AC 2012-3718: EXPERIENCES LEARNED IN CONDUCTING A SUMMER WORKSHOP ENTITLED "INTEGRATING NASA SCIENCE, TECHNOLOGY, AND RESEARCH IN UNDERGRADUATE CURRICULUM AND TRAINING (INSTRUCT)" FOR HBCU/MI INSTITUTIONS

Dr. Ajit D. Kelkar, North Carolina A&T State University

Ajit D. Kelkar is a professor and Chair of Nanoengineering Department at Joint School of Nanoscience and Nanoengineering. He also serves as an Associate Director for the Center for Advanced Materials and Smart Structures. For the past 25 years, he has been working in the area of performance evaluation and modeling of polymeric composites and ceramic matrix composites. He has worked with several federal laboratories in the area of fatigue, impact, and finite element modeling of woven composites including U.S. Army, U.S. Air force, NASA-Langley Research Center, National Science Foundation, Office of Naval Research, and Oak Ridge National Laboratory. His expertise is in the area of low-cost fabrication and processing of woven composites using VARTM process, fatigue and impact testing of composites, and analytical modeling of woven composites. Presently, he is involved in the development of nano-engineered multifunctional materials using XD CNTs and electro spun fiber materials. He is also involved in reengineering of several H-46 and H-47 helicopter components for NAVAIR using out of autoclave processing. In the past, he has worked on the one step processing of Composite Armored Vehicle using low-cost VARTM method in consortium with University of Delaware-CCM and UC, San Diego. In the modeling area, he is working on blast simulations for the Humvee vehicles subjected to various TNT blasts loadings and atomistic modeling of polymers embedded with CNTs and alumina nanoparticles. He is also involved in high velocity impact modeling of ceramic matrix composites and polymeric matrix composites embedded with electrospun nanofibers. He has published more than 200 papers in these areas. In addition, he has edited a book in the area of Nano Engineered materials. He is member of several professional societies including ASME, SAMPE, AIAA, ASM, and ASEE.

Dr. Ram V. Mohan, North Carolina A&T State University
Dr. Vinaya Kelkar, North Carolina A&T State University

Department of Biology

Dr. Keith A. Schimmel, North Carolina A&T State University

Keith Schimmel is an Associate Professor of chemical engineering, Chair of the Energy and Environmental Systems Department, and Deputy Director of the NOAA ISET Cooperative Science Center.

Mr. Earl Hilton Martin

EXPERIENCES LEARNED IN CONDUCTING SUMMER WORKSHOP ENTITLED "INTEGRATING NASA SCIENCE, TECHNOLOGY AND RESEARCH IN UNDERGRADUATE CURRICULUM AND TRAINING (INSTRUCT)" FOR HBCU/MI INSTITUTIONS

Abstract

North Carolina A&T State University conducted a week long workshop in the area of integrating NASA science, technology and research in undergraduate curriculum and training (INSTRUCT) during summer of 2011. This workshop was attended by faculties form nine HBCU/MI institutions including Tuskegee University, New York City College and Technology, Alcorn State University, University of Texas El Paso, Tennessee State University, Winston Salem State University, North Carolina Central University, Spellman University, University of Maryland Eastern shores. The workshop focused on integrating NASA science, technology and research content into the undergraduate curriculum and some existing K-12 outreach programs at North Carolina Agricultural and Technical State University (NCA&TSU). The purpose of the workshop was to significantly enhance and stimulate undergraduate learning in the areas of science, technology, engineering and mathematics (STEM) by utilizing the relevant STEM content of NASA sponsored research and education programs in conjunction with NCA&TSU faculty expertise. The faculties were presented with several educational modules developed at NCA&TSU. These modules included Atmospheric module, Biology module, Chemistry module, Mathematics module, Materials module. In addition several external speakers were invited from private industries and educational and government institutions. Workshop received overwhelming response and generated significant interest in using these educational models at their parent institutions. Systematic workshop assessment was carried out by submitting survey questionnaire to the participants. The response was analyzed. This paper presents further details about experiences 2011 summer workshop and description of various INSTRUCT modules presented during workshop.

Introduction:

In year 2010, NCA&TSU received a grant from NASA entitled "INTEGRATING NASA SCIENCE, TECHNOLOGY AND RESEARCH IN UNDERGRADUATE CURRICULUM AND TRAINING (INSTRUCT)". The purpose of the grant is to significantly enhance and stimulate undergraduate learning in the areas of science, technology, engineering and mathematics (STEM) by utilizing the relevant STEM content of NASA sponsored research and education programs in conjunction with NCA&TSU faculty expertise.

The mission of NASA and its four directorates (Aeronautics, Exploration Systems, Science, and Space Operations) requires STEM content that includes the bio-chemical sciences, physical sciences (earth and atmospheric sciences), engineering and mathematics. This project has developed and implemented innovative pedagogical concepts of integrating the associated NASA STEM content into the related courses at NCA&TSU.

Goals and Objectives

The vision of the INSTRUCT project is to integrate NASA content into STEM undergraduate courses with a primary emphasis on stimulating interest in STEM disciplines towards increasing the number of underrepresented minorities and women in theses areas. The specific goals of the INSTRUCT program are to:

1. Increase and stimulate the participation of underrepresented students in STEM disciplines
2. Retain underrepresented students in STEM disciplines
3. Foster the integration of NASA content into undergraduate education and training
4. Promote the career preparedness of undergraduates by integrating NASA content based learning techniques throughout the STEM curricula
5. Increase the number of students going to graduate school in NASA relevant technology areas
6. Increase student and faculty exposure to NASA research and technologies and their relevance to undergraduate academic courses.

To achieve these goals and objectives it was decided to develop several NASA related STEM modules and introduce them in the STEM curriculum. During the first year of the project several faculty members from STEM discipline developed various modules. In the second year of the project all modules that were developed based upon STEM education research and best practices were implemented in various undergraduate courses at NCA&TSU. An interdisciplinary team approach was utilized that allowed NASA content to be incorporated into biology, physics, mathematics, atmospheric science, and engineering courses. Brief description of these modules is provided in next section.

Earth and Atmospheric Sciences Module:

Aerosol Module (http://weatherstudy.weebly.com/)

This module is designed for the UNST 234 Weather and Climate Studies course offered as a general education elective. American Meteorological Society Climate Studies course materials that are rich in the use of NASA data are used in the course. Over the course of the NASA INSTRUCT project, the module has been used in five offerings of the in-person course and four offerings of the distance education version of the course. Among various issues in weather/climate studies, aerosols are chosen for a module because of their significant impact on the atmosphere, climate, and human health. NASA scientists and technology has made important contributions to a better understanding of aerosols in the environment. Through text, pictures, and animations aerosol concepts are presented along with research needs. NASA data and animations of aerosol transport are also presented using a Magic Planet®. The module is broken into four sections: Atmosphere, Climate, Health Impact, and Dust.

Biology Module:

A bio regenerative Life Support System (BLSS) sustains life for an extended period of time in a closed system that includes waste recycling as a functional method of support. For future space missions, the goal is to build extraterrestrial space bases which employ the concept design

of a radiation free BLSS environment. Effectively maintaining a BLSS in an extraterrestrial space environment is difficult without protection from harmful space radiation such as galactic cosmic radiation (GCR) and solar radiation. Radiation produces high energy ions which penetrates tissue and destroys DNA. Without radiation protection, life in an extraterrestrial environment will perish. Therefore, it is necessary to design a model which not only supports life within the BLSS, but also prevents the harmful effects of external destruction from radiation. We must reduce the exposure of the radiation in order to maximize the potential for human survival in a BLSS. We hypothesize that countermeasures taken to reduce radiation exposure by radioactive shielding will increase safety within a BLSS. The specific aims included in this study are 1) design a BLSS model that is capable of supporting advanced life's growth and survival for an extended period of time in an extraterrestrial environment, and 2) identify various shielding methods for the model which will inhibit radiation exposure from impacting the BLSS. In this module we used numerical integration computer software to simulate our model. Through mathematical modeling students were able to better define exposure limits within a BLSS with different types of radiation shielding and countermeasures. Results from the model show the rate at which DNA damage occurs with and without shielding. Our model BLSS also integrates the energy flow components occupying the system including human and plant life. In conclusion, through this module, students were able to design an effective model which would help to prevent space radiation from penetrating the system to optimally increase health and life expectancy of humans and plants occupying the space base.

Calculus Module**:**

Mathematics Module I

Mathematics and in particular calculus are integral requirement of STEM education. At NCA&TSU all students studying engineering and science disciplines are required to take calculus. Although the content of calculus is important for student's leaning in other courses, many students view calculus as hard and not useful. They do not relate the relevance of calculus to the key science and technology applications. The student's perception is that they now have many modern computational tools to help them get by without a solid understanding of calculus.

As mentioned earlier, learners of all ages are more motivated when they can see the useful applications of what they are learning. The plan is to use selected relevant topics in NASA's mission to enhance the quality of the teaching of calculus. The need for scientific computations involving the application of calculus in NASA's space explorations will be emphasized. Current events such as the year of 2009 being the International Year of Astronomy and successful replacement of the Hubble telescope camera by NASA astronauts will be utilized to motivate and educate students about astronomy and mathematics along with the contributions that exploring space makes to society and culture.

This will be achieved in a systematic manner with development of a module incorporating NASA activities and content into the teaching of calculus. For example, students will be introduced to information about the shape of various space crafts and shown that the volumes of such space crafts can be computed by using the disk and shell methods in calculus. Other issues such as computing light reflection on different shapes of mirrors will be included in the modules.

Mathematics Module I:
The project “Design Crew Module and Find the Volume”

In teaching Calculus II, we used a module which involves using Disk method to compute the volume of revolving object. This project is intended to help students to retain their math skills in algebra, and review related mathematics with applications in NASA related topics. The initial idea was only for students to learn application of the Disk method to find the volume of crew module—Orion.

Mathematics Module II
An Exploration of Hurricane Paths using Differential Equations

This teaching module aims at showing students the connection between the DE solving techniques and our daily weather phenomena (e.g., hurricane paths). The NASA's data is used to show this weather phenomenon (the hurricane paths, animation), after which the underline equations are introduced to students. For the simple differential equations, students in the class can solve and sketch the solutions by hands. The questions are given as words problems. Students need to figure out the equation, solve it, and then explain it. A GUI (Graphical User Interface, a Matlab program) for the equations has been designed and is made available specifically for Hurricane Katrina 2005. Students in the class can explore by themselves various hurricane paths. Students are encouraged to do a project to further explore the numerical prediction for the hurricane paths and write their own Matlab code for some simple numerical computations.

Physics Module :
Module to describe N-body Systems with Central Forces

Apply Newton’s equations of Motion for N-body, systems ($N > 3$) under central forces in three dimensions using rectangular and spherical coordinate systems. In most classical mechanics classes, the topics of N-body systems are rarely treated in detail because of the difficulty in computation. For astronomy (such as planetary and galactic systems), orbital dynamics for satellites or robotic exploration of the solar system, the problems are described in terms of N-body systems with a central force - gravity.

Materials Engineering Module:

Current and future space initiatives require lightweight material systems that can perform as load-carrying structures (structural skin and walls of spaceships, rovers, planet outposts, and space stations) in the operating conditions of space environments. The processing and manufacturing of such light weight material systems consisting of polymer composites (fiber-matrix composites with new material systems for nano-level materials integrated to improve thermo-physical properties, ceramic matrix systems for high temperature operating conditions, etc.) are important technological barriers that need to be addressed for the successful application of these new material systems. Carbon based fiber composites with epoxy resin systems are regularly used in several aerospace applications including high speed aircraft systems. These fiber composites are lightweight, and they can be tailored to meet specific property requirements

for advanced engineering applications. In addition, liquid composite molding processing techniques provide a capability for fabrication into complex, structural load-bearing systems for space vehicles, rovers, and human habitats and are of importance to NASA mission needs. The integration of these advanced composite material concepts into the curriculum content of the traditional engineering materials undergraduate course was the focus of this module[1].

For broader dissemination of the INSTRUCT modules which were developed at NCAT&SU, it was decided to conduct a week long workshop for faculty members from various HBCU/MI institutions similar to one which was conducted at NCAT&SU in Summer of 2008 in the area of Computational Science and Engineering[2]. The proposed INSTRUCT summer workshop information was electronically distributed to over 30 HBCU/MI institutions. We received over 20 inquiries about the workshop and 9 faculty members from various HBCU/MI institutions were selected for the workshop. These nine faculty members were from following HBCU/MI institutions: Tuskegee University, New York City College and technology, Alcorn State University, University of Texas El Paso, Tennessee State University, Winston Salem State University, North Carolina Central University, Spellman University, University of Maryland Eastern shores.

Workshop agenda was developed which included module presentations, guest speakers from various research centers, industry speakers. In addition there were presentations pertaining to technology transfer and economic development, intellectual property issues, patent information, IRB issues etc. The program details for one week workshop are given in Appendix A. In addition a systematic assessment of the summer workshop was performed by developing an assessment questionnaire. This questionnaire was distributed at the end of the workshop to each of the participants and the data was analyzed. The detail questionnaire and assessment of data is presented in Appendix B.

Conclusions:

The post workshop assessment from the participants clearly indicates that workshop stimulated significant interests in various modules and faculty members are certainly interested in implementing these modules in their curriculum at various HBCU/MI institutions. We are planning to offer similar one week workshop in Summer of 2012. The workshop contents will be significantly modified by taking into account the comments of the participants which are listed in Appendix B.

References:

1. Ajit Kelkar, Ronnie Bolick, Vijay Krishnan and William Craft, “Professional development and awareness building for teachers in the area of advanced materials, proceedings of ASEE 2006 Annual Conference & Exposition, AC 2006-2052
2. Ram Mohan and N. Radhakrishnan, “Computational science and engineering training workshop for faculty from under-represented and minority serving institutions”, proceedings of ASEE 2009 Annual Conference & Exposition, AC 2009-1657

APPENDIX A

Monday, June 13, 2011: Opening remarks, welcome

Atmospheric Module

Tuesday, June 14, 2011: Continuation of the

Atmospheric Module

Biology Module

Wednesday, June 15, 2011,

Materials Module
Mathematics Module - I

Thursday, June 16, 2011:

Physics Module
Chemistry Module
Mathematics Module-II

Friday, June 17, 2011:

Institutional Review Board (IRB) Presentation
Evaluation and Assessment

NASA INSTRUCT Certificates

Closing Remarks:

Conclusion of NASA INSTRUCT Summer Workshop

APPENDIX B

2011 NASA INSTRUCT (Integrating NASA Science, Technology and Research in Undergraduate Curriculum and Training) Summer Workshop
North Carolina A & T State University
June 13 – 17, 2011

Evaluation and Feedback Form

1. On a scale of 1 (Not useful at all) to 5 (Extremely useful), how useful was this workshop to learn about the North Carolina A&T State University's NASA INSTRUCT Program and learning the experiences in integrating NASA content into undergraduate education?__4.28__

   Please explain your rating: Each Alphabet Represent's a Different Workshop Participant.

   A. Tours to the labs were great; all modules are very effective for education NASA release projects.
   B. Organization and contents of the presentations were very good. Their relativity to NASA was emphasized during each presentation for example; NASA's expectations from proposers were pointed out in great details.
   C. I feel confident that after seeing the model developed by North Carolina A&T, we can develop similar but unique content of our own at Tuskegee University.
   D. The workshop is very comprehensive, covers teaching materials/module from physics, math, to materials, chemistry, and biology. The course modules are well com to NASA projects and missions.
   E. Presentations conveyed the infusion of NASA INSTRUCT across many of the STEM disciplines at the University.
   F. There were areas that showed great involvement, like the materials, chemistry. However, I didn't see a direct connection with the physics and math module.
   G. Workshop has showed a clear picture of what NASA learning module is and provided a big deal of information about its implementation into courses.
   H. This was an extremely useful workshop. The level of interdisciplinary connections and collaborations came out very clear.
   I. This workshop demonstrated how NASA content can be integrated into undergraduate programs via various modules. It was very informative to a person like me who is new to NASA and its programs.

2. On a scale of 1 (Not effective at all), to 5 (Extremely effective), how effective was the workshop in understanding NASA INSTRUCT project approach to support and promote and stimulate the students learning and teaching and interest in STEM areas? __4.83__

Please explain your rating:

A. This workshop shows all aspects of NASA INSTRUCT project approach to support and promote and stimulate the students learning and teaching and interest in STEM areas.
B. Find a way to communicate math to a less interested audience.
Mathematics, Computing, and computer applications should be distinct.
Math is a must-do science; so, time and materials should be vested to focus teachers and students interests. The Nanoengineering should apply more caution to maintain safety because any accident would push the program back some…
C. It gives us confidence in how to elect NASA content that we can use in our approach to stimulate interest in STEM areas.
D. The workshop provides excellent examples on teaching and student mentoring, The module will stimulate student interest and help understand real life problems.
E. Module presentations on classroom instructions were presented well.
F. No Comment
G. All presentations were useful and provided a ready to use module which can be easily repeated with minor adjustments.
H. I have now a much clearer understanding of where NASA wants to concentrate STEM research and education efforts to prepare future NASA workforce.
I. Different modules in STEM were used to clearly demonstrate how to stimulate student learning and teaching.

3. What did you like the best about this workshop?

A. The workshop organized very well, all nodules are very effective, and I like the tours to the lab too.
B. The hospitality, of the faculty, the organization (printed materials) was very good. NASA's objectives were communicated during each session. The first day (Monday) presentations were very professional in delivery and taking questions. Your office architecture is very inviting and could add life to the occupants. The magic planet and the thermal convection and the Chemistry presentation were good.
C. The laboratory hands on experiments were very useful, and I believe that students can benefit a great deal from it. I also enjoyed the hands on exposure in the materials module, we had a chance to see composite materials in the making, and we even have a chance to see real tensile tests.
D. The workshop in well organized, instructors are great and well prepared. I enjoyed the workshop.
E. Visit to the Nanotech Research Center
F. The hands on parts, since those would be the one to give to the students.
G. All presentations were useful and provided a ready to us module which can be easily repeated with minor adjustments.
H.

a.) Interaction with engineers and scientists in fields other than my own; possibilities of collaboration
b.) The atmospheric module was pretty good
c.) The materials module; biology and chemistry were also good
d.) Visit to the different facilities: outstanding!
e.) Many ideas generated during presentations and discussions
f.) IRB, Tech Transfer, and evaluation presentation

I. Nanoscience and Nanoengineering modules and demonstrations

4. What aspects of the workshop could be improved?

A. None
B. Nanoengineering and safety procedures.
C. I would like to see more hands on approach in the other modules similar to the materials module.
D. NASA produces many products such as satellite images and has done many experiments in space. I expect to see more to use these products in instruct.
E. Length – Could possibly be done in 3 – 4 days.
F. I think, perhaps not only interaction with 1to 2 instructors in each module, but more faculty. Also, see how it is actually implemented in the classes, not only on research.
G. I think that along with general sections it would be better to deliver special modules in separated parallel sections.
H. Some modules need extra punch. For example, the math module seemed more of an end-of-the-chapter problem than a module.
I. More hands on bring about how to develop proposal for NASA funding.

5. Overall, on a scale of 1 (Not at all) to 5 (To a great degree), to what degree did the speakers clearly and efficiently cover their practices and experiences for their subject modules and their topic areas? _4.4___

A. No Comment

B.

- However, some speakers did not differentiate between module and model.
- Nanoengineering needs to increase safety in the material testing lab

C. No Comment
D. Yes, the modules are well presented.
E. No Comment
F. I was a little disappointed with math and physics. In the math part specially. It just seemed to be a project in the classroom.
G. Most of the modules were presented on a very high level. One section was not prepared well.
H. Some deserved a 5 and others a 3.
I. All of them were excellent.

6. Which NASA INSTRUCT modules would you like to consider for implementation at your institution and in undergraduate programs? How could we help you in these efforts?

A.

1. Mathematic Module
2. 3D Games (NOAA)

B. Nanoengineering (manufacturing/materials), Earth Science Schedule, Research and Education (Micro Satellite…)
Help: Certification (Nanoengineering Material Certification)
Help: Membership with any of the Micro Satellite operations?

C. The materials module, by sharing some of your expertise in creating manuals for the students or some details about fabrication techniques and also evaluation techniques for the module.

D. I can use Biological module in a modified way.

E. Materials modules – make available on web.

F.

- Composites
- Chemistry
- Biology

G. I will readily implement material section and part of chemistry module. In addition, having in mind in a future developing research center for materials, I would use the experience of Nanoscience and Nanoengineering.

H. Atmospheric, materials and chemistry. Biology gave me great ideas, too.
I'll convey the message to colleagues to pick their interest and contact you for help with implementation. If modules are online, a URL for download would be great. Thank!

I. Biology and Nanoscience and Nanoengineering

7. Is there anything else you would like to add?

A. No Comment

B. Some presentations were not well prepared, e.g. Gravitational Orbits Module. There are lots math software to give that module a very sharp presentation, the math module-crew module... was good but not sharp—use software to simulate equations in real time ___ students need __ applications and quick feedback __ do not be carried away by keme calculations in presentations, you need to show how sharp the module is __ the students are the customers and the customers are always right. __ let us try to communicate math to them... The hurricane application of mathematics (DEqs) by Dr. Liu / Lin was very good and better than the math applications in the Crew Module and Gravitational orbit module. Over all good effort. Thank you.

C. No Comment

D. I would expect more theme-originate-1 workshops, such as NASA materials, Biological studies by NASA, etc. Proposal related issues at NASA such as NASA education programs and how to apply etc. would be helpful as well.

E. Excellent research facilities and research projects – cutting edge.

F. Perhaps, based on our background, we could get a more detailed workshop. I would like more hands-on experience.

G. I would like to thank all those who contributed their time and efforts to make this great workshop happen. Hope, the tradition of such workshops will continue and would be ready and willing to contribute my expertise too.

H. Many thanks for inviting me and for taking the time to organize the workshop. I am taking lots of ideas back home. It was very stimulating. Oh, and great food, too.

I. No Comment