AC 2007-514: UNIVERSITY OF ARKANSAS SCIENCE PARTNERSHIP PROGRAM

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University of Arkansas Science Partnership Program

Abstract

In 2005, the College of Engineering and the College of Education and Health Professions formed a partnership to assist the Northwest Arkansas Education Renewal Zone in engaging students in hands-on, standards-based science activities. It is well established that "hands-on" activities enhance the learning experience in the classroom,[1,2] and this is particularly true for English Language Learners (ELLs), who make up a significant fraction of some Northwest Arkansas schools. The University of Arkansas Science Partnership Program focuses on the professional growth of 6th, 7th and 8th grade science teachers through three summer institutes and follow-up activities. Teachers are teamed with engineering faculty to improve teaching skills and to increase the teachers' use, understanding and application of selected laboratory exercises. The Partnership Program consists of three parts: classroom/laboratory instruction at the institutes using a number of hands-on activities that can and will be used in the classroom; follow-up activities at the middle school/junior high schools; and evaluation, both during and after the summer institutes.

Introduction

The essence of the University of Arkansas Science Partnership Program (UASPP) is the word "partnership." The genesis of this partnership occurred during discussions between faculty who work in vastly different areas of the campus. Despite their apparent dissimilarities, it became clear that there are many common goals and interests. It became even clearer that it was possible to make those common goals and interests intersect in creative ways to improve science education, contribute to the recruitment strategies for both colleges and conduct a research project that would examine the effectiveness of the activities implemented.

The purpose of this paper is to describe the partnership developed to undertake the UASPP, its organization, the program itself, to present a sampling of the hands-on activities used in year one of the program, and to provide some preliminary findings regarding the teachers' evaluation of the first institute. Since the program is still in the early stages of implementation, the results do not include qualitative data from the follow-up activities or the quantitative standardized test scores for students. We expect to have all these data available by the end of the three-year program.

The Partnership

One truism about higher education is that many valuable endeavors can be implemented in numerous areas of a campus and rarely do all areas of the campus seem to be well-informed. The same is true for the The University of Arkansas Colleges of Engineering and Education and Health Professions. In fact, if you asked the faculty of each college, most would probably stare blankly if asked how the goals of these two particular colleges intersect. The primary purpose of Engineering is to prepare engineers and one of the primary purposes of the College of Education and Health Professions is to prepare public school teachers. What these authors discovered is that actually, these interests intersect in very important ways. Engineering has an interest in seeing first rate students graduate from high school who are proficient in math, science and technology. The College of Education and Health Professions is interested in making sure they prepare highly qualified public school teachers who can reach those students. While it is important to have highly qualified teachers in all areas of public schools, it has become abundantly clear recently that there is a shortage in the U.S. of highly qualified technically advanced students proficient in math and sciences.[3] This is the foundation of the partnership that inspired the ideas behind the UASPP.

The partnership was solidified by the complementary contributions each entity could bring to the project. In 2006 we became aware of a funding opportunity offered through the U.S. Department of Education's Title II, Part B funds of the No Child Left Behind Legislation. This program is called "The Mathematics and Science Partnership Program." It is designed to improve math and science instruction in schools considered to be "high need." Schools are defined as "high need" if 20% of the children they serve are from families with incomes below the poverty line or if the school has a high percent of teachers not teaching in their academic subjects, not teaching at their trained grade levels or schools with a high percent of teachers with emergency, provisional or temporary licenses. Both the College of Engineering and the College of Education and Health Professions wanted to apply for these funds to implement a science program to help the highly qualified teachers in the Northwest Arkansas region acquire new tools to address the challenging population of students they serve. However, neither entity had all the resources or expertise required to submit the proposal and implement the project independently. The College of Education and Health Professions was able to contribute a number of elements to the Engineering effort.

The primary Education program facilitating the UASPP is the Northwest Arkansas Education Renewal Zone. In 2004, COEHP created a consortium of 18 middle school/junior high schools and received funds from the Arkansas Department of Education to formalize this consortium as the Northwest Arkansas Education Renewal Zone (NWA-ERZ). Now NWA-ERZ serves 23 schools and seventeen of these serve children from families with incomes below the poverty line, and four are in some phase of School Improvement. All of these schools are either middle or junior high level schools.

The focus of NWA-ERZ has been to follow the state legislation that funded the program. This legislation was designed to provide a helping hand to schools in danger of consolidation. While the legislation governing this program calls for a number of items, two items in particular fit the goals of this partnership. They are: "1) Collaboration between and among higher education institution partners, education service cooperatives, schools, and communities participating in the education renewal zone, including within the academic departments within the higher education institution partners; and 2) A comprehensive program of professional development to assure the practical knowledge base of pre-service and in service teachers ….."[4]

The ideas behind the UASPP fit these requirements very well. The frequent contact by NWA-ERZ staff with the participating public schools has resulted in the kind of working relationship that generally takes time to develop. This established network provided Engineering an ideal mechanism to plan the logistics of the UASPP.

In addition to utilizing the established school network, Engineering felt it could benefit from Education's experience with the educational methodology required to work with middle level students. Additionally, the grant proposal required a working knowledge of both the federal No Child Left Behind standards as well as the state guidelines for teaching science. Last, the guidelines required that a needs assessment be conducted in the target schools and be presented in the proposal.[5] Engineering felt the development of such an assessment was more suited to Education's expertise.

Engineering contributed the cornerstone of the program that Education was unable to provide. The proposal guidelines required that programs be based on solid content. Education could not alone apply for this funding without the strong scientific component that Engineering could contribute. The partners wanted more than just basic science concepts. They also wanted the experiments to focus on analytical thinking and real world problem-solving skills that are hallmarks of engineering professions.

There are other strong reasons for this partnership. First, the National Science Foundation has recognized that we must introduce students to engineering and science in middle school, or even earlier, if we are to turn the tide on the national crisis of too few students entering the engineering discipline.[6] Anecdotal evidence through discussions between NWA-ERZ and participating public schools confirmed this, and led us to believe that teachers and students in public schools are not exposed often or early enough to the use of science to solve engineering problems in the real world. Most students in the middle level grades (6th, 7th, and 8th) do not know what engineering is and are not aware of or socialized to recognize these fields as career options in the same way they might be with other science topics that lead to medicine or other science fields. Research also tells us that women and minority students are drastically underrepresented in these fields.[7] To effectively prepare students for pursuing an engineering degree in college, it helps if students take the appropriate math and science sequences that typically begin in middle school or junior high, so that ultimately they have the math, chemistry, calculus and physics that will prepare them for an engineering major.

Our project asks engineering faculty to provide hands-on problem solving engineering and science experiments to teachers to implement in their classrooms in order to expose students to analytical thinking techniques often used in various fields of engineering. Our goal is not for these experiments to interrupt or replace the school's chosen curriculum, but rather to supplement it in a creative and fun way for the students. We hope that if teachers include these kinds of experiments in their classrooms at the middle level, it will alert kids that they have many options in science and math and that one of those many options is engineering. By the same token, this partnership also highlights to teachers and students that if engineering is not the chosen path for students then students also have the option of becoming teachers of science, math, or pre-engineering. This approach benefits Engineering recruitment efforts as well as those of Education. The two colleges do not see this as competitive. Even if a student chooses to become a science teacher instead of an engineer, they will benefit and influence future talented students in these fields.

University of Arkansas Science Partnership Program

Program Goal

The goal of the Science Partnership Program at the University of Arkansas is to establish and operate summer institutes and follow-up training for 38 middle and junior high school science teachers in grades six through eight from selected Northwest Arkansas Educational Renewal Zone partnership schools. Specifically, the Science Partnership Program aims to serve teachers whose student populations are high poverty, high percent of English Language Learners and/or whose schools are in some phase of school improvement. These professional development activities provide teachers with experiences that lead them to value and use curricula effectively, based on scientific research, aligned with challenging state academic content standards, and are objective-centered, experiment-oriented, and concept and content-based.

Program Objectives

1. Participating science teachers experience hands-on lab activities that are objective-centered and experiment-oriented.
2. Participating science teachers incorporate new hands-on laboratory activities learned during the Summer Institute and Follow-Up Activities to better plan for student learning.
3. As a result of participation in the Partnership Program, science teachers will change their classroom practices so that student performance in science is increased.

Research Base

The literature in our research base reflects professional development needs of highly-qualified teachers and the instructional strategies that best address student learning needs.

Harvard researcher Christopher Jencks and his colleagues concluded that test scores are determined by factors that schools do not control. The vast majority of differences in student achievement can be attributed to factors like the student's natural ability or aptitude, socioeconomic status, and home environment .[8] Wright et. al. indicate the opposite is true and have noted that the individual classroom teacher has the greatest effect on student achievement.[9] The implication of this study is that more can be accomplished by improving the effectiveness of teachers. From the results of their research, Marzano, et al. identified nine high-yield instructional strategies.[10] Teachers will improve their ability to utilize many of those strategies through the incorporation of the lab experiences.

Dr. Ruby K. Payne states that students from poverty are coming to school not only with a lack of concepts, but more importantly, with a lack of cognitive strategies. She argues students need to exhibit five skills during the lesson: Use planning behaviors, control impulsivity, use evaluative behaviors, explore data systematically, and use specific language. She argues that a lesson requiring these five skills would result in improved cognitive strategies, discipline and achievement.[11] The hands-on laboratory experiences of the Science Partnership provide the opportunity for students to practice these skills. Reuven Feuerstein argues that between Jean

Piaget's environmental stimulus and response should be mediation (i.e., the intervention of an adult). He identifies three stages in the learning process: "input, elaboration, and output". Strategies inclusive in laboratory activities complement Feuerstein's list of strategies for each of these three stages. Input strategies include focusing perception on specific stimulus, exploring data systematically, and using appropriate and accurate labels. Elaboration strategies, defined as "use of the data", include identifying and defining problems, comparing and summarizing data, and testing hypotheses. Output is the "communication of the data," including clear communication by students as they describe labels and processes.[12]

Echevarria, Vogt, and Short encourage hands-on materials and/or manipulatives to enhance guided practice. The authors contend that English language learners (ELLs) make more rapid progress in mastering content objectives when they are provided with multiple opportunities to practice with hands-on materials.[13]

Benchmark Examination scores for 2005, obtained from School Report Cards, indicated an achievement gap among combined populations, students whose family income level is below the poverty line, and students whose primary language is one other than English.[14] These populations are at the very heart of the No Child Left Behind legislation as local education agencies strive to meet the educational needs of low-achieving economically disadvantaged and limited English proficient children, among other disadvantaged populations. The lab activities inherently provide "hands-on" processes that include nonlinguistic representations, cooperative learning opportunities, and experimental inquiry, three of the nine high-yield instructional strategies identified by Marzano.[15] We believe that these hands-on learning experiences may better meet the needs of children of poverty and ELLs, as noted by several experts in the fields of understanding the poverty mindsets and education for ELLs, such as Ruby Payne and Jana Echevarria.[16, 17]

The population served by this program is both in a state of poverty and includes a significant number of ELLs. The need to assist Latino immigrants in Northwest Arkansas, especially in Washington and Benton counties, is a primary reason the partnership sought funding for the UASPP. According to a 2003 Hablamos Juntos report, the Latino population in Washington County increased from 1,526 to 12,932 and in Benton County from 1,359 to 13,469. These statistics span a 13-year timeframe and represent a 747% and an 891% Hispanic population boom, respectively.[18] The poverty level, increased percentage of ELLs, and schools in some phase of school improvement require that we assist our highly qualified teachers by providing them with tools to increase the achievement of these students.

The retention of highly-qualified teachers is crucial to the success of the populations in Northwest Arkansas schools. In their book *Classroom Instruction That Works*, Marzano, Pickering, and Pollock state the most important factor affecting student learning is the teacher. It is vital for these schools to retain proven teachers, especially those who understand and effectively plan for student learning with the special needs of economically disadvantaged and limited English proficient learners in mind.[19] Quality professional development for these highly-qualified teachers is one method of retaining them.

Richard DuFour and Robert Eaker assert that staff development programs of professional learning communities are based on the best available research and exemplary practices.[20] In keeping with that principle, the UA Science Partnership Program gathered relevant background and statistical information and compiled research on the issue of hands-on laboratory experiences as they relate to student achievement in science in order to provide opportunities for learning that are embedded in the daily work of educators and that fosters their renewal.

Project Activities

The cornerstone of the UA Science Partnership Program is the Summer Institutes during the three-year period. The initial Summer Institute was conducted in the summer of 2006. Every session was planned to address some aspect of the ten strands identified in the *K-8 Science Curriculum Frameworks* and the Needs Assessment Survey responses of the science teachers in the ten participating partner schools.[21] Prior to administration of the needs assessment, the schools had to make a commitment to participate. Recruiting the participating schools required the approval of the principal and a letter of commitment from the district agreeing to participate for the full three years of the program.

The instrument was designed and administered by personal interviews with science teachers or the lead mentor teacher in the science area. The needs-assessment instrument was devised to identify teacher quality and professional development needs for schools with respect to the teaching and learning of science. The first section addressed current teaching status and the following is an example of the questions used in this section.

Teacher Quality: Please mark the response that is applicable to your current teaching status.
__ 1. I am teaching in the academic subjects or grade level in which I was trained to teach.
__ 2. I am teaching in an academic subject or grade level in which I am not certified to teach.
If you marked Item 2, please indicate what course work, professional development activities or other training you need in order to earn certification in your current academic subject or grade

One hundred percent of the respondents polled teach in the academic subject and grade level for which they were trained and licensed. Therefore, all science teachers in these schools meet the state's definition of a highly-qualified teacher.

The second section of the needs assessment addressed the teaching and learning of science. Possible professional development topics based on the Science Curriculum Frameworks for grades six through eight were listed on the assessment tool, and teachers were instructed to rank those topics in order from their greatest need to their least important need. The following is an example of a question used to ask the respondents to prioritize their needs.

Possible professional development activities with respect to the teaching and learning of science, based upon the Arkansas Science Curriculum Frameworks and research-based pedagogy are listed below. Please rank them in order of your greatest need. Mark as few or as many as needed and add any other areas of concern that are not listed.
__ Living Systems: Characteristics, Structure, and Function
__ Life Cycles, Reproductions, and Heredity

__ Populations and Ecosystems
__ Matter: Properties and Changes
__ Motion and Forces
__ Energy and Transfer of Energy
__ Earth Systems: Structure and Properties
__ Earth's History
__ Objects in the Universe
__ Lab Activities
__ Horizontal and Vertical Curriculum Alignment
__ High-Yield Instructional Strategies
__ Differentiated Instruction
__ Learner Engagement
__ Disaggregation of Achievement Data to Plan for Student Learning
__ Design and Creation of Authentic Assessments of Student Learning
__ Other. Please list

All respondents marked lab activities as one of their top three priority needs. Suggested science labs for grades six through eight were also listed on the needs-assessment survey. Respondents were instructed to highlight the lab topics of greatest need. The top two topics marked were Arkansas Landforms and Newton's Three Laws of Motion. Predict Weather Conditions and Solubility Rates tied for third. Various other topics were also marked including: Mean, Medial, Mode; Charts, Graphs, Stem and Leaf Plots, Physical and Chemical Changes, Effect of Force on Direction and Speed, Geological Events, Potential and Kinetic Energy, and Predict Weather Conditions.

The authors reviewed numerous potential laboratory experiments for inclusion in the summer institute. Each potential experiment was carefully reviewed for safety, grade level appropriateness and alignment with the Science Frameworks. The review process continues throughout the life of the program to identify new activities and add them to a toolkit provided at the institute and maintained on the program webpage. Approximately ten laboratory activities will be developed for each institute.

Once sessions were presented regarding safety and action research, the laboratory experiments were conducted. A typical laboratory experience consisted of five parts. The presenter introduced the topic so that all participants understood the purpose of the exercise, its application and its potential role in the science curriculum. Teachers were divided into groups of four to five members from different schools and grade levels and asked to perform the experiments with the assistance of UA faculty. Teachers discussed the experiment, its application in science and engineering, the pros and cons of using it in middle level classrooms, and suggestions for modification to fit the needs of their students. Teachers evaluated each day's activities for later analysis.

In addition to the daily general laboratory activities, specific blocks of time were scheduled for curriculum mapping, as well as horizontal and vertical alignment among participants. Dr. Heidi Hayes Jacobs advocates collecting real-time information about what is actually taught to create curriculum maps.[22] Teachers had real-time information to develop maps with other grade-level teachers to align the activities to the Science Frameworks for each grade level. This activity ensures smooth transitions between grade levels in order to avoid gaps and overlaps in the curriculum.

The Institute concluded with a session on scientific action research focusing on data collection activities by the teachers and the subsequent data analysis and potential uses of that analysis by the school for future curriculum planning. The conclusion also included a discussion of the follow-up activities that would be conducted during the school year.

The follow-up activities provide additional time for inquiry, reflection, mentoring and sustain the long-term practice of including hands-on laboratory activities aligned with the Science Frameworks. UA faculty, graduate students, and program directors continue to serve as mentors for participating teachers by phone, e-mail, and personal visits for technical assistance and overall support. Follow-up activities include classroom observations by UA mentors and participating science teachers. At the end of each year of the project, final follow-up activities will include data collection by science teachers and a program evaluation. UA faculty review and disaggregate the data and collaborate with teachers to plan sessions for the upcoming year.

The UA Science Partnership Program will be more successful if it is designed to be sustainable after the life of the grant. To this end, summer institutes in years two and three, as well as the follow-up phases, will develop teacher mentoring at the school level. Teachers will be coached during the Institutes, as well as during the follow-up activities, to learn about implementing hands-on experiments in order to trouble-shoot for each other and to answer questions from peers attempting to implement the same experiments.

Second, the end of this specific program will not cut teachers off from UA resources. The on-line experiment toolkit and the listserv will continue to grow from additional contributions by UA faculty, as well as teachers who share creative experiments.

Year One Workshop Activities

A summary of the workshop activities is shown in Table 1. The daily sessions (3-4 hours) were conducted in the classroom (as opposed to a laboratory), since this is the mode of operation of experiments in the typical middle school classroom. Each of the teachers was given all of the supplies required to carry out the laboratory activities, a notebook containing background material and suggestions for each experiment, a detailed equipment list, list of experimental procedures and any safety issues to be addressed.

Day 1 activities included a discussion of the purpose and organization of the workshop, a discussion of the state mandated high school science frameworks and how the experiments fit into these frameworks, as well as an overview of the experiments and safety training by the Chemical Engineering Department Safety Officer. Safety training is of paramount importance in any "hands-on" activity, and is a mandatory requirement for all students that participate in any laboratory activity in engineering. Day 1 also included a short experiment on the liquefaction of soil during earthquakes, which was taken from The Exploratorium (http://www.exploratorium.edu/faultline/activezone/liquefaction.html). This experiment was of particular interest to teachers and students from this part of the country due to the recent publicity of the New Madrid fault in Northeast Arkansas and Southeast Missouri.

Table 1. Workshop Activities

Day	Activity
1	Introduction, safety training, Earthquakes
2	Teacher testing
3	Acids and bases, measuring the pH of household items
4	Ball sorting exercise
5	Preparing a mold terrarium
6	Ethanol by fermentation of sugars
7	Measuring the densities of solids
8	Vegetable/fruit batteries
9	Chemical reactions and reaction rates
10	Teacher testing, evaluation

Following science content knowledge testing on Days 2 and 3 consisted of understanding the behavior of acids and bases, and in predicting and measuring the pH of common household items (tap water, dishwashing liquid, lemon juice, vinegar, bottled water, a soft drink, milk, buttermilk, vegetable juice, drain cleaner, ammonia, baking soda solution, etc.) by using both pH paper and a pH meter. The ball sorting exercise of Day 4 was an engineering design, problem solving and optimization exercise in which the teachers try to design a sorter to sort balls of different sizes. They are given a myriad of odd materials, each of which has a cost associated with its use. The goal is to design the most efficient sorter while spending the least amount of money. In Day 5, a mold terrarium (from The Exploratorium, http://www.exploratorium.edu/science_explorer/mold.html) was constructed in an effort to investigate living systems, specifically the growth of mold varieties on common household food items.

Batch fermentation of table sugar (sucrose) to produce ethanol was investigated on Day 6 using the yeast *Saccharomyces cerevisiae* (purchased in a local supermarket). Aerobic fermentation to produce CO_2 and cells was contrasted with anaerobic fermentation to produce less cells, CO_2 and ethanol by this facultative organism. On Day 7, the densities of a various solids were obtained by finding the ratios of the measured masses and volumes. Simple batteries were constructed on Day 8 using different metals as electrodes, along with fruits and vegetables as electrolyte solutions. Connecting these batteries in series enabled the teachers to power a light bulb. Finally, the teachers learned about chemical reactions and reaction rates in Day 9 by observing two reactions: the reaction of baking soda and vinegar to produce salt, CO_2 and water; and the fading of phenolphthalein in basic solution. Final testing and evaluation occurred on Day 10.

The daily experiments were organized as follows:

- A presentation/discussion of the topic background (each teacher was given a notebook containing background material)
- Execution of the experiment

- A discussion of the experiment, possible alterations and the problems/limitations for use in their classrooms
- Discussion of how the experiment fits into the state mandated science frameworks
- Evaluation

As an example, consider the production of ethanol by fermentation, the experiment of Day 6. The topic background focused on ethanol as an alternative fuel source (from sugars, corn, lignocellulosics), the yeast and its ability to grow both aerobically and anaerobically, and the planned execution of the experiment. The experiment then followed, in which the teachers compared:

- anaerobic growth and production of ethanol vs. aerobic growth and,
- CO_2 production during ethanol production both with and without agitation.

The moderator and teachers then discussed what happened and why, possible questions that the teachers might pose to students (such as why the same yeast can be used in making bread, making beer and wine, and producing energy), and experimental alternatives (fermentation of molasses or starch, the addition of nutrients, temperature effects). The integration of an experiment that lasts several hours into the classroom was also discussed, as well as how this would affect its ultimate use in their classrooms. Finally, the teachers evaluated the presentation and the experimental investigation.

Program Evaluation

The success of the program is being measured by performance of participating teachers and students on standardized assessment tests, and by teacher evaluation of the experiments. The teacher assessment was developed at the University of Louisville Center for Research in Mathematics and Science Teacher Development, and will be administered both at the beginning and at the end of each workshop. Students are tested each year in the spring as part of the State's required accountability testing system. We plan to use the Iowa Test of Basic Skills (ITBS) as the assessment of student performance.

Results from the evaluation of the daily experiments by the participating teachers are shown in Table 2. The teachers were asked to evaluate the alignment of the activity with the Arkansas Science Curriculum Frameworks, the quality of the presenter (moderator), whether or not they would incorporate the activity into their classroom curricula, whether or not they felt like they knew whom to contact for further information, whether the resources from the experiment would be useful to them in the future, and whether the time spent on vertical alignment of the experiment into the curriculum frameworks was useful. Evaluations were obtained for each of the experiments using a 1-5 rating system, where 5 indicates that they strongly agree.

Table 2. Evaluation of Daily Experiments

Evaluation Statement	Experiment/Evaluation							
	1	2	3	4	5	6	7	8
Lab activity is directly aligned with the Arkansas Science Curriculum Frameworks	4.7	4.5	4.8	3.8	4.6	4.7	4.9	4.7

Presenter was knowledgeable regarding the topic presented	4.4	4.9	5.0	4.8	5.0	4.9	4.3	5.0
I will incorporate the activity into my curriculum	4.2	4.2	4.8	3.7	4.4	4.3	4.5	4.6
I know who to contact with questions about this activity, especially as it relates to implementation in my classroom	4.7	4.9	4.9	4.8	4.8	4.8	4.6	5.0
Resources provided during this activity will be useful to me in the future	4.5	4.7	4.9	4.0	4.8	4.7	4.8	4.7
The time provided for vertical alignment was useful to me	4.4	4.6	4.8	4.5	4.8	4.7	4.9	4.8

Experiments:
1. Earthquakes
2. Acids and bases
3. Ball sorting
4. Mold terrarium
5. Ethanol production
6. Densities of solids
7. Batteries
8. Chemical reactions

Evaluation:
5—Strongly agree
4—Somewhat agree
3—Don't know
2—Somewhat disagree
1—Strongly disagree

Perhaps the most important assessment statements relate to the willingness to incorporate the activity into the curriculum and the usefulness of the activity in the future. In general, all of the activities scored well in these (and other) areas. However, the ball sorting activity rated highest in both of these areas (4.8 and 4.9, respectively), and the mold terrarium rated lowest (3.7 and 4.0, respectively). Comments from the ball sorting activity included "Excellent high inquiry opportunity" and "Thanks. I think I'll start the year with this activity". Comments from the mold terrarium experiment included "Doesn't specifically fit, but I can make it work" and "Most closely aligned to 5th grade frameworks".

There were additional evaluation questions asked in order to learn what the participants thought of the Institute more generally. For example, we asked the participants to tell us whether or not they felt the presenters were knowledgeable, whether the resources provided were useful in the future and whether or not they learned something from this Institute they would use in their classroom. Of the 24 respondents, 20-24 agreed that the presenters were knowledgeable, the resources were helpful and they would use what they had learned in the classroom. Some of the open-ended responses included the following comments:

1. "Dr. Clausen has been great. Everybody involved has been wonderful."
2. "The partnership between the College of Education and the College of Engineering was great. I think there is a lot we can learn from each other.
3. "Resources have been great. The people and the materials will help me out a lot."

Last we asked participants if they felt they knew who to contact with questions, if they would recommend this activity to others and whether or not they would like to see similar activities presented in the future. With the exception of one respondent, all participants understood who to contact with questions, would recommend the Institute to others and would definitely like to see such activities provided in the future. Some of the open-ended responses included the following comments:

1. "Working with peers is very helpful. One gets different perspectives from the different grade levels and even people from your own grade level but from different schools."
2. "I would highly recommend this to others."

Overall, the participants were very pleased with the Institute and they were happy with the experiments and materials used during the Institute. As a result, the teachers will be equipped with the tools to incorporate these new hands-on laboratory activities into their classroom activities so that student performance in science is increased. However, there were some lessons learned regarding this Institute that will be used to improve subsequent years of the program.

Lessons Learned

Because of the way in which the Arkansas Science Curriculum Frameworks are structured with minimal overlap from grade to grade, it is very difficult to structure workshop activities which fit equally well in each of the middle school grade levels. The teachers were often challenged by the moderators to find ways to make a particular activity fit into their grade level curriculum when the fit was not obvious. There were also times when the activity was appropriate for any grade (the ball sorter activity), but the teachers were then challenged to make sure that the activity would fit within their frameworks while being easy enough for sixth graders and complex enough for eighth graders. The moderators are now more familiar with the frameworks, and will also solicit the help of the teachers in suggesting and planning experiment topics for Year 2.

A second lesson learned included the way the participant groups were structured. With minimal overlap in the Arkansas Science Curriculum Frameworks from grade to grade, a workshop with participants from all grade levels may not be optimal. For purposes of vertical and horizontal alignment, subsequent Institutes will include the opportunity for participants to group with the same grade level but different schools. This gives participants a better opportunity to talk about curriculum planning for their grade level, and to get ideas from participants from other schools.

Some teachers requested that the complexity of the lab activities be increased for specific subject areas and for specific grade levels. Many participants had helpful suggestions during follow-up discussions with regard to what types of lab activities would be helpful in subsequent Institutes. These concepts and ideas will be incorporated into subsequent workshops.

Conclusion

The partnership developed to implement this program is an innovative one that has spawned other valuable activities. The first year of this program is considered a success, and many teachers have requested their school be allowed to send more teachers next year. Not only was the partnership able to acquire external funding to support the program, but the partnership worked effectively and efficiently to organize and implement the Institute. The participating science teachers experienced hands-on lab activities that were objective-centered and experiment-oriented. The teacher evaluations of the lab activities and the overall Institute were very positive and the lessons learned from year one of the program will lead to significant improvements in subsequent years. As a result, the teachers will be equipped with the tools to incorporate new hands-on laboratory activities learned during the Summer Institute and Follow-Up Activities to better plan for student learning. The teachers will be able to change their classroom practices so that student performance in science is increased.

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