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Research Activities in the Education of Teachers

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Introduction

Our goal for science, engineering and science education students at Kansas State University has always been that they understand the intellectual content of their discipline *and* the process by which that discipline develops new knowledge. While instructional laboratories help students understand the processes of science and engineering, the understanding that research is an ongoing, complex endeavor occurs only when the student is part of that research effort. KSU encourages all students to become actively involved in research and to become an active part of student-centered research programs.

In most science and engineering departments, nearly 90% of the approximately 3300 undergraduates participate in research, as do all graduate students. In an average year 25-30 undergraduates will co-author research papers with their faculty mentors. Providing an opportunity to participate in research is especially critical for students who will become science teachers and those working teachers who are enrolled in graduate programs. To be able to teach their students how scientific knowledge develops, these students and science teachers must understand the research enterprise. Although our goals for future and present teachers are similar to those for our science and engineering students, the research experiences that are a natural part of the science and engineering curricula do not automatically become available to teachers.

Kansas State has attempted to include research in the education of undergraduates who are preparing for careers as science teachers and education graduate students who are already science teachers in schools. Several recent projects to address this goal have come from collaborations of research science faculty and education faculty. Informed by recent research in both science and pedagogy, we have designed several major KSU programs that integrate research into these students' education. While each of these programs attempts to meet the special needs of pre-service and in-service teachers, some programs have proved to be more successful than others.

Most of the programs described below were supported by the National Science Foundation and represent on-going collaborations among the science departments and the College of Education. Many of them predate the KSU RAIRE grant and were major factors in our application for the Award. As indicate below, additional funding for some of our program has come from the Howard Hughes Medical Institute and the Department of Energy.

The Capstone Research Course

The best way to understand scientific endeavors is to actively participate in them. Thus, providing some type of research experience for each student preparing to become a science teacher is a laudable goal. For students planning to be middle and high school teachers, this experience would be limited to those students planning a career in science teaching. For the elementary school teachers, however, we must realize that almost all of them may become teachers of science. However, providing a true research experience for the large number of students preparing to be teachers could be difficult.

For pre-service teachers we frequently provided research-like activities in which the students do not necessarily work directly in a research lab but take part in classes that provide them the opportunity to work together on contemporary issues. While their work may not be cutting-edge research, it offers them a view of the models and methods of contemporary science. In some situations, it can be a capstone on their study of science. An important aspect of these types of instructional activities is the pedagogical structure. The future teachers will learn best about the scientific process if they are involved in activities that are similar to that process. Lectures on contemporary scientific research are not appropriate. Instead, we need to have the future teachers become involved in experimentation, model building and analysis in a manner similar to contemporary science.

Our first effort to provide to integrate research into the education of teachers began as a model curriculum in the late-1980s. The program was a response to concerns that science faculty were not sufficiently involved in the education of science teachers and that few elementary teachers understood the content or processes of science or the connections between the sciences.

Faculty involved in this project came from the Departments of Biology, Chemistry, Geology, Mathematics, Physics, Elementary Education, Secondary Education, and Educational Technology, along with teachers from the local school district. The set of courses was based on research in cognitive learning about how students learn science. Science faculty on the team developed hands-on components that fit into a carefully thought-out structure that emphasized the cumulative nature of scientific knowledge. [1, 2]

The integration of research and education was featured in a capstone course that focused on the centrality of research in science and the connections between the sciences. Because it draws on so many fields, ecology was selected as the subject for this course. The 9,000-acre Konza Prairie Research Area (http://www.konza.ksu.edu/), operated by the KSU Division of Biology, provided an ideal laboratory for research and education. In the capstone course, students majoring in elementary science education were able to use their accumulated knowledge about science to develop hypotheses, and test them through research.

This capstone course was generally taken as a three-credit course during the semester before student teaching. It was not required of all elementary education majors but was an option for those students who wished to focus on the teaching of science in the elementary schools.

This project continued for several years and its graduates are now successful elementary teachers. When the College of Education revised much of its curriculum for elementary education majors in the 1990s, many of the components of this special program for future elementary science teachers were integrated into the curriculum for all future teachers, thus affirming its value and efficacy in training teachers. The capstone course remained an option.

The effects of the integration of research and education on the future teachers in the Science, Math and Technology Elementary Education program have been assessed, in part, by examining their behavior as teachers in the classroom [1]. When these students were completing their student teaching, a member of the project staff observed their teaching behavior and analyzed it using the Expert Science Teaching Educational Evaluation Model (ESTEEM). This model is used to analyze behavior of teachers with respect to teaching for student conceptual understanding. The analysis is based on a model in which teachers move through five stages of development -- novice, advanced beginner, competent, proficient and expert [3]. Table 1 shows the primary traits observed in each of the stages.
Dean: I think I understand that in the Figure below, the X axis are teaching behaviors, but I can't relate the numerical Y-axis values to the table (below) by which I gather they were scored. Or perhaps I am wrong to assume that the data in Figures 2 and 3 is derived from this table. Perhaps there is another scoring system, which is not defined here. You need to clarify that some, and give some information about the scoring system. Please also make clear whether the control group of student teachers were also from Kansas, and evaluated by the same people. Can you combine the data in Figure 2 and 3 – by simply putting three bars under each category? We could, but the vertical scale in Figure 3 is a finer scale because the differences are smaller. I think that the tables communicate better when they are separate. P.S. The data is pretty impressive. Thanks.

Table 1: The stage of teacher development defined by the evaluation model.

Stage of Development	Traits of the teacher
1. Novice	Skill development
2. Advanced beginner	Broad skills; Use of sophisticated rules
3. Competent	Problem solving; Decision making
4. Proficient	Analytical thinking; Intuitive organization and understanding of tasks
5. Expert	Maturity; Practical understanding; Automatic and fluent performances

Using ESTEEM our student teachers were compared with other student teachers who were at the same time in their careers. Figure 1 shows that the student teachers from this program averaged about 3 (competent) in each of the categories measured while other student teachers were between novice (1) and advanced beginner (2).

In creating the ESTEEM system, the researchers identified expert teachers and scored their level or stage of development on the same items. The expert teachers were selected from lists provided by State Boards of Education, faculty in Colleges of Education and similar sources. Figure 2 shows a comparison of our *student* teachers with these established teachers.

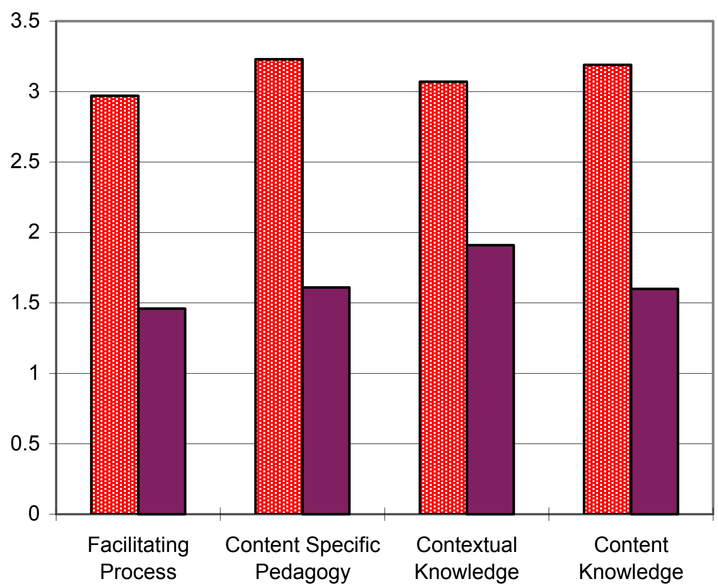

Figure 1: A comparison of teaching skills for student teachers in the Math, Science and Technology Program and other student teachers at the same level in their careers. The vertical axis is the Stage of Development as listed in Table 2.

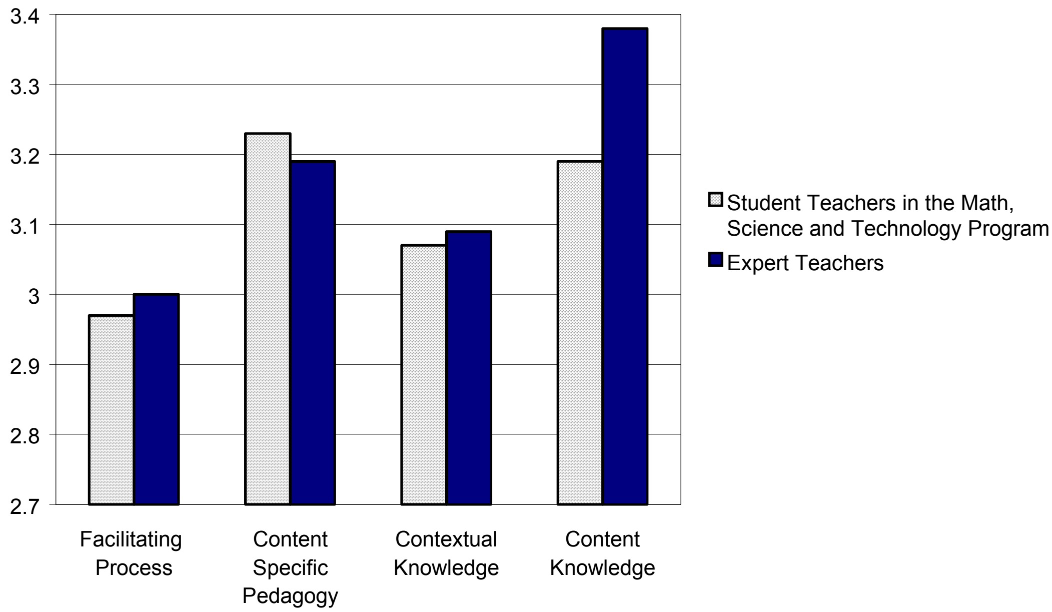

Figure 2: A comparison between our *student* teachers and experienced teachers who have been identified as experts. The vertical axis is the Stage of Development as listed in Table 1.

The results of these comparisons are quite clear. On behaviors related to conceptual understanding, the student teachers in the Science, Math, and Technology Program performed significantly better than other students at similar stages in their careers and were comparable to experienced teachers. Because the teaching of conceptual understanding is an important part of teaching science at any level, we conclude that the initial phase of this program has been effective in meeting its goals. Unfortunately, because of changes in emphasis brought about by changes in state and laws related to teacher preparation, this program has ceased to exist in the form described here. Thus, no further data of this nature have been collected.

Adapting Research Methods to the K-12 Classroom

We have developed research activities that can be used in the classrooms of K-12 teachers and students for hands-on experimental work. Research techniques and data can be adapted for secondary classroom teaching in either of two ways. In one, data collected by sophisticated instruments are made available to teachers and their students. In the other, research level techniques are adapted so that school students can perform the experiments, share data and draw their own conclusions. Our program focused on the latter.

Creating Student Experiments: To create tabletop experiments that students can complete in their classrooms one needs to find scientific experiments that do not require large research groups or extremely sophisticated equipment, but are not simple verifications of what is already known. Instead, the experiments can begin with activities that teach the basic science to the students and then allow them to use their imaginations to create new and interesting experiments. The “trick” is to provide sophisticated science that does not need sophisticated equipment.

An example of this approach is the Genetic Education Network (GENE) that was created in the late 1980s by Tom Manney, a professor of physics and biology at Kansas State University. Dr. Manney’s research over a large portion of his career focused on the effects of radiation on the life cycle of yeast cells. Because the energy in ultraviolet light is sufficient to cause genetic damage to these yeast cells, experiments can be performed without the need of high-energy electromagnetic radiation. Furthermore, yeast is a common, harmless organism. While some strains are much better than others for these purposes, none of them requires sophisticated equipment or special handling [4].

Dr. Manney and his colleagues developed a box in which the yeast cells were exposed to ultraviolet light. This box had appropriate safety features so that the ultraviolet source, a common germicidal lamp, was never turned on unless the door to the box was closed. Thus, it was safe for use by secondary students who expose yeast cells to the ultraviolet source for different periods of time. As shown in Figure 2, some experiments could begin with natural sunlight.

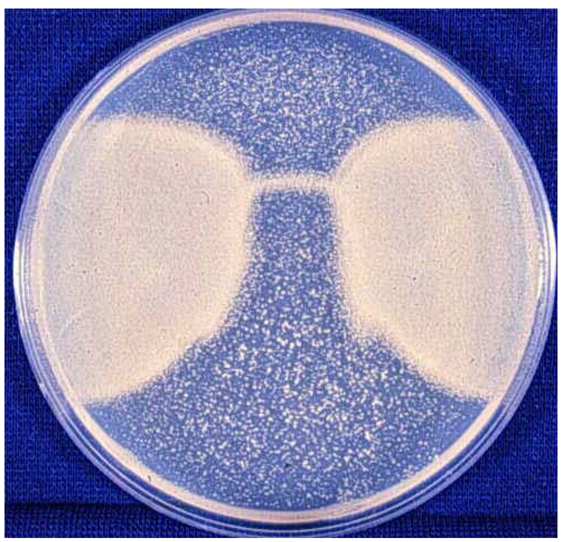

Figure 2: Yeast cells were spread on a growth medium, exposed to sunlight while a portion of the cells were shaded with sunglasses, then incubated for several days.

To understand this research, the teachers needed to learn about biology, physics, statistics and chemistry. The interdisciplinary nature of the genetics experiments is particularly appropriate for science teachers in Kansas and other states. Since many of our education graduates teach in rural schools, they are sometimes responsible for all the sciences taught in their schools. An interdisciplinary background provides present and future science teachers in small schools the knowledge the need to integrate the courses that they teach.

Networking via E-mail and the World Wide Web has allowed students to compare similar sets of environmental data recorded at a variety of different locations throughout the world. Students in the GENE project would sometimes expose their yeast at a specified time of day for a specified duration, and record various atmospheric conditions at the time of the exposure. After monitoring the effect on their yeast samples, the students would compare their results with data from other locations with different weather conditions at the time of exposure. Their collaboration illustrates that researchers must cooperate to obtain meaningful results.

Teacher Preparation: Whether the teachers are using data taken by sophisticated equipment or using sophisticated techniques with relatively simple equipment, they need a significant amount of preparation before they can use these research activities in their classrooms. The teachers themselves are unlikely to have had experiences during their undergraduate careers that prepare them for these types of activities. Even if they had some experience, the relevant science has probably changed significantly. To meet the needs of the teachers, the researchers involved in such programs must provide background information and suggest ways to interpret and understand the research results.

We have found that a four-to-six-week summer workshop in which about 25 teachers meet on a university campus for several weeks effectively provides them with both background information and familiarity with the experimental process. During that time several scientists can work with the teachers to provide the appropriate background in basic science and research techniques. The teachers also do the first experiments with the equipment and yeast cells. The best approach is to provide the teachers with the equipment that they will take back to their schools after the workshop. In that way they become familiar with the same set of apparatus that their students will be using later.

We have found it most useful to provide some information about pedagogy, but to leave the primary development of lessons for use in secondary classrooms to those people who know the classrooms best. Once the basic ideas are understood, the teachers work in groups to prepare lessons adaptable to their classes. When a project of this nature operates over several years, teachers who have been highly successful during the first year can be invited back to be lead teachers for successive years. In this way, the teachers teach each other about the things they know best while learning from the research faculty about the scientific aspects of the lessons.

Teacher Networking: It is important that the teachers communicate and interact with each other after the summer workshop. Frequently, teachers involved in these activities are the only science teachers in schools drawing from a large geographical area. Thus, they need support and ideas from others who have a similar interest in bringing research activities to their students. List-serves and web-based communications can encourage and support communication and collaborations. These types of activities stimulate continued participation better than simply saying, "We need to keep talking after the workshop ends."

Assessment: Over a four-year period 101 high school teachers participated directly in the GENE program. Our assessment of the effects of the program on these teachers shows some very positive effects. Because these graduate student teachers return to KSU only during the summers, much of the evaluation of the GENE program has been completed through mailed questionnaires followed by in-depth, structured telephone interviews. By beginning with a set of written responses, the telephone interviewers can select items about which they need additional information or clarification. In this way, we have acquired profiles of the effects of the GENE program. We are aware that all of the conclusions from this assessment are based on self-reported data. Independent data collection has not been completed at this time.

As graduate students, these teachers learned appropriate methods of teaching with research-level organisms and as they learned about contemporary experimental methods in genetics. They used the scientific methods, research techniques and the related pedagogical approaches in their own classes. Table 2 displays the numbers of students using the materials in different ways.

Table 2: Numbers of students who used activities from the GENE project during a four-year period.

	Elementary School	**Middle School**	**High school**		
			Regular classes	Advanced classes	Independent Study
Number of Students	152	3072	8155	4472	2434
Average Classes/Teacher	3.5	3.3	2.9	2.3	

The most striking result is the number of independent study projects completed by the high school students. Over 2,400 students have used real research organisms and completed independent projects during the four years covered by the survey. These results represent an average of over nine student research projects per teacher per year. Having experienced research quality work in their graduate studies at KSU, these teachers were able to offer similar opportunities to their students.

Value of adapting research to the classroom: These types of research activities offer ways to integrate scientific research with the education of in-service teachers and secondary education students. One attractive feature for secondary teachers is that the program provides them with information about doing contemporary research, but also gives them materials that they can use in their classes. In addition, many programs like the GENE program and the atmospheric science program, cut across the traditional disciplines. This is especially beneficial to those science teachers who must teach more than one discipline. Materials that show science as a cross-disciplinary activity are especially beneficial to them. (For examples of teaching materials see http://www.phys.ksu.edu/gene/chapters.html.)

These programs can have impacts far beyond a single campus. For example, the GENE program (http://www.phys.ksu.edu/gene/) that began at KSU is now available on a national scale [5]. Many of the projects mentioned here are valuable because they are not limited to one campus or to the geographical area where a large facility happens to be located.

Introducing Contemporary Research Ideas Through Visualization

When combined with other pedagogical methods, computer visualization can be a powerful way to introduce teachers and students to research level activities and provide the background they require. The materials we have developed to teach quantum physics to future teachers and their students through visualization address content that ranges from the early 20th Century discoveries to contemporary applications such as white light emitting diodes and medical diagnosis. Teachers who are trained with these materials can use them in their classrooms to teach students how abstract ideas are related to contemporary applications. Thus, the teachers and students are prepared to understand and even carry out modern research, even though they do not have the mathematical preparation traditionally demanded.

The instructional materials for secondary school students and teachers are called *Visual Quantum Mechanics - The Original* [6]. Often, quantum mechanics is taught in such a way that students learn the mathematics of quantum mechanics and never know what it is good for. The curriculum units in *Visual Quantum Mechanics* [7] instead introduces devices such as light emitting diodes (LEDs) whose operation can only be explained by understanding quantum mechanics. Although they do not always know their name, students recognize that LEDs are found in computers, remote controls, etc. By examining the properties of LEDs, students learn how the light emitting properties are related to the quantization of energy in atoms. The course introduces other devices such as the scanning tunneling microscope and magnetic resonance imaging machines that students and teachers may have heard about but probably not encountered. Students and teachers are not expected to use a scanning tunneling microscope, but using a program of interactive simulations; they can build and "use" these devises.

The curriculum is divided into four major instructional units. Each instructional unit requires approximately 10 hours of class time and can be inserted in a number of places within the typical physics course – rather than just at the end. The units require only those physics prerequisites that are absolutely necessary. The unit called *Solids & Light* concentrates on the LED and teaches about discrete energy states in atoms and energy bands in solids. *Waves of Matter* introduces the basic wave properties of matter and *Seeing the Very Small* concentrates on quantum tunneling with the scanning tunneling microscope. *Luminescence: It's Cool Light* looks at many different light-emitting devices and the various ways that energy levels, bands and gaps can be used to explain their behavior. More information about the individual units is available on our Web site http://web.phys.ksu.edu/vqm.

Because we rely on technology to help us teach complex concepts, we frequently find that students and teachers expect the technology to "do it all." Their view is that the students will work at computers and learn - other activities will not be necessary. However, we have always developed materials with the assumption that interactive computer visualizations, hands-on activities and old-fashioned written materials would all be an integral part of the learning experience [8]. The "backbone" of our pedagogy has been paper and pencil worksheets that the students use to guide themselves through the learning process with the help of the teacher. The teacher helps students understand, ask questions to guide the learning and, occasionally, provides explanations. The teacher-student relation is a critical part of the interactive environment.

To bring these materials to the classroom, we provide for teachers instruction that is quite similar to what they will use with their students. The pre-service teachers enroll in a one-semester course that teaches them the concepts using *Visual Quantum Mechanics.* During this semester they learn the science that is behind modern devices that use quantum physics in their design and understand the research that lead to those devices. Upon completion of the course they are able to pass that information onto their students and help these students understand the research process.

From a large number of field tests and a careful evaluation of student attitudes and learning, we have concluded that the Visual Quantum Mechanics materials have been successful in teaching some abstract concepts to present and future teachers and their students, all of whom have limited science and mathematics background [9]. We feel that we have built a foundation for providing instruction that enables teachers and students to understand the research process and to become involved in research at a variety of levels.

Integration of Education and Research in Instructional Development

A situation which occurred several years ago and involved the physics courses for education majors exemplifies how the integration of education and research can inspire new instructional material. During a physics class for elementary education majors, one of the students accidentally pointed the remote control of a VCR at a video camera. When he pressed a button on the remote, he noticed that light appeared on the video monitor that was connected to the camera. He realized that he was "seeing" the non-visible infrared (IR) light coming from the remote control. The course instructor became interested in using this process to allow students to detect non-visible infrared or ultraviolet light. A more extensive investigation into the response of video cameras to non-visible light was completed by a senior in secondary physics education. Her short paper described the spectral response of some video cameras, and she captured pictures of IR radiation from devices such as burners on electric stoves. She also learned that video repair people commonly use an inexpensive detector the size of a business card to determine if a remote control is emitting IR. This fascinating detector card became the subject of further study by the Education Research Group in the Physics Department.

The Physics Education Group began developing lessons and experiments that allowed students to create an energy level model for the card. Two research physicists who hold a patent on an IR sensitive material that changes its electrical conductivity when exposed to infrared radiation became involved in course development. The energy level model for their material provided insight into the equivalent model for the detector card, but it was somewhat complex for beginning students, so the physicists provided a simpler model. The outcome of the intersection of teaching and research was a series of experiments for the physics course taken by future secondary science teachers that included an interactive computer program that enables students to compare their experimental observations with an energy level model of the detector card (Figure 4). This experience shows how the curiosity of students raised questions that only contemporary research could answer, and how research in basic physics can enhance the preparation of teachers.

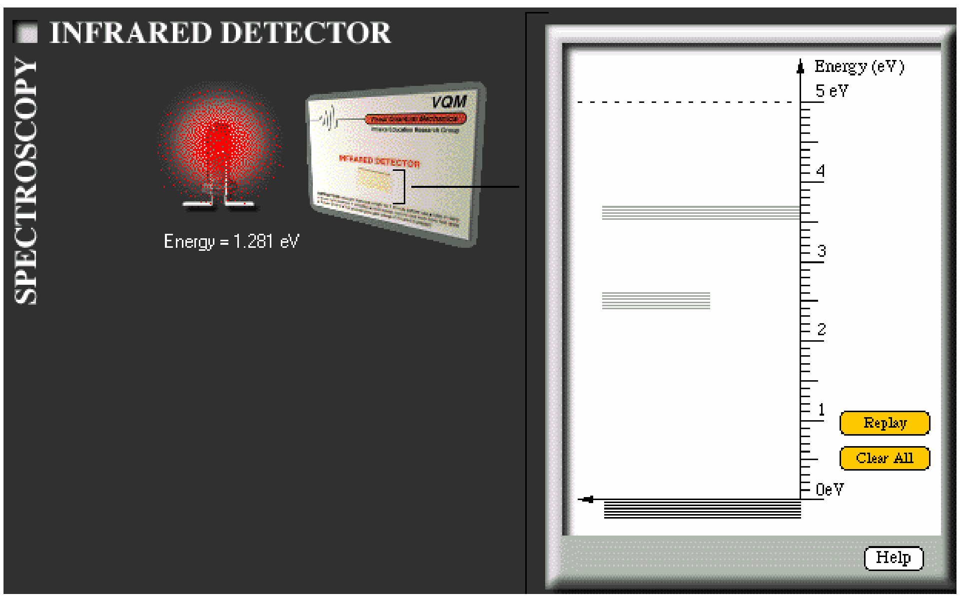

Figure 4: A screen capture of the interactive program that can help students understand how low-energy infrared light is converted into higher energy visible light. After selecting energy levels for the "pumping" light and of the infrared light, they can determine if the model predicts that visible light will be emitted from the card when IR strikes it.

Teachers and Future Teachers in Research Laboratories

Kansas State science and engineering students typically participate in faculty research project as research assistants. We have attempted to provide similar experiences for future secondary school science teachers and to in-service teachers. We have had some successes but have also found that the nature of the education curriculum and the students' expectations make this quite difficult.

Most science majors at a research university expect that research will be part of their education because it is part of the culture of science. As early as their first year at the university, they hear about the research-related activities of fellow students and expect to become involved. Science education students do not usually have the same expectation. Science is an interest, but teaching science is the primary goal. As university faculty, we need to explicitly build the expectation of doing research in future teachers.

A second issue for involvement of future teachers is the nature of their curriculum. Because teachers in a sparsely populated state are likely to teach several of the science disciplines, they must take a broad range of courses and necessarily limit their depth of knowledge in any one science. As a result, future teachers do not have the depth of knowledge they need to be considered valued research colleagues until later in their undergraduate programs. By the time the future teachers can work effectively in the laboratories, their curriculum starts getting in the way. Usually, the last semester of a future teacher's career is devoted to practice teaching, which consumes large amounts of time and energy, and the student's preceding semester is devoted to a very heavy course load in preparation for practice teaching. Thus, when the students' knowledge of science is strong enough for them to be active in the research laboratory, they are most focused on other necessary activities.

A third issue is the expectations of the science faculty. Frequently, faculty see the future science teachers as less interested and less prepared than the science majors, and the faculty are less likely to invest their grant money in hiring a future teacher as an undergraduate research assistant. Similar situations exist for in-service teachers who can only participate in research during the summer. Even then, the expectations of both the teachers and the research faculty can cause problems.

It is possible to create environments in which the future teachers can be active in a research setting and can succeed. We have tried several approaches, and each has had some success. Two "affirmative action" programs have been attempted. As part of a Howard Hughes Medical Institute grant, our Division of Biology provided stipends for students who wished to work during the school year and possibly continuing into the summer summer in biological or science education related research. To emphasize our desire to include future teachers, some of the stipends were reserved exclusively for them. The future teachers who became involved in research as a result of this effort performed very well. However, their numbers were very small. While we had funding for up to five students per year, only three applied for the first year. Many students never applied, because they felt they did not have enough time during the last two years of their studies. When the number of interested future teachers declined to zero, the program was dropped.

A similar effort was supported by our RAIRE grant. Several departments on our campus have Research Experiences for Undergraduates (REU) grants. We learned that future teachers applied to some of these programs, but were seldom selected because their science backgrounds were usually weaker than other applicants. The RAIRE program offered to pay the incremental cost for adding one or two future teachers to each of the programs. These students needed to meet all other qualifications of the programs but were expected to have slightly less background in the sciences. For each of two summers the REU programs in biology, chemistry, and physics took advantage of this offer. Each added 1-2 students to their existing programs. Overall, the effort was quite successful. The 5-6 students performed well and the faculty saw that future teachers could be as successful in the laboratory as other science students.This effort has continued at a slightly lower level since RAIRE funding as ended. In one case a first year in-service teacher was included in an REU program even though he could receive no funding from the NSF REU grant. Thus, the program has promoted the inclusion of education majors in existing research efforts for undergraduates.

Since the early days of our program formal funding structures for including teachers in research activities and even in the research Experiences for Undergraduates have been created by the NSF. In fact, "NSF encourages inclusion in the REU program of K-12 teachers of science, mathematics and engineering. The Directorates for Biological Sciences, Computer and Information Sciences and Engineering, Engineering, and Mathematical and Physical Sciences have formal activities supporting Research Experiences for Teachers (RET), while other Directorates respond to requests on a case-by-case basis. Teachers may also be included in an international REU project. Information about RET activities is available on Directorate Web sites" [10]

In-service teachers have also been involved in research during the summer. An added feature of the GENE project was to have some lead teachers directly involved in research labs. After the first summers' activity, some lead teachers were asked to come to campus early for the second year. During this pre-workshop time the lead teachers spent part of their time working in a research laboratory and part of their time preparing workshop materials for the teachers who would come later.

Similarly our high energy physics program, funded by the Department of Energy, has recently joined QuarkNet (http://quarknet.fnal.gov/) which provides similar opportunities for teachers to become involve in research that is conducted both on university campuses and at FermiLab near Chicago. Through this program teachers become involved in the research activities of large collaborative groups and obtain tools and data to use in teaching their students about the experimental methods and theoretical models of investigating fundamental particles.

Another effort is to involve the education majors and in-service teachers in research related to science teaching and learning. As mentioned above KSU has a very active Physics Education Research Group which is located in the Department of Physics. This group routinely involves future teachers as well as undergraduate physics majors in it research and development efforts. These students contribute to the Group's efforts and learn about the underlying framework that drives contemporary pedagogy.

Each of these programs has been successful for students and in-service teachers. However, the numbers have remained relatively small in recent years. For undergraduate students the number majoring in science education has dropped significantly. So, we have a very small pool from which to draw. For in-service teachers funding for summer workshops has not been available form either federal or state sources. Teachers usually cannot afford to spend a summer without an income. (A few can be involved in the NSF Research Experiences for Teachers program.) Fortunately this situation is likely to change as the federal government puts new emphasis one assuring that all teachers are "highly qualified."

Summary

The focus of many of our efforts has been to create an environment where teachers and future teachers could become involved in research-like activities. Because these groups have unique curricula and challenges, many of the activities must be structured differently from those designed for science students. The range of programs described here provided many different types of activities, but each was designed so that teachers and students understand how science is done because they have participated in research or research –like activities. Some of these efforts have become incorporated into a broad curriculum while others have provided a model for similar activities. For the most part, the programs described here provided these groups of students with opportunities that they would not have otherwise had. Both the teachers and the student they teach have gained from this integration of teacher education and scientific research.

Kansas State University (http://www.ksu.edu) identifies itself as a "student-centered research university." Its enrollment is over 23,000 students of whom about 19,000 are undergraduates. Of the undergraduates about 2500 are enrolled in the College of Education, 3,300 in the College of Engineering and 700 in the various sciences which are part of the College of Arts & Sciences. These students are taught by about 900 faculty members, 85% of whom have terminal degrees in their disciplines. The sciences faculty numbers about 130, engineering has over 100 teaching faculty, while education has about 60 faculty members. KSU was founded within weeks of the passage of the Morrill Act in 1863, and thus can claim to be the nation's first land-grant university. In keeping with the land grant mission, KSU has long maintained active research programs in the basic sciences, engineering, technology and agriculture. The transition from "Kansas State College of Agriculture and Applied Sciences" to a comprehensive State University began in earnest shortly after World War II. Today, KSU's offerings include programs traditionally associated with the land grant mission alongside those typical of a comprehensive public research university.

Acknowledgements

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