A CURE for education: how can genuine scientific experiences inspire future scientists?

What is it like to be a research scientist conducting hands-on experiments in a working lab? How well can science lessons prepare – and encourage – students for careers in STEM? **Dr Ying Gao**, assistant professor from **Nantong University, Xinglin College,** in China and currently based at **Jackson State University** in the US, is investigating how course-based undergraduate research experiences (CUREs) can transform the learning experience and encourage students to think like real scientists.

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Field of research
Education research

Research project
Using course-based undergraduate research experiences to improve the experience of African American Geotechnical engineering learners

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PROFILE

💬 Talk like an ... **education researcher**

Collaboration — working with other people to reach a shared goal. During CUREs, learners are encouraged to collaborate with each other to form new ideas and support each other's learning

Course-based undergraduate research experience (CURE) — a learning opportunity that allows students to take part in and learn from real-world scientific research projects

Discovery — the act of finding something new. During CUREs, learners are not simply given information, but are expected to discover it for themselves

Historically black colleges and universities (HBCUs) — higher education institutions that were established to serve African American learners specifically

Scientific mindset — an outlook on life that is driven by curiosity and involves questioning and testing hypotheses about the world around us

STEM — science, technology, engineering and mathematics

Science lessons need to teach the wonders of the known universe in classrooms or educational settings, often through old textbooks and in relatively short amounts of time. The miracle of life is boxed into graphs and diagrams, while the mysteries of time and space are sucked into a black hole of incomprehensible equations and formulae!

Of course, education has to start somewhere, and it is important to learn fundamental knowledge and basic practical skills to become a scientist. However, it can be hard to get to grips with difficult concepts from books and PowerPoint presentations or to feel inspired by an experiment that has been conducted countless times in classrooms all over the world.

At its core, science is about discovery. Surely, we can find a way to learn these skills in a manner that also teaches us to adopt the scientific mindset. A mindset that is curious, inquisitive and that asks questions about the world around it.

Dr Ying Gao, based at Nantong University, is an education researcher who has been studying at the College of Education and Human Development at Jackson State University, investigating the potential of a new educational model to do just that. Ying's research is focused on a geotechnical engineering course that uses course-based undergraduate research experiences (CUREs) to give its learners the chance to gain practical skills and develop a scientific mindset through participation in genuine scientific research.

What is different about CURE courses?

"In traditional laboratory classes, learners explore the scientific world in a fixed routine with a variety of scientific exercises," says Ying. "Learners carry out predetermined scientific research according to instructions from an experiment manual." This way of learning, as many of us have experienced, can feel dull and unproductive.

"Contrary to traditional lab courses, CUREs create a laboratory learning environment in which learners are completely absorbed in a variety of novel research," explains Ying. Students taking part in CUREs are fully immersed in real-world scientific research; they learn how to create research questions and design studies, collect and interpret data, and communicate their findings to other people.

For example, learners on the geotechnical engineering course that Ying has been focusing on take part in a research project investigating the potential for drones to improve land surveys. Land surveying is a fundamental part of all civil engineering projects. As part of their CURE, learners use drones to collect data on research sites such as dams and bridges.

"With the assistance of modern technology, learners have the opportunity to apply what they have learnt to a real-world project," explains Ying. "Taking part in these experiences gives learners a deep understanding and an intuitive feeling of scientific practice."

What are the benefits of CURE courses?

To compare CURE courses with traditional courses, Ying surveyed learners from both course types before the start and at the end of their courses. These surveys asked learners about different aspects of their course, such as how much they were encouraged to collaborate with others, how much they were expected to use their own initiative, and what their career aspirations were.

The results from these surveys show that the CURE model inspires learners to seek further education in engineering and prepare themselves for engineering jobs in the future. Ying explains, "Lab courses embedded with CURE elements can improve learners' competence in experimental design and data analysis, inspire their enthusiasm in science, and convince them to continue with their studies."

These results are particularly encouraging because Ying's research took place at Jackson State University, one of the largest Historically Black Colleges and Universities (HBCUS) in the US. Before the civil rights movement in the 1960s, many American colleges and universities limited their intake of, or refused entry to, African American students. HBCUs are higher education institutions that were created to serve African Americans.

Why are CURE courses so important at HBCUs?

"In 2017, the number of African American learners enrolled by American public colleges and universities in STEM majors was only one-fifth of the number of white learners," says Ying. African American learners also have higher drop-out rates and lower graduation rates than other learners. "As a result, the involvement of African Americans in STEM occupations is strikingly low," she adds.

These worrying statistics are the result of a whole host of barriers – from a lack of mentorship and support, to fewer opportunities, to more overt forms of discrimination – that can make higher education more challenging for African American learners.

Implementing CURE courses at more HBCUs could help to improve the situation. Findings from Ying's research show that the CURE course she implemented improved learners' self-confidence and encouraged more of them to consider careers in STEM fields.

Scientific research that impacts all of society needs researchers from a range of backgrounds and with a range of perspectives. Encouraging and developing African American STEM experts is a vital part of the diversity we need to benefit us all.

What are Ying's next steps?

Ying will continue to study CURE courses and their impacts on African American learners. In future studies, she will interview learners to gain a deeper understanding of their survey responses. These interviews, along with advice from teaching experts, will allow Ying and her fellow educators to adapt and improve the CURE model.

"We expect that instructors from different courses at the university will adopt the CURE model in the future," says Ying. "We hope that this will strengthen STEM education for our African American undergraduates, help to cultivate their talents and prepare them to compete in the global job market."

About *education research*

Education is one of the most important aspects of our development as human beings. A good education allows us to communicate with other people, develop new skills and understand the world arounds us. Without a proper education, we may struggle to feel confident socially, find work, take care of ourselves and lead a fulfilling life.

Education research is the process of studying, testing and, ultimately, improving our education practices. Education researchers aim to understand the mechanisms by which humans learn in order to identify new and better ways of teaching.

Over the last few years, one of the big questions in education research has been how best to integrate technology into education. During the COVID-19 pandemic, this question was put to the test as schools and universities around the world were forced to move all of their teaching online.

Overnight, teachers and learners had to adapt to video calls and virtual classrooms. How long can learners pay attention on a video call? How does a lack of social contact affect learning? Can teachers support students properly without face-to-face interactions? These are the types of questions that education researchers are still trying to answer, with many concerned about the consequences lockdowns had on schools and young people.

While it is clear that technology cannot replace in-person learning, there is still huge potential for it to enhance and augment our teaching methods. In fact, it is hard to imagine how a school could function these days without access to computers, the internet and smart boards. As technology continues to evolve, so too does its place in the classroom.

One new technology, augmented reality, is already being used in some classrooms. For example, medical students use simulation software to practice surgical procedures, whilst some mathematics teachers are using augmented reality to teach trigonometry (**futurumcareers.com/how-augmented-reality-can-help-you-learn-trigonometry**).

Pathway from school to *education research*

Education research is often offered as a post-graduate course such as a master's degree or a PhD. To qualify for these courses, it is likely that you will need to have achieved a good grade in a related undergraduate course.

Undergraduate courses in the social sciences (such as psychology and sociology), humanities (history, geography, etc.), and liberal arts (literature, philosophy, etc.) could all prepare you for a postgraduate course in education research.

During an education research post-graduate course, you will learn about different education methods, how to design studies and conduct research, and about the impacts that education has on society.

Throughout your studies, you will need to learn skills such as statistics, research methodology and experimental design so that you are able to conduct impactful research when you graduate.

Q&A
Meet *Ying*

Who inspired you to become an education researcher?
My supervisors, Professor Yin and Assistant Professor Wen, who have done an outstanding job in their research fields. Their commitment and diligence inspired me a lot.

### What experiences have shaped your own career?
When I had teaching practice as a student teacher in a poorly-equipped primary school in China for half a year, I was deeply touched by students' eagerness to learn knowledge and their optimism towards life. Education can help you to see a bigger world which you have never experienced before. Education can inspire the light in your heart and motivate you to pursue your own dreams.

What are your proudest career achievements so far?
I was awarded an 'Excellence in Teaching' prize in 2019 in our city.

What are your aims for the future?
To help more students not only acquire knowledge but also inspire them to realise their dreams. To make their hopes and dreams reality. To light their path to career success and life satisfaction.

> " *Education can help you to see a bigger world which you have never experienced before.* "
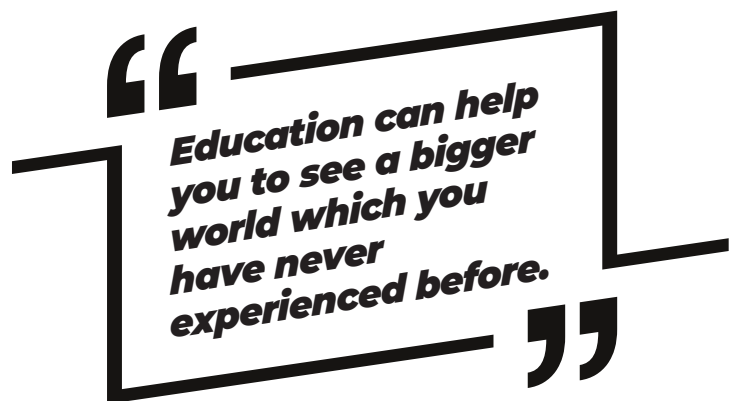
Ying's *top tips*

1. Be honest with your research.

2. Focus on your research.

3. Avoid distractions!

4. Keep moving forward.

Explore careers in
education research

Societies such as The American Educational Research Association (**aera.net**), The Society for Educational Studies (**soc-for-ed-studies. org.uk**), and The British Educational Research Association (**bera.ac.uk**) are great places to learn about current topics in education research, connect with other education researchers and get careers advice from more experienced people.

Some education researchers may be employed by a university to conduct research into many aspects of education including the societal importance of education, inequalities in education, educational psychology, and the study of human learning.

Other education researchers may be employed by schools, education departments or teaching companies to help them improve their practices and provide a better education for students.

A great way to find out more about a career in education research is to talk to an education researcher. Why not get in touch with the education department at your dream university and see if you can chat to one of their researchers about their work?