DR MALCOLM J D'SOUZA

Teaching experiment

Dr Malcolm J D'Souza explains the decade-long transformation that a National Centre for Research Resources grant has driven, creating a dynamic and exciting environment, where research drives undergraduate teaching for student benefit

Firstly, what is the motivation behind this venture? What do you hope to achieve?

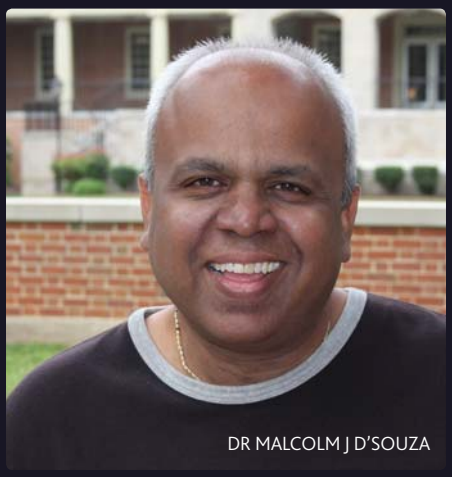
In 2001, the University of Delaware and its partner Wesley College (Wesley) applied for an Institutional Development Award (IDeA) from the National Center for Research Resources (NCRR) at the National Institutes of Health (NIH). The IDeA programme requires all higher education institutions and medical schools within a state to partner with each other on biomedical research projects. Later, together with a NSF Experimental Program to Stimulate Competitive Research (EPSCoR), Wesley focused on research methods to train undergraduates to understand and use scientific methods in critical thinking and experimental design. Prior to 2002, Wesley served primarily as a teaching institution. As a result, most of its STEM undergraduates joined the workforce on graduation, typically in lab-tech positions. Anecdotal evidence also suggests that very few went on to graduate or undertake professional programmes, and there is only one known instance of a student attending medical school pre-2001. After receiving the Awards, our main goal was to train our undergraduates to ensure that they can be successful in graduate and professional programmes, or careers in industry or government agencies. This should help increase the scientific capability that is currently lacking in Delaware.

Why have you decided to focus investment on the development of Wesley's scientific community?

The NIH provided the funds strictly to advance biomedical research capability within Delaware. Together with the NSF funds, they aim to broaden the participation of Delaware's diverse student population in science and technology career pathways, and to bridge the gap between discovery research and application to help solve Delaware's environmental problems and create jobs. Wesley did not have funds to train students in undergraduate research in science or in the use of advanced instrumentation techniques that are needed in any graduate science programme or in professional programmes. Prior to receipt of NIH or NSF funds, few faculty members were involved in 'authentic' research projects. Evidence suggests that there were less than 10 scientific publications in Wesley's 129-year history prior to 2002.

How has the NIH IDeA Network of Biomedical Research Excellence grant been beneficial to Wesley?

We decided to use the external support to concentrate on the enrichment of Wesley's STEM programmes, including a Mentored Directed Undergraduate Research Programme. Students can enrol in this programme for credit and also get paid as a research assistant. In summer, students have the option to complete a 10-week paid internship at Wesley or a partner institution. Additionally, all of our STEM undergraduates (except Medical Technology)



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have to complete a capstone research project during their senior year. The Med-Tech students have to complete a clinical programme in their senior year. In order for the STEM faculty to develop viable research projects, we had to update or purchase the instrumentation, renovate some of the lab spaces, purchase supplies, and provide online library access using grant funds.

What do you consider to be the greatest challenge facing science in the 21st Century?

Our biggest task is managing the global population, and its impact on healthcare and its impact on the environment. Science has to lead, and is leading, the way to sustainability; however, progress seems to be rather slow. We can change this equation of our unprecedented demands by encouraging undergraduates to become involved in research projects that force them to think about fresh approaches, since education has been shown to change one's preferences.

Finally, what inspires you to work with science undergraduates? What have you learned from the students you mentor?

When I was a student, my mentors at Northern Illinois University gave me an opportunity that I just 'took and ran with'. I see myself in the typical Wesley STEM undergraduate, so I try and give them that same opportunity. I have to admit that working with undergraduates is, at times, frustrating, but it is nontheless extremely rewarding. It is frustrating because, in the lab they can sometimes have a short attention span and one is constantly in competition with other forces. However, undergraduate research projects often result in more questions which produce a much more meaningful and authentic solution. Consequently all of our peer-reviewed manuscripts have been accepted for publications and several presentations at scientific meetings have received national or regional awards. Undergraduates are enthusiastic and malleable, beginning as a 'blank slate' and soon maturing. They are quick learners, especially in instrumentation techniques and technology.

Helping underrepresented STEM undergraduates

By providing innovative research-based undergraduate programmes, **Wesley College** is able to use federal funding to significantly improve the lives of disadvantaged students who attend the institution

WITH NUMEROUS INSTITUTIONS attempting to encourage first generation and financially disadvantaged students to adopt STEM disciplines, a number of innovative and interesting projects have been launched. Yet at Wesley College this has been the norm for over a decade now. With over a half of their students from minority backgrounds, four-tenths of attendees comprised first generation students, and an adjusted mean family income of only US $24,000, Wesley is dealing with exactly the students that need to be included in such groundbreaking programmes. The results are impressive. Against an average STEM retention rate across three years of 44 per cent, the directed research programmes achieve a staggering 97 per cent. With similar results being seen in their partner institutes, this is an incredibly high impact practice.

Dr Malcolm J D'Souza, who is leading the team at Wesley, shares experiences with the target students, having grown up in India with parents who did not complete high school. Consequently he is in a strong position to push for the benefits that this integrated undergraduate research programme can offer students, allowing them to develop within a flexible syllabus that moves with them. The hope is that this work will continue transforming Wesley's learning environment, just as it has over the last decade.

It is not only the lives of the students involved in the programme that are being transformed by Wesley, but the areas that they are conducting research in; a particularly pertinent research project involved the creation of a cancer drug database. Whilst this was being completed, it was noted that a number of the pharmaceutical companies were not complying with the Food and Drug Administration (FDA) guidelines, failing to fully report their experimental data in the drug-files published online. As a result, the US Government Accountability Office used Wesley's information in order to criticise the companies, seeking to force them to fully comply with regulations.

Cutting-edge research also includes the documentation of the reactions of chloroformates, esters of chloroformic acid. These esters are common precursors when synthesising a number of pharmaceutical and agricultural products, and Wesley's undergraduate research results have now appeared in numerous patent applications. These successes are indicative of the way that the programme can engage undergraduates, but there are also more general benefits. By introducing students to the intricacies of science and mathematics, Wesley is able to help foster their interest and understanding, guiding them towards STEM disciplines.

PROJECT PROGRESS

There are a number of ways that this work will now be able to progress. The example of the cancer database is now developing, with a mathematics major making the information freely available online. This means that there is now a collaborative online database that clinical researchers and clinicians are able to access and update. D'Souza explains that such projects can result in excellent teaching methods: "Seeing its potential and our success with this undergraduate, the Chair of the Mathematics Department, Dr Derald Wentzein has now initiated a minor in informatics that will be offered as part of their maths programme". The hope is that a future extension of the grant will be able to facilitate this initiative. Furthermore, Wesley is applying for assistance to award 16 $6,000 annual scholarships to minority students who are enrolled in the college STEM courses. The success over the last 10 years demonstrates

TRANSITIONING UNDERGRADUATE RESEARCH IN SCIENCE AT WESLEY TO MEET THE CHALLENGES OF THE 21ST CENTURY

OBJECTIVES

- To modernise available research facilities in order to address critical research laboratory deficiencies to aid a growing mentored STEM undergraduate research programme
- To attract and assist underrepresented students in their research endeavours

KEY COLLABORATORS

Dr Karl Steiner

Dr Donald Sparks

Jeanette Miller

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CONTACT

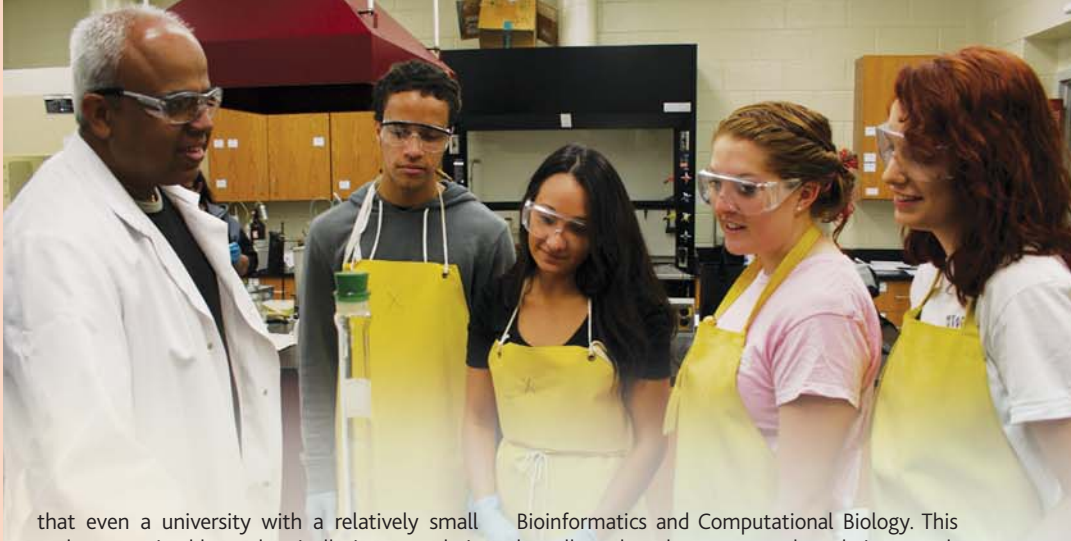
Dr Malcolm D'Souza
Professor of Chemistry & Director of Sponsored Research

Wesley College
120 North State Street
Dover, DE 19901
USA

T +1 302 736 2528
E malcolm.dsouza@wesley.edu

www.wesley.edu

DR MALCOLM J D'SOUZA is Professor of Chemistry at Wesley College, Delaware. He has published 72 peer-reviewed journal articles, has over 250 abstracts in conference proceedings, and has established a nationally recognised Wesley College Undergraduate Directed Research Program in Chemistry. He has been especially effective at involving undergraduates in his research projects and has mentored over 100 undergraduate students since 1992, with 50 undergraduate co-authors on his list of peer-reviewed publications. In June 2012, D'Souza received the American Chemical Society's (ACS) 2012 E Emmett Reid Award, which recognises high-quality teaching in chemistry at small colleges in the ACS Mid-Atlantic region.



that even a university with a relatively small endowment is able to drastically improve their educational outcomes. With 44 undergraduate researchers receiving national awards and recognition, and 40 gaining co-authorship in peer-reviewed publications, it is clear that they are achieving their aims.

BREADTH OF TEACHING

The programme is also attempting to equip students for a range of challenges that they could face having graduated from Wesley. This includes an annual ethics training seminar series, preparing students for a more broad-minded assessment of their work. Furthermore, there is a summer element to the teaching which includes roundtable discussions involving former students with current undergraduates. Here they can discuss a number of elements, from careers and attending graduate school to effective scientific communication. This is a key opportunity for students whose parents have not participated in higher education, since it gives them a chance to learn about the opportunities open to them. The undergraduates' experience is further enriched by a close partnership with the Delaware American Chemical Society Section. This allows Wesley participants to conduct experiments to stimulate younger students, getting them interested in science at an early age. In the fall of 2011, the Wesley College faculty reached a consensus to include undergraduate research beginning at freshman level as part of a new core curriculum. D'Souza is excited by this development: "In the near future, an undergraduate research experience will probably be a signature feature of every Wesley course". With the focus on research agreed, it is hoped that this will soon be a reality.

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STATE PARTNERS

The programme has been successful because of its collaborative strength. Wesley has consequently been able to offer their undergraduates access to the advanced instrumentation at any of the core centres at the University of Delaware, including the computational facilities at the Center for Bioinformatics and Computational Biology. This has allowed students to complete their research project at any other partnering institutes. The assistance has extended to those who are running the programme, with advice and suggestions for grant submissions and related tasks coming from Dr Karl Steiner, Dr Donald Sparks and Jeanette Miller, who are all involved in the collaboration.

Miller is the Associate Director of both the IDeA programme and EPSCoR initiative, which strengthens education and research in science and maths, and has been instrumental in placing undergraduates in research laboratories at the University of Delaware during the annual summer internship programmes. They have also offered these students the chance to improve their public speaking skills through a presentation of their work at the end of summer. With these core partnerships at the centre of this work, Wesley and the other institutions have been able to push forward the participation of their students in innovative research-led programmes.

SHARED BENEFITS

Wesley has been able to use part of its grant money to overhaul many of their facilities, including the organic chemistry laboratory, the chemistry and biology storerooms, the biology prep-room, three undergraduate research laboratories; to purchase high-end instrumentation in chemistry and biology; and to install WiFi and SmartBoard technology in classrooms and labs. Consequently, they have been able to accommodate graduate students working on site towards their goals, including students from the University of Delaware and Delaware State University. Seeing an undergraduate research project through to fruition has been beneficial, demonstrating to students the opportunities that further study can offer. Wesley has been able to contribute a number of students to programmes at both of these universities, and their summer interns continue to work there. As such, Wesley is building on their progress, becoming a feeder school for other graduate programmes, which they are now expecting to develop further.