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## Paper Session II-D - Project Vision: A Model Program to Educate the Next Generation of Engineers, Scientists, and Mathematicians

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# **Project VISION: A Model Program to Educate the Next Generation of Engineers, Scientists and Mathematicians**

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## **Abstract**

Project VISION (Very Intensive Scientific Intercurricular On-Site Education) is a joint effort among NASA/John F. Kennedy Space Center, Florida International University, Universidad del Turabo, Miami-Dade County Public Schools and the Caguas/Gurabo Public Schools in Puerto Rico. The project's main mission is to institutionalize change among the elementary and middle school science and math teachers at participating schools. Thereafter, the teachers provide their students with continuously enriched instruction in the principles of science and math through the use of hands-on and minds-on experiments called learning modules. These learning modules have been classified according to the national science and math education standards established by the National Committee on Science Education Standards and Assessments and the National Council of Teachers of Mathematics, respectively.

The use of learning modules that require hands-on and minds-on activities in a classroom setting garners great enthusiasm and motivation on the part of the target students for the understanding of the lesson's underlying math and science principles. With this enthusiasm and motivation, comes acceptance, attention, discipline, acquiescence, and collaboration. Additionally, the use of hands-on activities may also require learning through a gamut of senses. Not only can the student use his/her eyes and ears during these activities, but most times, they can also use their senses of touch, smell, and taste, as well as intuition. Learning is, therefore, achieved using most or all the human senses. The combination of motivation/enthusiasm and the use of multiple senses creates an ideal environment conducive to learning at a profound level.

During the project's first two years in Florida, attention was focused on Homestead Middle School, in Homestead, Florida. This middle school was chosen to be the test site of the program's various activities due to its being a hard-to-staff school as well as for the demographics of its student population: rich ethnic diversity; mostly low income families; poor scores on standardized tests.

## **Background**

The nation is experiencing severe changes in its national economy as a result of the world's continuing transformation into a global market. Greater numbers of scientists, mathematicians, and engineers will be required if our nation is to remain competitive in this increasingly technology-driven world economy. In recent international educational surveys, our nation has been shown as trailing behind most of the world's industrialized nations in the quality of science and math education provided at the elementary, middle and senior high school levels. Comparison of test scores with those of other nations proves that our students' foundation in science and mathematics is greatly inferior. Without a quality science and mathematics educational background, our nation's students start their college careers at a disadvantage when compared to the students from other industrialized nations. This disparity will eventually lead to a national shortage of highly qualified scientists, engineers, and mathematicians as well as a deterioration in the quality of life for all US citizens.

Another fact about our nation is that it has one of the best, if not the best higher educational system in the world. The large numbers of students from foreign countries who flock to enroll in our nation's institutions of higher learning attest to this fact. Our higher education system is an asset that we must harness for the benefit of those students still in the beginning stages of their academic careers.

In addition to the institutions of higher learning, our nation has another valuable asset that can be utilized to assist the public schools, the National Aeronautics and Space Administration (NASA). NASA, as mandated by Congress and directed in its strategic mission, has developed a wealth of up-to-date educational information and materials available for the public's use. Project VISION makes use of this information and material by identifying, adopting, adapting and then integrating this information into the elementary and middle school curriculums. (NASA's Spacelink website address is <http://spacelink.nasa.gov>)

Project VISION strives to develop a methodology by which the resources of NASA and our higher education system can be tapped in order to assist the nation's public schools in developing brighter, more resourceful scientists, mathematicians, and engineers. Project VISION has developed a systemic approach to solidifying an alliance among NASA, two institutions of higher learning, and two local public school systems. The methods and successes, as well as failures, developed by this project will serve as a critical guide to expanding these activities nation-wide. The extent of our educational crisis is such that a model should be developed that could be replicated at every public school system in order to achieve the significant results needed to overcome this crisis.

## **Introduction**

Project VISION is tasked by the National Aeronautics and Space Administration (NASA) to support the President's Executive Order 12821, *Improving Mathematics and Science Education in Support of the National Education Goals*. The ability of the US to maintain its leadership in the world economy depends, in part, on its ability as a Nation to educate and train talented scientists and engineers. This process must begin as early as middle school, or even sooner. At whatever level this focus must occur, the fact remains that for college students to succeed in careers in science, math or engineering, they must first be prepared at the pre-college level.

The role of Project VISION is to serve as an intermediary between the educational resources available through the Internet at federal and state data depositories, and the science and math teachers at the target public schools; between the availability and the demand for

these resources. Several government agencies, especially NASA, have accumulated thousands upon thousands of high quality Learning Modules that contain hands-on and minds-on activities. However, despite their technical and scientific prowess, these agencies lack the time, personnel and contacts to be able to identify, adopt, adapt, test and then effectively integrate these learning modules into the individual curriculums of the nation's school districts, much less be able to train teachers on their use. On the other hand, the nation's public school math and science teachers, can not easily search out appropriate learning modules from the vastness of the Internet, and then prepare them for class presentation.

Project VISION fills this gap between the available resources and the persistent needs. The project identifies, adopts, adapts, tests and then integrates learning modules into the science and math curriculums of elementary and middle public schools. The project then trains pre-service teachers to prepare and present these learning modules to the target teachers (in-service) and their students. By observing these presentations, the in-service teachers will be able to conduct these hands-on activities on their own, long after the project has ceased. They are also given all the materials and Internet addresses associated with these learning modules. And, as an incidental effect, the target teachers' students learn and benefit from these presentations that are, at the same time, being used to train their teachers.

### **Training Methodology**

Project VISION has developed a training system for the science and math teachers of the elementary and middle schools consistent with the use of learning modules with their hands-on and minds-on activities. The learning modules to be used will be selected based on the level of the target audience, elementary or middle school, and on the given subject area, math or science. They were also selected in deference to the preferences of the participating teachers and school administrators. The Project VISION Training Methodology consists of three components: *Learning Modules*, *Personnel*, and *Training Options*.

#### ***Learning Modules:***

A basic premise of Project VISION is that there already exists sufficient educational materials (learning modules) to compliment almost every subject, for every level of study from Kindergarten through 12<sup>th</sup> grade. These learning modules can be accessed through the Internet at the data repositories of the federal, state, and local governments, at public and private libraries, and at public and private universities. Therefore, it is not that there is a lack of learning modules that prevents local public school systems and teachers from incorporating them, with their hands-on activities or experiments, into the regular academic curriculum. Instead, it is a combination of not knowing where they can be found; how to access them; where they fit into the competency based curriculum (CBC) or equivalent national education standards; and, how to adapt these learning modules for use in the classroom. It is precisely at this point where the activities of Project VISION couples existing educational resources with prevailing needs in order to create an enhanced science and mathematics curriculum.

#### ***Personnel:***

In order to perform the actual teacher training, the following personnel are involved at one stage or another. These individuals perform a specific

*Public School Teacher:* This is the individual who is undergoing the training. For the purposes of this program, this teacher should instruct math and/or science classes at the participating public school.

Lead Teacher/Teacher Trainer: This is the individual who will perform the actual training and evaluation. The Teacher Trainer will present the learning module alone, or in conjunction with the public school teacher, depending upon the training option selected.

Training Assistant: This is the individual who assists the Teacher Trainer to obtain the necessary materials and supplies, present the learning module, coordinate the hands-on activities, and serves as a general assistant during the entire process. The Training Assistant allows the Teacher Trainer to be able to conduct observation and evaluation and not be caught up procuring and distributing supplies, and other time consuming tasks.

### **Training Options:**

Project VISION provides two (2) distinct training options or methods. The first option provides a more simplistic approach to teacher training. In this method, the project staff present the learning module, while the public school teacher observes. The expectation is that the public school teacher, given copies of all the materials and information used, will be able to present this same learning modules on her/his own throughout the her/his teaching career. In the second option, a more didactic approach is taken. In this option, the public school teacher gradually increases her participation in presenting a learning module until she/he presents one completely on his/her own.

Option 1: Project VISION staff provides 3 to 5 learning modules chosen by the target teacher from a list of recommended learning modules. The staff then prepares and presents these learning modules within an actual classroom setting. The target public school teacher serves as an observer or trainee in order to learn how to do the module. The teacher also assists the staff members in maintaining classroom discipline. After observing each learning module presentation, the target teacher should be able to understand the theory and application of the learning module, and should be able to present these learning modules on his/her own.

Option 2: The Project VISION staff conducts a more in-depth training on the identification, preparation and presentation of learning modules in a classroom setting. This option provides for a ten-step training process as follows:

**Step 1: Consultation and Coordination**

**Step 2: Learning Module 1 – Pre-presentation Classroom Preparation**

**Step 3: Learning Module 1 – Presentation (Initial Learning Module)**

**Step 4: Learning Module 2 – Pre-presentation Classroom Preparation**

**Step 5: Learning Module 2 – Presentation (Pre-Solo Learning Module)**

**Step 6: Learning Module 3 – Pre-presentation Classroom Preparation**

**Step 7: Learning Module 3 – Presentation (Semi-Solo Learning Module)**

**Step 8: Learning Module 4 – Pre-presentation Classroom Preparation**

**Step 9: Learning Module 4 – Presentation (Solo Learning Modules)**

**Step 10: Evaluation and Feedback**

**Step 1: Consultation and Coordination**

During this step in the training system, the Teacher Trainer and the participating public school teacher meet to discuss delivery schedules, choose three learning modules (Initial, Pre-Solo, and Semi-Solo) and coordinate other matters.

**Step 2: Learning Module 1 (Initial) – Pre-presentation Classroom Preparation**

In step 2, the public school teacher presents to the target classroom the theoretical information that correlates with the subject matter of the learning module. This background

material is obtained from the assigned textbook, the learning module, or other sources of information that the teacher would normally use for class lectures.

**Step 3: Learning Module 1 (Initial) – Presentation**

In this step, the Teacher Trainer and an assistant present the learning module to the target classroom. This presentation includes the hands-on activities that involve all the students in the classroom. The public school teacher serves as an observer during this presentation. However, the responsibility for class discipline remains with the public school teacher. The supplies and materials needed for this activity are obtained and funded by Project VISION.

**Step 4: Learning Module 2 (Pre-Solo) – Pre-presentation Classroom Preparation**

During this next step, the public school teacher presents to the target classroom the theoretical information that correlates with the subject matter of the second learning module. Again, this background material is obtained from the assigned textbook, the learning module, or any other sources chosen by the teacher.

**Step 5: Learning Module 2 (Pre-Solo) – Presentation**

In this step, the Teacher Trainer and the public school teacher present the learning module to the target classroom jointly. This presentation should be a team effort involving both individuals (one-third by the public school teacher and two-thirds by the Teacher Trainer). The responsibility for class discipline remains with the public school teacher. The supplies and materials needed for this activity are obtained and funded by Project VISION.

**Step 6: Learning Module 3 (Semi-Solo) – Pre-presentation Classroom Preparation**

During this next step, the public school teacher presents to the target classroom the theoretical information that correlates with the subject matter of the third and final learning module. Again, this background material is obtained from the assigned textbook, the learning module, or any other sources chosen by the teacher.

**Step 7: Learning Module 2 (Semi-Solo) – Presentation**

In this step, the Teacher Trainer and the public school teacher present the learning module to the target classroom jointly. This presentation should be a team effort involving both individuals (two-thirds by the public school teacher and one-third by the Teacher Trainer). The responsibility for class discipline remains with the public school teacher. The supplies and materials needed for this activity are obtained and funded by Project VISION.

**Step 8: Learning Module 3 (Solo) – Pre-presentation Classroom Preparation**

During this next step, the public school teacher presents to the target classroom the theoretical information that correlates with the subject matter of the third and final learning module. Again, this background material is obtained from the assigned textbook, the learning module, or any other sources chosen by the teacher.

**Step 9: Learning Module 3 (Solo) – Presentation**

In this step, the public school teacher presents the learning module to the target classroom. The Teacher Trainer is present during the presentation, but only serves as an observer and guide. The responsibility for class discipline remains with the public school teacher. The supplies and materials needed for this activity are obtained by the public school teacher and are funded by the school.

### **Step 10: Evaluation and Feedback**

In the last step of the training system, the Teacher Trainer provides the public school teacher with feedback concerning his/her performance during the learning module presentations. The feedback is provided in a fully professional manner, and an evaluation is provided to the teacher that lists the possible strengths and weaknesses observed. If requested, the Teacher Trainer may provide the administration of school with confidential and specific written results based upon observation and evaluation conducted during the training

The public school teacher will be engaged in 3 to 5 learning modules. Each learning module will be divided into two sections: Pre-presentation Classroom Preparation and the Presentation. During each of the Pre-presentation Classroom Preparations, the public school teacher presents the theoretical background on the subject matter to be presented during the learning modules. Thereafter, the learning modules are presented. The public school teacher increasingly conducts more and more of the learning module presentations. Therefore, during the first learning module presentation, she/he is strictly an observer. During the second, she/he conducts one-third of the presentation. During the third, she/he conducts two-thirds. During the fourth, the public school teacher conducts the entire presentation. In this manner, the public school teacher gradually gains the knowledge and experience to conduct learning module presentations on his/her own, without the assistance of the project staff.

In the last step of this training option, the Teacher Trainer provides the public school teacher with feedback concerning his/her performance during the learning module presentations. The feedback is provided in a fully professional manner, and an evaluation is provided to the teacher that lists his/her possible strengths and weaknesses observed.

### **Conclusion**

With the advent of the Internet, the first step in providing instantaneous, low-cost, and standardized educational materials to all parts of the nation has been achieved. Building upon the Internet, many federal and state agencies, as well as public and private institutions have created and compiled outstanding repositories of high quality education materials. These learning modules, with their hands-on and minds-on activities, can be used to enrich local area classroom curriculums. This enriching process may make the difference between producing students with a standard or mediocre understanding of the principles of math and science, or students who have mastered these areas and have the potential, as well as the motivation to become the next generation of scientists, mathematicians, engineers and leaders. Project VISION has developed its own website that contain links to several hundred quality learning modules at <http://www.eng.fiu.edu/vision/>.

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