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"Teaching is an instinctual art, mindful of potential, craving of realizations, a pausing, seamless process." - Bart Giamatti, former president of Yale University and former National League Baseball Commissioner

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Navigating the Future of Professional Development

Introduction

Florida has identified a critical need to attract, train and retain science and mathematics educators in their respective fields. In a report published by the Florida Department of Education, findings indicate that middle and high school level mathematics, science, and technology areas represent half of the subjects where Florida is facing a teacher shortage. The report also found that 23-percent of new science teachers and 14-percent of newly hired teachers are teaching out of their fields.

Seeking to address these issues, Florida’s Technological Research and Development Authority (TRDA) sought and received funding from the US and Florida Departments of Education to create and run a unique teacher professional development organization.

This paper will review current research, and look at possible avenues to address the science and mathematics teacher shortage. One alternative, TRDA’s The Endeavour Academy, will be discussed in detail. The Endeavour Academy is a teacher professional development organization that offers diverse, hands-on, content-based programs designed and delivered by experts in science, mathematics and technology subject areas. Objectives of the program include improving the qualifications of and helping to recruit and retain mathematics and science teachers and giving teachers’ tools and curricula to adapt for the classroom.

Background Information and Research

“Science scores for fourth and eight graders remained unchanged between 1996 and 2000. Unfortunately, that’s the good news. Everyone should be concerned. Eighty-two percent of our high school seniors are not proficient in science. Education Secretary Rod Paige said the study by the National Assessment of Educational Progress tested about 49,000 students across the country. The three-point drop for high school students is especially troubling, Paige says, at a time when math and science skills have never been more vital to everyday life.

Some of us serve our country as scientists. The rest of us can serve our country by ensuring that, in science and math and in reading and history and in the other subjects, that no child is left behind.” (Radio cut, The National Assessment of Educational Progress report on science education. 2001).

“Education Secretary Rod Paige was among the speakers at a “Summit on math education” held by the American Association of Publishers. We need to study how young children learn arithmetic and simple arithmetic concepts as well as how older children learn the more rigorous concepts. He said parents can give their kids a head start on skills like counting and basic concepts like more, or less, or half. Making children comfortable with these concepts prepares them to learn better when they reach first grade. Understanding how students learn math, and using that understanding to improve how math is taught will be vital, Paige says, to making sure that no child is left behind without the skills needed to succeed.” (Radio cut, The National Assessment of Educational Progress reports on science education. 2001).

“In an age now driven by the relentless necessity of scientific and technological advance, the current preparation that students in the United States receive in mathematics and science is, in a word, unacceptable.” This is evaluation of current educational standards in ‘Before it’s too late: A report to the nation from the National Commission on Mathematics and Science Teaching in the 21st Century.’ (September 27, 2000) Sadly this sentiment is echoed in study after study.

The Commission further suggests there are four compelling reasons for students to achieve competency in these areas. First is the constant of change in the global economy and in workplace demands in science, mathematics and technology; second is that every citizen needs basic comprehension of math and science for everyday decision-making; third is national security interests and fourth is that the “deeper, intrinsic value of mathematical and scientific knowledge shapes and defines our common life, history and culture.”
One widely-held belief among many education experts that American students are under-performing in the science and mathematics fields when compared to their peers in other countries. This perception was quantified in The Third International Mathematics and Science Study and its companion study in 1999. (TIMSS and TIMSS-R). “The TIMSS 1999 Benchmarking Study enabled states and school districts within the United States to participate in TIMSS 1999, also known as TIMSS-Repeat or TIMSS-R. TIMSS 1999 enabled countries to evaluate their mathematics and science programs in an international context.”

The TIMISS-R study involved students in 41 nations. The results were startling in both their student and teacher assessment. On the student level, the students in the 13 participating U.S. states had average performance in mathematics, clustering in the middle of the participating countries; science performance was slightly better with U.S. students clustering in the upper half of international distribution; US students generally had poorer scores in measurement and geometry as well as in physics. U.S. students performed very well up to the fourth grade. (TIMISS)

This mirrors the findings of various studies through the years. “There was a steady decline in science achievement scores of U.S. 17-year-olds as measured by national assessments of science in 1969, 1973, and 1977.” (A Nation At Risk: The Imperative For Educational Reform, April 1983)

TIMISS also quantified teacher preparation by country. “Results varied dramatically across the Benchmarking jurisdictions concerning the percentages of students taught by mathematics majors, but there was more consistency in the high percentages taught by teachers with education majors. This pattern was the reverse of that found for the five high-performing Asian countries. A similar pattern was found in science, but the picture is complicated by the fact that teachers can major in different science subjects – e.g., biology, physics, or chemistry.” (New TIMSS Report: U.S. Benchmarking Results for Eighth Grade Math & Science Performance in 13 States, 14 Districts/Consortia, April 4, 2001).

Ironically, when asked how prepared the teachers felt they were to teach in their particular subject, 75 percent of American mathematics educators rated themselves “very well prepared” but only 27 percent of science teachers felt “very well prepared.”

The study also found that students receiving more hours of instructional time in mathematics and science did not guarantee success. “Providing instructional time is not sufficient, however, if that time is not spent productively. Interestingly, the teachers in Korea as well as in high-performing Naperville and the First in the World Consortium reported comparatively less amounts of instructional time than many of the other TIMSS participants.” (New TIMSS Report: U.S. Benchmarking Results For Eighth Grade Math & Science Performance in 13 States, 14 Districts/Consortia, April 4, 2001).

TIMSS proved that interruptions detract from instructional time. In Japan and Korea, countries that scored very high in TIMISS, the majority of students were in mathematics and science classes that never had interruptions for announcements or administrative tasks. Indicative of further erosion of instructional time, compared to international students, the Benchmarking participants reported an unusually large amount of classroom time devoted to working on homework, particularly in mathematics. Participants in the study were asked how often the eighth graders started homework in class. The U.S. participants reported working on homework in class 74 percent of the time, compared to the range of 43 to 90 percent of international students.

Dr. Ina V.S. Mullis and Dr. Michael O. Martin, co-directors of the International Study Center at Boston College concluded, “TIMSS Benchmarking reports provide a unique perspective for a systematic investigation of educational policies and practices. It is clear from the TIMSS results that improving students’ opportunities to learn requires examining every aspect of the educational system, including the curriculum, teacher quality, availability of resources, students’ motivation, instructional effectiveness, parental support, and school safety. TIMSS reminds us that there is no "magic bullet" or single factor that is the answer to higher achievement in mathematics or science. Raising achievement involves improvements in a number of important areas related to educational quality.”

The shortage of teachers in mathematics and science is particularly severe. “A 1981 survey of 45 States revealed shortages of mathematics teachers in 43 States, critical shortages of earth sciences teachers in 33 States, and of physics teachers everywhere. Half of the newly employed mathematics,
science, and English teachers are not qualified to teach these subjects; fewer than one-third of U. S. high schools offer physics taught by qualified teachers.” (A Nation at Risk, 1998)

Recognizing that many educators are not qualified in every area, the State of Florida requires consistent professional development. The Department of Education Web site notes “it is essential that educators keep current with the latest research and innovations if higher student achievement is to be realized.”

“The 1997 comprehensive study of Staff Development in Florida revealed that on a given non-instructional day, Florida’s school districts deliver more than 6000 offerings in professional development for the state’s over 135,000 teachers, not including school - generated professional development events.” (www.firn.edu/doe/profdev/inserv.htm)

Education Secretary Rod Paige recently said, “Not only do we still have an achievement gap between races and economic groups, but this gap is not shrinking, and it may even be widening.”

He noted that the U.S. government has spent nearly 125 billion dollars on primary and secondary education, but without quantum leaps in the quality offered. “We have got to put it to better use. What has been missing from our education system is not money, it's results. Our system needs more money, but it also needs reform. (Remarks by Education Secretary Rod Paige at the American Federation of Teachers’ Quality Educational Standards in Teaching, Biennial Conference, Washington, DC, July 13, 2001.)

The ‘Before It’s too Late’ report notes that teaching style, in most cases, has not changed to reflect technological improvement, innovation and the changing world. The report names the characteristics of high quality teaching and implies that by focusing educator preparation and on-going, consistent, integrated professional development, mathematics and science students will progress. (September 27, 2000)

**Addressing the qualified teacher shortage**

Before it’s Too Late said there are two premises at the core of the report. The first is that American students must improve mathematics and science performance, thus the title. The second premise seeks to give hope by suggesting the solution is as simple as creating an environment of better teaching for the students. Which would result in improved performance.

At the college level, students could be taught how to teach with a more equitable balance of teaching theory with practical application. Whereas students through the fourth grade are testing at acceptable learning levels, as the student ages, teachers fail. College curricula would be developed to teach mathematics and science at specific levels, for example high school mathematics or middle school science. Widespread changes in colleges seem unlikely as a short-term solution.

Specialists could be trained to go into schools to teach teachers how to teach mathematics or science. These traveling specialists would teach teachers of certain grades in groups. For example, sixth through eighth grade science teachers could comprise one specific class. These specialists could be assigned school districts and simply rotate between the schools and grades, seeing each teacher several times a year. Costs for this alternative could be exorbitant for each school district.

Teachers are currently required to obtain yearly continuing education credits. This is most often done through conferences, which may or may not target a teacher’s specialty. While conferences are the preferred method, the teacher is at the mercy of the conference organizer’s standards.

**The Endeavour Academy**

Teacher training represents an exciting and affordable avenue to address the qualified teacher issue. Established with such a purpose in mind, The Endeavour Academy is a teacher professional development organization that offers diverse, hands-on, content-based programs designed and delivered by experts in science, mathematics and technology subject areas. The Academy’s mission is to assist school districts improve recruitment, preparation, retention and professional growth of math, science and technology teachers by using resources from the Space program, high-tech industry, and research institutions.
The program seeks to aid in the retention of science and mathematics teachers and to enhance student interest and performance in science and mathematics disciplines by:

- Expanding the knowledge base and qualifications of teachers in mathematics and science subjects
- Stimulating the use of innovative and hands-on methods of teaching mathematics and science
- Supplying teachers with turnkey systems to use in the classroom

Any teacher from Kindergarten through 12th grade is invited to attend the Academy. Workshops are divided into subject tracks and grade ranges. Mathematics, science and technology disciplines are segmented by subject and content. Grade ranges include K-2, 3-6, 7-9, and 10-12. The workshops are designed to carry over into the classroom. Instructors assist teachers with curriculum development conforming to Sunshine State standards during the workshop. Most workshops provide teachers with valuable take home equipment such as telescopes, star charts, circuit boards, interactive CD-ROMs, Web pages and prepared experiment kits for the classroom.

The Endeavour Academy brings together the finest science and mathematics workshops available into a concise catalog accessible in print and online. Teachers seeking professional development options can peruse the catalog, select workshops and sessions, and register online through the Academy Web site. Phone and mail registration methods are also available.

Wolves of the Sea is one workshop offering. Held at SeaWorld, Kindergarten through 12th grade teachers will find relevance for use in their science classes. The catalog explains the workshop in the following way: "What training techniques does SeaWorld use to communicate with the whales? How do we ensure that the animals are healthy and mentally stimulated? Through the SeaWorld Teacher Saturday’s program, The Endeavour Academy will offer K-12 teachers the opportunity to gain valuable professional development in marine and environmental science. Explore the incredible natural history of the ocean’s top predator. You’ll see killer whales first hand at SeaWorld.”

Another example of a workshop offering is Small Scale Chemistry, a workshop that offers 9th through 12th grade teachers the opportunity to strengthen their background in chemical analysis and gain hands-on knowledge of chemical instrumentation technologies through innovative, self-directed small-scale chemistry experiments. The workshop will be facilitated by a senior scientist in the Chemical Analytical Lab at Midwest Research Institute. Teachers will receive a toolkit containing over $200 of materials to utilize in the classroom, a teaching curriculum and laboratory manuals, an interactive chemical instrumentation CD-ROM, and a variety of additional tools.

A review panel comprised of educators, professional development representatives and content experts determine whether workshops will be included as part of the Academy curriculum. This panel is comprised of highly qualified individuals, many on the Ph.D. level. They will bring professionalism and experience to the table, benefiting every student. A call for participation to interested potential vendors is distributed and advertised three times per year. The Academy catalog is then updated to reflect new offerings and sessions based on selected workshops. Only those workshop offerings receiving positive assessment results will be renewed as Academy workshops.

All workshops will be marketed directly to teachers, school district professional development departments, and schools. A comprehensive marketing plan, including direct mail, brochures and posters will ensure that every science and mathematics teacher in Florida is aware of the Academy and its offerings.

Thanks to co-funding from the US and Florida Departments of Education and the Challenger license plate, the Academy offers workshops at reasonable prices. Costs vary for each workshop based on content and location. As part of the Technological Research and Development Authority, The Endeavour Academy will provide financial support to schools and teachers wishing to participate in workshops so that they have access to the quality programs of the Academy. Depending on the workshop costs, materials requirements and other incidental costs, assistance may include reduced workshop rates, stipends, and/or equipment costs. It is important to note this is not a grant program. Workshop providers
will offer programs through the Academy and receive compensation based on fees and the number of registrants.

The Endeavour Academy meets State of Florida requirements for professional educational training programs as set forth in Section 231.600, Florida Statutes. Each educator attending a workshop is eligible to apply for an in-service point for every instructional hour of the workshop. However, each teacher is responsible for applying for the points after completing the workshop.

The Academy will administer registration, marketing, bookkeeping and workshop assessments. Cash and in-kind matches from the responding organizations and from second parties are encouraged. Overhead is not allowed, however, direct workshop and administrative expenses may be included in the workshop budget. Workshop providers are welcome to engage in marketing activities; however those costs will not be covered through the contract with The Endeavour Academy.

The Endeavour Academy seeks to provide teachers and school districts with a measure of confidence in the training programs that are offered through the academy, and therefore encourages submission of only high-quality, innovative programs. The academy provides certain resources for distance learning and computer-based workshops through partnerships with Brevard Community College, the Midwest Research Institute, the Astronauts Memorial Foundation, NASA/Kennedy Space Center and other organizations and sites. Workshop sites may vary. Participants are welcome to use facilities at school districts, those made available through the academy, or workshop-specific sites of their choosing.

The programs will be available at various locations across the state, including sites on and around NASA-Kennedy Space Center, laboratories and industry facilities, on-site at schools/districts, and sites specific to field needs or through distance learning options.

Results and Measuring Success

The Endeavour Academy is committed to tracking teacher response to the workshops and actual impact on students. Recognizing that the surest way to success is by personal contact with those affected, teachers will be asked for immediate feedback through surveys at the close of each workshop.

Data obtained from these surveys will be used to gauge interest as well as expected impact on the students. This statistical data will be combined with classroom follow-up. A student pre- and post-test is being developed for teachers to give to their students. The test will be administered prior to the teacher’s attendance at the workshop and then again at the end of the year, allowing student progress to be tracked. The data obtained will be used to evaluate workshops and incorporate positive characteristics, resources and teaching tools into new workshop offerings.

A new test must be created because the FCAT does not yet cover science and technology, which makes it difficult to rely on FCAT scores as a measurement tool. As other measurement tools are created or become available, they will be integrated into the Academy’s success measurements.

Annually, the review panel will evaluate the workshop surveys, along with the pre- and post-test results from the students. Decisions will be made concerning the effectiveness and response to each workshop, thus ensuring high quality workshops are offered.

The Endeavour Academy is considering development of an emotive survey to gauge teachers’ attitude toward teaching and their comfort level. This tool would be expected to function as an indicator in the area of teacher retention.

Conclusion

In study after study, American students’ peers in the International community outperform them in the areas of mathematics and science. The ramifications of this are complex and far-reaching. The least is the impact on the individual student’s life. At the other end of the continuum, America’s future workforce is struggling to keep up with the changing world of math, science and technology, which directly affects our ability to compete in the global marketplace and economy.

The Endeavour Academy is designed to provide professional development for the educator, but always with the eye on the student. Experts in science, mathematics and technology subject areas will deliver the hands-on, content-based programs. The Academy will draw together the community of math
and science teachers by providing them with a central organization from which they can access resources, improve themselves, and capitalize on their talents.

The Endeavour Academy will also address the problem of educators teaching outside of their fields of expertise by giving them grade specific tools to use in their classrooms.

With funding from private and governmental sources, every teacher will have access to the program, and in turn every student can benefit from The Endeavour Academy and its progressive and cutting-edge approach. The Endeavour Academy provides a clear cut map for educators as they steadily navigate their professional development.

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