix		
Participant	**Data Collection Method**	**Focus**
Fellows	Survey Interview	▪ Pedagogical understanding ▪ Communication ▪ Understanding of inquiry-based learning ▪ Breadth of content knowledge ▪ Professional standing
Teachers and Schools	▪ Content pre/post test ▪ Survey ▪ Teacher and Principal interviews ▪ Classroom observation	▪ Understanding optics , impact of GK-12 program, classroom practices
K-12 Students	▪ Survey using Views of Nature of Science Questionnaire (VNOS) ▪ Interview selected Students	▪ Attitudes towards science and understanding of the Nature of Science
University	Survey advising Professors	▪ Connections between UNM and APS ▪ Impacts on Fellows
Community	Survey Parents	▪ Attitude towards science and UNM

The Resource Teacher/Coordinator would observe and record classroom practices at the beginning and end of each school year using the Classroom Observation Protocol (COP) developed as part of the NSF-funded Collaboratives for Excellence in Teacher Preparation (CETP). Additionally, case study reports were to be accomplished for each school site by using interview and observation data collected by the Ph.D. student. Case studies would provide descriptions of how the project was implemented at each school site. Interview protocols were to be used to ensure consistency in the data collected.

Evaluation Questions and Expected Measurable Outcomes of the Project

The evaluation questions in the initial proposed project description were designed to measure four functions: 1) what is happening; 2) what is working; 3) what problems are occurring; and 4) what changes should be made (if any). Specifically, the initial project evaluation questions were:

1. To what extent did the Graduate fellows benefit from the experience of participating in the GK-12 Project?
2. Did the GK-12 Project impact K-12 student interests and attitudes toward learning STEM related topics [optics and photonics specifically]?
3. Did the GK-12 Project contribute to the classroom teachers beliefs and professional development toward teaching STEM related topics?
4. To what extent did the GK-12 Project promote the transfer of plans and technical know how to other schools (i.e., educational institutions beyond the realm of the target study)?
5. How effective were the inquiry based instructional modules in fostering student understanding and enjoyment of STEM related topics?
6. Did the Graduate fellow's participation in the preliminary orientation session and periodic seminars promote their abilities in being successful contributors to the GK-12 Project?

Evaluation Transition to ISR

At the end of the second year of the project, the NSF was concerned that "independent" reviewers accomplish the assessment of all GK-12 grants. As the OPE stakeholders prepared for the grant renewal, they decided to shift the assessment/evaluation function for the final year of the grant from COE to the UNM Institute for Social Research (ISR). The transition from the COE to the ISR occurred on July 31, 2006.

Paul Guerin Ph.D., the PI for ISR, designed a modified evaluation drawing on work by evaluators from COE and the initial evaluation methodology to finish the initial grant and support any grant extension.

College of Education Interim Report

At the request of ISR, the College of Education staff completed an assessment of their involvement in the first two years of the OPE project. Below is a summary of the COE's assessment.

Evaluation Process

A graduate student designed the evaluation process used by the College of Education. This process relies on survey instruments, requiring all the participants in the program to be surveyed at least twice a year. The fellow students were surveyed after their orientation, after the first semester and at the end of the second semester. The teachers were to be surveyed at the end of both the first and second semester. The students were to be surveyed at the beginning and end of each school year.

This process did not prove to be entirely successful, especially during the first year, because so many students did not return the surveys. This was partially influenced by APS IRB policy requiring students to get permission from their parents to fill out these surveys. Many teachers also failed to turn in their surveys, the most common obstacle being the length of the survey. The surveys took an average of 10 to 15 minutes to complete. To remedy the problems experienced in the first year, the evaluation process in the second year used more classroom observations and interviews were used in place of surveys.

Fellows

The GK-12 program consists of up to 12 fellow graduate students working at a high school (West Mesa), middle schools (Truman, Carter, and Adams) and elementary schools (Carlos Rey, Alamosa, Susie Rayos Marmon, Chaparral, Edward Gonzalez, and Mary Ann Binford). All of these fellows have previous undergraduate work in sciences and engineering. Even though the GK-12 project focuses on optics and photonics, the fellow students were not from that field. Most of the fellows are male, and one is female in this year's cohort. The fellows were very good students but had little to no background in teaching. These fellows receive generous stipends (considerably more than assistantships pay) and career opportunities as incentives to participate on the project.

Generally, the fellows enjoyed the project and found it challenging and rewarding. The main obstacle to the project resulted from scheduling and coordinating with teachers. Often times, fellow students would have to work with substitute teachers because the normal teachers were not present. Fellows did not have any problems with keeping up with their schoolwork as observed by their academic advisors. A frequent complaint coming out of the fellows dealt with unmotivated students in the classes. Another complaint dealt with the fact that many teachers (especially in the elementary school) were not familiar with the science subject matter, which meant that the bulk of the teaching load fell onto the shoulders of the fellows. The project outlines the fact that the fellows are "subject-matter experts" and that the teachers are "instructional experts." So in essence, some of the teachers violated the program's guidelines.

Judging from the observations, the fellows adequately met the goals of the National Science Foundation. These goals include getting graduate students "out of the lab and interacting with the schools to help improve science education in public schools. The conference in Washington, D.C. especially helped because fellows from all over the country were able to collaborate with each other.

Schools

The main problem concerning all the schools relates to overcrowding. To adequately house students every school in the cluster has to use portable buildings. Because of the overcrowding issue, many of the middle school classes do not have enough materials and supplies for all of the students. This mitigated the intended lesson put forth by the experiments. Language barriers also inhibited the lessons and were particularly evident at Alamosa elementary. At West Mesa High School, about 1/3 of the students clearly seemed disinterested in the subject matter.

Teachers

Teachers at the high school and middle school levels are expected to be "science teaching specialists," and at the elementary level, "science teaching generalists." Of the two teachers at West Mesa High School that participated in the GK12 program, one was a veteran physics teacher involved in the program's creation, and the other was relatively new to full-time teaching. At the middle schools, the teachers had a similar range as the one described at West Mesa High. The teachers particularly appreciated the fellows' help with the science fairs, since the teachers lack expertise in the area. The teachers and fellows worked the best when the teachers "made it clear to the fellows what they need in the area, and the fellows developing modules that address the standards directly."

ISR Evaluation Methodology

ISR drew on multiple information sources and perspectives to evaluate the project. ISR staff implemented a quantitative and qualitative data collection method and developed an observation instrument, a scaled questionnaire, methods for observing, protocols for conducting observations in the classroom, and survey instruments. The evaluation team made an effort to triangulate research methods because a project as dynamic as OPE could not rely on quantitative evaluation measures only. Quantitative and qualitative strategies described in Table 2 were used to answer the OPE project research questions.

Table 2 Data Collection Methods

Data Collection Methods and Quantity Matrix	
Method	**Quantity**
Surveys:	9 out of 9 fellows - 25 out of 37 teachers
Observations:	101 observations during the 2006-2007school year
Informal Interviews:	Informal conversations with participants
Official UNM Registrar Data:	8 fellows described

Surveys

Surveys are the most economic and efficient method for sampling large numbers of participants at once. In December 2006, the ISR staff created two survey instruments; one was given to the OPE teachers and one to the fellows. In January 2007, the survey instruments were approved through the University of New Mexico IRB process. ISR staff distributed the surveys by hand to each fellow and teacher in February 2007.

Non-Participant and Participant Observation

Observations by staff were framed by guidelines put forth by standards of ethnographic fieldwork, in which interpersonal relationships and interactions are examined among the fellows, teachers, and students. At the school sites, the staff took observation notes and objective descriptions of the activity. Additionally, ISR staff created analytical notes, which offered an analysis and interpretation of the event and activity in the classrooms. Typically, ISR staff did not participate in classroom activities so as not to influence the process and affect the lesson. However, in a few situations the ISR observer was obliged to participate when the OPE fellow or the classroom teacher specifically invited the ISR staff to participate in the classroom activity.

Interviews

To accommodate busy teachers and fellows, ISR observers often conducted informal interviews during breaks between observation sessions. Comments from the fellows and teachers were included in the observer's notes. Overall, interviews proved useful in identifying obstacles and successes in the project.

Official School Data

During February 2007, ISR staff distributed consent forms to teachers and fellows. These consent release forms were used to acquire the fellow's official UNM records, i.e., grade point averages, majors, etc. Teacher information included years of employment, education level, and college major.

Third Year Project Summary

During the first two years of the project, 16 graduate fellows were placed in 10 schools in the West Mesa Cluster of the Albuquerque Public School District. During the third year of the project (2006-2007 school year), nine (9) graduate students from the University of New Mexico (UNM) School of Engineering were employed by OPE to work as fellows. The OPE fellows provided direct assistance to three (3) science teachers at one high school, three (3) science teachers at two middle schools, and 31 teachers at six elementary schools in the West Mesa Cluster. As conceived in the project description, fellows assisted teachers in the classroom and were responsible for developing and presenting inquiry-based science projects to the teachers and students. Fellows were also expected to support existing or assist in developing new science clubs and participate in family science events, e.g., science fairs and expositions. At the beginning of the 2006-2007 school year, fellows attended a training and orientation session organized by the APS Project Manager and the OPE PI. Fellows attended the regularly scheduled seminar led by the Project Manager and reported their hours weekly to the Project Manager via e-mail. Seminar sessions had an average attendance of eight fellows per session (89%) throughout the year.[1] The seminar sessions afforded the Project Manager an opportunity to advance the fellow's

[1] Seminar attendance compiled from fellow's weekly work logs.

knowledge of the public school system, plan future activities required by the grant, provide information on the standards-based curriculum, debrief and discuss the previous weeks' activities, and connect the fellows to other STEM activities in Albuquerque. Table 3 provides a brief summary of facts and activities for the OPE project during the 2006-2007 school year.

Table 3 School Year Facts & Activities

School Year 2006-2007 Facts & Activities

- Nine UNM graduate students were employed as fellows. One fellow was assigned to West Mesa High School, two fellows were assigned to work at middle schools, and six fellows were assigned to work at elementary schools in the West Mesa Cluster of the Albuquerque Public School District.
- 37 teachers participated in the OPE Project.
- Fellows were typically assigned to work at a specific school.
- The OPE Project dealt with students in grades 4 through 12.
- Fellows spent a minimum of 10 hours each week providing direct assistance to teachers and 5 hours a week preparing outside the classroom.
- PI's and APS staff conducted a training/orientation workshop for the fellows, one week before the beginning of the 2006 Fall semester.
- The APS Project Coordinator worked closely with the fellows on a daily basis and led a well-attended on-going bi-weekly seminar for the fellows.
- OPE fellows had approximately 4,900 contacts with students during the 2006-2007 school year.
- During the 2006-2007 school year, ISR staff observed a total of 101 classroom sessions, 10 sessions at West Mesa High School, 33 at the middle schools, and 58 sessions at elementary schools. ISR staff also attended all the seminar sessions and several administrative meetings during the school year.

Findings 2006 Fall Semester

Quantitative

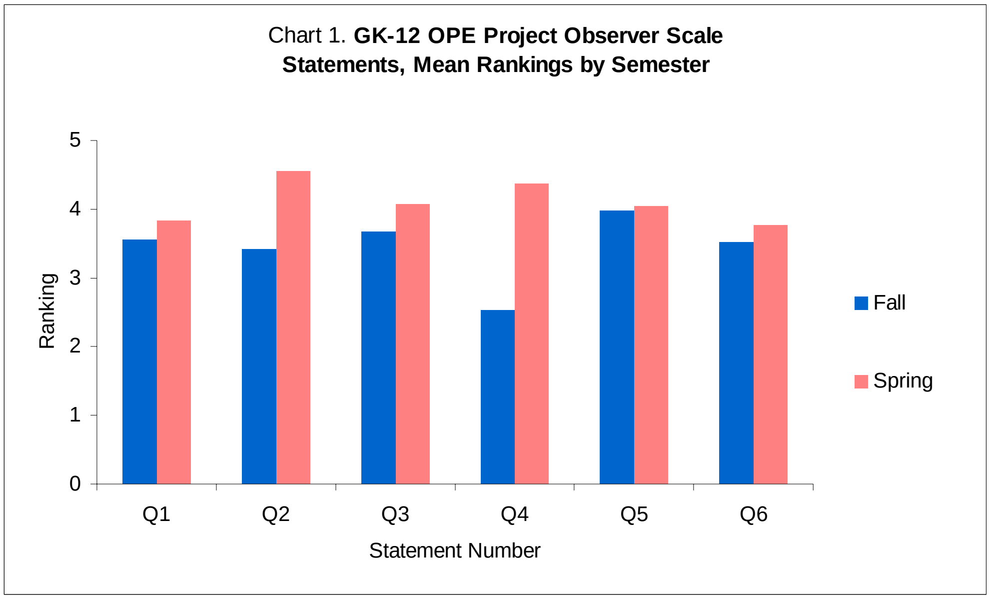
While observing in the classrooms, ISR staff completed an "Observer Scale." The Scale contained six statements that related to the goals of the Project. ISR staff viewed the class sessions, focusing on six behaviors they were instructed to look for that exemplified the six statements on the Scale (see Table 4). They ranked what they observed on a scale of 1 to 6, with 1 suggesting the behavior was not observed and 5 indicating the behavior was displayed to a "great extent" during the class session. A ranking of 6 means the ranking was not applicable.

Table 4 Observer Scale Statements

Observer Scale Statements
Q1. The Teacher encourages the Students; uses hands-on interactive activities; uses science terminology; and asks probing questions.
Q2. Students are allowed to discover on their own with Teacher guidance; work in groups.
Q3. Students appear to be interested; learning scientific method.
Q4. Teacher and Fellow plan together before class.
Q5. Fellow demonstrates confidence, expertise, and communication skills.
Q6. Teacher's instructional content benefits from the Fellow's contribution.

Using the Observer Scale data, ISR reported in a preliminary Report in Brief completed in February 2007, that during the 2006 Fall semester, the fellows appeared to be confident and improved their communication skills in the classroom. Teachers and fellows used inquiry-based interactive teaching techniques and teachers benefited from the fellow's contribution. These are positive actions despite the limited time the teachers and fellows had for planning together. Chart 1 describes the ISR observer data for each of the statements on the Observer Scale for the 2006-2007 school year.

Chart 1 Observer Scale Statements, Mean Rankings by Semester

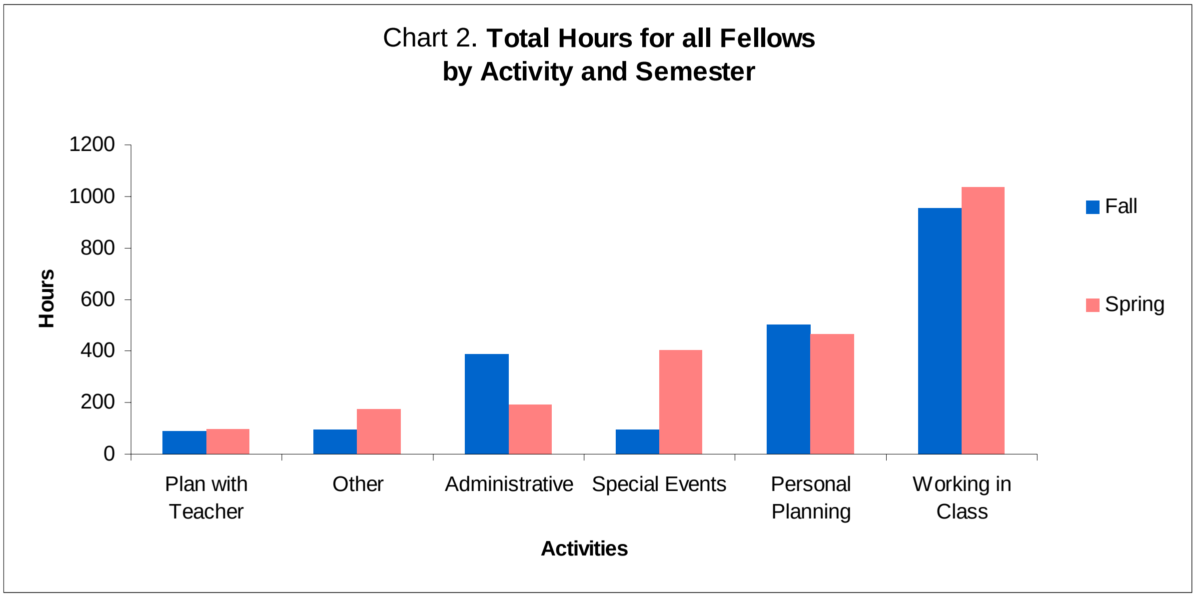


During the Fall Semester the fellow's abilities in the classroom (Q5) was the highest rated observable behavior (mean score of 3.9) scored by ISR observers. Students appeared to be interested in the class activities (Q3, mean of 3.7). Teachers received a mean score of 3.5 for encouraging the students (Q1); incorporating inquiry-based learning techniques in the class activities; and benefiting from the fellow's contribution (Q6). Teachers scored slightly lower (3.4) allowing students to discover science and work in groups (Q2). Observers found it difficult to determine whether teachers and fellows are planning together before each class session. Observers asked directly for this information. Observers felt the lack of participation during activities by the teacher or the fellow during classroom activities was an indication of the level of planning (Q4, mean of 2.5).

ISR observer ratings were higher in all categories for observations taken during the Spring 2007 Semester. Observers saw students discovering science on their own as teachers guided learning (Q2, mean of 4.6). Additionally, planning seems to have improved, as observers saw more interaction between teachers and fellows (Q4, mean of 4.4) and interpreted this to mean more planning had occurred. This observation proves false after reviewing the fellow's work logs.

The fellows were required to give the APS Project Manager and ISR a weekly work log of their activities. Work logs include the frequency and amount of time spent on six specific activities: working in the classroom, personal planning, planning with a teacher, special events, administrative tasks, and miscellaneous tasks. This information gave the Project Manager a management tool and provided ISR staff with data to compare with the observation scale data.

Chart 2 Fellows Hours by Activity and Semester



During the Fall 2006 semester, the fellows spent on average approximately 13% (276 total hours) of their time planning with the teachers, attending special events, and on miscellaneous tasks. Fellows spent 18% (389 hrs.) of their time on administrative tasks, i.e., completing work logs, journal entries, time sheets. Administrative tasks are skewed due to the large amount of time spent in training at the beginning of the semester. Approximately 500 hours (24%) of the fellow's time was spent on personal planning before classroom sessions, this includes time finding appropriate labs and demonstrations. Hours working in the classroom amounted to approximately 45% (950 hrs.) of their time (see Chart 2).

During the Spring Semester the amount of time changes in administrative activity, i.e., fellows spent 193.5 hours or 50% less time in this activity. The Fellows logged 404 hours in Special Events during the Spring Semester, up from the 93 hours recorded for the Fall Semester. This is not surprising, as the school year winds down, the fellows attended more special events, i.e., science fairs, Intel International Science and Engineering Fair.

Qualitative

During observation sessions, ISR staff recorded comments and summarized their observations. These ISR Observer's comments relate to the four (4) topic areas on the Observer Scale. Qualitative information was difficult to analyze and put into context. During the 2007 Spring Semester, qualitative analysis was minimized as it was discovered that survey data was more crucial to the evaluation and required time for the ISR staff to process. Below is a sample of comments from the observer's analytical notes during the 2006 Fall Semester.

Sample of some of the more positive comments:
"The lab in this class period was completely inquiry-based learning."

"Overall the students seemed to enjoy the lab and about half the class were close to solving the problem on their own."

"The students were obviously excited to be working with lasers. I think that they had a good time while also learning a lot about the scientific method."

The teamwork and partnership between (teacher) and (fellow) made this lab activity possible."

"(The fellow) exhibited guidance and confidence when working with the students."

"The teacher seemed to gain from the fellow's knowledge and presentation of genetics."

"The teacher stated how much she like the fellow's microscope lab and how well the students had responded."

"The fellow did a great job involving the students with no teacher involvement and a relatively alienating lab."

Sample of less positive comments:

"The (teachers) activity was a worksheet, which led to little discovery by the students on their own."

"The lack of involvement on (the fellow's) part led me to believe that there was little collaboration."

"Neither teacher (I observed) was involved in any of (the fellow's) activities at all."

"The teacher explained that the fellows' activity was like "ice cream", a reward rather than a contribution to the regular class."

The ISR preliminary report disclosed that, fellows and teachers attempted to teach using inquiry-based learning techniques; students were interested in lab activities; planning seemed very beneficial to the success of the labs; and student participation in class went down when the fellows were absent.

Fall 2006 Mid-Year Suggested Changes

ISR made several suggestions to the OPE stakeholders in the February 2007 Report in Brief. Obviously, the more information that exists about the OPE project the more can be learned about how the project works and what could be improved for the benefit of other GK-12 projects. Our observations and informal interviews were a beginning but we felt the surveys and background information on the fellows would add to our ability to measure the project. Findings from the quantitative and qualitative data suggest that several time management changes would improve the program. We suggested two immediate changes to the project in our report in brief.

1. Planning – The teachers and fellows would benefit by routinely planning together. Time is a factor, but a few minutes of planning would benefit the student's learning experiences. Planning, or the lack of planning, impacts the teacher's capacity to use and learn inquiry-based techniques; the student's opportunities for discovery; and the fellow's chances to transfer their research to the classroom. Planning is an integral part of our second suggestion as well.

2. The Role of the fellow – We have observed fellows serving in many different roles in the classrooms. Some fellows are encouraged by the teacher to take an equal share in teaching the class, other fellows are "encouraged" to sit and help when asked by the teacher for a special demonstration. Obviously, it is too late to make significant changes in the teacher's functional use of the fellows, but lesson planning would clarify the fellow's job in the classroom. The fellows are extremely intelligent, motivated, and energetic and clarifying their role would be a positive change in the OPE Program.

Description of OPE Fellows and Teachers

ISR staff was able to collect information to describe the OPE fellows from information we found in the UNM Registrar's files, resumes, and direct questions asked of the fellows. Table 5 characterizes the 2006-2007 Fellows. Teachers were asked in the survey to describe themselves. See Table 6 for their responses.

Table 5 Description of 2006-2007 Fellows

Description of 2006-2007 Fellows	
Characteristic	**Summary**
Demographics	• 4 fellows are white, 4 are Hispanic, and one is Asian. • 8 Males and 1 Female. • *7 fellows are single - 1 fellow is married. • *Average age is 25.3 - Maximum age 32 years old, minimum is 22 years of age. • 4 fellows are working their second year on the project – 5 are first year fellows.
Education	• All fellows have BS degrees in physics, electrical engineering, or mechanical engineering. • *6 fellows are in Masters Degree program – 2 are in a Ph.D. program. • *All fellows have GPAs above 3.0. • *3 fellows received honors as undergraduates. • *5 fellows received their BS degree from New Mexico colleges – 3 fellows graduated from colleges outside NM. • *Fellows primary research topics, e.g., Super Luminescent Diodes, Optoelectronics, Laser Microscopy, renewable energy.
Employment & Income	• *All fellows have a previous employment history. • *4 fellows have experience as teaching assistants – 3 fellows have experience as research assistants. • *All aspire generally to jobs in research or development. • *6 fellows report GK-12 Scholarship is their primary source of income – 3 fellows report also relying on income from grants and student loans.
Activities	• *4 fellows participate in extracurricular activities • *6 fellows belong to professional organizations or affiliations

*** 8 fellows reporting**

All the fellows are in an engineering graduate program and aspire to jobs in research or scientific development. Several (3) have received honors as undergraduates. Most of the fellows (8) are males, four are Hispanic, and one is Asian. The fellows seem to have been good selections for the OPE Project. ISR Observers have noted in staff meetings that the fellows are very intelligent and have many innovative ideas for instructing the APS teachers and students about science.

Teachers were asked in the survey to describe themselves. Twenty-five of 49 teachers (51%) returned completed surveys. Their responses are summarized in Table 6. ISR attempted to increase the number of teacher responses by awarding at random, two $50 gift certificates to teachers who completed the survey. A surprisingly small number of teachers completed the survey, considering the popularity and benefit of the OPE Project to the teachers and schools and the monetary incentives. The ISR Staff made at least two attempts and in some cases, three attempts to collect surveys from the teachers. A large percentage (44%) of the teachers responding to the survey had taught for five years or less.

A small percentage (16%) majored in a science related field in college; most (60%) majored in education related fields in college.

Table 6 Description of 2006-2007 APS Teachers

Description of 2006-2007 OPE Project APS Teachers: Responses to a Survey*	
Characteristic	**Summary**
Schools & Experience	• 25 teachers responded to the survey – 80% teach elementary grades – 16% teach in the middle schools. • 44% have taught school 5 years or less – 1 year is the minimum and 25 years the maximum years taught. • 58% have taught science 5 years or less.
Education	• 16% (4) teachers majored in a science related field in college. • 60% (15) majored in an education related field in college. • 28% (7) graduated from college less than 5 years ago. • 56% (14) of the teachers graduated from UNM. • 4 graduated from a college outside of New Mexico. • 44% (11) have Masters Degrees – 5 in Elementary Education – 2 Elementary Administration.

*** 25 Teachers reporting**

Report Results

Evaluation Question 1: To what extent did the Graduate fellows benefit from the experience of participating in the GK-12 Project?

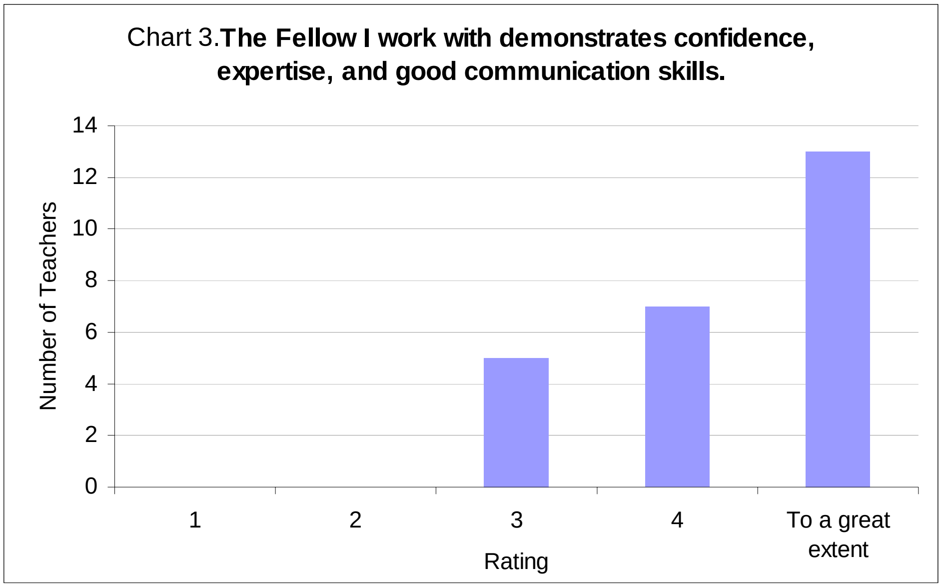
The fellows report that they have benefited from participating in the GK-12 Project. The ISR Survey included four questions that address the first evaluation question. Fellows were asked if the project broadened and deepened their educational/professional experience; did the assigned teacher contribute to the fellow's ability to communicate; and did the GK-12 project help the fellows clarify their research(Table 7). Fellows agree that the project was beneficial to their education. They express mixed opinions about the project benefiting their communication skills. Three (3) did not agree with this statement. Regarding their own research, the fellows agree that the project has helped them clarify their work.

Table 7 Fellows benefit from project

	The GK-12 Program broadened/deepened experience this year	Teachers contributed to better understanding of communication and presenting	GK-12 Program has helped clarify understanding of research
N	9	9	9
Mean	3.8	3.0	3.2
Minimum	3	2	3
Maximum	4	4	4

Chart 3 expresses the teacher survey responses regarding the quality of the GK-12 fellows on the project. All teachers agreed that the fellows are capable and qualified. Thirteen teachers gave the fellows the highest rating ("5") for this topic.

Chart 3 Teacher's summation of Fellows abilities



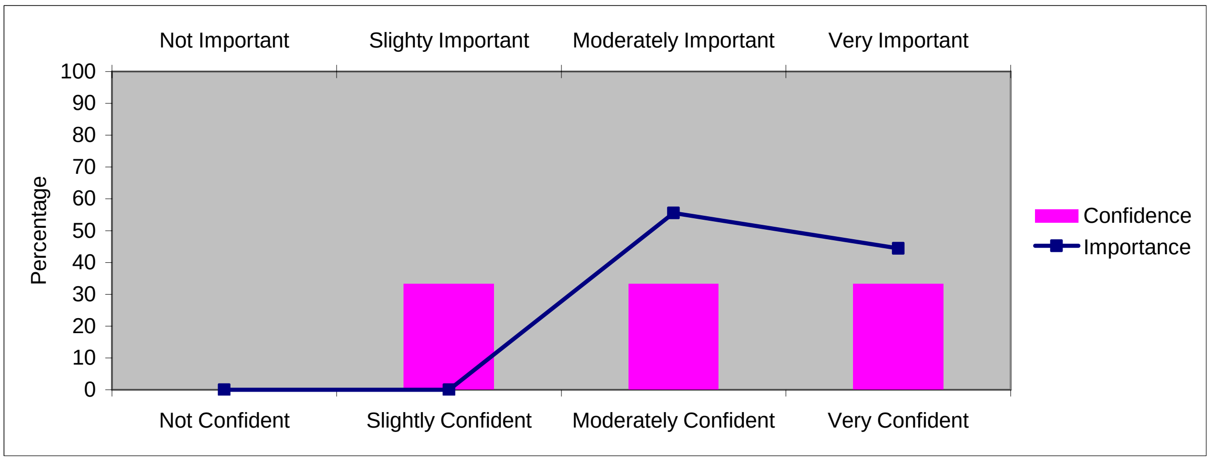
The survey included questions aimed at measuring the fellow and teacher's feelings of the importance and level of confidence they have to issues related to the evaluation questions. Figure 1 expresses the fellow's level of confidence in their ability to use various teaching techniques and importance of this ability. Fellows rated their ability as moderate to very important (55.6% moderately important, 44.4% very important) but they were split on the level of confidence in their ability.

Figure 1 Fellows ability to use teaching techniques

Confidence & Importance: Ability to Use a Variety of Instructional Techniques

Confidence		Importance	
Not Confident	0.0 %	Not Important	0.0 %
Slightly Confident	33.3 %	Slighty Important	0.0 %
Moderately Confident	33.3 %	Moderately Impo	55.6 %
Very Confident	33.3 %	Very Important	44.4 %

Average Confidence	3.0
Average Importance	3.4
Gap Result	-0.4



ISR Observers rated the fellows' abilities as very high during observed classroom sessions (see Table 7), with a mean rating of 4.2 from 101 observations completed during the school year.

Table 7 Observer's responses to fellows abilities

	Fellow demonstrates confidence, expertise, and communication skills.
N	95
Not Applicable	6
Mean	4.2
Minimum	1
Maximum	5

To what extent did the fellows benefit from the GK-12 project? The data from the surveys and observer ratings points out that the fellows did benefit from the project. Their educational experiences were enhanced and their communication skills improved. The opportunities to teach, present, and direct experiments seems to have had more impact on the fellow's improved communication skills than the teacher's influence on the fellows.

Evaluation Question 2: Did the GK-12 Project impact K-12 student interests and attitudes toward learning STEM related topics [optics and photonics specifically]?

Teachers and fellows were asked if students appear to be interested in learning the scientific method. ISR Observers were also asked to rate the student's interest in learning the scientific method. Fellows were neutral to positive on this question with five fellows (55.6%) scoring the student's level of interest as "3" and 4 fellows giving an overall rating of "4." Teachers rated the student's interest toward the subject more positively than the fellows did. Twenty-five percent (5 out of 20) of the teachers gave the students a top rating of "5."

While observing class instruction by the fellows, ISR Observers rated the interest level of the students as being interested to some extent (Table 8).

Table 8 Observer's rating of student interest

	Students appear to be interested learning scientific method.
N	99
Not Applicable	2
Mean	3.9
Minimum	1
Maximum	5

Figure 2 shows the confidence and importance the fellows placed on the topic of developing students' interest in science. They rated the importance of the topic very high with an average score of 3.9 but they rated their confidence in developing the student's interest lower, with an average score of 3.1.

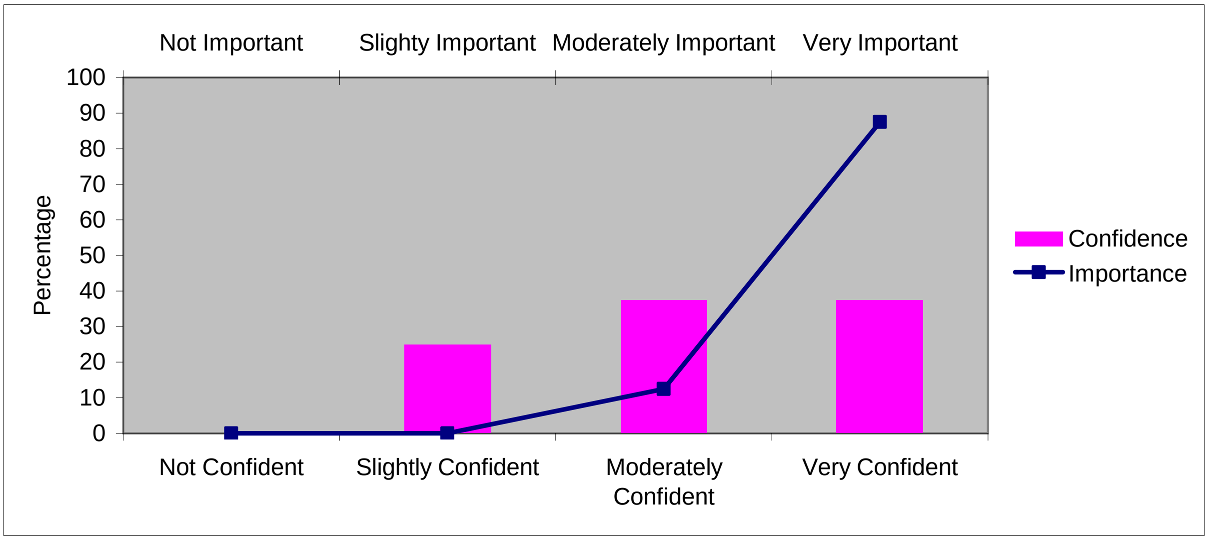
Responses from the teachers and observers indicate the GK-12 Project impacted the students in a positive manner. The fellow's responses indicate the fellows felt inadequate but they hope they are having a beneficial impact on the students. Teachers and ISR observers report the students are attentive and have positive attitudes toward the subject matter suggesting the fellows have had a positive impact. However, findings related to this question suffered in the analysis due to a lack of data from students. A word from the students would have possibly been more insightful on this question than the opinions of the teachers, fellows, and observers.

Figure 2 Fellows Responses to developing student interest

Confidence & Importance: Developing Students Interest in Science

Confidence		Importance	
Not Confident	0.0 %	Not Important	0.0 %
Slightly Confident	25.0 %	Slighty Important	0.0 %
Moderately Confident	37.5 %	Moderately Important	12.5 %
Very Confident	37.5 %	Very Important	87.5 %

Average Confidence	3.1
Average Importance	3.9
Gap Result	-0.8



Evaluation Question 3: Did the GK-12 Project contribute to the classroom Teachers beliefs and professional development toward teaching STEM related topics?

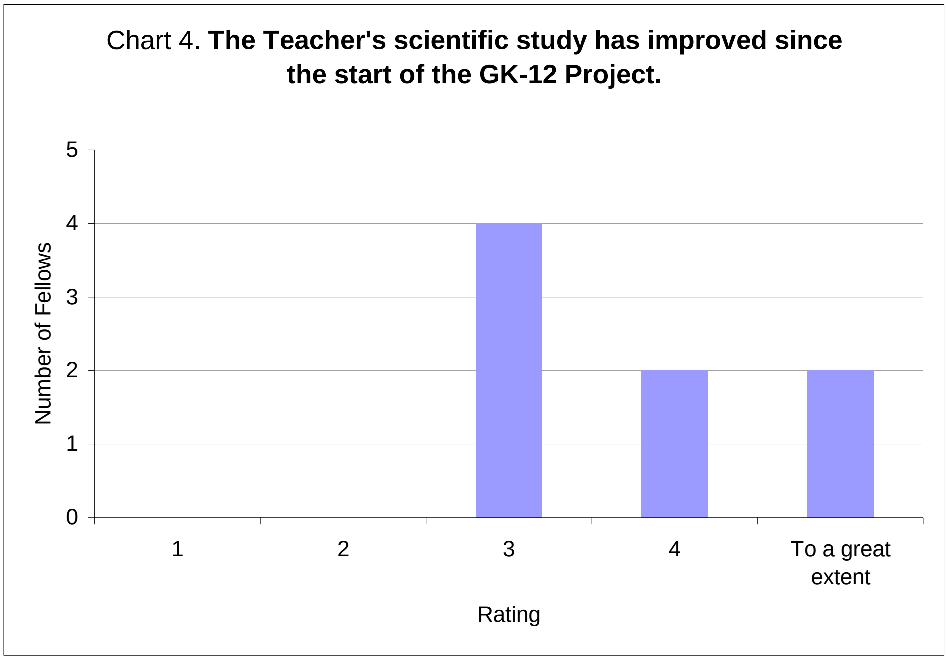
ISR Observers report that the teacher's instructional content has benefited somewhat from the fellow's contributions (Table 9).

The fellows are split in their judgment of the teachers' scientific study improving because of the OPE project and the fellow's contribution. Four of eight fellows were neutral on the issue (Chart 4).

Table 9 Observer's responses: Fellows benefit Teachers

	Teacher's instructional content benefits from the Fellow's contribution
N	87
Missing	1
Not applicable	13
Mean	3.6
Minimum	1
Maximum	5

Chart 4 Fellows response to Teacher's improvement

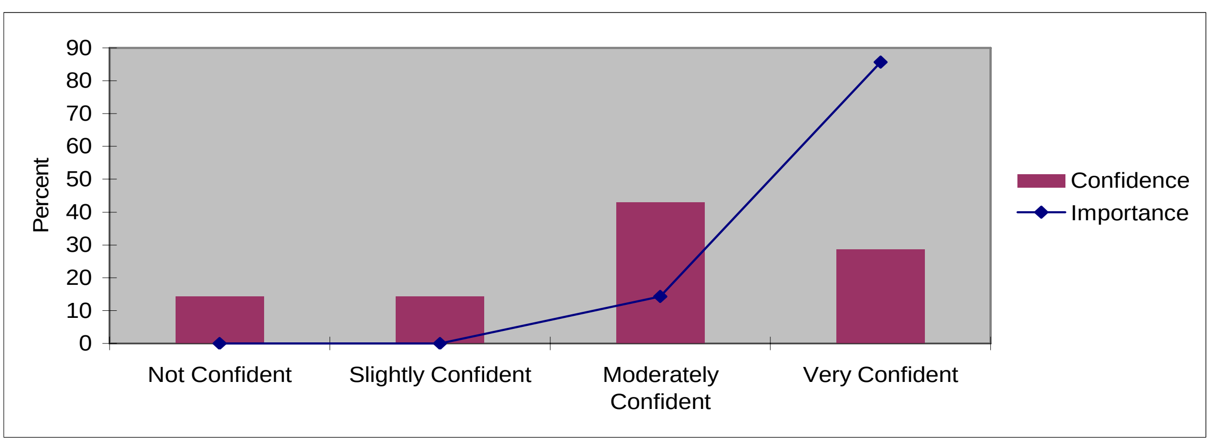


Teachers were asked to indicate how confident they felt about using inquiry-based learning techniques in the classroom and how important this issue was for their students. Figure 3 shows that the teachers felt this was very important (average rating of 3.9) but they are not as confident in their use of this technique in the classroom (average rating of 2.9).

Figure 3 Teacher's use of inquiry-based techniques

Confidence & Importance: Use of Inquiry-Based Techniques

Average Confidence	2.9
Average Importance	3.9
Gap Result	-1.0



The teachers think they are very proficient at teaching facts, rules, and vocabulary. They rated their confidence on this question with an average score of 3.9, but the importance of teaching facts and vocabulary is not as important to the teachers. They gave this topic an average importance rating of only 3.4 (Figure 4).

Overall, the GK-12 Project seems to have stimulated the teacher's awareness of their need to develop their teaching methods, and perhaps to emphasize student inquiry more and teaching science facts less. Teachers are very confident in their ability to teach facts and vocabulary but less sure of their ability to use the inquiry-based technique as advocated by the OPE project. ISR observers were perhaps generous in their rating the fellow's impact on the teachers. The fellows rated the teacher's improvement low in comparison to the observers. It might be the teachers feel a need to fall back on old teaching techniques when they teach facts and rules, because facts and rules involve the "tested" material that students need to know for promotion.

Figure 4 Teacher Responses to teaching facts

Confidence & Importance: Teaching Facts, Rules, and Vocabulary

Confidence		Importance	
Not Confident	0 %	Not Important	0 %
Slightly Confident	0 %	Slightly Important	14.3 %
Moderately Confident	14.3 %	Moderately important	28.6 %
Very Confident	85.7 %	Very Important	57.1 %
Average Confidence	3.9		
Average Importance	3.4		
Gap Result	0.4		

Evaluation Question 4: To what extent did the GK-12 Project promote the transfer of plans and technical know-how to other schools (i.e., educational institutions above and beyond the realm of the target study)?

Several issues are important if the GK-12 Project is promoted to other locations in the APS system. Adequate science equipment, materials, and the level of collaboration with UNM are necessary for the project to succeed and give students a hands-on inquiry-based learning experience. Adequate equipment and supplies is considered important to promote GK-12 beyond the West Mesa Cluster target area. ISR asked teachers and fellows several questions regarding the importance of the need for supplies to make the GK-12 model succeed. Teachers felt that adequate supplies in the classroom are very important (mean of 4.6, Table 10). They were split on the question of existing supplies in their classrooms, a mean of 3.6 rated less than to just adequate. Teachers also felt that GK-12 cannot succeed without special equipment (mean of 2.6) and only 5 (20%) teachers felt they had adequate classroom computers (mean of 3.0).

Table 10 Teacher responses to importance of supplies and equipment

	Adequate supplies are important	There are adequate supplies	GK-12 can succeed without special equipment	I have adequate computing equipment in classrooms
N	25	25	25	25
Mean	4.6	3.6	2.6	3.0
Minimum	3	2	1	1
Maximum	5	5	4	5

Teachers gave the project positive scores on the ability, knowledge, and science experience of the GK-12 fellows, but teachers agree that equipment and materials are needed for complete success.

How supportive the teachers and fellows perceive the APS and UNM stakeholders, is another issue related to promotion and expansion of the project. We asked teachers, if the UNM stakeholders had provided professional development resources to enhance science in the classroom; and we asked teachers and fellows if UNM GK-12 faculty had collaborated with the schools and fostered professional development. Teachers were neutral on the question on whether UNM had provided professional resources to enhance science instruction (Table 11). On the issue of collaboration, the fellows disagreed that UNM faculty had collaborated with assigned schools (mean of 2.7). On the question of collaboration, the fellows disagreed or strongly disagreed that UNM faculty had collaborated with assigned schools (mean of 2.6, Table 12). The fellows and teachers seem to feel the UNM and APS stakeholders are not actively engaged in routine activities of the project during the school year.

Table 11 Teacher responses to UNM collaboration

	UNM has provided resources to enhance science instruction	UNM faculty collaborate with my school
N	25	22
Missing	0	3
Mean	3.0	2.7
Minimum	2	2
Maximum	4	4

Table 12 Fellows responses to UNM collaboration

	UNM faculty collaborate with assigned schools
N	9
Mean	2.6
Minimum	1
Maximum	3

During the 2007 UNM Summer Intersession the fellows worked to produce a video on DVD of their science experiments and material. Seven of the nine fellows self-organized to pursue the development and production of a DVD containing video demonstrations and accompanying text documents of the fellows' most successful classroom presentations. The work is aligned with NM state science standards and is hands-on applications for students. Plans for dissemination include distribution to APS science teachers, statewide availability to other teachers, posting on our website and creating links on others, and coordination with NSF for other options.

Additionally, the fellows are providing follow up for the International Science and Engineering Fair held in Albuquerque in May 2007. They will produce for teachers who attended a CD containing instructions for all of the hands-on learning centers provided for students at the ISEF.

Fellows have also spent time during the summer reflecting upon their two semesters of classroom experiences, journaling those reflections, and sharing them in seminar with each other. Once the grant extension was approved for the upcoming school year, fellows began planning (including scouting local resources and field trip opportunities at museums). Other future initiatives have been in discussion and initial planning stages (i.e. engineering career emphases; work with a new PBS program regarding engineering).

Evaluation Question 5: How effective were the inquiry based instructional modules in fostering student understanding and enjoyment of STEM related topics?

Fellows and teachers were asked specific questions regarding inquiry-based instruction. Fellows acknowledged their exposure to inquiry-based learning was limited (44% no exposure or very limited exposure). Fellows agreed strongly that inquiry-based learning is important and they frequently use inquiry learning techniques in the classroom but their responses were split on just how effective inquiry learning is in the classroom (see Chart 5). Fellows also responded that inquiry-based teaching has affected student achievements (Figure 8). The fellows responded positively in the areas of, improved classroom activity, students using problem-solving techniques, and students being able to recall content.

Chart 5 Fellows rating effectiveness of Inquiry module

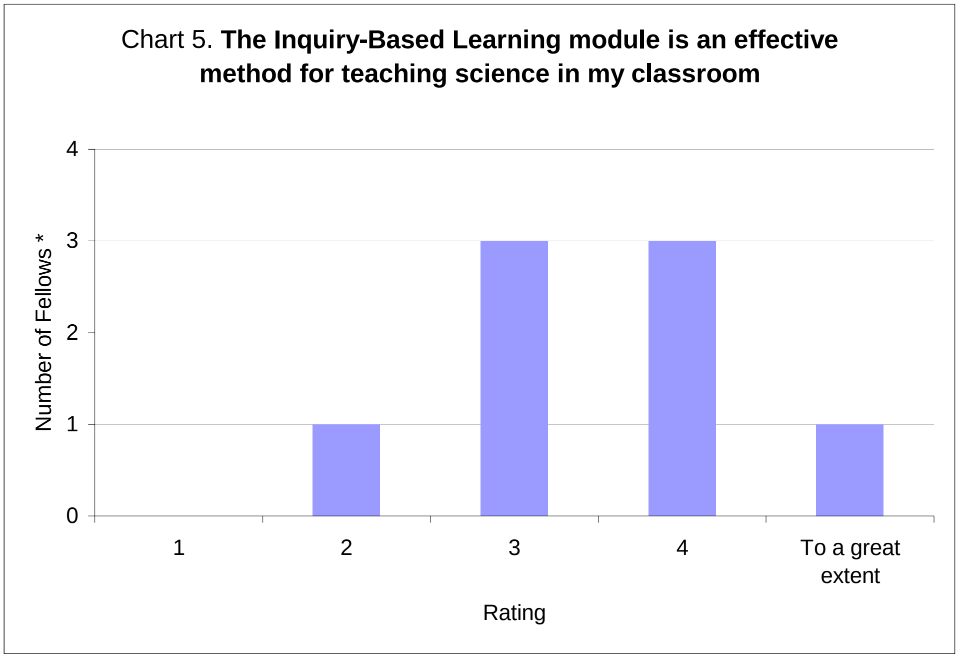


Figure 5 Fellows Responses on gains using inquiry-based teaching

Observed gains from inquiry-based teaching

Performance Indicators	Counts: Yes	Counts: No
Performance on teacher-made exams	0	9
Student Assignments	1	8
Student Projects	2	7
Classroom Activities	5	4
Problem Solving	5	4
Student Recall of Content	7	2
Other: Quality/Depth of Questions	1	8

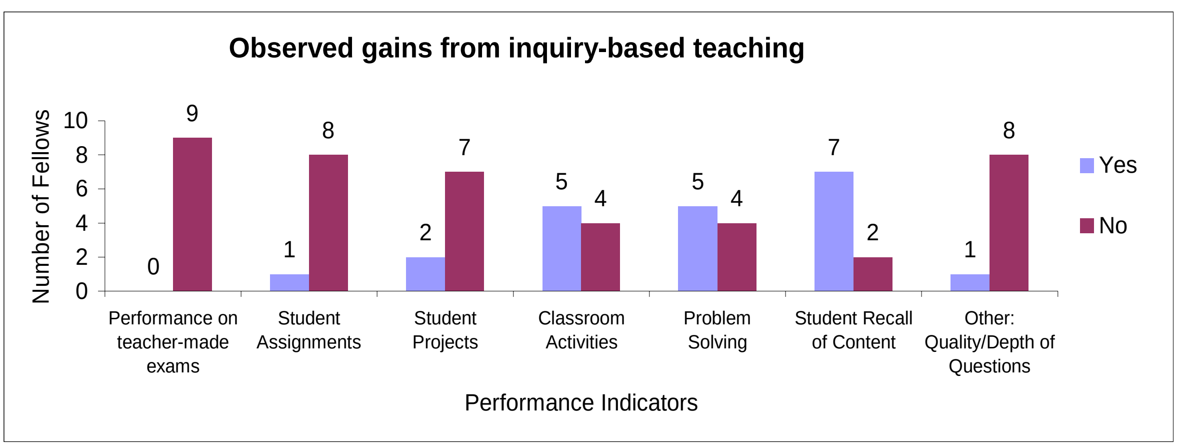
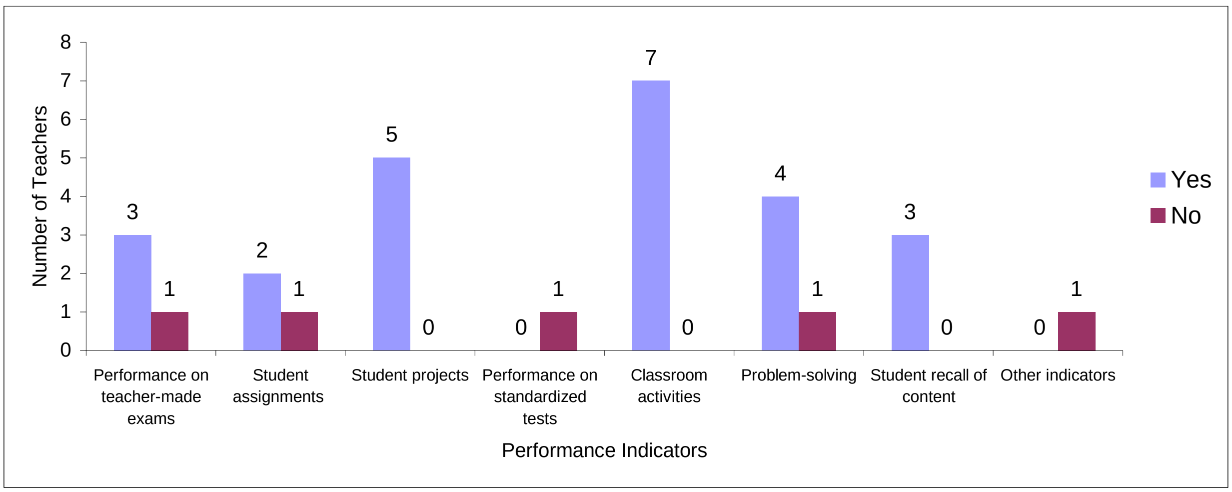


Figure 9 shows teacher's responses regarding specific gains they have seen in the classroom. Teachers report positive gains on teacher-made exams, student assignments, student projects, hands-on classroom activities, problem solving, and recall of content. Fellows and teachers agreed that inquiry-based instruction techniques have been effective in the classroom.

Figure 6 Teacher responses to gains from inquiry-based teaching

Observed gains from inquiry-based teaching

Performance Indicators	Counts Yes	Counts No
Performance on teacher-made exams	3	1
Student assignments	2	1
Student projects	5	0
Performance on standardized tests	0	1
Classroom activities	7	0
Problem-solving	4	1
Student recall of content	3	0
Other indicators	0	1



Teachers' responses were very similar to the fellows' on the issue of inquiry-based teaching. Teachers reported having limited exposure to the inquiry technique (mean of 3.4). They feel it is important (mean of 3.9), they use the technique in the classroom, and they seem to think inquiry learning is effective (See Table 13).

Table 13 Teacher responses to Inquiry-Based

	Been exposed to Inquiry-Based Learning Module	The Inquiry-Based Learning Module is Important	Use of Inquiry-Based Techniques	Inquiry-Based Learning module is effective in the classroom
N	25	25	25	24
Missing	0	0	0	1
Mean	3.4	3.9	3.7	4.0
Minimum	1	1	1	1
Maximum	5	5	5	5

ISR Observers also rated the teacher and fellow's use of inquiry-based techniques. Table 14 illustrates that in general the observers saw the teachers using inquiry techniques to some extent during classroom sessions. Inquiry techniques are not used in the classroom exclusively. The number of missing data points in Table 14 demonstrates this point. This response represents that, during observation sessions inquiry-based learning techniques were not used for various reasons, e.g., the teacher or fellow did not present material using inquiry techniques during the class, the class lesson consisted of a vocabulary or test review, or a quiz was given during the class session.

Table 14 Observer Responses to Teachers using Inquiry-Based Techniques

	Teachers encourage the students to use hands-on interactive techniques	**Students are allowed to discover on their own and work in groups**
N	93	85
Not applicable	8	16
Mean	3.4	3.4
Minimum	1	1
Maximum	5	5

Inquiry based techniques are important to the OPE project. Fellows, teachers, and observers have noted that inquiry techniques are being used in the classrooms and seem to be having a positive impact on the students.

Evaluation Question 6: Did the Graduate fellow's participation in the preliminary orientation session and periodic seminars promote their abilities in being successful contributors to the GK-12 Project?

All nine fellows attended the preliminary orientation session before the school term began. The fellows reported having a positive attitude about the GK-12 project before it began (Table 15). At the time of the survey, all the fellows reported a very positive attitude toward the project, mean of 4.9.

Table 15 Fellows attitude toward project

	Attitude about program before it began	**Current attitude about program**
N	9	9
Mean	4.3	4.9
Minimum	3	4
Maximum	5	5

In this report, it has been noted that a high percentage (89%) of the fellows routinely attended the bi-weekly seminars. In the survey, the fellows strongly agree that the seminars were helpful (see Table 16). Fellows also gave three suggestions for improving the seminar: 1) include the teachers; 2) learn more teaching skills; 3) more contact between seminars, i.e., e-mail and small group planning.

Table 16 Fellows attitude toward seminars

	The Seminar was helpful
N	9
Mean	3.6
Minimum	3
Maximum	4

Fellows participated in the orientation event and the routine seminars. Fellows report having a good attitude about the OPE project and agree that the seminars are helpful.

Conclusion

Fellows, teachers, and ISR observers agree, they did benefit from the project. Fellows experienced enhanced educational opportunities and their communication skills improved. Teachers seem to have been stimulated by participating in the project to expand their teaching skills and students were exposed to science in new meaningful ways. The OPE project demonstrated the positive impact that high quality upper level researchers can make by participating in a local public school system.

The OPE project existed for two years, before ISR joined the project and created a feasible evaluation to follow the third year of the project. ISR designed a two-part method for collecting qualitative and quantitative data. The method included evaluation questions designed to address the NSF goals and measure outcomes, observations in the classroom, and surveying teachers and fellows.

Survey findings and observer ratings show the fellows benefited from the project as their educational experience and communication skills improved. The activity of teaching and presenting experiments seems to have impacted the fellow's more than the teacher's guidance. Teachers and ISR observers report the students were attentive to the fellows and had positive attitudes toward science. The GK-12 Project seems to have impressed teachers and increased their practice of using the inquiry-based teaching technique. Fellows, teachers, and observers noted that inquiry techniques are being used in the classrooms and seem to be having a positive impact on the students. Teachers feel that equipment and materials are important to teach students and the OPE has provided resources to the schools but the fellows and the teachers do not associate UNM support with routine support in the local schools. The project stakeholders made an effort early in the project to recruit qualified fellows, match fellows to teachers, and require the fellows to manage their time on the project. Additionally, planning events and regular advisory sessions, i.e., seminars were well attended and useful to the fellows.

The OPE project demonstrates it is difficult but not impossible for a local higher education institution to mentor and provide resources to local public schools. It is difficult, but the positive benefits are worth the effort. As we found, graduate students can learn new means of communicating; teachers can be motivated to incorporate new research findings and teaching techniques into their daily routine; and students can discover science in new ways.

The project originally proposed the creation of a series of new learning modules for teachers and students. The University of New Mexico College of Education was to mentor the project with expertise on classroom instruction and education theory (page 11). The COE did not assist with this task. Rather than creating modules, the fellows created a DVD and accompanying materials for circulation among APS teachers and others. This alternative could serve the same purpose as the modules.

The resulting evaluation by ISR was tenuous in three particular areas. One, time constraints prevented the researchers from surveying students. Responses from the students would have broadened the understanding of the impact of the OPE project. Two, collecting student test scores from the teachers and a specific pre/post test to measure precisely the impact of the OPE project goals would have enriched the findings of the research. Finally, a significant weakness of the project was the loss of the COE midway through the project. The lack of early data and foundational analysis diminished the evaluation of the project and probably disrupted some continuity gained over the first two years of the project.

Future projects of similar nature to the OPE project could benefit from the experiences of the OPE project. For example, teachers need additional resources and practical examples demonstrating the use of inquiry-based teaching methods in the classroom. The value of inquiry-based techniques seems beneficial to the students as they discover science, but inquiry techniques require thoughtful planning. Further studies could test the difference that inquiry techniques make in student exam scores.

Appendix

ISR Observer:______________________

GK12 Engineering

Classroom Observation Form

DRAFT – (revised 09/28/06)

Site (*circle one*): Belen Socorro Albuquerque

Name of School: ____

Name of Class: ____

Activity (*tutoring session, regular class, experiment*): ______________________________

____

Date: ________________ **Begin time**: ___________ **End time:** ___________

Name of Teacher and Fellow: ____
(*if Fellow is not present write: "Fellow not present"*)

How many students are involved? ____________________________

Grade Level(s) of students involved: ____________________________________

Are others present (*i.e. parents*? *If so, how many?)* : ____________________________

____

Observer Comments:

OBSERVATION NOTES

What happened during the class session? Who was involved? What questions were asked? Were students paying attention? Did activity leader have control of students? Please be as descriptive as possible. Use quotation marks for direct quotes; describe interactions, recurrent themes, non-verbal communication. Avoid assumptions and vague language. This space is for observational notes only. **Please attach your typed analytical notes to this completed form. At the end of your analytical notes, you should make bullet points of issues, concerns or items that may deserve further attention.**

Field Notes	**Notes to Self (interpretive/analytical)**

OBSERVER SCALE

		Not at all				To a great extent	N/A
1	The Teacher encourages the Students; uses hands-on interactive activities; uses science terminology; and asks probing questions.	1	2	3	4	5	6
2	Students are allowed to discover on their own with Teacher guidance; work in groups	1	2	3	4	5	6
3	Students appear to be interested; learning scientific method.	1	2	3	4	5	6
4	Teacher and Fellow plan together before class.	1	2	3	4	5	6
5	Fellow demonstrates confidence, expertise, and communication skills.	1	2	3	4	5	6
6	Teacher's instructional content benefits from the Fellow's contribution.	1	2	3	4	5	6

The University of New Mexico

GK-12 Survey for Teachers

The Institute for Social Research at the University of New Mexico has been contracted to conduct an evaluation of the GK-12 Program. The attitudes and opinions of the program participants are an important part of our evaluation. We would like to ask you about your experiences in the GK-12 Program. Your answers to this survey will help us to evaluate the program and make recommendations to secure the future success of the program.

This questionnaire is confidential and will only be seen by the researchers. We are legally bound to preserve the confidentiality of all respondents. Your participation is completely voluntary.

SECTION I – DEMOGRAPHIC DATA

1. Your Name ___________________________________
2. School Name ___________________________________
3. The grade level(s) you teach ________________________
4. Counting this year, how many years have you taught at either the elementary or secondary level? *(round to the nearest year and include part-time teaching experience)* ___________________ years.
5. How many years have you taught science? *(round to the nearest year and include part-time teaching experience)* ___________________ years.
6. What was the major field of study for your Bachelor's degree? ______________
7. What year did you receive your Bachelor's degree? ______________
8. What college or university did you graduate from? _______________________
9. Do you have a Master's degree? _____________
10. What was the major field of study for your Master's degree? ______________
11. What year did you receive your Master's degree? ______________
12. What was the major field of study for your last degree? ___________________
13. What college or university did you graduate with a Master's degree?___________
14. During the last two years, how many college courses have you taken in science or science education? ____

15. During the past two years, have you taken college courses in any of the following? Check all that apply.

___ Methods of teaching science
___ Biology / Life Science
___ Chemistry
___ Physics
___ Earth Science

16. During the past five years, have you taken courses or participated in professional development activities in any of the following?

___ Use of computers in the classroom
___ Use of computers for data analysis
___ Use of multimedia for science education
___ Laboratory management or safety
___ Inquiry-based science instruction

17. Please estimate how many hours you spent in professional development workshops or seminars in science or science education during the past year? _________ hours.

18. Do you belong to one or more professional organizations <u>related to science</u>?

___ Yes
___ No

SECTION II – INQUIRY BASED TEACHING METHODS

19. Since becoming involved with the GK-12 program, how frequently have you used inquiry-based activities in your science teaching?

___ Not at all
___ Less than once a week
___ Once a week
___ More than once a week

20. How has inquiry-based teaching affected student achievement in your classroom? (go to Question 22 if "no observable gain" was observed)

___ No observable gain have been noted.
___ Some gains have been observed.
___ Moderate gains have been observed.
___ Large gains have been observed.

21. If gains in student achievement have been observed, which performance indicators have shown improvement? Check all that apply.

___ Performance on teacher-made exams
___ Student assignments, like homework
___ Student projects
___ Standardized tests results
___ Hands-on classroom activities
___ Student problem-solving in the classroom
___ Student recall of content
___ Other (please state) _____________

22. Which performance indicator(s) demonstrate your observation of "no observable gain"? Check all that apply.

___ Performance on teacher-made exams
___ Student assignments, like homework
___ Student projects
___ Standardized tests results
___ Hands-on classroom activities
___ Student problem-solving in the classroom
___ Student recall of content
___ Other (please state) _____________

23. How has inquiry-based teaching affected student motivation in your classroom?

___ No observable differences have been noted.
___ Students are less receptive/responsive to learning.
___ Students are more receptive/responsive to learning.

SECTION III – PERCEPTION OF INQUIRY AND TEACHING SKILLS

Please indicate <u>how confident</u> you feel about the following aspects of skills and knowledge related to teaching and <u>how important</u> you believe these issues are for the grade level(s) you teach.

My Level of Confidence					Level of Importance			
Not Confident	Slightly Confident	Moderately Confident	Very Confident		Not Important	Slightly Important	Moderately Important	Very Important
1	2	3	4	Teaching facts, rules, and vocabulary	1	2	3	4
1	2	3	4	Use of inquiry-based learning techniques in the school	1	2	3	4
1	2	3	4	Encouraging students to explore methods for solving problems.	1	2	3	4
1	2	3	4	Implementing inquiry-based instruction in the classroom	1	2	3	4
1	2	3	4	Guiding students as they carry out an experiment.	1	2	3	4
1	2	3	4	Developing students' abilities to critique and analyze results.	1	2	3	4
1	2	3	4	Developing student interest in science.	1	2	3	4
1	2	3	4	Knowledge of the state curriculum standards for science.	1	2	3	4
1	2	3	4	Ability to use a variety of instructional techniques in the classroom.	1	2	3	4
1	2	3	4	Incorporating hands-on materials in teaching.	1	2	3	4
1	2	3	4	Motivating students to consider advanced studies in science.	1	2	3	4

Not Confident	Slightly Confident	Moderately Confident	Very Confident		Not Important	Slightly Important	Moderately Important	Very Important
1	2	3	4	Facilitating student learning using a collaborative teaching environment.	1	2	3	4
1	2	3	4	Facilitating students working in small groups.	1	2	3	4
1	2	3	4	Overseeing classroom discipline/classroom management.	1	2	3	4

Please respond to the following statements by circling the number that best indicates your response to the statement.

		Not at all				To a great extent
38	Students in my classes appear to be interested; learning the scientific method.	1	2	3	4	5
39	I guide students to make discoveries and to work in groups.	1	2	3	4	5
40	I encourage students to use hands-on interactive activities, science terminology, and ask probing questions.	1	2	3	4	5
41	I plan with the Fellow before class begins.	1	2	3	4	5
42	The Fellow I work with demonstrates confidence, expertise, and good communication skills.	1	2	3	4	5
43	My instructional content has benefited from the Fellow's contributions.	1	2	3	4	5
44	Collaboration between the Fellow and the Teacher is important.	1	2	3	4	5
45	I am satisfied with my current level of collaboration with the GK-12 Fellow.	1	2	3	4	5
46	Adequate supplies, materials, and equipment in the classroom are important for the GK-12 Program to succeed.	1	2	3	4	5

47	There are adequate supplies, materials, and equipment in my classroom to perform the experiments required by the Standardized Test Program.	1	2	3	4	5
48	The GK-12 Program can succeed without special equipment.	1	2	3	4	5
49	I have adequate computing equipment in my classroom.	1	2	3	4	5
50	I have been exposed to the Inquiry-Based Learning module.	1	2	3	4	5
51	The Inquiry-Based Learning module is important to teach science to students.	1	2	3	4	5
52	I use Inquiry-Based Learning techniques in the classroom.	1	2	3	4	5
53	The Inquiry-Based Learning module is an effective method for teaching science in my classroom.	1	2	3	4	5
54	I have knowledge of the scientific method adequate to meet the needs of my students.	1	2	3	4	5
55	It is important for Teachers to increase their scientific knowledge.	1	2	3	4	5
56	Working with the GK-12 Fellow has improved my knowledge of science.	1	2	3	4	5
57	Working with the GK-12 Fellow has improved my ability to teach science.	1	2	3	4	5
58	I was involved in the planning and design of the GK-12 Program in my school.	1	2	3	4	5
59	I had a positive attitude toward the GK-12 Program before it began.	1	2	3	4	5
60	My current attitude toward the GK-12 Program is best described as positive.	1	2	3	4	5
61	I was given the resources, training, and direction necessary to perform my role in the GK-12 Program.	1	2	3	4	5

		Not at all				To a great extent
62	The Fellow who I am most familiar with plans activities for the classroom.	1	2	3	4	5
63	The Fellow's ability to communicate to the students has improved since the start of the GK-12 Program.	1	2	3	4	5

Next 3 Questions for Belen & Socorro Teachers only

64	The GK-12 Orientation was beneficial for understanding my role and responsibilities in the Program.	1	2	3	4	5
65	The Orientation handouts and materials were helpful to the job I perform in the classroom.	1	2	3	4	5
66	The training during the orientation was adequate for working with students in my school.	1	2	3	4	5

Next 2 Questions for Albuquerque Teachers only

67	My understanding of the GK-12 Program would benefit from a formal Orientation about the program.	1	2	3	4	5
68	Handouts and materials about the GK-12 Program would be helpful to me.	1	2	3	4	5

SECTION III – COLLABORATION AND PROFESSIONAL DEVELOPMENT

69. Do you have a Fellow assigned to work with you?

___ Yes
___ No

70. How often do you meet or communicate with your Fellow?

___ Almost daily
___ Once a week
___ Several times a month
___ Once a month
___ Less than once a month

71. What is the <u>primary</u> focus of your meetings or communications with the Fellow? (choose one)

___ Study of academic content of the subject I teach
___ Understanding New Mexico standards and helping students master the NM standards.
___ Prepare lesson plans for the next day or week.
___ Collaboration for improving instruction.
___ Strategies for creating and maintaining safety and order in the classroom.
___ Other; specify ____

72. What <u>else</u> do these meetings or communications focus on? (Choose all that apply.)

___ Study of academic content of the subject I teach
___ Understanding New Mexico standards and helping students master the NM standards.
___ Prepare lesson plans for the next day or week.
___ Collaboration for improving instruction.
___ Strategies for creating and maintaining safety and order in the classroom.
___ Other; specify ____

Finally, please circle the response that best describes your answer to the statement.

73. Participating in the GK-12 Program broadened and deepened my educational/professional experience this year.

Strongly Disagree	Disagree	Agree	Strongly Agree

74. The GK-12 Fellow has contributed to my better understanding of scientific study.

Strongly Disagree	Disagree	Agree	Strongly Agree

75. The University of New Mexico through the GK-12 Program has provided professional development resources to me to enhance my science instruction in the classroom.

Strongly Disagree	Disagree	Agree	Strongly Agree

76. University of New Mexico faculty through the GK-12 Program collaborates with my school and is engaged in professional development programs.

Strongly Disagree	Disagree	Agree	Strongly Agree

77. What do you like most about the GK-12 Program? Explain your answer in the box.

This completes the survey. Thank you for assisting us in this important research. Your time and effort are appreciated.

GK-12 Survey for Fellows

The University of New Mexico

The Institute for Social Research at the University of New Mexico has been contracted to conduct an evaluation of the GK-12 Program. The attitudes and opinions of the program participants are an important part of our evaluation. We would like to ask you about your experiences in the GK-12 Project. Your answers to this survey will help us to evaluate the program and make recommendations to secure the future success of the program.

This questionnaire is confidential and will only be seen by the researchers. We are legally bound to preserve the confidentiality of all respondents. Your participation is completely voluntary.

SECTION I – DEMOGRAPHIC DATA

1. Your Name ________________________________

2. Name of the School(s) where you teach __________________________

3. The grade level(s) you teach ______________________

4. Before the GK-12 program, did you have any teaching experience?

   ___ Yes
   ___ No

5. Have you taught at either the elementary or secondary level?

   ___ Yes
   ___ No

6. If you answered yes to Question 5, how many years have you taught? *(round to the nearest year and include part-time teaching experience)* _________________ years.

7. Please check the highest level of formal education you have completed.

   ___ Bachelor's degree
   ___ Bachelor's degree + 15 hours or more
   ___ Education specialist
   ___ Master's degree
   ___ Master's degree + 15 hours or more
   ___ Doctorate

8. What was the major field of study for your last degree? _________________

9. During the past two years, have you taken courses or participated in professional development activities in any of the following?

___ Use of computers in the classroom
___ Use of computers for data analysis
___ Use of multimedia for science education
___ Laboratory management or safety
___ Inquiry-based science instruction

10. Do you belong to one or more professional organizations <u>related to science</u>?

___ Yes
___ No

SECTION II – INQUIRY BASED TEACHING METHODS

11. Since becoming involved with the GK-12 program, how frequently have you used inquiry-based activities in your classroom teaching?

___ Not at all
___ Less than once a week
___ Once a week
___ More than once a week

12. How has inquiry-based teaching affected student achievement in your classroom? (go to Question 14 if "no observable gain" was observed)

___ No observable gain have been noted.
___ Some gains have been observed.
___ Moderate gains have been observed.
___ Large gains have been observed.

13. If gains in student achievement have been observed, which performance indicators have shown improvement? Check all that apply.

___ Performance on teacher-made exams
___ Student assignments, like homework
___ Student projects
___ Standardized tests results
___ Hands-on classroom activities
___ Student problem-solving in the classroom
___ Student recall of content
___ Other (please state) _____________

14. Which performance indicator(s) demonstrate your observation of "no observable gain"? Check all that apply.

___ Performance on teacher-made exams
___ Student assignments, like homework
___ Student projects
___ Standardized tests results
___ Hands-on classroom activities
___ Student problem-solving in the classroom
___ Student recall of content
___ Other (please state) _____________

15. How has inquiry-based teaching affected student motivation in your classroom?

___ No observable differences have been noted.
___ Students are less receptive/responsive to learning.
___ Students are more receptive/responsive to learning.

SECTION III – PERCEPTION OF INQUIRY AND TEACHING SKILLS

Please indicate <u>how confident</u> you feel about the following aspects of skills and knowledge related to teaching and <u>how important</u> you believe these issues are for the grade level(s) you teach.

My Level of Confidence					Level of Importance			
Not Confident	Slightly Confident	Moderately Confident	Very Confident		Not Important	Slightly Important	Moderately Important	Very Important
1	2	3	4	Teaching facts, rules, and vocabulary	1	2	3	4
1	2	3	4	Use of inquiry-based learning techniques in the school	1	2	3	4
1	2	3	4	Encouraging students to explore methods for solving problems.	1	2	3	4
1	2	3	4	Implementing inquiry-based instruction in the classroom	1	2	3	4
1	2	3	4	Guiding students as they carry out an experiment.	1	2	3	4
1	2	3	4	Developing students' abilities to critique and analyze results.	1	2	3	4
1	2	3	4	Developing student interest in science.	1	2	3	4
1	2	3	4	Knowledge of the state curriculum standards for science.	1	2	3	4
1	2	3	4	Ability to use a variety of instructional techniques in the classroom.	1	2	3	4
1	2	3	4	Incorporating hands-on materials in teaching.	1	2	3	4
1	2	3	4	Motivating students to consider advanced studies in science.	1	2	3	4
1	2	3	4	Facilitating student learning using a collaborative teaching environment.	1	2	3	4
1	2	3	4	Facilitating students working in small groups.	1	2	3	4
1	2	3	4	Overseeing classroom discipline/classroom management.	1	2	3	4

Please respond to the following statements by circling the number that best indicates your response to the statement.

		Not at all				To a great extent
30	Students in my classes appear to be interested; learning the scientific method.	1	2	3	4	5
31	I guide students to make discoveries and to work in groups.	1	2	3	4	5
32	I encourage students to use hands-on interactive activities, science terminology, and ask probing questions.	1	2	3	4	5
33	I plan with the Teacher before class begins.	1	2	3	4	5
34	The Teacher(s) I work with demonstrates confidence, expertise, and good communication skills.	1	2	3	4	5
35	My instructional content has benefited from the Teacher's contributions.	1	2	3	4	5
36	Collaboration between the Fellow and the Teacher is important.	1	2	3	4	5
37	I am satisfied with my current level of collaboration with the GK-12 Teacher(s).	1	2	3	4	5
38	Adequate supplies, materials, and equipment in the classroom are important for the GK-12 Program to succeed.	1	2	3	4	5
39	There are adequate supplies, materials, and equipment in my classroom(s) to perform the experiments required by the Standardized Test Program.	1	2	3	4	5
40	The GK-12 Program can succeed without special equipment.	1	2	3	4	5
41	I have adequate computing equipment in my classroom(s).	1	2	3	4	5

42	I have been exposed to the Inquiry-Based Learning module.	1	2	3	4	5
43	The Inquiry-Based Learning module is important to teach science to students.	1	2	3	4	5
44	I use Inquiry-Based Learning techniques in the classroom(s).	1	2	3	4	5
45	The Inquiry-Based Learning module is an effective method for teaching science in my classroom(s).	1	2	3	4	5
46	I have knowledge of the scientific method adequate to meet the needs of the students.	1	2	3	4	5
47	It is important for Teachers to increase their scientific knowledge.	1	2	3	4	5
48	Working with the GK-12 Teacher has improved my knowledge of public education.	1	2	3	4	5
49	Working with the GK-12 Teacher(s) has improved my ability to teach science.	1	2	3	4	5
50	I had a positive attitude toward the Program before it began.	1	2	3	4	5
51	My current attitude toward the GK-12 Program is best described as positive.	1	2	3	4	5
52	I was given the resources, training, and direction necessary to perform my role in the GK-12 program.	1	2	3	4	5
53	The Teacher who I am most familiar with plans activities for the classroom.	1	2	3	4	5
54	The Teacher's scientific study has improved since the start of the GK-12 Program.	1	2	3	4	5

SECTION III – COLLABORATION AND PROFESSIONAL DEVELOPMENT

55. How many Teachers are you assigned to work with during this semester?____

56. Typically, how often do you meet or communicate with a Teacher?

___ Almost daily
___ Once a week
___ Several times a month
___ Once a month
___ Less than once a month

57. What is the **primary** focus of your meetings or communications with the Teacher? **(choose one)**

___ Study of academic content of the subject I present
___ Understanding New Mexico standards and helping students master the NM standards.
___ Prepare lesson plans for the next day or week.
___ Collaboration for improving instruction.
___ Strategies for creating and maintaining safety and order in the classroom.
___ Other; specify ___________________________________

58. What **else** do these meetings or communications focus on? **(Choose all that apply.)**

___ Study of academic content of the subject I teach
___ Understanding New Mexico standards and helping students master the NM standards.
___ Prepare lesson plans for the next day or week.
___ Collaboration for improving instruction.
___ Strategies for creating and maintaining safety and order in the classroom.
___ Other; specify ______________________________________

E-MRGE Belen & Socorro Fellows answer Questions 59- 61.

59. I attended a GK-12 Orientation at the beginning of my assignment.

___ Yes
___ No

60. The GK-12 Orientation was helpful.

Strongly Disagree	Disagree	Agree	Strongly Agree

61. What would you do to improve the GK-12 Orientation?

____

____

Optics & Photonics Albuquerque Fellows answer Questions 62-63.

62. The Seminars facilitated by the APS Program Manager were helpful.

Strongly Disagree	Disagree	Agree	Strongly Agree

63. What would you do to improve the Seminars?

____

Finally, please circle the response that best describes your answer to the statement.

64. Participating in the GK-12 program broadened and deepened my educational/professional experience this year.

Strongly Disagree	Disagree	Agree	Strongly Agree

65. My Teacher(s) has contributed to my better understanding of communication and presenting scientific research.

Strongly Disagree	Disagree	Agree	Strongly Agree

66. Presenting my research and understanding of science to students and teachers has helped me clarify my understanding of my research.

Strongly Disagree	Disagree	Agree	Strongly Agree

67. University of New Mexico faculty through the GK-12 program collaborates with the school(s) where I am assigned and are engaged in professional development programs.

Strongly Disagree	Disagree	Agree	Strongly Agree

This completes the survey. Thank you for assisting us in this important research. Your time and effort are appreciated.