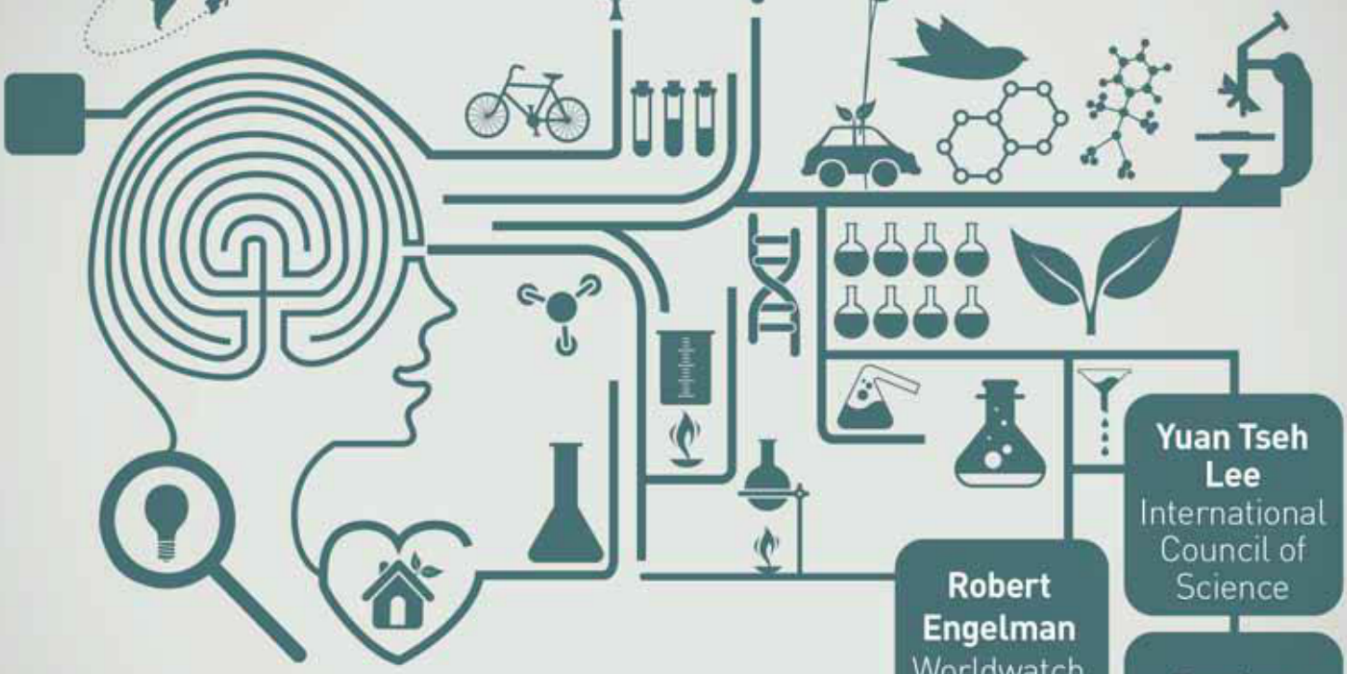
International Innovation

Disseminating science, research and technology

SCIENCE 101



Yuan Tseh Lee International Council of Science

Robert Engelman Worldwatch Institute

Preview Pujiang Innovation Forum

RESEARCHERS OF THE PRESENT INSPIRING **SCIENTISTS OF THE FUTURE**

RESEARCH SPOTLIGHT

The Nature Conservancy • US National Park Service • Yukon to Yellowstone Conservation Initiative
American Vacuum Society • Engineers Canada • American College of Physicians

| North America • October 2013 |

Welcome

to *International Innovation*

NEW AND SIGNIFICANT changes in the science funding arena may shift the geographical source of innovation as we know it. Contrary to the belief that the US is leading the way in discoveries, Canada's federal and provincial governments spend roughly CAD $11.5 billion a year on research, the highest of all G7 countries. Over the next six years, a small fraction ($24 million) will be injected into 15 Natural Sciences and Engineering Research Council of Canada (NSERC) Collaborative Research and Training Experience (CREATE) initiatives to propel priority research areas such as climate change and genomics and deliver valuable job skills to science and engineering graduates.

Meanwhile, budget sequestration has hampered the growth in funding required for the US to remain competitive. The National Institutes of Health will be forced to cut US $1.7 billion from its budget this year alone (after a decade of cuts, only one in seven approved grants now receives funding). If this continues, the difficulty in securing financial resources may ultimately deter young scientists from pursuing the careers the US works so hard to promote. Losing its edge in the market, the EU or China may shortly overtake the region in R&D; in fact, for the first time in recorded history, the US ranks third for scientific paper citations, behind the UK and Germany. As the Internet, GPS, lasers and vaccines were all federally funded, the financial deficit does not bode well for future innovation.

That said, in August 165 college presidents called on Obama and Congress to end the federal budget cuts. The impact is yet to be felt, but as the scientific community continues to collaborate and explore new revenue streams further afield, there is every hope that the current state of play will be revised.

John Porter, Chairman of Research!America recently noted that: "A nation's leadership must view research through the prism of future generations: our children and grandchildren, who will benefit from both a health and economic standpoint as a result of today's scientific discoveries". This thread runs throughout this issue of *International Innovation*, which features research that is set to empower aspiring scientists to succeed in today's labour market.

Sustainability is another core theme explored in this edition, beginning with the International Council for Science, whose overarching message is one of universal access to science and sustainable practice. Similarly, The Nature Conservancy and Worldwatch Institute – both proponents of sustainable resource use and action on climate change – are united in their cause for a better future for all. Protecting the environment is tantamount to nurturing the next generation of scientists; without valuing key assets, we lose the ability to preserve both knowledge and natural capital.

Enjoy the Issue!

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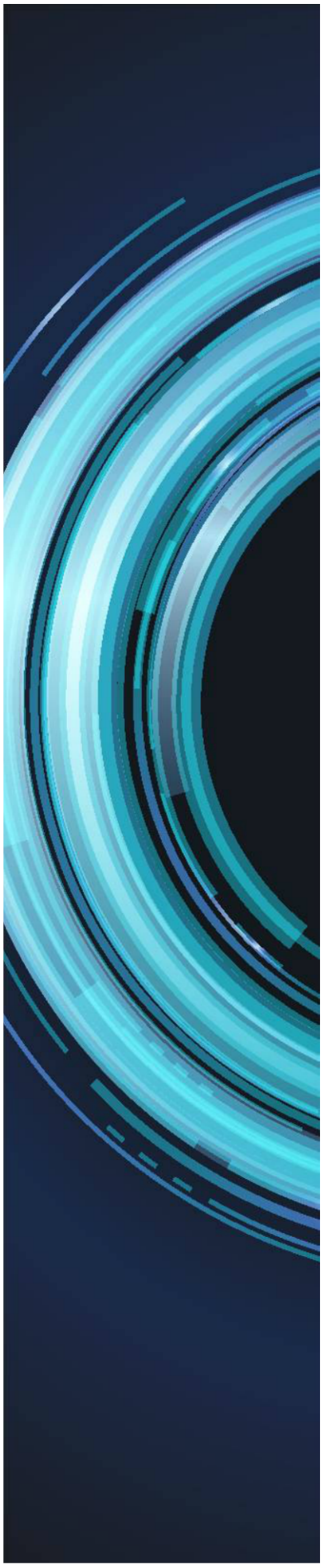


Nurtured from the STEM up

Ensuring students from all backgrounds are given the opportunity to excel in STEM courses and careers is key to strengthening knowledge in these disciplines. **Dr John K Coleman** provides an overview of LINC, a multimedia project designed to boost participation and achievement among underserved students

Could you explain the aims of Langston's Integrated Network College (LINC)?

LINC's objective is to contribute to an increase in the number of underserved students who enter college, receive undergraduate, and advanced degrees in STEM disciplines, and choose STEM careers. Our aim is to ensure our objectives are achieved, so we have a holistic approach to ensuring a successful outcome. We programmatically incorporate strong values for participants such as expectations of high achievement, intense mentoring, research and other experiences outside their existing environment, and of course academic excellence. When necessary, we create innovative programmes to bridge learning and information gaps that might impede success.

How does the STEM Digital Village (SDV) work as part of LINC? What services does it offer?

SDV serves not only LINC scholars but all STEM students by providing relevant content that impacts their education, such as study aids, personal development tools, scholarship and fellowship information, and links to other resources within and outside the university. This one-stop resource makes it much easier for STEM students to be aware of and access information critical to their success. SDV also showcases LINC scholars' activities and successes, ensuring that they can share their accomplishments beyond the Langston campus, and specifically among family, friends and STEM personnel at other institutions. Student researchers and potential summer intern partners can review the kinds of research topics in which our scholars participate, as well as appreciate that they have excelled in their work based upon their record of winning recognition at national competitive events.

Do SDV users benefit from being able to set up their own website?

Perhaps more important than setting up their own website as a first step, SDV promotes scholarly research and coherent reporting in that students construct many articles that appear in a section called Student Links. Here, they demonstrate their writing skills, and ability to discern relevant information and articulate it in a way that is actionable. They also maintain their professional profiles. Site visitors exceed 63,000, confirming that there is benefit in providing a social network for STEM scholarly activities.

Is NSF funding important to the continuation of LINC and its initiatives?

Scholarships are a key element in increasing the number of participants in STEM disciplines. Funding for merit scholarships through the National Science Foundation (NSF) continues through 2014. However, since funding has been a collaborative effort since the inception of LINC, some forms of student scholarships will continue. The LINC network is continuously seeking financial support towards this end.

Beyond funding LINC, NSF grant support has substantively impacted Langston University's infrastructure through its assistance in creating academic and instrumentation instructional laboratories, and research & learning processes that will endure beyond the formal LINC funding cycle. LINC elements such as SDV, Competency Performance Recordings for Learning (CPR-L) and intense mentoring are now embedded and will continue, albeit with less support than is currently available. Additional funding would enhance SDV's capability to expand in order to meet future opportunities – we are actively seeking financial backing that will permit us to do this.

How crucial are national conferences to spreading the word about LINC?

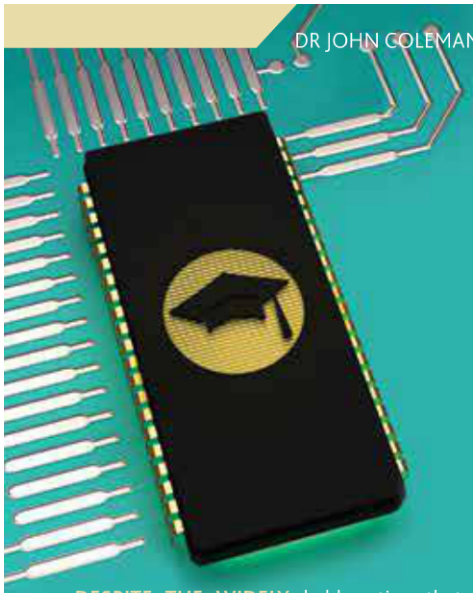
LINC has been featured at numerous local and national conferences, LINC scholars' presentations have won awards at many national competitive events, and I've had the good fortune to have been a featured presenter at numerous venues. Our most recent presentation was at the NSF's Quality Education for Minorities Network conference in Baltimore, MD during November 2012, where I presented information on our CPR-L as part of a workshop on evidence-based STEM instructional strategies.

During 2013, our LINC scholars presented their research findings at the Emerging Researchers Conference in Washington, DC where a top award was garnered, and at the National Institute of Science-Beta Kappa Chi Joint conference at Reston, Virginia, where over half of our 10 presenters won awards. During LINC, the increase in competitive awards for interns' research presentations has risen from one or two intermittently to between eight to 10 annually, a 450 per cent increase.

What does your role as Lead Organiser entail?

My role involves responsibility and oversight for all facets of the programme, including recruitment, ongoing leveraged scholarship funding and securing support from Langston University faculty and staff. Although I provide direction, the real energy in the programme comes from the day-to-day operational support provided by program coordinators. None of this would work without the follow-up and follow-through of our collaborators. The LINC network diagram shows how all this support comes together.

The key to our success, however, is in the way Langston University leverages its resources to create an integrated entity that is LINC. Its key managers have also ensured that industry CEOs and the Oklahoma higher education oversight team (Board of Regents) experience research project presentations by our scholars. Combined, all our efforts make a huge impact on LINC's success.



Breaking down **barriers**

An innovative project based at **Langston University** is harnessing digital technology to drive success among traditionally underrepresented demographics within STEM classrooms and the workforce. Their work promises to secure a bright future for US education and industry in these areas

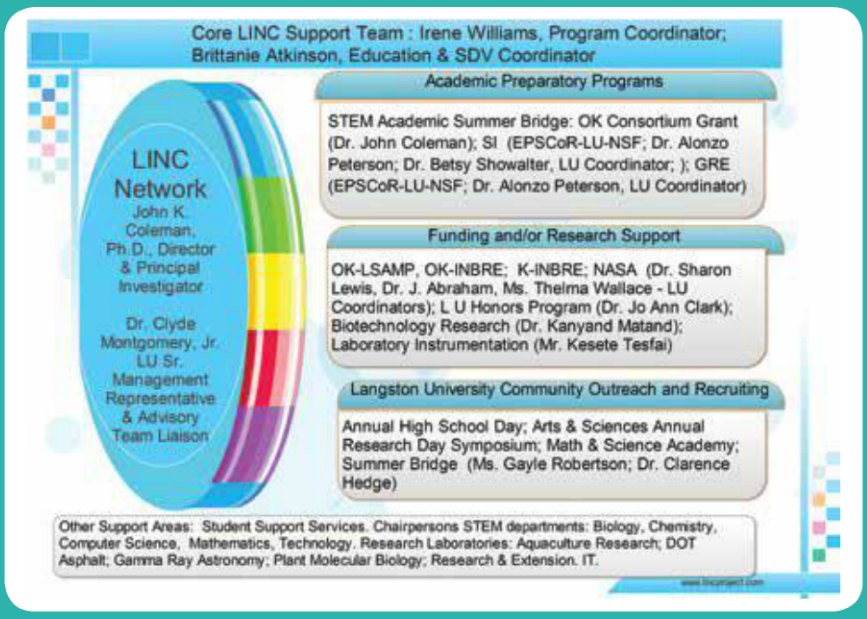
DESPITE THE WIDELY held notion that a diverse workforce is a successful one, the progress of ethnic minorities in advanced Science, Technology, Engineering and Mathematic (STEM) careers has been slower than might be expected. While National Science Foundation (NSF) figures show that the share of Bachelor and Master degrees attained by underrepresented minorities has steadily risen since 1991, only around 7 per cent of doctorates are awarded to minorities annually, a figure that has gone relatively unchanged since 2000.

With the number of STEM jobs growing at three times the rate of those in other sectors over the past 10 years, it is crucial that gifted young individuals, regardless of background, receive the opportunities necessary to develop the skills required of such positions. Furthermore, in order to benefit from the realisation of a truly representative STEM labour force, action is needed to address the specific obstacles faced by many underserved students in pursuing higher education or moving up the career ladder.

Langston's Integrated Network College (LINC) based at Langston University – a historically black university (HBCU), Oklahoma, USA – is an initiative designed to encourage underserved students with their education and careers in STEM disciplines. LINC was established in 2003 and, backed by two HBCU-UP NSF funding grants totalling US $5 million, has administered programmes for all Langston University STEM students and offered specifically targeted support to an average of 35 scholars each year. Presided over by Principal Investigator and Lead Organiser Dr John Coleman, LINC offers participating students a range of opportunities that includes tutoring, mentoring, research placements, innovative teaching and learning, and academic advice.

LINC represents Langston University's understanding of the power of collaboration and commitment to STEM. Langston's stalwart support from the university's top management down through all departments enabled the integration of over 20 internal and external research and scholarship resources to produce and deliver LINC's programmes. From its implementation, LINC has enjoyed support from several presidential regimes, including current President, Dr Kent J Smith, Jr and current Vice President of Academic Affairs and LINC Advisory Team Liaison, Dr Clyde Montgomery.

The importance of ensuring programmes such as LINC prepare minority students for success in STEM disciplines cannot be overstated. Indeed, a brief submitted by the National Center for Science and Engineering Statistics states that the two most prominent types of universities in which black science and engineering (S&E) doctorate recipients receive their bachelor's degrees are HBCUs and research universities with very high research activities. Between 2002 and 2011, 10 of the top 11 baccalaureate-origin institutions for black S&E doctorate recipients were HBCUs.



STEM DIGITAL VILLAGE

A central component of LINC is the STEM Digital Village (SDV), an online platform that hosts a wealth of valuable tools for students, including resources for educational and personal development, and information on scholarship and fellowship opportunities. Key achievements of LINC participants are also shared publicly via SDV: "In this regard, SDV serves as a marketing tool," Coleman enthuses. "Potential Langston students can see the kinds of activities and support that we offer, and aspire to similar achievements."

The role of SDV and its features are constantly evolving, and the LINC team is currently working on enhancing its alumni community elements. This space is used by LINC alumni to share their experiences of graduate school and professional life with current scholars, and serves to support mentorship. In addition, Coleman and his colleagues have proposed another section of SDV dedicated to supervised outreach programmes led by LINC scholars for promising high school students interested in STEM.

PROBLEM SOLVING

During LINC's first phase (2003-08) a thorough assessment of the aptitude of incoming students was conducted to observe the efficacy of high school teaching and learning practices, and identify common weaknesses among new

AWARD WINNERS HOLD CERTIFICATES AT BKK/NIS 2013 ANNUAL CONFERENCE

LANGSTON UNIVERSITY CAMPUS

participants. The analysis included test scores and information on learning difficulties. A wide range of lessons have been drawn from this process, from issues surrounding verbal STEM problems to poor comprehension rooted in an approach that focuses on broad-scale topics instead of component problems. Langston reports that its findings mirror similar findings reported by institutions of higher eductaion throughout the US.

To remedy some of the teaching and learning pitfalls pinpointed by the evaluation, the LINC group devised the Competency Performance Recordings for Learning (CPR-L) process. "CPR-L is a teaching and learning instructional strategy aimed at resuscitating students' learning of the analytical process of problem solving," Coleman explains.

HOW CPR-L WORKS

The evidence-based CPR-L method is iterative and draws upon modern technology. Typically, a student is presented with a core concept-related conundrum for homework and, using a tablet computer, must make a recording of themselves teaching the problem-solving process. Before using the tablet, the student must put pen to paper and work through the question using a specified set of rubrics. Once they are satisfied that they understand the process, the student will then use the tablet to make an audio recording of how they arrived at their solution. A visual breakdown of their problem-solving process is also captured as the student writes their workings out on the tablet. The entire class is required to develop CPR-L videos as an expression of their learning; in so doing they practice the highest form of learning and retention – learning by teaching.

The resulting CPR-L videos are presented via a projector in class. Those of a particularly high standard are displayed on video screens within Langston University's Physical Science building and uploaded to SDV as a record of achievement and as an educational tool for the producers' peers. Further, instructors can use them to isolate students' course content weakness and recommend precise interventions.

Since 2009, the CPR-L process has been implemented in chemistry Summer Bridge STEM classes with great success – 2012 class score improvements were at 212 per cent, a substantial increase upon the 2008 pre-CPR-L figure of 85 per cent. Aspects of CPR-L have also been used in the university's Introduction to Chemical Research programme since 2007, where the number of research presentation awards given out has more than doubled that of years where the CPR-L process was not used.

PROVIDING VALUABLE MENTORING

A key obstacle faced by many underserved students is a lack of visible role models providing inspiration to pursue an advanced STEM education and career. In a significant effort to improve this situation, LINC offers a suite of mentoring and research internship opportunities.

Participation in a research internship is a core requirement of LINC, and the programme's staff assist students with all aspects of securing a placement, from checking that personal statements and applications are exemplary, to ensuring that students have the financial backing to support their internships. By building and maintaining strong relationships with a wide range of external organisations, students have been successful in obtaining highly sought-after internships with institutions including Caltech, the Johns Hopkins School of Medicine, NASA and the University of California, Berkeley.

PROMOTING FURTHER STUDY

LINC places an emphasis on encouraging all participants to aim higher with their education and continue into postgraduate programmes and, if successful, are eligible to receive a scholarship of up to $30,000, courtesy of a partnership with the Louis Stokes Alliance for Minority Participation. The fact that the number of STEM graduates who have matriculated to further study has increased by 133 per cent under LINC clearly shows that such efforts are paying dividends.

To date, LINC has been incredibly successful, particularly within chemistry, where the number of undergraduates has increased fivefold since the pre-LINC period. While the project's NSF funding will officially continue through 2014, financial support secured through external partnerships will guarantee the continuation of SDV at its current capacity. However, in order to continue expanding the service and further the impact of LINC, Coleman and his team are currently pursuing backing from other sources.

INTELLIGENCE

LANGSTON'S INTEGRATED NETWORK COLLEGE FEATURING THE STEM DIGITAL VILLAGE

OBJECTIVES

- To increase the number of underserved students who enter college, receive undergraduate and advanced degrees in STEM disciplines and choose STEM careers
- To expand the diversity of participants in the Langston University STEM programme

KEY COLLABORATORS

Dr Clyde Montgomery, Vice President – Academic Affairs; **Dr Clarence Hedge**, Dean – Arts & Sciences; **Drs Alonzo Peterson**, **Zola Drain**, **Fondjo Futou** and **In Hai Ro**, STEM Department Heads; **Irene Williams**, Program Coordinator; **Brittaine Atkinson**, Education and STEM Digital Village Coordinator, Langston University, USA

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LANGSTON UNIVERSITY

WE CARE WORLDWIDE
LINC COLLABORATOR SDV PROJECT

NSF