

## PROJECT DESCRIPTION

### THE INVESTIGATIVE MIND IN DEVELOPMENT

#### A. VISION AND THEME

Like many states, Arkansas is struggling to provide a quality education for its youth and to compete in the technological 21<sup>st</sup> century. National education rankings consistently place Arkansas at 49<sup>th</sup> or 50<sup>th</sup> in the education it provides, as measured by both national test scores and per capita expenditure<sup>1</sup>. One outcome of this struggle is that only about 2% of Arkansas students entering high school have chosen to go on to receive a college degree in all of math, science, and engineering combined<sup>2</sup>. Together, these figures paint a challenging picture of Arkansas schools and the need for change. To meet this challenge, the state of Arkansas has responded with a statewide plan for consolidation of small school districts to reduce operating costs and to increase per capita expenditure. Although this is a positive step forward, state-wide focus on the effectiveness of K-16 education presents a unique opportunity to look more directly at the current approach to teaching science.

Traditionally, the approach in Arkansas K-16 schools has been based on the lecture/listen format. As a result, for many students, learning science has been more about reading from textbooks and answering questions at the end of a chapter than about “doing or visualizing” science. This approach is in sharp contrast to that outlined by the National Science Education Standards<sup>1</sup>. These standards state that students should “be able to identify questions that may be answered through scientific investigations; perform an investigation using the scientific method; interpret results of experimental observations; use scientific evidence to make predictions; and communicate the problem solving process”. However, while many teachers are dedicated professionals and often “make do” by purchasing materials with personal funds, insufficient time coupled with inadequate training have left teachers and their students without a teaching approach that inspires critical thinking through investigation. The issue of inadequate training has become particularly critical this year for all Arkansas science teachers, since science now joins math and reading with required science standardized testing focused on inquiry and critical thinking. For many years, the Arkansas school system has focused its resources on math and reading skills, driven by standardized testing. These same schools will now use some of their resources to prepare teachers to meet the new science requirements. Given this heightened awareness there has never been a better opportunity to impact science education in Arkansas.

Recognizing the power of an investigative approach to teaching science<sup>3-10</sup> the goal of this University of Arkansas proposal is to expand the National Science Digital Library holdings in order to seize this opportunity and transition the current education approach to one that leads to greater science and technology skills and corresponding career interests for students. Our program called the “*Investigative Mind in Development*”, is based on the learning through doing paradigm, and is presented to science teachers, and then consequently to their students, by

practicing scientists. In this vision, physics and chemistry science professors, guided by their passion for teaching science will carefully prepare multimedia presentations that are designed to tutor K-16 science teachers on hands-on demonstrations that not only make science concepts clear<sup>11</sup> but also bring a “solving a mystery approach” to teaching science. Imagine a demonstration that creates a mystery, yes, it is entertaining, but this demonstration is designed to do something much more important<sup>12</sup>. It is designed to provoke the student and engage the mind to not only recognize the mystery but to be tantalized to “want to know why” such behavior was observed. And even more compelling, to be inspired to investigate the logical reason for the behavior. We believe that the Digital Library can bring this ability to every science teacher and engage every student in this way (<http://comp.uark.edu/~davewall/proposal/index.htm>).

## **B. ROLE OF THE MODERN LIBRARIAN**

The role of librarians has evolved as a result of the application of technology in libraries along with the evolution of the internet, while retaining their integral role in supporting higher education’s core missions of research and education. The role that librarians play in the learning and teaching environment already involves<sup>13,14</sup>:

- Selecting appropriate material, in whatever format, to support teaching, instruction and research to their respective clientele;
- Facilitating the creation and discovery and use of these resources;
- Librarians also anticipate the information needs of their clientele, requiring subject-based knowledge and a thorough understanding of the teaching programs and research needs of faculty and students;
- They also form partnerships with faculty to incorporate *information literacy skills* in the curriculum. Information literacy allows individuals to "recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information". In this regard, the PI is co-teaching with Biological Sciences faculty, a one hour credit course in information literacy for science students.

To be sure, as noted by Kreiser: “..... Librarians have come a long way from the time when they were considered caretakers of the book collection. Now they are information providers, consultants, curriculum activists, instructional designers, instructional leaders, production specialists and most important, teachers”<sup>15</sup>. Librarians have for a long time, filled a very unique role in helping faculty pursue their research and to provide the right information at the right time when it is most. Even though a growing percentage of the scientific research materials are available electronically, librarians all the more serve as the solid bridge between the technology, the information, and the users. Librarian-faculty partnership has become more vital in this paradigm in meeting the information needs of the net-generation of students and to assist the faculty in delivering a quality education.

Because of the shift in emphasis of the medium in which information is now transferred and accessible to users, librarians have begun to actively engaged in organizing parts of the web and providing metadata and archival encoded description to material relevant for their user clients. The emphasis has shifted to providing value-added services that can provide the retrieved information in its appropriate context with some precision. For example, at the University of Arkansas, our library is an active participant in the AgNIC (Agriculture Network Information Center) project, a diverse, voluntary global alliance of land-grant and other agricultural colleges and universities, faculties of agriculture and veterinary medicine, national agricultural libraries, and other agriculture-related organizations, both governmental and non-governmental<sup>15</sup>. AgNIC is customer focused, providing openly accessible agricultural information over the World Wide Web. Our institution is responsible for gathering, organizing, and creating metadata for web-accessible resources relating to all aspects of the rice industry, locally and nationally, in this national repository, and for promoting the use and utility of this scholarly resource.

As noted by the Associations of College and Research Libraries, “the changes that are occurring in technology, in research, teaching and learning, have created a very different context for the missions of academic and research libraries. This evolving context can afford a moment of opportunity if libraries and librarians can respond to changes in proactive and visionary ways”<sup>16</sup>. They allude to the fact that there are diverse unmet needs in the academy and that librarians are in a unique position to redefine their functioning to seize opportunities. One of these important opportunities, as is indicated by our survey results, and addressed by this proposal, is to work in partnership and in collaboration with the teaching faculty and play an active and meaningful role in:

- ***Record and preserve outstanding teaching methods*** – methods that fully integrate useful multimedia demonstrations in science instruction in the classroom, ranking them, and assign metadata tags to reflect their usefulness when they are integrated with the course, and make them available via the web for universal access; and
- ***Identifying useful multimedia demonstrations in chemistry and physics*** that are already available on the web - evaluate their usefulness, their level of instruction, write summaries to reflect their coverage and usefulness and systematically organize these using the National Science Library Digital Resources. These of course, will be fully integrated with the existing resources in the National Science Digital Library.

A properly presented science demonstration, a live experiment done in the classroom, can allow students to collectively participate in science. They can observe and be amazed, even entertained, with the unexpected outcome of the experiment – *but then begin to reason out why it happened the way it did*. In this way we are teaching science by developing the investigative mind. Unfortunately, when a classroom demonstration either fails to work properly or simply fails to engage the class, the opportunity to develop the investigative mind is lost. The end result, all too frequently, is that the demonstration is simply omitted the next time the teacher presents

the material. There simply exists little if any opportunity for the practicing teacher to see how that particular demonstration may be successfully presented by others delivering its cognitive value or how the demonstration is successfully used to develop student curiosity? The National Science Digital Library can provide an effective pathway to existing or new resources that provides video tutorials of specific demonstrations that stress their cognitive value.

### C. GOALS AND OBJECTIVES

Built around the conceptual focus of “solving a mystery approach to leaning science”, the ultimate goal of the *Investigative Mind in Development* program is to inspire critical thinking and a compelling desire to “know”, through investigation. In this way we will have an improved opportunity to transfer to our students the excitement we experience when, with relentless step-by-step pursuit, we are the first to uncover the answer to a scientific mystery. Just as scientific investigations originate with a question that engages a scientist, so too must students engage in the activities of learning. The demonstration therefore first acts as the driver of the learning experience by presenting a strategic question that gets students thinking about the concepts that will be explored in the lesson. However, it also creates the opportunity for the student to develop an investigative mind-set. With this goal in mind our objectives are:

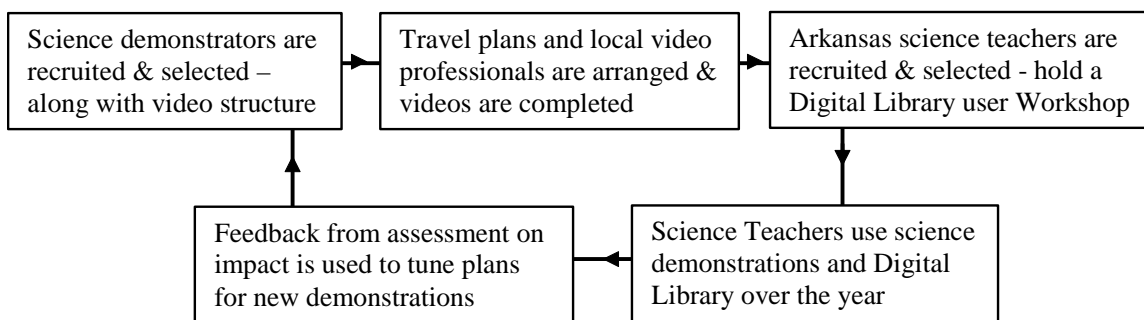
- ***Create Multimedia presentations of tutorial demonstrations*** – We will accomplish this by video recording the best at physics and chemistry demonstrations throughout the nation. The outcome will be clear activities based on lessons learned by a host of excellent science teachers throughout the U.S. For example, several science professors are famous for the effectiveness of their demonstrations. They will play the role of the science demonstration tutor. They will also play the future role as decision maker on new science demonstrators to capture on video and on what videos to include.
- ***Implement a 3-year plan to sustain the Investigative Mind in Development (IMID) program*** by integrating it into the fabric of the digital library with the support of the University of Arkansas Library System. We will accomplish this through a partnership between University of Arkansas librarians and physics-chemistry faculty.
- ***Conduct an ongoing longitudinal evaluation*** that provides evidence for the impact tutorial multimedia presentations have on science demonstrations can have on K-16 education. This evidence will open further opportunities for the university to become a driving force for improving science education in the America.
- ***Develop specific tactics for dissemination of results*** as a model that can be used by other institutions. Our first approach will be to conduct workshops which will be presented by the university of Arkansas proposal team. We will also form broad partnerships with other professors to continue to provide the opportunity to maintain growth of library holdings in the future.

## D. PROJECT PLAN

Our project plan is logically structured in six parts: (1) Developing multimedia science demonstrations that lead to improved science education from grades K through 16; (2) Implementing the use of these multimedia demonstrations throughout Arkansas through a series of digital library workshops; (3) Assessment and Evaluation; (4) Specific strategies for dissemination; (5) Making the video tutorials an integral part of the Digital Library collections, easily accessible and searchable; and (6) Promoting the program's potential as a national model.

### 1. Developing multimedia presentations of science demonstrations

Our project is planned to involve at least 10 to 20 Premiere Science Demonstrators who are passionate about the role of science demonstrations and their impact. They will be recorded carrying out physics or chemistry demonstrations while showing how they engage the student's mind in the mystery involved, the clarity of concept, and most importantly, its cognitive value. Any existing videos that meet our criteria will of course be investigated but although a preliminary search has uncovered valuable material, what we found would be difficult to use in the format needed for our goal. Following the initial selection by the IMID team, the growing group of selected science demonstrators will itself act as the peer review and selection committee. After video recording, editing, testing, the multimedia presentations will be made available on the Digital Library by using metadata standards and fully described. These will be utilized in a series of summer workshops design to build literacy for use of the Digital Library using multimedia presentations of science demonstrations as a focus (Fig.1).



**Fig.1. Plan for developing multimedia presentation of science demonstrations**

If we stop for moment and ask what we remember most about a science class, for many of us, it is almost always a demonstration that brought out the investigative nature of science and made a concept clear as well as its relation to everyday life. The multimedia demonstrations that we propose here are designed to do just that, most especially for young beginning teachers but designed to effective for all.

Imagine if every science class started with a science demonstration that presented students with a puzzling observation. Suppose this was followed by the opportunity to develop the investigative mind by discussing and proposing solutions and even testing the solution. The suspense, the excitement, the competition all adds up to “doing science”. This could even be

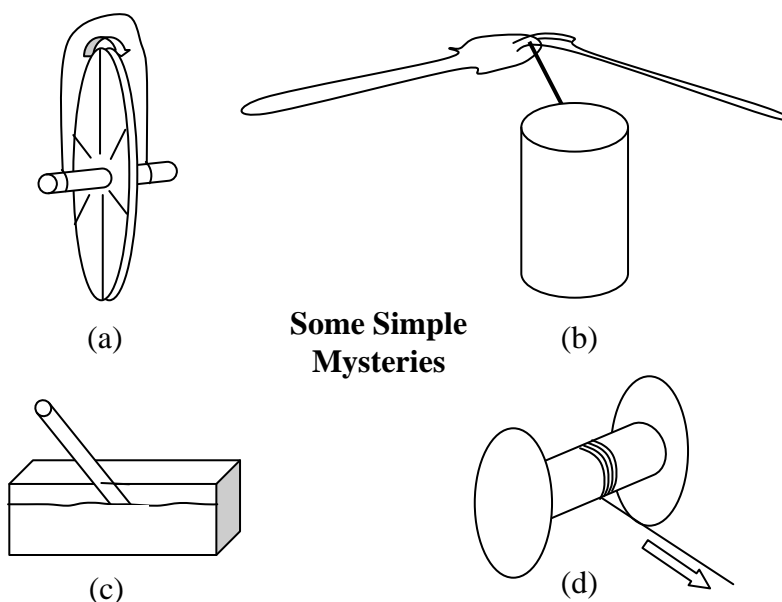
followed by “hands-on” experiments that develop the learning experience even further. But meanwhile the demonstration opens the door, creates the environment, peaking interest, to engage students and develop an investigative mind-set or the desire to want to know why.

Picture a teacher demonstrating a spinning bicycle wheel held at both ends (Fig 2) by a rope when one end is suddenly removed and yet the wheel continues to be upright? Or air flowing over a model airplane that stays upright. Or a fork and spoon connected and balanced over the edge of a glass by a match stick. Or a glass tube that suddenly disappears as it is dipped into a tank of clear liquid. Or a large spool of tread that moves in the opposite direction when pulled by a string. Or a fish tank that makes a laser beam bounce several times off the bottom of the tank before leaving. Or grape

soda that is poured through a special filter that absorbs the color so that the soda flows out clear but without a change in taste. Or even the table cloth that is pulled from beneath the table setting leaving the tableware undisturbed. All of these are certainly intriguing mysteries. Each demonstration is planned to peak interest and curiosity, preparing and stimulating the student to think – “why is that”?

But very importantly, these observations create the opportunity for the student to explore possible explanations to the observation. To have each student engaged in a relentless

step-by-step pursuit, to be the first to uncover the answer to the scientific mystery. For this to happen, the teacher must have a clear understanding of the phenomena as well as the skill to explain or reinforce a correct *intuitive* explanation. Students must be driven to observe, puzzle, discuss, perhaps observe again, and explain. It would be most effective if the students or teacher would first offer a clear explanation that does not depend on mathematics. One must be able to understand science intuitively and realize that the mathematics or tools like the “right hand rule” are just short cuts but not real understanding of underlying science. The fact that science makes good sense is what makes science appealing as opposed to intimidating and should be our first approach to understanding. Without this investment by the student and response from the teacher the demonstration becomes entertainment and in many important ways the demonstration has



**Fig.2** (a) Bicycle wheel that continues to stay upright even when one loop is removed from supporting the axle; (b) Fork and spoon that are balanced at the edge of a glass with a match stick; (c) A glass tube that disappears as it is dipped into glycerin; and a spool of rope that rotates toward the person pulling the rope.

failed both the teacher and the student. For this reason, each tutorial video of the science demonstration taking place in the classroom will be complimented with a video of an interview with the demonstrator discussing the plan to develop the student's investigative mindset and with clear intuitive understanding of the underlying science.

The point is that when a teacher's demonstration fails to engage a class in learning it may not be the demonstration itself that is at fault. The fault more likely lies in the way the demonstration is presented and the connections made to the science. It's frequently not what one does – so much as how one does it and even how one observes it. The position of this proposal is that it would be most useful if teachers could see experienced teachers present their versions of that demonstration before live audiences and to hear them discuss how the demonstration has prepared the student to search for an intuitive understanding of an explanation. A reference book on demonstrations would be helpful, of course, but any text description would be a distant second in terms of usefulness to seeing and hearing the demonstrator in action. Of course, teachers rarely have the opportunity to travel to distant sites to watch other colleagues. As an alternative we propose to create a collection of tutorials of commonly done physics and chemistry demonstrations, a collection that it can be easily accessed and easily added to.

Still better than seeing one famous demonstrator, at work in the classroom or lecture hall, would be for our colleagues to see several demonstrators at work. That way, one could compare various presentation styles and synthesize one that works. There is no best way to present a demonstration. Each teacher must develop their own style. Not every teacher is going to dress up as a magician, as does Clint Sprott who is widely famous for his public shows done at the University of Wisconsin. Not every teacher is going to dress up their demonstrations as magic tricks, as does Dave Wall in his *Physics of Magic* public shows. Those forms of showmanship might fit some teacher's style, but certainly not most. The public persona of a science teacher is highly personal.

## **2 Implementing the use of multimedia presentation of demonstrations throughout Arkansas through a series of science digital library workshops.**

Our program will begin every summer with workshops for Science Teachers. In our program Science Teachers are carefully recruited and ready to work in partnership with the *IMID* team to bring a teaching approach to the classroom that emphasizes student learning through their wonder of how things work. Testing the multimedia demonstrations effectiveness to convey to the teachers a blend of content knowledge and the skill to develop a classroom culture for inquiry learning will require careful design and redesign of the program. After 3 years of experience, the workshops will be well organized and managed by the University of Arkansas Library and structured into 4 successive days. There will be two workshops each summer – one for grade level K-8 and one for grade level 9-16 to allow for strong camaraderie and the potential for two different levels of science demonstrations.

**Step One** - This first day is for Science Teachers to work as a group, acquiring Digital Library skills, confidence, and an understanding of the goal of the program, before they begin to work with the Science Team who will lead the effort on demonstrations. During the day, Teachers learn about accessing the National Science Digital Library in a class taught by University Professor Lutishoor Salisbury and Professor Usha Gupta. Activities range from being given a specific assignment, all the way to exploring the digital library for any aspect of interest to them. Science Teachers work independently and present their search results that are then followed by a general critique of the entire group of science teachers in order to let everyone share in the experience.

**Step Two** - At the start of the second day the *IMID* team join the Science Teachers in an effort to develop to bond as a cohort group. It is during this time that specific Teacher teams form, either naturally, or are encouraged by the *IMID* team as we recognize a good match. The activities develop student understanding of what it means to open the student thinking process so that creativity can be nurtured and encouraged. The Science Teacher teams then begin work with the *IMID* team on inquiry based demonstrations by observing the video that they will use during the next school year. These examples are then discussed from the point of view of their level of inquiry and how the Science Teacher teams would modify the demonstration to increase the investigative level. We expect that this activity will strengthen and increase trust between the Science Teacher and *IMID* team.

**Step Three** - During the third day of the summer workshop there is a clear change in focus. While the first two days were devoted to improving the demonstration skills of our Science Teachers and promoting the Teacher- *IMID* team, the focus of the third day is on content and creative development of investigative demonstrations. The professional development of science teachers requires learning science content through the perspectives and methods of investigation. The structure of the day is that in the morning, the Science Teacher- *IMID* team will critique the multimedia demonstrations. The idea is to examine the demonstration from the point of view of content and to see how the demonstration brings to life different science concepts. The Science Teacher - *IMID* team then dissects the demonstration, discuss the objective, investigate how to implement it into the classroom, and examine how and if it accomplished the goal. This is a very special day were Science Teachers get to express their passion and develop their investigative skills.

During the afternoon of the third day, the Science Teacher- *IMID* teams will present what they consider to be a new and creative demonstration that overcomes the issues raised in the morning. This allows the Science Teachers to realize that their goal is not simply to bring inquiry based activities into the classroom, but to create an inquiry mindset where inquiry based demonstrations and activities will become the natural course of teaching and learning everyday.

**Step Four** - During the fourth day our Science Teacher- *IMID* teams will get to practice their skills in the classroom. The *IMID* team will run a morning only summer camp of science

demonstrations for 20 to 30, 1-8 or 9-16 grade students with the grade level depending on the group of Science Teachers. The demonstrations during the camp are presented by the Science Teachers who utilize their demonstrations of the previous day and present them to our student campers. Videos of the science teachers in action will be made for instructional purposes. The student camp provides a simulated classroom environment for Science Teachers to get experience in implementing a demonstration with the opportunity for constructive criticism (during that same afternoon round table discussions) to improve the effectiveness of their presentation.

In addition to the summer workshop, the *IMID* program provides continuous training for its Science Teachers throughout the school year via the National Science Digital Library. Each of these multimedia presentations on the National Science Digital Library will be designed in exactly the same format with the same objectives so that the Science Teacher will be able to capture the demonstration quickly and efficiently.

### **3. Assessment and evaluation**

We consider the development and implementation of our evaluation plan as being a critical factor in program implementation and the ultimate success of the *IMID* program. The assessment strategy has evolved in conjunction with the evolution of the *IMID* program development, and is derived from the project goals and objectives. The evaluation plan includes both formative and summative assessment components: formative assessments will primarily be used to assess progress in reaching our goals and making decisions regarding program operations, whereas the summative assessment will be used to measure our progress in reaching our vision or more practically, our planned outcomes. Early assessment is critical to providing necessary feedback for program implementation. For this reason, we have partnered with the College of Education. Dr. Ronna Turner, the Director of the Office of Research, Measurement, and Evaluation of the College Education has been included as a partner in the initial project evaluation design. Evaluation strategies include a mixed methodology with the collection of quantitative and qualitative data from primary stakeholders for benchmarking the progress of the *IMID*.

The assessment-evaluation of the *IMID* program (table 1) will document change in the education of students, change in the schools within which they are being educated, and the students' understanding and interest in science. It will include a view into the change in the culture of science education, moving from classroom learning as the primary instructional format to an investigative-based learning environment. Attention will be given to describing and evaluating processes within the program, as well as comparing attitudes and outcomes with respect to stakeholder groups. The evaluation will be built around a number of key questions of central importance to the primary stakeholders. Questions to be addressed include: (1)What are the differences in the impact on the student population in the *IMID* program as compared to

students not participating in *IMID*? (2) Have we changed the approach for teaching science to one that attracts a larger more diverse group of both students and science teachers by demonstrating significant value to both? Is there an increase in the numbers of women and minorities that sustain an interest in science or engineering as a career? (3) What role does investigative learning and a supportive environment have on the academic success of students in underrepresented groups? (4) Is evidence of a developing investigative mind observed after *IMID* implementation that was not seen prior to *IMID* implementation? (5) How is the science teacher culture within the participating schools different from what it was prior to initiating this program? (6) To what extent has *IMID* had an impact on the University Library beyond its own boundaries? (7) Once *IMID* is established, how do science teachers perceive the role of science demonstrations, both holistically and in comparison to other science teachers? The following type of data will be obtained to address the research questions.

<b>TABLE I Assessment and Evaluation Plan</b>			
<b>Group</b>	<b>Measure</b>	<b>Time</b>	<b>Responsibility</b>
Students	<p><b>Assessment</b> - probing student interest in science, confidence in ability to do science; demographics, academic preparation, academic performance, and graduation success rates.</p> <p><b>Evaluation</b> - to explore effectiveness of science demonstrations as a method to develop the investigative mind-set.</p>	<p>Start &amp; end of the year</p> <p>End of year</p>	<p>Together, Professor Turner as the <i>IMID</i> Evaluation Director, and Professor</p>
Science Teachers	<p><b>Assessment</b> - probing teacher perception of student skills and interest in investigative science activities; demographic information; participation in developing new demonstrations.</p> <p><b>Evaluation</b> - of perceptions of the science demonstrations as a method to develop the investigative mind.</p>	<p>Start &amp; end of the year</p> <p>End of year</p>	<p>Salisbury, as the <i>IMID</i> Director, will supervise the implementation of the student assessment and</p>
Librarians	<p><b>Assessment</b> – of the expanded role and effectiveness of Librarians.</p> <p><b>Evaluation</b> – of the growth in the use of the Digital Library and teachers’ perception of the usefulness of the resources</p>	<p>End of year for both</p>	<p>program evaluation.</p>

- **Students** - A longitudinal assessment of the impact on students will be conducted using survey instruments to assess level of interest and attitude about science and technology subjects, plans for future study in these areas, as well as career goals. Annual questionnaires will provide a

measure of attitudinal differences and change in attitude of students in the *IMID* and non-participating groups. University population data will be used to compare students' backgrounds and academic preparation, the diversity of their science and technology course selection, performance in major and non-major science and technology courses, drop-out rates, and four-year graduation rates. Survey and observation data will be collected on the types of demonstrations that are being conducted in the schools, as well as their level of participation in the investigative nature of the demonstration.

- **Science Teachers** - Self-report, observation, and survey instruments will be used to measure science teacher perceptions, activities, and cultural interactions. Science Teachers will be surveyed regarding confidence in their abilities to present effective science demonstrations and the ability for science demonstrations to make a significant contribution to the development of the student's investigative mind-set. The Science Teachers will also be surveyed regarding the types of activities and skills perceived as being important for effective demonstrations, and their level of creativity and ability to investigate. Data will be collected on the types of demonstrations as well as if new demonstrations are created. Background data of the Science Teachers will be recorded to provide profiles of faculty program participants (gender, ethnicity, field of study).

- **Librarians** - Questionnaires or interviews will be used to record Librarians' perceptions of science teacher attitudes about the *IMID* and the university Library interest in sustaining the Center. In addition, they will also probe the interest in the library community, both on and off campus, to work with science teachers in an effort to make more tools available to them that could result in improved instruction. The evaluation will also investigate if any significant use of the NSDL has developed during the course of the project.

#### **4. Specific tactics for dissemination**

The impact of the *IMID* will be to develop and implement a new path to learning for the up coming generation of scientists and engineers who will lead discovery in the 21<sup>st</sup> century. It has the potential to serve as a model for other mid-size graduate institutions like our own that wish to bring together collaborative teams of university scientists and librarians to extend the role of the library. To provide this opportunity to other institutions, we developed a dissemination plan that we believe makes it possible for us to share our results with the community in a cost effective, timely and personalized manner. The basic idea here is to communicate results in as many ways as possible and to make the dissemination clear, easy to access, and interactive. Of course our people are our best conduits of our program but in addition we propose, to use: (1) Publication in discipline education journals; (2) Presentation at various conferences and colloquia at other universities; (3) An interactive web page that not only presents program results but allows for questions and suggestions by the customer; (4) NSF reports by our evaluation team that describes the outcomes and identifies the important variables; (5) having all of our multimedia science demonstrations easily accessible at the Digital Library.

The critical element of utilization is that individuals at other sites must fit the *IMID* within their organizational structure, previous experience, and available budget. This last point is critical for dissemination - cost of the program and cost effectiveness. While program effectiveness will hopefully be demonstrated from results from our “Student Assessment and Project Evaluation Plan”, the initial cost and the cost to sustain the program is another matter. While support requested from NSF is substantial, this is because the *IMID* is an experiment - a case study - to develop, implement, and evaluate an innovative pathway that will *change existing culture*. We seek to change the existing science training culture to one that could potentially attract a larger more diverse group of students and science teachers by demonstrating significant value to both groups. It is this demonstration that is the key. The budget for this proposal is basically to put together and edit the science multimedia demonstrations, all as an experiment that will provide a proof-of-principle. This is not to say the program is inexpensive, but it is to say that *if we demonstrate* value to both students and science teachers, program dissemination depends more on the passion of a group of individuals for science education than on finances.

## **5. Plans to incorporate activities as an integral part of the Science Digital Library**

Our plan for dissemination is centered on the results from our evaluation team. Having seen the power of one successful example on the enthusiasm for the participation of others, our plan is to develop a series of multimedia science demonstrations and to make them easily accessible on the Science Digital Library. With these few examples and their effectiveness we expect that additional demonstrations will be developed by passionate science teachers who feel that it is an honor if not obligation to take part. In addition, we also plan to publish our assessment and evaluation findings.

## **6. A National model and strategy to sustain the *IMID***

Through dissemination of our results we have an opportunity to be a national model for other mid-size graduate institutions like our own that wish to broaden the role of the library while enriching science education in K-16 Schools. By partnering with science teachers around the nation, with the University of Arkansas Library System, and the National Science Digital Library, we have an excellent opportunity to sustain growth in the library collection.

## **E. RECRUITMENT AND SELECTION OF SCIENCE TEACHERS**

Science Teachers will initially be recruited by a Selection Committee, composed of the PI and the *IMID* management team. This committee reviews written recommendations, transcripts, and evaluates a written essay on teacher interest in participating in the *IMID* program. Our initial approach will be to invite all Science Teachers who teach Physics or Chemistry to participate.

Selection of our Science Teachers will be based on evidence for commitment in previous activities and an assessment of the potential for commitment to developing an investigative based learning environment. Incentives for participation beyond professional development and the help from the *IMID* team include free access to the multimedia science demonstrations on the

National Science Digital Library.

## **F. ORGANIZATION, MANAGEMENT, AND INSTITUTIONAL COMMITMENT**

The *IMID* management and implementation team is comprised of recognized experts in different areas of the educational community. For example, the University of Arkansas Library System is represented by Professor Salisbury (PI), Head of the Chemistry Library and Professor Gupta, who is head of the physics library. They both have a long history of developing effective and innovative evidence-based library programs for physics and chemistry. They are particularly interested in expanding the library's role in assisting these disciplines in delivering a quality education and in improving science education in Arkansas. Both of them will organize the workshops and insure easy access to the multimedia presentations of science demonstrations.

Professor Wall has long history in science demonstrations and in fact has particularly focused on using magic tricks to make certain science concepts both interesting and clear. Professor Wall has already over the years, more for his own instruction, filmed several, rather well known scientists performing science demonstrations. He will have the responsibility to visit and capture videos of presentations science demonstrations in action along with interviews that reveal the underlying science.

Distinguished Professor Salamo is the Physics Advisor to the *IMID* program, and brings his national reputation in science research and education to the program. Meanwhile, Professor Durham, chairman of the Chemistry Department, has a long history of excellence in teaching and in the use of science demonstrations. Salamo, along with Durham will organize and lead the workshop mentoring of science of teachers with the use of fascinating science demonstrations.

Ronna Turner has brought her talent and track record of assessment techniques to the *IMID* program and implemented extensive program measurement and evaluation tactics. Dr. Turner is Director of Office of Research, Measurement, and Evaluation (ORME) in the College of Education and developed the State of Arkansas' K-12 standardized testing database.

Our plan to continue support for the *IMID* program is driven by the UA Library interest in demonstrating the significant impact a university can have on K-12 education in Arkansas. As a direct result of this vision, the Director of the UA Library has committed the university to fully support the *IMID* program after NSF support. This significant commitment is in a letter from the Director (see "supporting documents").

## **G. SCIENCE DEMONSTRATION PARTICIPANTS**

A group of well known science demonstrators around the U.S. are partnered with *IMID* to support its goals (see "supporting documents"). These include:

- Paul Hewitt of City College of San Francisco is the author of the most widely used physics textbook in the world. He is a master teacher who has received the Milliken award for teaching by the AAPT.

- Harvey Leff of Cal State University Pomona is a master teacher and locally famous demonstrator. He is the current President of the National AAPT
- Eric Mazur and the Mazur Group at Harvard have been leading advocates of Peer Instruction in physics teaching and have led educational research efforts in this country.
- Clint Sprott is a nationally famous demonstrator as is his colleague, Bassam Shakhshiri in the Univ. of Wisconsin chemistry department. Both present annual public shows. The Sprott collection of 31 videos is the closest examples of what we would like to create.
- Tom Zepf of Creighton University is famous for his Haunted Lab and his presentation of science as a mystery to be solved. He is also a magician who debunks pseudoscience and teaches physics teacher workshops on the use of rope magic in the classroom.
- Paul Robinson of San Mateo High School is a master teacher at the high school level and has taught numerous New Teacher workshops for the Northern California-Nevada section of the AAPT. His workshops emphasize the use of physics demonstrations in the classroom and are always full. He is Section Representative and Historian of that section and holds its Distinguished Service Citation.
- Lynda Williams of Santa Rosa Junior College is the famous Physics Chanteuse. She is a master teacher, performer, and popularizer of science.
- Joe Redish of the University of Maryland author of the excellent book *Teaching Physics with the Physics Suite* and is a leading researcher on physics education.

## **H. PROFESSOR/SCHOOL COMMITMENT**

We are initially partnered with 4 school districts in Northwest Arkansas: Springdale, with 14,545 students, and a growing Hispanic population, Fayetteville, with 8,212 students, and an affluent population, Rogers, with 12,791 students, and Bentonville, with 7,322 students, representing major areas of Northwest Arkansas. Together, they each present a culture that makes their challenges unique and comparisons interesting. Each of these schools eagerly embraces bringing demonstrations into their classrooms to help create an inquiry-based environment that focuses on science in everyday life. In addition, we are also partnered with the Physics and Chemistry Introductory courses at the University of Arkansas.

## **I. ACHIEVEMENTS UNDER PRIOR NSF SUPPORT RELAVENT TO THIS PRPOSAL**

**University Professor Salisbury**, PI, is the Head of the Chemistry Library and is also Agriculture, Food & Life Sciences Subject Specialist at the University of Arkansas. She has introduced various innovative methods to reaching out to science faculty and in providing information literacy instruction for students at all levels. She had completed several studies in evidenced-based collection management, in effectiveness of information sources and in information seeking behavior of scientists. She has also introduced innovate methods of reaching out to users who are at remote locations across Arkansas through the Arkansas Agricultural Extension Services. She does not have NSF support related to the proposed subject.

**Professor Gupta** is Head of the Physics Library. In addition to collection management, she has completed several studies in evidence-based evaluation of chemistry and physics collections. She has played a vital role in converting several collections to the electronic media and has implemented Super Service as a way of revitalizing instruction and providing documents on demand to faculty and graduate students at the University of Arkansas campus. Together with University Professor Salisbury, she has conducted several comparison user studies with print and online versions of scholarly journals. She has also conducted targeted user surveys on specific online products. She does not have NSF support related to the proposed subject.

**Professor Salamo** - Co-PI on a NSF MRSEC grant on the “Physics of Nanostructures” (*DMR-9983678*). He has published over one hundred papers in referred journals, given numerous contributed and invited talks, and contributed several book chapters. He also pursues the development of interdisciplinary research and education as co-PI on NSF-IGERT and GK-12 grants. Under IGERT he developed a new Ph.D. degree on microelectronics-photonics now with over 60 students. In the GK-12 program he has helped bring inquiry into science classes in the 6-7 grades in Northwest Arkansas. He has also developed a new nanoscience course and laboratory under an NSF CCLI grant and has worked as co-PI on an NSF-PFI funded program on entrepreneurship in education which has increased the number of Phase I SBIR’s in Arkansas by a factor of 5. He is a Fellow of the Optical Society of America.

**Professor Durham** – is Chairman of the Chemistry Department and currently supported by NIH on biological electron transfer reactions that play an essential role in numerous important biological processes, including energy production in mitochondrial respiration and the synthesis of numerous cellular materials. Genetic defects in electron transfer proteins are responsible for a variety of human health problems. The long range goal of his research program is to develop a detailed understanding of the features which govern these reactions. He does not have NSF support related to the proposed subject but has been the primary force behind education reform in the University Chemistry Department.

**Professor Turner** - Co-PI on an NSF project (*REC-9988050*) to assess the impact of NSF systemic initiative programs. The NSF allocated over 0.5 billion in funding to SI programs and the outcome was a limited amount of data, which did not provide the necessary information to formally document a specific educational effect directly attributable to SI funding. Turner evaluated the “process” of data collection, assessment (or documentation) and dissemination of data, and the general conclusion was all of these elements are inextricably linked to a well-developed research design. The outcome was a recommendation to the NSF to require a more scientifically based research design as part of the proposal process. We further recommend the development of a model of mandated elements/data that must be collected to help create a system for the NSF to document the effect with external researchers analyzing the archival data to cross-validate or further investigate the impact of NSF funded educational programs.