**Democracy's College**

**Episode 14: Equity in Mathematics Education**

Welcome to the Democracy's College podcast series. This podcast focuses on educational equity, justice, and excellence for all students in P-20 educational pathways. This podcast is a product of the Office of Community College Research and Leadership, or OCCRL, at the University of Illinois at Urbana-Champaign. Learn more about OCCRL at occrl.illinois.edu.

In this episode, Dr. Eboni M. Zamani-Gallaher from OCCRL talks with Dr. George Reese, the director of the Office for Mathematics, Science, and Technology Education at the College of Education at the University of Illinois at Urbana-Champaign, about equity in mathematics education.

**Dr. Zamani-Gallaher:** Good afternoon. We are here with Dr. George Reese, director for the Office for Mathematics, Science, and Technology Education in the College of Education at the University of Illinois at Urbana-Champaign. Dr. Reese has been part of that organization for 20-plus years, and his organization's goals are to promote bridge K-12 STEM teaching and learning via the use of new digital technologies and university-community collaborations. Dr. Reese was a high school mathematics teacher in the late 1980s and early '90s before coming to the University of Illinois. He has also served as president of the Illinois Council of Teachers of Mathematics (ICTM). Dr. Reese, thank you for joining us for Democracy's College.

**Dr. Reese:** It is my pleasure to be here.

**Dr. Zamani-Gallaher:** We wanted to talk to you about your work in particular with equity being a major concern in academia and in all areas. I just wanted to know if you would share your perspective on what it means to have equity in mathematics education.

**Dr. Reese:** Yes, thank you Eboni. I think equity is a vital issue in mathematics education and has been for a long time. It's simply a fact that mathematics and mathematics education is not equitably distributed. Quite the contrary, achievement in mathematics as a school subject has often been used to rank and sort students. It's been this way for a long time. A report from going on 30 years ago, 1989, from the Mathematical Sciences Education Board made note of that. In thinking about this for this discussion with you, I looked up that quote. This is from a report called *Everybody Counts*, in 1989. It says,

> From high school through graduate school the half-life of students in the mathematics pipeline is about one year. On average we lose half of the students in mathematics each year, although various requirements hold some students in class temporarily for an extra term or year. Mathematics is the worst curricular villain in driving students to failure in school. Mathematics acts as a filter; it not only filters students out of careers, but frequently out of school itself.

I think that as true that was almost 30 years ago, it's even more true now. So equity in mathematics is absolutely critical, because our history of teaching mathematics has had dual problem and opportunity. The opportunity is that mathematics is so vital for the modern world and such a vital entrée into the technologies and the technological careers of today. On the other hand, it has been used historically and is still used as a filter.

**Dr. Zamani-Gallaher:** Thank you. Some argue that there is a disconnect in math curriculum between secondary and postsecondary education. I'm wondering if you can talk about the alignment between secondary and postsecondary, and what do you see as some of the challenges that arise as a result of being loosely coupled sometimes?

**Dr. Reese:** The issues of vertical alignment are also part, just as the history of equity is and of inequities, of the history mathematics education, going back to even the Sputnik era, and then the New Math, and up to the Nation at Risk, and NCTM standards, and the curricula that were developed around those standards, and the creation of revised standards, and then the accountability movement from No Child Left Behind. When you look over that history it has been a history of trying to change, upgrade, and create higher standards for mathematics education in K-12. Meanwhile, what changes have taken place in higher education I think have not necessarily been aligned with efforts to change things in the K-12 arena. I think it's important to look a little bit at that history, because when we see the disconnect today, I think a lot of it can be looked at as efforts to tighten up and articulate what should be demanded of students. But we are still wrestling with ways to get students to those levels of achievement. Having a clear and coherent understanding of what mathematics is good for and helping students develop a passion for problem solving, those still remain challenges. Having a sense of quantitative literacy, for example, in all of our high school students is absolutely vital today. They need to know how much, what portion of the federal budget, is a billion dollars. What is the ratio of foreign aid to food stamps? How do we understand them? Or more personally, how would we calculate a rate of credit card payback for a particular rate of interest? So, the question of a disconnect between what we teach in high school and what we teach in postsecondary has come about naturally from the way in which schools have been historically, but now that we want more for more students and more is required of them, we need to address those disconnects more directly. I want to say too that I think our schools sort students into achievement brackets early on. That too is part of that history. Those achievement brackets in math especially tend to sort students in ways that are today detrimental to students who are not immediately identified as college bound. So if a student is separated, and it happens very early, into classes that are if not remedial at least have a lower standard of mathematics expectations and content delivery, they tend to stay there. That becomes a self-reinforcing cycle of underachievement, where students go to postsecondary education and struggle. They find themselves not prepared. So the alignment issue is more important today than it's ever been, because we have so much more we need to give in terms of STEM education and mathematics education in particular to students.

**Dr. Zamani-Gallaher:** Thank you. And so, one of the outcomes of when things aren't necessarily aligned in the math curriculum is that we have seen increasing numbers of students needing remediation and assigned to developmental ed when beginning their college years. What has been the impact of remediation on STEM students, in your opinion, especially when we think about if they move from developmental mathematics and hopefully through that sequence into calculus and calculus I or II for instance?

**Dr. Reese:** The impact by and large has not been as positive as we would like, and I think remediation in particular, in analyzing the problem, I think we need to look at what has led to this situation in the first place. My friend Peter Brownfields, a retired mathematician who started at the university, who was a student in the late '40s, early '50s, he said calculus at that time was a second-year undergraduate course. There wasn't any calculus in high school. Today we see more students taking calculus in high

school than we do in 2- and 4-year colleges. So for our elite student the pathway is well paved, and for students who are put into remedial education it's not so well known. So with the emphasis on STEM and STEAM now there is a recognition that you need to have better pathways and more sophisticated pathways for students to achieve success, and it's not just success in the workplace, it's to be quantitatively literate citizens. What happens in mathematics in particular is that as students get behind and fall further behind, both the intellectual knowledge and the emotional investment in mathematics will decline, which I think is natural. After all, who would want to keep doing something that they don't feel they're making progress in? They often find themselves done with high school and then taking a placement test and bang back into developmental math. I think that can be debilitating for some, but it has been a challenge that in my experience and the experience in working with OCCRL and traveling around the state that community colleges and to some degree high schools are taking on, I don't want to say aggressively, but as best they can because they are recognizing it as a problem to get more mathematics to all students earlier and to really provide the supports that are necessary to take students, to help students who haven't experienced success get that success. I keep going back to the history of how we got here, because it is a fairly new phenomenon. In the last 40 years we have had a revolution in the need for more sophisticated mathematics, science, and technology learning for all students, because the jobs of the past have disappeared, but also the requirements of citizens in this age of social media to be more quantitatively literate are so many, and so new, and so jarring, so it's a big challenge. It's requiring an enormous effort, and I see community colleges and schools trying to do it. They are certainly going to need a lot of support to achieve equity; we're not there yet.

**Dr. Zamani-Gallaher:** In 2015, you co-authored Illinois STEM College and Career Readiness: Forging a Pathway to Postsecondary Education by Curbing Math Remediation with some of the OCCRL research associates. In that brief there were several partnerships and initiatives highlighted between selected community colleges and high schools that were really putting forth efforts to reduce remediation. As you think about and reflect on some of that work, what were some of the successful programs, and how could we get to a point where we could possibly scale up or sustain some of that success? Are there any takeaways or lessons learned from that project?

**Dr. Reese:** Yes, I think fondly of that project. We were able to visit a number of community colleges that had established relationships with high schools to try to identify students who might struggle and provide them with support to achieve success in college mathematics to reduce the amount of time in remedial mathematics, sometimes taking developmental mathematics in the high school. We were able to observe and describe those efforts. Jason Taylor, I think it was, who developed a very nice logic model of how institutions developed not just the academic interventions, but thought about how those aligned with the high school programs, that kind of vertical alignment you were asking about earlier, that bridges that disconnect between high school and colleges and also the student supports. I cannot emphasize enough how much it struck me visiting these programs how important the human relationships seemed to be for the success of the students. That is, we like to think of projects, or we hope to find a silver bullet, that key, that if you introduce this curriculum, or you create this set of projects, or you use this pedagogical style, that's going to kind of suddenly scale to meet the need of students who have been struggling in mathematics. We found, or you observe when you go, that there are many factors, and that some of them require supports that are quite individually based. Students in community colleges, as you know, are often working; they are balancing all kinds of responsibilities as well as dealing with in mathematics the fact that they may not have done well in the past and have

emotional upset around the topic itself. It's not just the math, it's also a panoply of supports that are needed to help students get success. I think one takeaway that I got from working with that project and seeing the programs around the state was that it is a complex, interrelated process with many different strands that heroic human beings, if I can use that word, are balancing at community colleges and high schools to help students achieve success. Seeing those schools make that effort is inspiring, because I think we can eventually find those pathways that are going to help all students become highly quantitatively literate.

**Dr. Zamani-Gallaher:** Thank you. You know, I'm thinking as we move forward I'd like for you to spend some time sharing with us some equitable practices that you think may be helpful, could be implemented to reduce remediation, and what are some that you feel would encourage more underrepresented racial minority students through STEM math pathways?

**Dr. Reese:** I think it is important for all of us as math teachers to do our best to acknowledge and learn culturally responsive pedagogies. I think that's a growing field in mathematics education and a growing area of recognition among those of us in math education that we need to be doing more. A sense historically was that math was just math. It was kind of a-cultural. There was nothing about it that was evocative of issues of equity or inequity that needed to be addressed, because it was simply numbers. I think that we have today a much more sophisticated notion about the ways in which mathematics are useful, not just our society overall in a technical sense, but the ways in which mathematics has been used to promulgate and reinforce historical underrepresentation of women and minority groups. The emphasis of culturally responsive pedagogy is, I think, an important set of knowledge and the practices that come from it. In an ideal world I would like to see less sorting of students, which we tend to do rather early even in elementary schools. We have gifted programs. If we have gifted programs, we often have classes that are remedial. Another practice that troubles me, as I have been working in computing and mathematics in the elementary school, is that we often see that students are taken out of opportunities like computer programming to have remedial work in mathematics, which is often just skills based and not inspiring creative effort to understanding mathematics deeply. I would like to have less sorting. I think at the high school and community college level contextualization of mathematics learning is a very important process for students who many times just find the naked mathematics, equation solving, to be terribly boring. But if you are in a digital or electronics class learning the Boolean algebra and the types of mathematics that you need to understand digital circuity in the context of digital circuity, it can be much more motivating. I would think it would be same thing with something like auto mechanics. In this day and age, auto mechanics means dealing with computers and dealing with functions, so learning some mathematics in that context, contextualized mathematics learning, is an important practice that to me seems to be growing. One practice that I feel a little ambivalent about but I think research at least at the postsecondary level is indicating has some success is computer supports for learning. Programs that identify where students are in their skills and provide online supports for them to catch up on those skills seem to have some success. I say that I am ambivalent about them because I have ambivalent feelings about computers used as skill builders. I think that in many ways that has not helped the digital divide become less of a divide. Nonetheless, I think there is some evidence that some of these programs can help students catch up on skills. I think a best practice, even though it's difficult and expensive, is finding ways to get high schools and community colleges talking to each other, having teachers meet, having them share syllabi, just as they did in the STEM CCR program that we referred to earlier. That helps them to tell students in high school: Here is what is

coming. Here is why you need to be more familiar with mathematics, not just to have pre-requisites, but also because it is going to be useful in the careers that you will be looking at, in the modern careers of, say, of working with AutoCAD, or computer programming, or digital electronics, or what have you. So things like that. I would like to see less sorting. I would like to see more contextualized learning. I would like to see greater culturally relevant pedagogy and more collaboration and communication, and, where appropriate, computer-based learning in skills.

**Dr. Zamani-Gallaher:** Thank you. Our time is coming to a close, and this has been really helpful. One thing I'd like to ask is what call to action or advice would you share with our listeners relative to engaging and successfully matriculating students of color in mathematics?

**Dr. Reese:** I would say, again as a teacher, we all have responsibilities to learn about and employ culturally relevant pedagogy. A teacher that I admire greatly, Debra Meyer, has said that teaching is mostly listening, and learning is mostly telling. That seems correct to me. So when I am looking at classes, observing, and assisting, I look for places where I see students who are presenting, who are talking, who are illustrating, who are writing on the board, since I think that that kind of activity and learning go together. I would advise students, as I advise my own daughter, to look for math classes where students are doing a lot of talking and writing and presenting. My call to action would be to say that learning more mathematics should be an empowering experience for everyone who encounters it, that we should find mathematics instructors that care about your learning more than just covering mathematics content. That would be my call to action.

**Dr. Zamani-Gallaher:** Thank you, George.

**Dr. Reese:** Thank you so much Dr. Zamani-Gallaher; it's been a pleasure.

**Closing:** For more information about equity in mathematics education, we recommend that you visit the Office of Mathematics, Science, and Technology Education's website. For more podcasts, links to today's recommended resources, or to share your comments and suggestions, visit occrl.illinois.edu/democracy or send them via Twitter @occrl. Tune in next month for a special panel, *Where to Start: How Community Colleges can Scale Up their Registered Apprenticeship Programs*. This informative panel was hosted by Dr. Anjale Welton and Devean Owens. Background music for this podcast is provided by DubLab. Thank you for listening and for your contribution to educational equity, justice, and excellence for all students.