

The Inaugural SAMSA-Masamu STEM Workshop

Overview:

The SAMSA-Masamu STEM Workshop was held on November 22, 2016 as part of the 34th Annual SAMSA Conference, which was held on November 21-24, 2016 at University of Pretoria, South Africa. The workshop examined and discussed current evidence-based models, best practices, and strategies for increasing the quantity and quality of undergraduate and graduate degrees for students in Science, Technology, Engineering, and Mathematics (STEM) disciplines.

The workshop had the following panel speakers:

Africa

- Dr. Senelani Dorothy Hove-Musekwa, Professor, National University of Science and Technology (Zimbabwe)
- Dr. Faraimunashe Chirove, Senior Lecturer, University of KwaZulu-Natal (South Africa), Vice President of SAMSA
- Dr. Eunice Mureithi, Professor, Department Head of Mathematics, University of Dar es Salaam (Tanzania)

USA

- Dr. Suzanne Lenhart, Professor, University of Tennessee; NIMBioS Director for Outreach; Previous President of Association for Women in Mathematics (AWM)
- Dr. Abdul-Aziz Yakubu, Professor, Howard University, Previous Chair of Mathematics Department at Howard University

Panel Chair

- Dr. Overtoun Jenda, Professor and Assistant Provost for Special Projects and Initiatives, Auburn University (USA), Co-Chair of Masamu Steering Committee

Each panelist was asked to address one or two of the following questions:

1. What promising programs are offered at primary and secondary school levels to give students exposure to careers in Science, Technology, Engineering, and Mathematics (STEM)?
2. What promising programs are offered at undergraduate and graduate levels to retain students in STEM disciplines?
3. What promising programs are offered at undergraduate and graduate levels to retain female students in STEM disciplines?

I. Summary of Panel

a. Exposure to STEM careers in Primary and Secondary Schools (K-12)

Dr. Senelani Dorothy Hove-Musekwa – National University of Science and Technology (NUST) (Zimbabwe): At NUST, only 30% of new students were entering

STEM disciplines while 70% were selecting non-STEM majors. This was a huge problem for a Science and Technology University. Noticed that lack of students in STEM at university level is a result of inadequate high school preparation. Education directors and vice chancellors met to discuss introducing activity-based teaching methods. Workshops were held on Saturdays for 50 primary and secondary school (K-12) teachers in Bulawayo and have now expanded to 3 provinces. Students visit campus on Saturdays 8:30-2:30 to receive help in math, biology, chemistry, and physics. Program is still ongoing. NUST enrollment has since increased to 65% STEM. Methodology of teaching (activity-based) has increased appreciation for STEM subjects among K-12 students. Funding comes from NUST and province governments. NUST introduced a school enrichment center in Bulawayo for training teachers and for student enrichment activities. Students pay a minimal amount to attend to cover costs of teachers and materials. Another problem was lack of undergraduate research. Students now spend two weeks on undergraduate research in a STEM subject before beginning their third year and entering attachment (co-op) programs.

Dr. Suzanne Lenhart – University of Tennessee (USA): Much recent research shows that active learning is beneficial. US has standards-based tests that include modeling. Therefore, modeling needs to be taught at the high school level. Tennessee Department of Education has provided funding for modeling workshops for high school teachers. One-day international mathematical modeling competitions are held where students work in teams of 4-5. Suzanne visits high schools once a week training students to work on modeling projects. Mathematics enrichment also takes place through clubs, Mu Alpha Theta, and special events such as Olympiads and summer and Saturday workshops. Faculty develop modules and activities for teachers, and teachers are taught as they would teach the material to their students. Information and reports of such best practices are disseminated online and through journals for K-12 education. Application workshops are held for grades 2-8 with activities showing applications of math/science. Most funding for K-12 activities is provided at the state government level.

b. Retention in STEM for undergraduate and graduate students:

Dr. Faraimunashe Chirove – University of KwaZulu-Natal (South Africa): University of KwaZulu-Natal offers a peer instruction program in mathematics and other subjects. Students are often afraid to approach lecturers for help, but are willing to approach their peers. Instructors are students who have successfully completed the course. Students attend at pre-scheduled times and are tracked by an academic development officer. Student performance is tracked through formative and summative assessments. Most students have improved academically, and the program has improved their chances for program completion. The other focus is on educating future teachers – teaching teachers how to teach mathematics and other STEM subjects. This covers both content and pedagogical knowledge. At the graduate level, all retention programs are research-based. For example, there is a Math Bio Club which is interdisciplinary, while other clubs such as Numerical Analysis Club are specialized. Clubs provide training and activity-based projects to improve members'

abilities in mathematical modeling, analysis, etc. This does not require any funding, only willingness of faculty to train students.

Dr. Abdul-Aziz Yakubu – Howard University (USA): Generally, in the US, funding for top students is easier to secure at the graduate level than the undergraduate level. Exposure to undergraduate research (REU) is especially beneficial. REU programs last 8-10 weeks on university campuses – modeling classes and establishing real-world connections during the first 2 weeks. Weekly speakers from industry where possible and leading scientists who interact with the students to establish human connections and enable them to picture themselves as future scientists. Once in the program, students choose their own research groups and problems. REUs are usually funded by the US National Science Foundation – proven successful by numbers of publications, presentations, etc. Conferences and publication opportunities are available for undergraduates – for example, SIAM Undergraduate Research Online (SIURO).

At the graduate level, more funding is available. Assistantships and fellowships are available for students with high undergraduate GPAs. Some have required research components where students work with faculty members and receive training for their own research career. There are also exchange programs within the US for short-term or long-term visits, sending students to experienced faculty members with aligned research interests for students to receive training and mentoring. Good relationships with PhD advisors are extremely important in achieving success.

Faculty in mathematics departments at US institutions is often not diverse. There are programs that are funded by government agencies in the US (such as NSF and National Institute of Health (NIH)) that address this problem. For example, NSF funds the Alliance for minority postdocs, which awards 5 fellowships each year on a competitive basis. The Alliance funds postdoc fellowships for 3 years: 2 years at a university and 3rd year at a national institute. This places participants in a good position to obtain faculty positions at a research university.

c. Retention in STEM for female students:

Dr. Eunice Mureithi – University of Dar es Salaam (Tanzania): Undergraduate entry from high school is the biggest hurdle. Tanzania federal government has a loan board – not all students receive loans, but females entering STEM are given top priority. Upon entry to the university, academic advisors support female students (and male students) to advise on both academic and social aspects. To improve retention, first-year university courses are taught by the most experienced faculty members. The university has an equal opportunity policy. The Gender Center supports women and encourages female students, especially in STEM.

The Department of Mathematics at University of Dar es Salaam offers both MSc and PhD programs. The biggest problem is lack of funding. The department tries to raise funds by writing grant proposals to international funding agencies and other

organizations. Funding received is given out to students based on merit, but equal numbers are given to males and females so that they compete within each gender. Weekly seminars for students are held for them to present research to faculty and get assistance and feedback. East African Universities Mathematics Program has harmonized curriculum throughout the region, making it easier to retain students within the region.

Dr. Suzanne Lenhart – University of Tennessee (USA): University of Tennessee Mathematics REU tries to make sure to have equal (or more if possible) numbers of female students in summer REUs. Emphasize working in teams along with modeling skills and group roles and dynamics, and includes activities to promote teamwork. The Association for Women in Mathematics has student chapters across the US. Undergraduate research conferences are also available for female students. Competitive funding from federal agencies is available for programs for female students.

II. Summary of Points Brought up by the Audience

University of Pretoria, South Africa: Engineering is the STEM area where South African children are most interested. Mathematics is the area with least interest. It is important to understand that throughout the STEM areas, many students have been told that they are unable to succeed. Although many would like to enter engineering, many are not prepared, thus creating a problem of access. Throughout the country, people agree that the level of mathematics instruction in high schools needs improvement. Teachers are not well trained, but universities must work with the high school graduates they receive. Bridge programs are offered as flagship programs – university decided that any students who need preparatory instruction must attend a bridge program. Math department plays a significant role in the program. The bridge adds 3 semesters to a typical 3-year program. First semester is introductory exposure to material and normal first semester material is taught in the bridge's second and third semesters.

Faculty of education trains teachers while mathematics, physics, and chemistry courses are taught by members of the science faculty. It is difficult to attract students in mathematics, and it is a challenge to have students achieve honors levels. Once in honors level, masters level, or PhD level, retention is a challenge due to the prospect of well-paying jobs in other field. Retaining PhD graduates in academia is just as difficult since many enter industry or leave Africa. In South Africa, there are many programs which are used to encourage retention. For example, the National Research Foundation (NRF) gives universities 120,000 ZAR for each research publication in STEM in a recognized journal. However, these funds are not given to the author, but faculty benefit from it indirectly. Furthermore, such programs do not exist in many other Southern Africa countries. Retention is an issue at all levels of the pipeline, including in STEM careers.

Auburn University, USA: US has similar challenges regarding retention in STEM. Low-income students are attracted to higher paying areas (engineering) over mathematics. Minority students are underrepresented in STEM fields in the US. Problem is often due to resources in rural K-12 schools. Lobbyists are hired to make a case and convince Congress to pass legislation and funding to support STEM programs. REUs are offered in both pure and applied math, and many REU students go on to further study in mathematics and STEM. NSF LSAMP program provides funding for minority students to study STEM fields – offered at both undergraduate and graduate levels.

US-Africa collaboration is key because the goals are the same – increasing human infrastructure in mathematical sciences. Another area of underrepresentation is students with disabilities. Funding is available in the US from federal government for peer mentoring and research experiences for students with disabilities.

Auburn University, USA: From past Auburn University REU experience, “there’s no such thing as a bad REU.” Intensive research experience is always beneficial for students. Even if starting with small numbers, REU programs are good investments in students.

Nigeria: What has been discussed regarding challenges in South Africa is also true in West Africa. Small numbers continue from year to year in graduate programs. Much larger numbers in arts departments as compared to science departments. Ratios can be as bad as 1,000 to 10. It is challenging to fund research at universities.

Alabama State University, USA: Working at an HBCU (Historically Black Colleges and Universities) in the US, the university has realized that while issues do exist with high school student preparation, they also exist with middle school preparation. The university has started Saturday Academies where students visit campus 3-4 times per semester to participate in group projects and hands-on projects using puzzles and problem solving to introduce math, biology, and chemistry subjects. Such exposure to both content knowledge and a college campus is important because many come from families with few or no college-educated family members. Subject to availability of funds, the plan now is to begin to host traveling Saturday Academies to take the activities to communities that are unable to afford travel to a university campus.

Zimbabwe: It is important to look at STEM issues early. Encourage pregnant mothers, preschoolers, and elementary school students to value STEM education. Concentrating on lower levels and introducing programs for young children will have impact. Ministry of Education should be included in STEM discussions.

University of Malawi: Initiatives taking place in faculty of science: Career Talk program. In this program, faculty members are encouraged to travel with an LCD projector. When they have a free hour or two, they visit local schools and talk to students. Nationwide program through Ministry of Science, Education, & Technology was implemented for the first time this year and was a success. Faculty in other areas

(communications, etc.) are involved in national advertising of STEM by recording radio programs about math and science to be broadcast on local radio stations. Finally, the university has an open door policy allowing school groups to come and visit labs and the library.

Auburn University, USA: The Alabama Alliance for Students with Disabilities in STEM (AASD-STEM) at Auburn University provides scholarships, peer mentoring, and research experiences for students with disabilities in STEM. Many students with disabilities have been told that they cannot be successful in STEM, so this program aims to provide support and encouragement. It is funded by National Science Foundation. Cascading mentoring from grad students to undergrad students is used, where both academic and social issues are discussed. This takes place in informal settings in cluster groups of 5-7. Issues discussed are both related and not related to disability conditions. Students also meet in large groups with faculty members and guest speakers to discuss topics such as research opportunities, career paths, graduate school, etc., and ways to succeed. The program is beginning to scale up by expanding to other universities in the Southeast part of the US. Faculty mentors often work on this program without pay in order to provide help to students.

University of Swaziland: The government understands the importance of promoting STEM disciplines. 1,500 scholarships are available each year with 1,000 of them reserved for STEM disciplines, including agriculture. The Ministry of Education runs in-service workshops at the end of every school term and teachers are encouraged to attend by providing meals and money for them to travel from rural to urban areas to attend these workshops.

III. Next Steps:

1. Identify programs that have been effective in various countries, then ask for funding from SADC, NRF, etc. to implement across the region. Seek help from the deans and university presidents/vice-chancellors to lobby national governments to improve STEM programs.
2. Promote collaboration from different countries in research as well as STEM education.
3. Create a mechanism for learning from each other and passing on information about successful programs.
4. Work with local teachers on their level so that they can help themselves.
5. Suggestion that this forum singles out mathematical sciences from the general STEM areas and declare mathematical sciences as a critical area of importance among SADC countries.

6. Teach importance of science while children are still young. Computers/calculators have weakened some basic skills. Mental sums and similar skills are important to develop and teach the importance in primary and nursery years.
7. Everyone can agree that mathematics salaries will not become equal to engineering salaries. Reducing distance and building relationships between professors and students (mentoring) will help lead students into mathematics. Giving help outside of office hours, providing assistance finding funds, etc.
8. Mathematics should be made compulsory for all students. This will develop interest and show students that they are capable of doing mathematics. Parents can also play a role in encouraging their children and alleviating fear of mathematics. Invite as many female mathematicians as possible to be guest speakers for children. Constantly remind students of the applications and importance of mathematics. Show primary and secondary students that other jobs besides teaching can come from mathematics. Include mathematics in songs and encourage mental math skills in children.
9. Become involved in politics, both national and at a higher level such as SADC. For small, poor countries, funding is not available. Collaboration between countries would help lobby funding agencies and regional development consortia for funding. Create visible initiatives – mathematical competitions, television programs, etc. that can be shared with funding agencies.
10. Faculty and administrators must be willing to get on students' levels and provide meaningful guidance and mentorship, and also emphasize the relevance of the applications of mathematics. Create awards for both students and mentors, and nominate especially helpful faculty mentors for awards.
11. Mathematics can create a positive example by caring about individuals who are discriminated against, for example, students with disabilities, women, and underrepresented groups.
12. Staying connected within this STEM Workshop group of participants to keep high levels of passion and energy will be important for future work. Facebook group, email list, etc. would create accountability. Masamu will thus create an email list and type up notes from this workshop to be sent to the SAMSA Executive Committee. Discussion will be continued and promising practices should continue and grow. Another STEM Workshop will be held next year at SAMSA 2017 in Dar es Salaam.