Technology in Science Education:

A Grant Proposal

By

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ABSTRACT

Through the use of technology in science education the students, staff, and community members of the Randolph School District can broaden their knowledge of science content and application. Due to the lack of student laboratory data collection devices, this project's intended is to address the problems arising from a limited use of technology in the Randolph High School Science Department. Students will use and develop laboratory activities using technology. Further development via presentations to community members will be used to educate the population on the importance of technology in education, specifically science education. The gain of quality equipment that promotes the use of technology in a science setting may increase standardized test scores, and more importantly increase student problem-solving skills. The key project outcome is to enhance the science curriculum by providing materials that allow for on-the-job experience and college preparatory laboratory activities. Implementation of such equipment in the Randolph School District Science Curriculum will expose students to

the variety of tools available for data collection. The use of temperature, motion/light, pressure, voltage, and pH probes will lessen the existing gap between school and work in collection, synthesis, and interpretation of data. Curriculum enhancements, resource materials and teacher training are the expenditures associated with this project.

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I would like to thank my parents, my husband, my children, and my colleagues for their support in all of my endeavors, especially this one.

TABLE OF CONTENTS

List of Figures

Chapter 1: Introduction

Until recently, the educators at the Randolph School District have never had the opportunity to experience classroom tools that correlate with those used in real world science. The overall goal is to enable students and the community members of Randolph, Wisconsin to experience use of such tools. Handheld computer based digital collection tools and graphing software allows for such experience. We are aware of the use of such equipment in numerous districts thus we have the feeling we are not serving the students as best as possible. These handheld tools are important additions to the school as a whole. Not only in the students' lives, but those of the community as well. The tools allow for collection of data at any site, not just the science classrooms. Students will be allowed to collect data, in regards to pH, light, temperature, motion, and conductivity. As a result of the significant investments being made in hardware, software, and infrastructure, there is a need for instructional integration of technology in K-12 classrooms. "It is apparent that with the acceleration in the pace of technological innovation and saturation in society, skills such as problem solving, synthesizing information, and communicating via technology are essential for today's students," (Barron, Kemker, Harmes & Kalaydjian 2003). Handheld computers were first introduced as electronic versions of the daily planner. Today the handheld is seen as a universal access device, able to supply information in whatever facet we desire (Franklin, Sexton & Hongyan Ma, 2007).

Statement of the Problem

The increasing need for technology in K-12 schools is a high priority nationwide, particularly, in the area of science education. To address these demands, educators need to provide instructional strategies that allow students to use, experience, and develop a comfort level with technological tools. There is an increasing need for improved technology in our school district and science programs. Increasing technology usage in the science department of the Randolph School District will enable students to perform hands-on experiments with tools that perform calculations that could not occur without specific software programs and equipment.

Currently, in the Randolph High School Science program we do not have any digital collection equipment. Using such equipment will allow for more accurate collection of data and graphical representation of data which will allow and require students to use knowledge and critical thinking skills to apply the results. This proposal supports inquiry-based learning which is supported by the Wisconsin Science Standards and also meets requirements of the No Child Left Behind Act.

Statement of Significance

The Wisconsin State Standards for Science Education require the ability to "advocate a solution or combination of solutions to a problem in science technology" (1998, p. 19). The Science Department at the Randolph High School is limited in addressing this state standard and others at both the state and national levels due to lack of technological equipment. This grant will be a team effort of the Toyota Tapestry, the Randolph School District, and Randolph School District Teaching Staff. Technological knowledge in the science field can be most constructive in a hands-on approach. This project will contribute to student and community member knowledge and may serve as a model for other science programs throughout the nation.

The science department currently attempts to use other methods to enable students to gain opportunities in information collection. Using the proper equipment, such as digital scales, temperature and pH probes, light/photo-gate sensors, time lapse devices and updated laboratory techniques (manuals), and in-service training, students will be given the opportunity to learn using the latest strategies approved for education. Teachers trained by the manufacturer of the equipment will be present to demonstrate proper use and experimentation techniques to other teachers in the district, the students and community members in science using such equipment.

Students leaving high school are often unprepared to be successful in college and on-the-job training due to lack of experience with technological tools. As we are a small rural district with a high population (40%) of students receiving free/reduced lunch, Randolph alumni have spoke of the disadvantage they feel as other students have used and/or been exposed to digital data collection devices (R. Droessler, guidance counselor, personal communication, April 2007). Due to the high percentage of Randolph students that continue their education beyond high school (80%), resources and technological tools need to become more accessible to meet the demands of society.

Schools that have a greater number of students and larger budget currently have access to such tools. It is the medium-to-small sized schools, like Randolph, that are at a disadvantage to usage of these resources. The student population at the Randolph High School (grades 9-12) is currently 177 students, 170 of which are in one or more science classes that could be using the digital equipment, specifically the Vernier developed equipment (R. Droessler, personal communication, April 2007). Vernier, maker of software and technology products, distributes tools for data collection in high school laboratories. Through the use of a computer interface and select probes, students are able to run experiments without manually collecting data. The data is then plotted for graphically interpretation. Students must generate logical explanations from the graphed results. The use of this project, or those similar, can be easily duplicated by others as to allow for more student access at all educational locations.

It is assumed that learners using the digitized equipment will be regular education students, limited English speaking, emotionally disturbed or learning disabled students, not cognitively disabled students.

Definition of Terms

Digital Collection Devices. A digital collection device is a sensor which generates a signal representative of a select characteristic and sends it to a target area.

Pressure. Pressure is the force per unit area applied on a surface in a direction perpendicular to that surface (Wikipedia).

Regular Education Student. A student who is not receiving any additional services from a special education resource.

Standardized Test. A standardized test is a test administered and scored in a standard manner. The tests are designed in such a way that the questions, conditions for administering, scoring procedures, and interpretations are consistent and are administered and scored in a predetermined, standard manner (Wikipedia).

Voltage. Voltage is the difference of electrical potential between two points of an electrical or electronic circuit, expressed in volts. It measures the potential energy of an electric field to cause an electric current in an electrical conductor (Wikipedia).

pH. pH is a measure of the acidity or alkalinity of a solution (Wikipedia).

Limitations of the Study

The study is taking place in one year time. This limits the number of responses received and those surveyed will only be those currently enrolled in a science course, not all students.

Methodology

The following pages include a literature review in support of technology in the classroom, project goals and objectives, and a project implementation plan. The grant project goals and implementation are included in Chapter three and four. Chapter five will include a discussion of the plan. The surveys to be given pre- and post- project are included as appendices, as well as, the grant cover letter and proposal.

Chapter II: Literature Review

Introduction of Research Supported Problem/Need

Educators began conducting systematic observations and research on student learning and understanding of physical concepts, models and lines of reasoning (Aarons, 1997). The concepts in science education can be overwhelming for many students of all levels. Teachers today try to relay the content information as well as the scientific method used my scientists to uncover this information. Educators need to bring together as many possible insights into the teaching of the aspects of science (Aarons, 1997). As science and industry are reliant on technology, increasing technology usage in schools is an ever-increasing demand on schools. Using all and any types of technology, teachers can create a more effective instructional environment by increasing student engagement, use of authentic assessment, and making learning fun (Aarons, 1997). Using technology in the classroom has the greatest impact on student and teacher interest, motivation, student behavior, and development of higher-order thinking (Patterson, 2007).

In a study performed by Kent State University, results highlight these impacts of interest, motivation, behavior, and thinking. The findings in use of mobile computing devices suggest motility beyond the classroom, as learning extended beyond the classroom and increased motivation which in turn led to increases in the quality and quantity of student work" (Swan, Van't Hooft, Kratcoski & Unger, 2005).

> "Teachers interviewed in study agreed that their students' motivation to learn and engagement in learning activities was improved by their use of mobile computing, which resulted in increased student productivity and improved quality of work" (p. 106).

Students of the study confirmed these results. It was noted that student comments included: more organized, ease in use, and "more fun."

Student Engagement

Student engagement is critical in six areas: (1) organizing and planning, (2) referencing, gathering and analyzing information, (3) learning and self-improvement, (4) communicating, (5) teaming and collaborating, and (6) technology and integration (Franklin, Sexton & Hongyan Ma, 2007). Students can better organize and plan in the allotted time. Students are better able to apply the technology to all aspects of their education. To gather and analyze information displays student ability to decipher what is important. The technological tools provide opportunities to students to continue learning outside the classroom. Communication and teamwork are increased with technological tools. And technological skills developed with such tools are transferable to similar tools.

The use of handheld based science activities enhanced not only inquiry and engagement of students but also the organizational skills they possessed (Gado, Ferguson & Van't Hooft, 2005). The tools offer quick reference to important information and data is organized into easy to read tables (Franklin, Sexton & Hongyan Ma, 2007).

Students using technology in education are able to demonstrate their ability to reference information with responsibility and validation (Barron, Kemker, Harmes & Kalaydjian, 2003). Gathering and analyzing both quantitative and qualitative data are collected and analyzed concurrently using computing devices (Gado, Ferguson &Van't Hooft, 2006). Analyzing data includes problem-solving skills. To generate meaning, students must identify categories, patterns, and themes, finding intervening variables and build o=logical sense of evidence (Gado, Ferguson & Van't Hooft, 2006).

Learning and self-improvement are keys to developing self-regulated learners (Zimmerman & Tsikalas, 2005). By linking the processes from technology to performance and self reflection, learners see the positive changes in their cognition, motivation, and behavior which "develop feelings of competence and control" (Zimmerman & Tsikalas, 2005, p. 269).

It is apparent that with the acceleration of technological innovation and saturation in society, skills such as problem solving, synthesis and communication are essential for all students (Barron, Kemker, Harmes & Kalaydjian, 2003). Technological skills have been emphasized by educators and government officials as tools for communication, research, and problem solving (Barron, Kemker, Harmes & Kalaydjian, 2003).

Instructors need to use technology to provide sustained opportunities to make connections between technology and communication (Turnley, 2007). Frequent use of technological tools allow students to begin to engage technologies as embedded aspects of communication, rather than neutral, autonomous tools (Turnley, 2007).

Teaming and collaboration take place in most teaching science laboratories. These small computing devices allow for dynamic collaboration between multiple users (Gado, Ferguson & Van't Hooft, 2006). Technology creates a community environment for research, collaboration, presentation of knowledge, and implementation of new ideas (Patterson, 2007). Handheld computers have the potential to support both personalized and collaborative learning through classroom response, participation, and data gathering (Swan, Van't Hooft, Kratcoski & Unger, 2005). Handheld computing differs from a desktop computer in that users interacting with a mobile system interact with other users and collaborate on data gathering (Gado, Ferguson & Van't Hooft, 2006).

Technology and its integration into education as can play a more significant role in education and everyday life if it becomes more human-centered (Swan, Van't Hooft, Kratoski & Unger, 2005). Using mobile computing technology in education offers a greater chance of "becoming a lifelong-learning tool for anyone, anywhere, anytime" (Swan, Van't Hooft, Kratoski & Unger, 2005, p. 100). Handheld computing devices can provide schools with a realistic alternative for technology integration and meeting the challenges of improving student achievement (Gado, Ferguson & Van't Hooft, 2006).

Research supports the ideas of student engagement in all learning as opposed to traditional lecture based instruction. Traditional instruction differs from problem-based or engaged learning in that problem-based students are required to supply more than just answers to questions but also clear explanations and justifications for them as well (Schmitt & Lattery, 2004). Problem-based learning students had significantly higher overall critical thinking disposition skills than those of lecture-based students on course completion and continued to have higher scores after the course (Tiwari, Lai, So & Yuen, 2006). Those students engaged in learning demonstrated significantly greater improvement in analytic, systematic and critical thinking. Videotaped observations of students using mobile computing devices provide confirmatory evidence of student engagement in learning while in use (Swan, Van't Hooft, Kratcoski & Unger, 2005). Limiting factors why schools are not all currently using mobile computing devices is due to technological attitude resistance and cost (Gado, Ferguson & Van't Hooft, 2006).

Authentic Assessment

Educators understand the role of assessment in teaching and learning in a more expansive way than in the past (Tomlinson & Germundson, 2007).

> "Necessary as it is to figure out what a student understands and can do, that kind of assessment has an ominous finality about it. A teacher may see who 'got it' and who didn't- but it is time to move on. Other than passing judgment, such assessment of learning has little to offer either the teacher or student. We have more recently begun to think about assessment for learning and even assessment as learning" (p. 29).

During assessment for learning, teachers check in with broader goals in mind, using a chart of student progress. A chart is used to create a check system to ensure all levels of competence are met, beginning with the entry level knowledge expanding to the advanced concepts. Instructional goals of methodology, evaluation, and justification are monitored and insights are gained so that key curricular goals are accessible to each learner.

One of the most striking characteristics of using hand-held computing devices is the variability of between classes and individuals which suggests the ways in which such technology is appropriated to individual/personalized learning (Swan, Van't Hooft, Kratcoski & Unger, 2005). "The higher the level, the more the teacher is integrating technology and moving from teacher-centered activities towards learner-centered activities," (Barron, Kemker, Harmes & Kalaydjian, 2003, p. 492). The use of technology as integral part of the curriculum encouraged students to draw conclusions from information they find or discover themselves. Technology is a tool to solve problems and increase students' understanding of concepts. Findings suggest that mobile computing devices provide increased levels of conceptual understanding (Swan, Van't Hooft, Kratcoski & Unger, 2005).

Learning is Fun

The art of teaching is to awaken the natural curiosity of young minds for the purpose of achievement and satisfaction (Torres, 2005). The use of mobile computing devices may increase student motivation to learn and increase their engagement (Swan, Van't Hooft, Kratcoski, & Unger, 2005).Teaching with passion strikes interest in our students, having passion in the classroom means doing everything within our means to interpret the instructional process in such ways that learning comes alive and inspires our students (Torres, 2005).

A study conducted by Christensen (2002), confirmed the premise that technology increases student enjoyment in the classroom. Results showed an increase of 27% in class enjoyment when comparing a technology based classroom with a non-technology based class, taught by the same instructor, which did not incorporate technology using the same lessons. "Positive teacher attitudes toward information technology foster positive attitudes in their students" (Christensen, 2002, p. 429).

Science activities with handheld computers might be considered "best practice" in the sense that the material is beneficial and motivational for students to improve understanding (Gado, Ferguson & Van't Hooft, 2006, p. 507). "The greatest impacts of technology are in student and teacher interest and motivation," (Patterson, 2007, p. 24). With technology and the inquiry that is its companion, has allowed for students to feel that their learning is in their control, therefore they become active learners (Gado, Ferguson & Van't Hooft, 2006).

Technology fills a need. "Any educational product that is going to be successful must be able to keep learners on task" (Baule, 2007,p.17). It is engaging, flexible, and provides results. The use and success of technology based education is prepared to make students engaged and enjoy learning.

The significant investments made in technology hardware, software and infrastructure, demonstrate the need for support regarding the instructional integration of technology in the K-12 classroom (Barron, Kemker, Harmes, & Kalaydjian, 2003). It is apparent that in increase in technological innovation, to promote skills such as problem solving and synthesizing information are essential for today's students (Barron, Kemker & Kalaydjian, 2003). Using technology, students sharpen their skills of interpretation and concluding instead of the skills of data collection, which have already been mastered.

Technology fills a need in education, replacement of an existing item with a technological tool allows for greater productivity and lower error rate (Baule, 2007). For example, a laboratory activity that requires temperature data at 20 second intervals needs a minimum of two people, one to read the thermometer and one to record, maybe even a third to add reagents. With computer aided tools, you only need one student to set-up and push run to have the equipment collect data for you. Computer technology proves to be a highly efficient system which allows more time for the interpretation of the data instead of the collection of data.

Research suggests, effective science instruction should focus on four crucial skills: (a) laboratory skills, (b) hands-on learning, (c) instructional technology, and (d) formative assessment (Wenglinsky, 2007). "Teachers with these skills were more likely to avoid cookbook laboratory exercises and encourage their students to make connections between laboratory exercises and underlying scientific concepts" (Wenglinsky, p. 25). To design a laboratory exercise in chemical reaction prediction is an example of knowing concepts, not repeating content knowledge. It is through the use of "sophisticated research instruments" that students are better able to observe and experience science knowledge (Wenglinski, p. 26).

Students whose teachers addressed laboratory skills scored nearly one-half a grade level above students whose teachers lacked such instruction (Weglinski, 2007). The quality of instruction and education depends on the representational tools at the students' disposal and how they are used (Lattery, 2004). Laboratory skills developed with technological tools are better able to transfer into future educational endeavors or career opportunities.

Research findings indicate the uses of technology in hands-on engagement of learning leads to an increase in time spent on learning activities and high quality work (Swan, Van't Hooft, Kratcoski & Unger, 2005).

> "Teachers should allow for real world application and curriculum to which the students can relate. Emergent curriculum based on the interests of students can be implemented and easily facilitated with handheld computers," (p. 507).

Once familiarity with the equipment exists, they engaged in more hands-on problem-based, student-initiated inquiry (Gado, Ferguson & Van't Hooft, 2006).

Technology in education acts as a catalyst for integration of instructional technology and math/science (Clark & Ernst, 2007). Findings suggest the personalization of learning supported by hand-held computing devices and their potential usefulness in amplifying learning is already extended outside the classroom (Swan, Van't Hooft, Kratcoski & Unger, 2005). Handheld technology provides a way to extend the use of the desktop computer to field environments in which a smaller, mobile technology can be used to collect data and content to be returned and further expanded through a desktop computer (Franklin, Sexton & Hongyan Ma, 2007).

Engagement in reflective and constructive analysis of personal experiences using the digital collection devices demonstrate the value in formative assessment (Gado, Ferguson & Van't Hooft, 2006). Formative assessment informs the process for ensuring learning among diverse individuals (Tomlinson & Germundson, 2007).

The provisions of the No Child Left Behind Act, authorized in 2001 by the United States Government, demands schools meet the needs of all students in all grade levels (Handson, Burton &Guam, 2006). Provisions in this act have spawned numerous school improvement initiatives and reform (Handson, Burton & Guam, 2006). Schools must take a series of steps to meet these demands to achievement of these meeting student need goals. One of these goals is to test students not only in the areas of math and reading but, as of the 2007-2008 school year, science as well. A step toward this goal is integration of technology in education to make students accountable for their own learning, thus higher achievement. An additional step to meet these requirements is to support integration of accountability and data-based decision making skills into curriculum.

Research Area

Computer-based science activities enhance student inquiry abilities, organizational skills, engagement in science content learning, and attitudes (Gado, Ferguson & Van't Hooft, 2006). The National Science Education Standards indicate the relationship between science and technology is so close that any presentation of science without developing an understanding of technology would portray an inaccurate picture of science. It is time for education and technology to collaborate and show it is essential for student success to have the two lead together (Hanson, Burton & Guam, 2006).

Concurrent with the standards movement, educators need to emphasize technological skills rather than on the hardware and programming of such tools (Barron, Kemker, Harmes & Kalaydjian, 2003). Technology taught as a tool used to communicate, conduct research, and solve problems is more in alignment with these standards.

These data collection devices, are mobile and flexible to use. They make it possible to communicate, conduct research and solve problems. Collaboration or communication between multiple users and real-time data collection in scientific investigations allow for a seamless integration of technology and learning. In other words, the technology allows for real-time interpretation. "When used appropriately, technology can have a beneficial impact on teaching and learning," (Franklin, Sexton &

Hongyan Ma, 2007, p. 42). As the research data is being collected, changes can be made and immediate results seen, cause and effect data. The data that is collected is directly projected into the computer's graphing program and multiple students can project their data on the same graph, which offers great opportunities for scientific reasoning.

Mobile handheld computing devices have evolved into powerful and affordable learning tools (Franklin, Sexton & Hongyan Ma, 2007). The small size and versatility have allowed for effective instructional tools. Of the teachers surveyed by Franklin, Sexton, and Hongyan Ma, 89% claim the handhelds to be an effective tool for teachers, 93% believe that handhelds can have a positive impact on students' learning, and 72% agree handhelds are more easily adaptive to the classroom flow of activity than desktop computers. Only a fraction of those participating in the study pronounce a difficulty in the use/temporary failure of the equipment. Overall, portable collection devices aid in organization/planning, gathering and analyzing information, learning and collaboration.

Small school district utilize the school to work or service learning as advanced education for those students who do not further their formal education after their senior year of high school. Incorporation of technology throughout students' collaborations with clients can help situate their practices within larger public contexts (Turnley, 2007). Professor Turnley, Service-Learning Researcher at New Mexico State University, reveals those students continuing their education and those that are not, can benefit by using and highlighting technology, communications can be drawn between technology and project management issues such as, collaboration, ethics, document design and research, which will be obstacles for both walks of life (Turnley, 2007). The world of work is changing as so is the world of technology. Opening the minds of students to learn concepts and techniques of content with technology also opens doors of opportunity for them throughout their lives (Handson, Burton & Guam, 2006).

Perhaps the strongest argument for gathering data interpreting the information from digital tools comes from Arizona State University (ASU) and their Modeling Instruction Program. The Modeling Method proposed by ASU has been developed to correct many weaknesses of the traditional lecture-demonstration method, including fragmentation of knowledge, student passivity, and the persistence of naïve beliefs about the physical world (Wells & Hestenes, 1995). This method allows students to be "actively engaged in understanding the physical world by constructing and using scientific models to describe explain, predict and control physical phenomena" (Wells & Hestenes, 1995, p. 606). Determining the relationship between the length of the string a bob s attached to in correlation to the time it takes to complete a period (a back and forth swing) is concept that can be easily discovered by the student using these technological tools. Adoption of the Modeling Method brings instruction closer to the emulating scientific practice. Tools, computers and handheld devices, are essential in completing the analysis and reasoning necessary to make the method successful. If data cannot be collected accurately and in a timely fashion, student interest is lost and/or data is unrepresentative of the task at hand. Using the modeling method and Vernier technology, for example, students uncover the rate at which gravity affects all things. Instead of being told, the learner discovers and retains the new information. The results of comparing a traditional classroom style and a classroom exercising the Modeling Method are astounding. The pre and post-test results of the Modeling students using technology showed an out-performance of 21% in content knowledge of both college level and high school level students compared to traditional methods (meaning those without student inquiry-based technology driven instruction).

The main focus of all teaching is to make students accustomed to supplying not just answers and clear explanations of how they got them, but also full justification for their approach (Schmitt & Lattery, 2004). The quality of the understanding depends on the representational tools at the students' disposal, and how they are used (Lattery, 2001). A student collecting data while riding an elevator using technology tools can collect 1000 or more data points every second, while the student using a watch and pad of paper can collect 1 data point every second if he/she is a fast writer. The experience lends to insight into both the content and the process of science (Lattery, 2001).

The Modeling Method (first designed for physics education) has, since Wells and Hestenes study on Modeling Method for Instruction (1995), gone beyond the science of physics to include chemistry, biology, and physical science. The method has shown tremendous gains in the content reasoning and understanding of physics that is has gone into these other science content areas. The value of the Modeling Method in all science content areas is strongly advised to grasp the principles and concepts to reliably reason and problem-solve. A biology student can collect the gases evolved from a respiring grass hopper in an oxygen rich environment and one in an oxygen deprived environment.

Summary

Science activities with handheld computers might be considered best practice in the sense that the material is beneficial in bridging the gap between science education and technology education (Gado, Ferguson & Van't Hoof, 2006). The use of handheld computers and digital collection devices during science investigations promotes the notion of autonomy. This allows students to develop greater self-regulation and control during the learning process, and gain knowledge beyond what could be gained using textbook or traditional laboratory investigation beyond a non-technology based classroom. It allows greater experience and exposure to tools that will be used in their future not those that are for educational purposes only.

Chapter III: Project Goals and Objectives

According to the EnGauge Survey (2006), given to the parents of the Randolph School District, the need to improve the use of technology in all content areas was high improvement possibilities. The citizens of Randolph want to be better informed and included in the use of technology in the school. Citizens of the school district are beginning to question the ability of the school to prepare students in the area of technology. Due to this increased interest and desire for improvement, the science department is requesting funding to increase the students' exposure to digital data collection devices and allow for the presentation of such tools to community members. To meet the desires of the community and standards set by the department of education the science department has developed a plan to integrate technology into the science classrooms and community events.

Goal 1: To Increase Science Achievement on the WKCE (Wisconsin Knowledge and Concepts Exam) Test

By updating the current equipment (which is minimal and repair equipment is no longer available) used for student laboratory data collection, students will gain more experience and opportunity to interpret data, develop background knowledge and experience in using technology for data collection. Increasing the number of laboratory activities within the physics and chemistry classes at Randolph High School will allow the opportunity for 100 students per year to experience hands on data collection and data extrapolation experience.

Goal 2: In Using Laboratory Techniques, Students Will Practice Problem-Solving Skills

The purchase of updated equipment will allow for real-world data collection. Those students who will be going directly from high school to work and those furthering their education will be provided with equipment experience they will actually use on the job or college-level laboratory. Science inquiry leads to a solution when relationships can be drawn from one concept to another. For example, when students study the concepts of buoyancy and density, laboratory exercises where students must understand a relationship of the amount of water displaced and the weight of an object leads to an understanding of Bernoulli's Principle.

The completing of staff training to develop instructional strategies and repeated student practice will allow opportunities for students to design and implement their own experiments. In doing so, the development of problem-solving skills and the identification of alternative scientific or technological solutions are further developed to solve problems and argue their merits.

Goal 3: Train teachers in the use and instructional strategies of the equipment

To address this goal members of the science department will attend a training seminar to ensure personal understanding of the tools as to be prepared to have students use the probes for temperature, light, voltage, and conductivity,. Training will expose staff to learning past practices and experiences in the use of the Vernier equipment to increase personal instructional strategies

Goal 4: Increase student enrollment and achievement in upper level science classes

The opportunity is available to all students to enroll in classes of chemistry, physics, advance chemistry, and advanced biology. Students enjoy using technological tools and the output they can gain from their use. The use of new equipment will increase not only the enrollment, but also the performance in such classes.

The increase in hands-on activities using collection devices will benefit all students, including those in the special needs programs and those students who have English as a second language (ESL). Due to the ease of use and ability to collect data, special education students will be able to view the experiment while it is occurring instead of multi-tasking (writing the data and conducting the experiment at the same time). ESL students will not be required to make immediate translations of data, as it is collected and stored to be viewed at one's own time and pace.

By increasing the quality of our science equipment, the school district has the possibility to offer more Advanced Placement courses that would not otherwise be available. The requirements of offering college credit are very strict for high school programs. By providing the same or similar equipment that the college course offers, encourages the possibility of the label advanced placement and high scores on the tests that come with the label and grant higher education credit.

Goal 5: Create a Greater Connection to the Community

The school and community are always looking for ways to help each other. The industry and members of the village of Randolph support the school district by attending school functions, both athletic and academic, and sustaining our fund-raising efforts. It is time we demonstrate what we are educating students on and the technology we are using to do so. The demonstrations provide help to community members identify personal household problems. By hosting semi-annual workshops during the art fair, music concerts, parent conferences, and/or book fairs, students will demonstrate their use and knowledge acquisition of the handheld digital collection devices to test community members' water, soil, or other item(s) of concern.

This also allows for students to develop connections with community members. Most often people are assisted by those they already know. By making public appearances, students have greater visibility to business and industry to gain employment and/or scholarship opportunities.

Chapter IV: Project Methodology

Action Plan

The project will begin in June and July of the year 2008. At that time the equipment will be purchased and the training seminar will take place. In August of the same year, data collection will begin (enrollment and academic performance). The school year to follow, 2008-2009, the students will begin using and become familiar with the equipment. A community service event will also take place during this time. The end of the school year, May 2009, the final survey will be given. The science department will compile data in June and July of 2009 and growth will be evident from the results. Reports will be given to local media reporting the increase in student achievement. The table below outlines the activities of the plan and when they will be completed.

Table 1:
Project Timeline

Date	Activity
June-July 2008	Purchase equipment Attend training seminar
August 2008	Collect and compile data (enrollment and grade performance in science classes)

September 2008- May 2009	Use equipment
	Begin semi-annual community service
May 2009	Offer assessment survey
June-July 2009	Collect and compile data
August-December 2009	Note results

Assessment Tools

As a means to assess the success of the project, the Randolph Science Department will look at enrollment trends over a 5 year period (looking for an increase in student enrollment in science classes after the grant with new equipment versus before equipment). A comparison of the average grade earned before and after the use of digital collection equipment will be made. The grades will be looked at for all students enrolled in science. We realize the data will be slightly limited as students will be at a different grade level as the data will be collected over a two year period. An overall comparison will be made, no breakdown of sex or gender will be conducted.

A survey will be given to students at the beginning of the school year, before the use of the equipment and at the end of the year, after using the equipment (See Appendix A for pre-equipment survey and Appendix B for post-equipment survey). The surveys include questions regarding the use of technology and if the student feels he/she has gained more knowledge using the technology that if it was not available.

Budget

Personnel

Science educators of the district, will need the necessary training and experience to use these tools in the classroom. There are currently two teachers in need of the training at the high school level. The training will provide integration activities to be used in the classroom and proper setup and use of the Vernier brand data collection equipment and software. Training cost is $299.00 per person (2) per session for a total training cost of $598. Teachers are willing to attend the training without fee and no substitute teachers will be necessary, as the training is held in the summer months.

Travel

Training opportunities are held in select areas only. The closest training for our project will be in Chicago, Illinois. The training is held in June and July. The cost of travel for 200 miles at $0.46 per mile will amount to $92.00. No over-night fees will be needed as the training is for 1 day only.

Supplies and Services

There are numerous suppliers of hand-held data collection devices. They include Vernier, Pacso, IntelliGolf, Palm, Avago and Intermec. We have selected the Vernier brand hand-helds and probeware due to the education friendly and vast capabilities it offers. Vernier equipment is able to move to remote areas, user-friendly attachments, and software that can be used to enter the probeware data and data collected manually. The Vernier products allow the user to create graphs, tables, and access other powerful analysis tools.

The purchase of the Vernier Deluxe Package includes ten of each item (images taken from www.vernier.com):

Figure 1: Vernier Lab Pro LabPro interface is used as the heart of the data-collection system. It plugs into the computer while collecting data or after, if the data is collected at a remote location, and detects the sensors attached that are being used to make measurements.

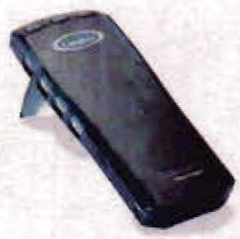


Figure 2: Motion Sensor The motion detector sensor attaches to the LabPro to start and stop time in velocity, acceleration, position, and other motion-type data.

Figure 3: Force Sensor The dual range force sensor is used to study friction, harmonic and circular motion, and impact. It replaces/enhances the use of a spring scale.

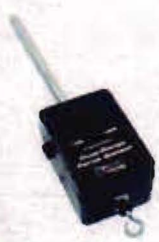


Figure 4: pH Sensor The pH sensor is used to find the level of hydrogen ions in a solution to give accurate acid/base values. It replaces/enhances the use of pH papers and indicators.

Figure 5: Voltage Probe The voltage probe is used to measure both alternating and direct currents in circuitry.

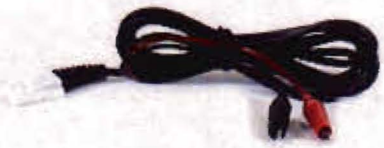


Figure 6: Temperature Probe The temperature probes are used for investigating temperature at user-set time intervals.

Figure 7: Light Sensor The light sensor is used to study energy, reflection, and polarity.

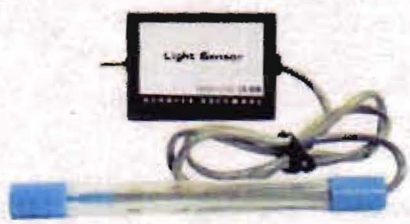


Figure 8: Conductivity Probe The conductivity probe is used to test for ability of solutions to conduct electricity and detect concentrations of solutions.

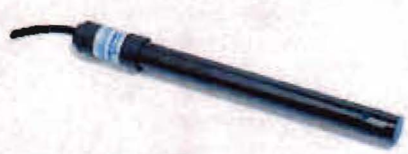


Figure 9: Gas Pressure Sensor The gas pressure sensor is used to test gas laws of volume/pressure/temperature.

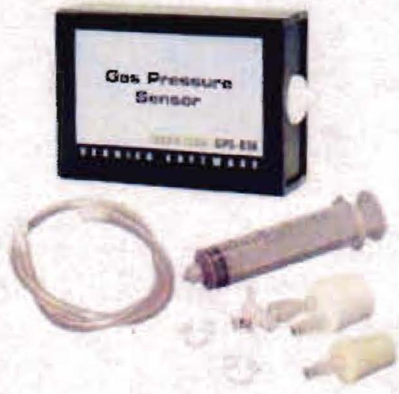
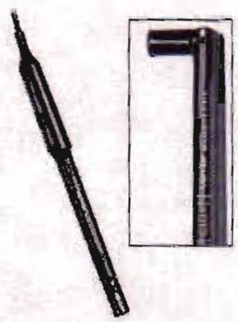


Figure 10: Magnetic Field Sensor The magnetic field sensor is used to study magnetic forces of the earth, magnets, and coils.



The science department is requesting ten of such packages to allow each lab group, 2-3 students, a collection package. Graphing calculators will be needed to collect data that may be collected outside of the classroom. The TI-83 Teacher Pack includes 10 student calculators, 10 guidebooks, a poster, 10 unit-to-unit cables, one USB TI-Connectivity cable and 40 batteries. To allow for demonstration of the proper use of the equipment and classroom collection data a projecting calculator screen and a teacher projecting calculator will allow for class discussion. These tools are not included in the package but are necessary for developing student technology knowledge and comfort. Teacher support materials (software and lab books) will be valuable resources to get started on development of our own projects and allow for practice use of the equipment. The total cost of the Teacher Pack and accessory tools is $10,804.00 (shipping charges are also added in this total).

Cost Sharing

This equipment will be used for multiple years and shared among classes. Our district is requesting the Toyota Corporation, through the Toyota Tapestry Grant Program, to help with the funding of the equipment, while the Randolph School District will also demonstrate their commitment by paying for the training and travel expenses, as well as the batteries and paper duplicating supplies needed each year. A breakdown of the budget is shown in Table 2.

Table 2:
Budget Request (quotes taken from Vernier Data-Collection Technology)

	Quantity	Cost (each)	Totals
PERSONNEL			$897
Teacher Training	3	$299	$897
TRAVEL			$92
Travel for Training	200 miles	$0.46/mile	$92
SUPPLIES AND SERVICES			$10,804
Venier Deluxe Package	10	$875	$8750
Set of Graphing Calculators	1	$980	$980
Projecting Screen	1	$326	$326
Projecting Calculator	1	$139	$139
Support Materials	1	$159	$159
	3	$45	$135
Shipping Charges	1	$315	$315
PROJECT TOTAL			$11,797

Dissemination Plan

The interest of the community in increasing technology usage at school is among high concern (EnGuage Survey, 2006). The local paper, school paper, and school webpage is devoted to publishing new findings in the school and use of technology. Providing articles and photographs will spark interest of parents, past, present, and future students. A presentation/demonstration of the new equipment to other staff and other science teachers at in-services and conferences held at the school and neighboring districts to further promote and offer gratitude to the supporting agencies. "The whole art of teaching is only the art of awakening the natural curiosity of young minds for the purpose of satisfying it afterwards" (Torres, 2005, p.4). With the help of the Tapestry, Randolph can create science and technological curiosity in the minds of students.

Chapter V: Discussion

Anticipation of Results

The school district anticipates an increase in enrollment, academic achievement, and overall motivation in students in science classes. The resistance to the use of technology in laboratory exercises we foresee occurring are: (a) student worry over breaking or impairing the equipment, (b) overall lack of confidence in using technology, and (c) parent/community concerns about not learning data collection the way they once had to. Student apprehension over technology breakage or malfunction is something we encounter with computer and we see the same may hold true for the Vernier equipment. Some students demonstrate resistance in technology use and may need additional coaxing to use and exhibit freedom to explore with the equipment. The parents may make evident their feelings of reluctance as they were taught the "old fashion way" and they still learned the information.

Literature Review Correlation

As stated in the above literature review, the integration of technology and science education is becoming a necessary development in the educational curriculum of high school science. Making the science department a "handheld-centric classroom, a place where teachers and learners have access to personal and shared digital tools making up a total technology infrastructure," (Gado, Ferguson, and Van't Hooft, p. 502). The use of digital collection tools and the training necessary will allow for the Randolph School District to meet these demands of education and more importantly, society.

After review of the literature, it is apparent that an effective instructional environment is one to strive for by increasing student engagement, use of authentic assessment, and making learning fun (Aarons, 1997). To develop functioning citizens, students must have the technological ability to solve problems and test their knowledge in the scientific processes that create solutions.

Further Study

The district anticipates further research in the area of student behavior and technology classrooms. In the literature review, authors: Torres., Swan, Van't Hooft, Kratcoski, Unger, and Christiansen, mentioned student behavior trends showing an increase or becoming more positive with the use of technology in the classroom. I see the possibility of an extension into the special education students who require behavior modification plans to remain in a regular education classroom.

As high school graduation requirements increase, I predict electronic portfolios to be an additional requirement. The electronic portfolio is a display of knowledge gained via a computer generated collection of assorted works. Using the skills and tools available from the science department, students will be better able to display themselves electronically in this portfolio, as much of their science assessments will already be computerized.

We also await the increased use in other disciplines using the equipment, specifically mathematics. The digital collection devices have endless possibilities with graphing and formula manipulation. Correlation with the math department will offer the students of Randolph High School greater exposure and valuable insight in the development of mathematical models.

Extended Knowledge

This grant proposal contributes to the ideals of state and national curriculum standards. It goes beyond the mandated forms and statements of educational growth. Using digital equipment, the students of the Randolph School District will have an advantage to students of other schools with similar enrollments. The results of the research will demonstrate to other districts the necessity of a small financial investment to gain monumental content knowledge growth. Demonstrations of the tools offered at conferences and in-services will facilitate this need and create desire amongst other districts to follow Randolph School District's lead in science education and technology integration.

References

Aarons, A. (1997). *Teaching Introductory Physics.* New York: Johns Wiley & Sons, Inc.

Barron, A., Kemker, K., Harmes, C., & Kalaydjian, K. (2003). Large-Scale research study on technology in K-12 schools: Technology integration as it relates to the national technology standards. *Journal of Research on Technology in Education, 35*(4), 489-507.

Baule, S. (2007). The components of successful technologies. *Teacher Librarian, 34(5)*, 16-18.

Christensen, R. (2002). Effects of technology integration education on the attitudes of teachers and students. *Journal of Research on technology in Education, 34(4),* 411-434.

Clark, A., & Ernst, J (2006/2007). A model for the integration of science, technology, engineering, and mathematics. *Technology Teacher*, 66(4), 24-26.

Engauge Survey (2006). Randolph School District.

Fortier, J., Grady, S., & Lee, S. (1998). Wisconsin's Model Academic Standards for Science. *Wisconsin Department of Public Instruction*, Milwaukee, WI.

Franklin, T., Sexton, C. & Hongyan Ma, Y. L. (2007). PDAs in teacher education: A case study examining mobile technology integration. *Journal of Technology and Teacher Education, 15*(1), 39-57.

Hanson, D., Burton, D., & Guam, G. (2006). Six concepts to help you align with NCLB. *The Technology Teacher, 66(1),* 17-20.

Lattery, M. (2001). Thought experiments in physics education: A simple and practical example. *Science and Education*, 1-12.

Patterson, P. (2007). Mission possible: Teaching through technology. *Principal*, 86(3), 22-25.

Schmitt, J., & Lattery, M. (2004). Facilitating discourse in the physics classroom. *Modeling Physical Science*, 1-52.

Swan, K., Van't Hooft, M., Kratcoski, A., & Unger, D. (2005). Uses and effects of mobile computing devices in K-8 classrooms. *Journal of Research on Technology in Education, 38(1)*, 99-112.

Tiwari, A., Lai, P., So, M., & Yuen, K. (2007). A comparison of the effects of problem-based learning and lecturing on the development of students' critical thinking. *Medical Education, 40,* 547-554.

Tomlinson, C., & Germundson, A. (2006). Teaching as jazz. *Educational Leadership,* 64(8), 27-31.

Torres, R. (2005). The art of teaching. *The Agricultural Education Magazine, 77*(6), 4.

Turnley, M. (2007). Integrating critical approaches to technology and service-learning. *Technical Communication Quarterly, 16*(1), 103-123.

Van't Hooft, I., Gado, R., & Ferguson, M. (2006). Using handheld-computers and probeware in a science methods course: Preservice teachers' attitudes and self efficacy. *Journal of Technology and Teacher Education, 14*(3), 501-529.

Wells, M., & Hestenes, D. (1995). A modeling method. *American Journal of Physics, 63*(7), 606-619.

Wenglinski, H. (2006/2007). The science teachers need. *Educational Leadership, 64(4),* 24-29.

Zimmerman, B., & Tsikalas, K. (2005). Can computer-based learning environments (CBLEs) be used as self-regulatory tools to enhance learning? *Educational Psychologist, 40(4),* 267-271.

Appendix A: Cover Letter

April 23, 2007

NSTA/TOYOTA
1840 Wilson Blvd.
Arlington , VA 22201-3000

To Whom It May Concern,
The Randolph High School Science Department is pleased to submit a proposal for grant program. As your guidelines request, I have enclosed the required information and documents. The Randolph High School is facing increasing demands for providing quality education particularly in the area of science education. A recent survey demonstrates the need for increased technology in the science department. Toyota Tapestry Grants have been awarded to numerous schools that demonstrate such a need. By increasing the use of technology in science laboratory equipment, students will be better prepared to meet the demands of college level coursework and work experiences. The school district would be extremely grateful to receive such funds that can broaden the science curriculum to better meet the nation's No Child Left Behind requirements.

The benefit to both your company and our science students would be beyond measuring. Thank you for your time in considering our proposal. Please feel free to contact me, Jackie Drews at the Randolph High School- phone (920)326-2425 ext. 2402.

Sincerely,

Jackie Drews, Science Chair
Randolph High School
110 Meadowood Drive
Randolph, WI 53956
jdrews@randolph.k12.wi.us

Enclosures

Appendix B: Grant Foundation Proposal Request

2006 TOYOTA TAPESTRY PROPOSAL APPLICATION FORM

PROJECT TITLE: ____________________

ENTRY CATEGORY (Please check one):
- ☐ Environmental Science Education
- ☐ Physical Science Applications
- ☐ Literacy & Science Education

Budget total (not to exceed $10,000): ____________________

☐ Large Grant (up to $10,000) ☐ Mini-Grant (up to $2,500)

School type: ☐ Rural ☐ Suburban ☐ Urban

Approximate school population: ____________________

CHECK ONE: ☐ Dr. ☐ Mr. ☐ Mrs. ☐ Ms.

Name: ____________________

Complete home address: ____________________ City ________ State_____ Zip________

School name: ____________________

Complete school address: ____________________ City ________ State_____ Zip ________

Home phone: (___) ________ School phone:(___) ________ Ext. ____ Fax: (___) ________

Work e-mail address: ____________________ Home e-mail address: ____________________

Names of project staff (optional, maximum of four): ____________________

____

Have you ever been awarded a Toyota Grant? ________ If yes, which one and what year did you win? ________

GRADE LEVEL TAUGHT (Please check one): ☐ Elementary School ☐ Middle School ☐ High School

Grades taught (K-12): ____________________ Primary discipline taught: ____________________

Number of years teaching science: ________ Number of science classes taught per day: ________
(Minimum three years) *(Not applicable to Elementary Teachers)*

Project Director: ____________________ Date: ________

Name: ____________________ Title ____________________

Home phone: (___) ________ School phone:(___) ________ Ext. ____ Fax: (___) ________

Work e-mail address: ____________________ Home e-mail address: ____________________

☐ I have read and support this proposal. To the best of my knowledge, I verify that the applicant will remain employed at my school for the 2006-2007 school year.

Principal: ____________________ Date: ________

In order to determine the degree to which diverse segments of the population are served by this program, we would like the Project Director to respond to the questions below. Completion of this section is voluntary. Awardees will be selected on merit, regardless of race, religion, national origin, or gender.

☐ Direct Mail ☐ Teacher Magazine ☐ Science & Children

☐ Science Scope ☐ The Science Teacher ☐ NSTA Conventions ☐ Colleague ☐ Internet ☐ Toyota ☐ Other ________

☐ Male ☐ Female

☐ Caucasian ☐ African American ☐ Asian ☐ Hispanic ☐ Native American ☐ Other

☐ Yes ☐ No If yes, how many times? ________

☐ Yes ☐ No

☐ Yes ☐ No

Completed proposals must be received by 5p.m. EST, Thursday, January 19, 2006.
Toyota TAPESTRY, c/o NSTA, 1840 Wilson Boulevard, Arlington, VA 22201-3000 NO FAXED PROPOSALS ACCEPTED.

Appendix C: Pre-Equipment Science Technology Survey

What current class are you in (circle one)?
Introduction to Physics and Chemistry
Chemistry
Physics
Advanced Chemistry

What is your current grade in school (circle one)?
9 10 11 12

What is your current grade in this class (circle one)?
A B C D F

On a scale of 1 to 10 (10 being high), how do you rate your enjoyment level in doing classroom laboratory activities?

Do you feel comfortable with the skills you have gained in collecting data?

Did you think it will be difficult to conduct laboratory exercises in advanced education or on the job laboratory tests without the use of technology in class?

Would you like to use new equipment, similar to what you might be using in college or on the job, in class?

Appendix D: Post-Equipment Science Technology Survey

What current class are you in (circle one)?
Introduction to Physics and Chemistry
Chemistry
Physics
Advanced Chemistry

What is your current grade in school (circle one)?
9 10 11 12

What is your current grade in this class (circle one)?
A B C D F

On a scale of 1 to 10 (10 being high), how do you rate your enjoyment level of using the Verner equipment compared to last year without it? Explain.

Do you find it easier to collect data using the new probes?

Did you find it difficult to learn to use the Verner equipment?

Now that you have experienced using the equipment does it interest you in taking other science classes that use this equipment? If so, which classes?

Do you feel using the Verner equipment has improved your grade?

Do you see the correlation of using the Verner equipment and the labs that correspond to it with class discussions?