

## **Research- and Practice-Informed Insights for Recognizing Rurality in Engineering Education**

**Dr. Malle R Schilling, Virginia Polytechnic Institute and State University**

Dr. Malle Schilling is an assistant professor in the Engineering Education Systems and Design program at Arizona State University. Malle's primary research interests lie at the intersection of rural education and engineering education, largely informed by her own experiences as a rural student who pursued engineering, and community engagement to address wicked problems through collaboration and systems thinking.

**Dr. Jacob R Grohs, Virginia Polytechnic Institute and State University**

Jacob Grohs is an Assistant Professor in Engineering Education at Virginia Tech with Affiliate Faculty status in Biomedical Engineering and Mechanics and the Learning Sciences and Technologies at Virginia Tech. He holds degrees in Engineering Mechanics (

# **Research- and Practice- Informed Insights for Recognizing Rurality in Engineering Education**

Dr. Malle Schilling and Dr. Jake Grohs  
2025 CoNECD

Welcome everyone to our session and thank you for joining us today! The title of our presentation for this session is Research- and Practice-Informed Insights for Recognizing Rurality in Engineering Education. We hope you are here because you already do some work in a rural space or that you are interested in learning a bit more about how we can better incorporate rurality in various aspects of what you do, whether that be connected to research, practice, or both.

## **Presentation Overview**

Who are we?

Relevant Background

Considerations for Practice

Considerations for Policy

Considerations for Research

To give you an idea of what we'll be talking about today, we'll introduce ourselves a little more formally and discuss why we are even talking about this, provide some relevant background information including some recent findings from my dissertation work, and then move on to talk about various considerations for practice, policy, and research related to recognizing rurality.

## Who are we?

- Applied research with students, teachers, schools and industry in Southwest Virginia (PI Grohs, GRA Schilling)
- Research focused on rurality and engineering education with a specific focus on partnership and engagement



Before we really get into anything, I think it's important you know a bit more about us and how we came to this work. When I was first starting my PhD at Virginia Tech, I worked on one of Jake's grants that was focused on an interorganizational partnership between middle schools and industry in Southwest, Appalachian Virginia. The goals of this project were around providing middle school students with hands-on experiences with engineering in a way that was locally relevant – meaning the activities they engaged in had some important context that students could see in their daily lives and the connections with industry partners who were in the classrooms with students demonstrated these connections further. These efforts have continued as a part of Jake's NSF CAREER grant and really inspired my own research which seeks to connect rural education and engineering education through a specific focus on partnership and engagement. So we're coming to this paper from a lens informed by research and practice, and I'm also a rural student, so I'm excited I get to be here to talk to you all more about this today.

## Relevant Background

What is rural?

What are the issues?

Why should we care?

Recent Findings

We'll move on to talking a bit more about relevant background information for understanding rurality in engineering education. So we'll talk a bit more about what we even mean by rural, what some issues are, and why we should care about it, followed by findings that are really framing the purpose of our presentation today.

## (HOLD FOR AUDIENCE ENGAGEMENT)

- Question 1: What most aligns with your current job/role?
  - Research, outreach and engagement, practice, policy, teaching, other
- Question 2: What do you think of when you think of rural?

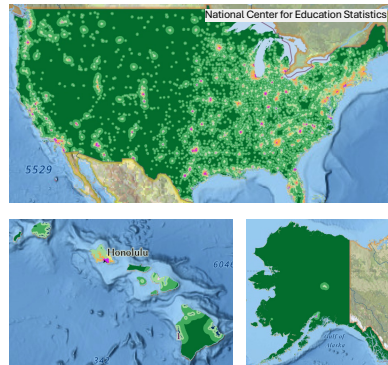
Engage audience to get them warmed up for what we will be discussing with the two questions. A tool like Mentimeter or PollEverywhere will be used to set this up to display responses as people answer.

## What is rural?

Thank you for engaging with us on those questions. It helps to get a sense of where everyone is coming from (add in more here based on audience responses).

## What is rural?

~20% of students in the U.S. attend a rural school<sup>[1]</sup>



[https://nces.ed.gov/ipeds/data/ipeds\\_datacenter/ipeds\\_datacenter.asp](https://nces.ed.gov/ipeds/data/ipeds_datacenter/ipeds_datacenter.asp)

Many of the definitions used for rural in education contexts comes from the National Center for Education Statistics (NCES). The NCES leverages locale definitions which are informed by the U.S. Census Bureau to classify schools and school districts. These definitions are generally defined by first identifying urbanized areas by population and moving out by distance from those urbanized areas. For example, in these maps, you can see different clusters, highlighted in pink, which are urban locales. Moving out from there is a sort of yellow, which represents suburban locales. They are harder to see but there are also towns on this map, highlighted in blue, then green represents all of the rural areas as defined by the NCES. About 20% of all students who attend a public school in the U.S. attend a rural school.

We know that these definitions are not exactly perfect. For example, the NCES definition is based on the actual location of a school and may not be representative of the population the school serves. For example, a school can be located in a town designation but serve a primarily rural student body. It is also important to note that many of the definitions we use for rural are in relation to urban, which is problematic when we are really trying to understand what it means to be rural— and these definitions are basically telling us that it's not

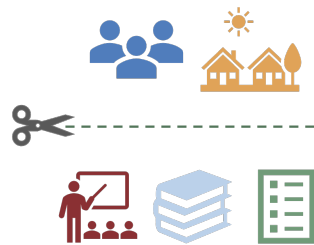
urban.

In addition to these demographic or population-based rural indicators, researchers often sometimes rely on political and economic definitions – such as defining the industry in a region (agriculture, energy production) or cultural and social definitions, which try to get at an understanding of rural life or rural lifestyles. Often, there are assumptions that rural places are conservative and represent some older way of life, that they are predominantly white, and often that they are backwards. Many of these approaches end up lumping rural into one homogenous category but it is important to recognize that as we talk about rural, there is a need to understand that rural looks different everywhere.

## What are the issues?

~20% of students in the U.S. attend a rural school

**Decontextualization of policies and practices<sup>[2-4]</sup>**



Many scholars, activists and educators have identified that a significant problem impacting rural communities and rural education in particular is that there has been a separation between the place and community and education, which can be referred to as decontextualization. This decontextualization of education has led to many policies and practices being created and implemented without a specific consideration for the communities being impacted. For example, many policies and practices in education were created and adopted through a lens of white suburbia, which does not really apply to the majority of students in the U.S. education system. When this happens, policies don't work for schools (e.g. funding models for public education relying on student body size and rural school populations) and practices may often demonstrate to students that their culture, way of life, and experiences don't apply in their education (e.g. standardized testing questions making assumptions around every student having some common experience like going on vacation).

This is particularly harmful for rural students, as they may often learn that staying in their rural communities is impossible and undesirable. This, in my view, has also carried over into our practices in engineering education where we have come to place a high value on students having experiences with advanced STEM

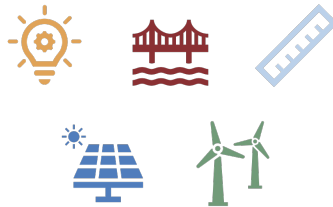
through extracurriculars or courses that indicate that they are prepared for engineering, without considering how students gain access to these opportunities and how this access varies greatly by where students attend school.

## Why should we care?

~20% of students in the U.S. attend a rural school

Decontextualization of policies and practices

**Rural students are underrepresented in engineering<sup>[5]</sup>**



All of this together has led to the fact that rural students are underrepresented in higher education and engineering, specifically. In fact, students from urban and suburban areas are more likely to enroll in any postsecondary education compared to rural students. Additionally, rural students might also often be low-income and first-generation students, which comes with an additional layer of barriers to entry for postsecondary education such as not having access to resources or knowledge from their closest peers or family members about how to apply to college in the first place. Related specifically to engineering, rural students often do not have an understanding of what it means to pursue engineering or what engineering careers might look like, though many rural students have a desire to attain better futures for themselves and participate in careers that bring them job security and stability. Understanding how space/spatiality plays a role in access to engineering will help us strengthen our understanding of equity in engineering education and will engage a group of students who otherwise go unnoticed in much of our education systems in the U.S.

## Recent Findings

Given that framing, I'd like to present a bit on some research that I conducted as part of my dissertation. . I'll introduce these two studies at a high level and then talk about three main findings or implications from these studies.

## Recent Findings

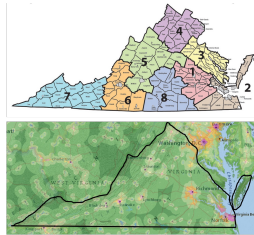
### Study One

Examining the possible **influence of individual- and school-level characteristics** on student **enrollment in engineering, engineering technology, and computer science postsecondary pathways** using descriptive statistics and logistic multilevel modeling with a state-level dataset

**RQ1.** How do enrollments in engineering\* pathways vary by geography?

**RQ2.** What individual- and community-level characteristics influence the likelihood of enrolling in a community college or 4-year engineering\* program?

### Study context



Level 2 (community)	Region 6 = Suburb	Region 6 = Town	Region 6 = City	Region 6 = Rural
Level 3 (individual)				

$N_{total} = 990,268$   
 $N_{4-year total} = 290,478$  and  $N_{4-year Eng} = 16,196$   
 $N_{CC total} = 268,586$  and  $N_{CC Eng} = 21,760$

The first study I'd like to introduce to you focuses on enrollment in postsecondary engineering, engineering technology, and computer science programs in Virginia. For this study, I used data from the Virginia Longitudinal Data System, which links different data sources for high school students in Virginia related to courses taken in high school, GPA, test scores, and ultimately postsecondary enrollment and related information. I used population-level data in this study, so there were about 990,000 students from 2003-2017 included in analysis, which is broken down further when you start to look at different pathways into college and into engineering. For this study, I leveraged both descriptive statistics and multilevel modeling to answer the two research questions here. For all analysis, I looked at two different levels: the individual level, which focuses just on individual students, and a community level, which I created by grouping students based on the region and the NCES locale of where they attended high school.

## Recent Findings

### Study Two

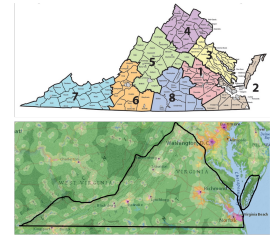
Exploring the **pathways of rural STEM professionals** to identify the **supports and barriers they faced, influences on their decision to stay in/return to/leave, and possibilities they see in their communities** using case study approach informed by interviews with rural STEM professionals in SW VA (Regions 6 and 7)

**RQ1.** What are the supports and barriers that STEM professionals from a rural region of Virginia experienced on their career pathways?

**RQ1.1** How do these supports and barriers shape their career choice?

**RQ2.** What factors influenced STEM professionals from a rural region of Virginia to stay in or return to their communities to pursue careers?

### Study context



Name	Category	NCES locale of high school	Job/Field	Pathway after high school
Arnold	Engineer	City/urban	Engineer at local company	Direct to four-year
Ann	Returner (different locale)	Rural/ fringe	Supply chain at local company	Four-year transfer to four-year
Chack	Stayer	Rural remote	Engineer at manufacturing company	Four-year transfer to four-year
Jackson	Returner	Rural distant	Engineer at local company	Direct to four-year
Kan	Stayer	Rural distant	Engineer at local company	Four-year and workday
Lane	Stayer	Town distant	Finance at local engineering company	Direct to four-year

For the second study I'll be talking more about, I focused more on understanding the pathways of rural STEM professionals to better understand the supports and barriers they faced on their pathway, and how these things influenced their pathway. Additionally, I wanted to understand more about the reality of being able to stay in Southwest Virginia, so I aimed to focus specifically on professionals who are from SW VA and who have stayed in SW VA, which is referring roughly to regions 6 and 7 on the map. For this study, I leveraged a case study methodology to understand the context of the region in terms of industry and higher education, and how that context may have influenced the pathways of the six participants in my study. 4 of the participants in my study have only ever lived in Southwest Virginia, one of the participants left after college but eventually came back, and one participant is from one rural community but pursued college and employment in a different rural community. Additionally, the participants represent different pathways, including direct to four year, transfer from community college to four-year, community college, and one participant actually started out in four-year but finished her degree at a community college.



Recent Findings

**Study One**  
Examining the possible **influence of individual- and school-level characteristics** on student **enrollment in engineering, engineering technology, and computer science postsecondary pathways** using descriptive statistics and logistic multilevel modeling with a state-level dataset


**Study Two**  
Exploring the **pathways of rural STEM professionals** to identify the **supports and barriers they faced, influences on their decision to stay in/return to/leave, and possibilities they see in their communities** using case study approach informed by interviews with rural STEM professionals in Southwest Virginia

So given the context of these two studies, there are three main findings or implications related to both studies that I'd like to talk more about.

Recent Findings

**Study One**  
Examining the possible **influence of individual- and school-level characteristics** on student **enrollment in engineering, engineering technology, and computer science postsecondary pathways** using descriptive statistics and logistic multilevel modeling with a state-level dataset

**Study Two**  
Exploring the **pathways of rural STEM professionals** to identify the **supports and barriers they faced, influences on their decision to stay in/return to/leave, and possibilities they see in their communities** using case study approach informed by interviews with rural STEM professionals in Southwest Virginia



Community college pathways for rural students

The first finding is related to the importance of community college pathways for rural students.

## Recent Findings



### Community college pathways for rural students<sup>[6-9]</sup>

There are a few different things I'd like to talk about.

## Recent Findings



### Community college pathways for rural students<sup>[6-9]</sup>

- Community colleges are an important access point for all students but particularly rural students
- Proximity, cost, ability to work while taking classes
- Community college connections to local workforce

Related to the first finding, researchers in our field have identified the importance of community college transfer pathways into engineering, and many states, like Virginia, have agreements that make it easy for students to do so. We also know that across the board, community colleges serve a broader range of students. For rural students, these community college pathways are especially important, regardless of whether or not they end up using a transfer pathway. For many reasons, this makes sense – for example, community college is a more affordable option for many students, they are often closer to a rural students' community, especially compared to many four-year institutions, and the curriculum offers a degree of flexibility to where a student can work and gain experience while they are earning their degree.

## Recent Findings

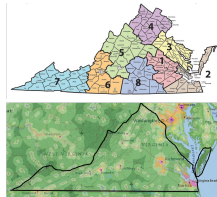


### Community college pathways for rural students<sup>[6-9]</sup>

- Community colleges are an important access point for all students but particularly rural students
- Proximity, cost, ability to work while taking classes
- Community college connections to local workforce

Region	City	Suburban	Town	Rural
1	0.57	0.73	--	0.80
2	1.34	1.16	0.77	0.99
3	--	1.14	0.92	1.11
4	1.78	1.33	1.24	1.57
5	1.09	1.36	1.46	1.63
6	2.54	2.89	3.46	3.37
7	2.83	3.78	5.59	8.61
8	--	1.25	1.16	1.35

\* Higher portions of rural students attend CC compared to 4-year



And I saw this represented in my first study. This table shows the ratio of students who first enrolled in community college for engineering compared to the number of students who first enrolled in engineering at a four-year college. While you can generally see that in general, it seems like more students enroll in community college first, it is especially true for students from rural locales in Virginia, and even more true for those students from Region 7.

## Recent Findings



### Community college pathways for rural students<sup>[6-9]</sup>

- Community colleges are an important access point for all students but particularly rural students
- Proximity, cost, ability to work while taking classes
- Community college connections to local workforce

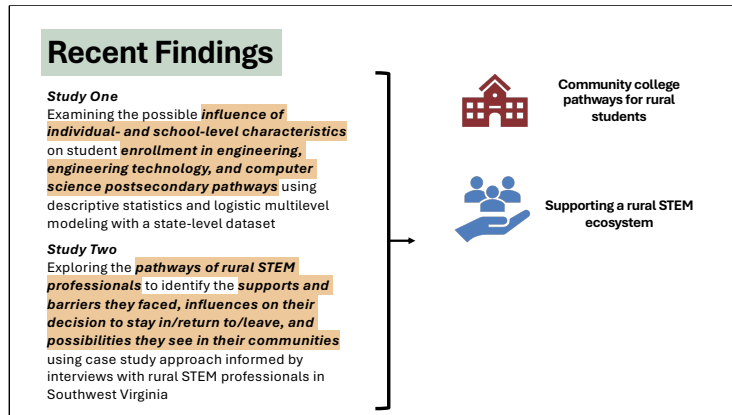
Region	City	Suburban	Town	Rural
1	0.57	0.73	--	0.80
2	1.34	1.16	0.77	0.99
3	--	1.14	0.92	1.11
4	1.78	1.33	1.24	1.57
5	1.09	1.36	1.46	1.63
6	2.54	2.89	3.46	3.37
7	2.83	3.78	5.59	8.61
8	--	1.25	1.16	1.35

\* Higher portions of rural students attend CC compared to 4-year

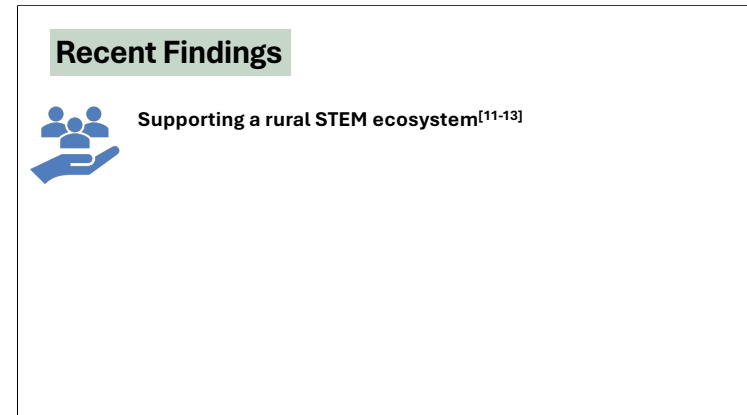
**Aya**

"But also, I think, just the, you know, the nature of the classes where you know, it was definitely a lot smaller, and it almost felt, you know, it almost felt like high school again... I thought I felt like I could go to my professors if I had questions, and I could talk to my peers, you know, if I had questions and it just... I think the intimacy of community college helped me a lot more than, you know, than, like a bigger school, like Tech."

Other reasons community colleges are crucial for rural students has a lot to do with the environment. For example, in my dissertation study, Aya and a few others noted that the environment and community at their community colleges was incredibly supportive and felt familiar. They were able to connect more with their classmates and they were able to get to know their professors, which they attributed to their success. Another one of my participants greatly valued being able to work at a local company to gain experience and to offset costs while completing their associate's degree and they are now actively supporting other students from their community who are interested in similar pathways.



The second finding is related to the need to support rural STEM ecosystems.



Here, again, I'll talk a little more about what I mean by ecosystem, some of the existing research, and some of the findings from the two studies.

## Recent Findings



### Supporting a rural STEM ecosystem<sup>[11-13]</sup>

- Importance of academic preparation for choosing engineering
  - College knowledge, advanced STEM courses and extracurriculars
- Investing in infrastructure to connect rural students with information and resources
- Fostering relationships between institutions of higher education and communities
  - Supporting rural STEM teachers with professional development opportunities and resources

Based on existing research, and something we have seen over and over again in our partnerships with local schools and teachers, is the need for support for a rural STEM ecosystem. When we use the word ecosystem here, we are talking about the people, relationships, resources, and infrastructure to support STEM in rural places. Many studies have identified that rural schools and teachers do not have the same resources to teach STEM that schools in other places might receive, which is a product of funding models, relationships with other institutions that can provide resources, and the recruiting and retaining of STEM teachers in rural areas. Because there is often a lack of this infrastructure in place, it also means that students go without information and resources that can help them pursue STEM as they go on in their education – for example, things that help them gain “college knowledge” or information about what it means to apply to college, get financial aid, and have some idea of what the experience of going to college is like. It also means that often, they do not have access to the courses and activities that are typically highly valued in engineering– for example, AP courses and things like robotics or other extracurriculars.

Additionally, many rural schools may not even have a guidance counselor to help students with this information, or if they do, there is often only one guidance

counselor to serve all of the students in that school. As such, students may overly rely on an individual teacher or may only have access to information from their parents– all of which can present significant barriers. However, we also know that institutions of higher education overlook rural students and schools, and typically do not seek to build relationships with rural communities. As one of my dissertation participants noted, he felt like he had to force his way in to college, a college that was essentially in his backyard, rather than being invited in, and he noted that many students from his community never even considered that institution to be an option for them.

The point here is that we need to invest in relationships and infrastructure to create an ecosystem to support rural communities and in particular those students and teachers who are interested in STEM opportunities. We have some experience with creating these opportunities in schools and building relationships with teachers but we, meaning those of us at institutions of higher education, have to be willing to invest our resources and efforts.

that have lower student enrollment, which is the case for many rural schools, are not as likely to be able to offer these advanced STEM courses.

## Recent Findings



### Supporting a rural STEM ecosystem<sup>[11-13]</sup>


- Importance of academic preparation for choosing engineering
  - College knowledge, advanced STEM courses and extracurriculars
- Investing in infrastructure to connect rural students with information and resources
- Fostering relationships between institutions of higher education and communities
  - Supporting rural STEM teachers with professional development opportunities and resources

#### Findings from Study 1 related to the role of Advanced Math Courses:

1. Students who have taken **more than one advanced math course** are **less likely to enroll in CC first for engineering** compared to four-year engineering students
2. Students who have taken **more than one advanced math course** are **more likely to enroll in four-year engineering** compared to other four-year students
3. Students who have taken **any advanced math course** are **more likely to go into some postsecondary pathway** compared to those that don't

And just to demonstrate the importance of this type of ecosystem, I want to talk about some findings related to my first study at a very high level. The results from multilevel modeling demonstrate the importance of students taking advanced math courses in high school on different enrollment outcomes. First, results indicate that students who take more than one advanced math course were less likely to enroll in community college first for engineering compared to four-year engineering students. Second, students who take more than one advanced math course are more likely to enroll in four-year engineering programs compared to other students in four-year programs. Finally, students taking any advanced math course are more likely to enroll in some postsecondary pathway compared to those students that don't go in to any postsecondary pathway. These findings indicate the role that having access to advanced STEM coursework plays for engineering, and in some ways speaks to how we think about academic preparation in recruitment and enrollment efforts in higher education generally but engineering more specifically. For example, if we continue to focus on recruiting students who are already on advanced STEM tracks, we are missing opportunities to engage with students who may not have access to these opportunities, and research suggests that schools that don't have as many resources, such as those in communities with lower SES indicators and those

Recent Findings



Supporting a rural STEM ecosystem<sup>[11-13]</sup>

- Importance of academic preparation for choosing engineering
  - College knowledge, advanced STEM courses and extracurriculars
- Investing in infrastructure to connect rural students with information and resources
- Fostering relationships between institutions of higher education and communities
  - Supporting rural STEM teachers with professional development opportunities and resources

Chuck

"So, I know that, like one of the things I noticed, especially when I got to Virginia Tech was speaking with a lot of the other students particularly a lot of them from Northern Virginia. You know... their schools have, like a big swath of classes that prepare them. And... it's not something you see available in Southwest Virginia. I mean, that may have changed by now, but at least at the time it wasn't that way."

Jackson

"I would love to see a stronger effort by the universities and programs, especially Virginia Tech, to recruit students from the local area. Because, you know, I felt more like I was trying to force my way in than I was being invited in. The most is that, you know, we're right in the backyard of the college, you know, where I grew up. I know that there's tons of super smart people there. And yeah, it feels like nothing is being done to try and to seek out those people."

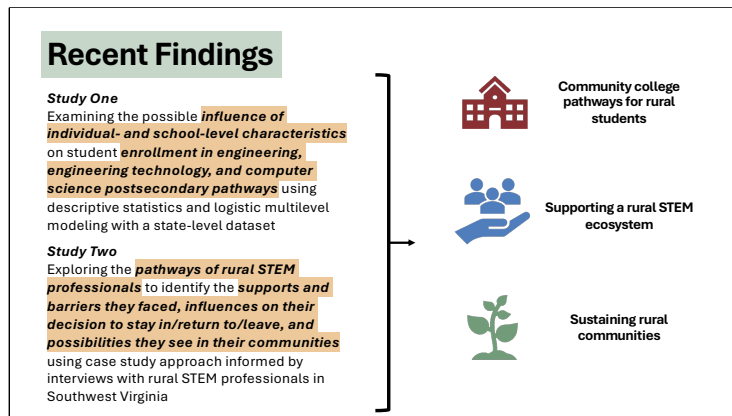
This research is further reiterated by the experiences of the participants in my second study. Here we can see Chuck saying he noticed there was a difference in the classes his nonrural peers were able to take at their schools in Northern Virginia, which are more suburban if you recall that map I showed you earlier, compared to the classes he saw in his school in Southwest Virginia. He suggests that his nonrural peers had access to classes prepared them more for being in college or pursuing engineering. Additionally, a few of my participants said that even though they were taking the hardest classes available to them, performing well on standardized tests, and were at the top of their classes in high school, it was a different story when they went to college. Jackson even said, in speaking about recruiting efforts specifically, that he would like to see more done because it felt like he was forcing his way in to college rather than he was being invited in. And again, it's not that there aren't incredibly talented people from his community, but there was so little being done to engage with the community and help prepare students from these rural communities be in college.

The point here is that we need to invest in relationships and infrastructure to create an ecosystem to support rural communities and in particular those

students and teachers who are interested in STEM opportunities. We have some experience with creating these opportunities in schools and building relationships with teachers but we, meaning those of us at institutions of higher education, have to be willing to invest our resources and efforts.

23

23



Finally, the third finding is related to the need to sustaining rural communities.



Here, when I mean sustaining, I am referring to an intentional investment in rurality which involves demonstrating relevant opportunities to rural students that allow them to stay in their communities if they so desire and/or creating new opportunities that encourage the thriving of rural places.



## Recent Findings



### Sustaining rural communities<sup>[5,7,14-16]</sup>

- Rural students may often desire to stay connected to home while they pursue their careers
- Connect students' interests to possible career pathways
- Make local careers and industries more visible to students

themselves in these pathways after gaining some understanding of what it means to work as an engineer, and they can do this while staying local, or maybe even through relocating to another rural community.

Many studies have identified that rural students do often have a strong connection to their communities. However, there is often conflicting messaging around the desirability of rural places and the opportunities that exist there. While it is certainly true that many rural places experience economic hardship, it not true of every rural place. In fact, many rural economies are focused on workforce development and supporting local talent, and are invested in making sure that rurality can be sustained. As such, we believe there are a number of ways to contribute to the sustaining of rural communities.

Many studies have shown the value of connecting students' STEM interests to actual, possible career pathways which in turn often makes local careers and industries more visible to students. For example, in my own study and in previous work we have done together, we have found that local industries want to support local students. They are interested in mentoring opportunities and being in classrooms, and even giving facility tours to students and teachers. Many local industries have been invested in building local talent and recruiting rural students into pathways that allow them to have job stability and security while pursuing a career that is meaningful to their communities. In making these connections and opportunities more visible, students might also be able to see

## Recent Findings



### Sustaining rural communities<sup>[5,7,14-16]</sup>

- Rural students may often desire to stay connected to home while they pursue their careers
- Connect students' interests to possible career pathways
- Make local careers and industries more visible to students

 Ken

So **my family's been here forever**...my family's been here for [hundreds of] years now... so...we have a pretty big family. **Everybody stays home**...So yeah, that that played a pretty big role...I didn't really have any plans to move out of the area, you know, **I thought I [might] have to work out of the area**, whether that's an hour drive to (other cities or towns in the region), but **never really had any intentions to leave where I was from**."

And again, these things are supported by the findings of my dissertation, in particular the second study. In this quote, we can see that Ken is talking about staying. His family had been in the area for hundreds of years and everybody stays home, so he really had no intention of leaving. He was willing to travel to nearby areas which would have probably been an hour or so away, but he knew he wanted to stay, and fortunately he was able to. This was true for many of my participants, most of the ones who left at some point knew they wanted to return eventually because of their community connections and/or because they preferred living in a rural area compared to other places. And now, participants like Ken, are super active in the community – whether that be working with students at the community college or coaching and mentoring different students and student groups – and they'd like to also see more of this and demonstrate that you can pursue careers like engineering and be able to stay and give back while making a good living.

## Recent Findings



### Sustaining rural communities<sup>[5,7,14-16]</sup>

- Rural students may often desire to stay connected to home while they pursue their careers
- Connect students' interests to possible career pathways
- Make local careers and industries more visible to students

 Chuck

"I mean, really, it was just, you know, to, to get a **good opportunity to, to make a decent living**, you know. I mean particularly for the area for Southwest Virginia, there's, **there's not a whole lot of opportunities for, for good paying careers**."

 Ken


"I like **putting things together, taking 'em apart**...figuring out how they work. So being able to reverse engineer something was... pretty neat, and **I've messed with power tools and... farm equipment** and things like that all my life. So I was... already decent at that. So now I kind of **get paid to play around and... figure out how to make things work**."

In addition to the idea of staying, it's important to think about how to leverage different career goals and desires and personal interests when we talk about sustaining rural communities. Here, Chuck is saying he wanted to pursue engineering as an opportunity to make a good living because there wasn't an abundance of those pathways in SW VA. Additionally, Ken talks about his interests growing up in taking things apart and putting them back together, which were influenced by using different power tools and equipment while working on the farm. Now, he said he gets to do those things and make money while doing it. These desires, experiences, and interests are relatively common for many rural students and these different assets – including the engineering knowledge and experiences – can be leveraged to show rural students that this is something they can do.


When we think about where we are pushing students to go, we often think of the flashy jobs and careers at big tech industries, for example seems to be a common one. However, in doing so, we ignore the importance of local economic development, whether that be local to the student's home community or even thinking about careers in the area immediately around an institution. With this finding, we are encouraged to reframe how we think about both student success

and satisfaction and contributing to and participating in local opportunities and rural thriving.


Recent Findings



Community college pathways for rural students



Supporting a rural STEM ecosystem



Sustaining rural communities

These findings, taken together, can help us think about various considerations for practice, policy and research, which we'll now get into.

## Considerations for Practice

What can we do in our  
practice (teaching,  
outreach, engagement)  
to engage more  
intentionally with  
rurality?

First, I want to talk about considerations for practice, more specifically thinking about the question: what can we do in our practice to engage more intentionally with rurality? With this question, I am framing this around things like teaching, outreach, and engagement, though practice may mean a variety of things to people in this room.

## Considerations for Practice

- Utilize community networks

This first point is related to utilizing community networks to engage and connect as a way to build relationships and share resources. While often times we might think about only think spreading information around schools or leveraging certain community members, we already know that rural school guidance counselors are typically stretched pretty thin and that relying on individuals often means that that individual becomes the sole source of information for students or that sometimes those individuals might even be unintentionally gatekeeping information by only getting it to the students who might be obviously interested in STEM. To overcome this, we have a few ideas to consider:

## Considerations for Practice

- **Utilize community networks**

- 4-H
- Churches
- Festivals/County fairs
- School events – sports, parent nights, community gatherings

- 1) Connect with those networks that are already very active in many rural communities, for example, 4-H is often a huge network in rural communities, and if you're at a land grant, you should be able to find folks who you can connect with pretty easily. 4-H often runs youth programming but is also often connected to the adults related to students (via farmers, other groups, for example) and can be a great way to build relationships.
- 2) I think it's also important for us to consider how to reach and engage with rural communities outside of the things we might normally think of. For example, churches may often be big community centers in rural places but also community festivals and county fairs may be good places to engage. I would also encourage thinking about how we can show up at school events, like football games, to engage more intentionally with rural students and community members. Really engaging with communities in the places where community happens is important – and sometimes that means we might also be volunteering at events to build those relationships (think setting up chairs, cleaning up, moving boxes).

## Considerations for Practice

- Utilize community networks

- **Reveal hidden curriculum**

Moving on to think about college knowledge, many scholars have discussed the role that “hidden curriculum” plays in the culture of engineering and how important it is to do our best to overcome this culture to make it more accessible.

## Considerations for Practice

- Utilize community networks
- **Reveal hidden curriculum**
  - What are the unspoken rules students should know?
  - What resources do students need to be accessing? What does it look like to access those resources?

For example, asking ourselves questions like “what are some unspoken rules that students should know?” or even thinking about important resources for students and what it looks like to access those resources. For those of us who work with students, this might be things related to going to office hours, including how to interact with professors and TAs when you go and how to ask questions and what to expect; or even thinking about how to help students form study groups. A few participants in my study said that they never knew how to talk to their professors or TAs and felt like they caught on late to different resources that could help them get their questions answered or learn how to study in this new environment. Furthermore, if you work in recruiting or you engage students regularly, how can you think about sharing this information with them - how do you think about supporting their guidance counselors or teachers in sharing this information? How do you get this information into rural communities more broadly?

## Considerations for Practice

- Utilize community networks
- Reveal hidden curriculum
- **Recognize and value various experiences**

Finally, one last point to consider, is understanding that not every student is starting from the same point. Students in our classrooms likely come from all over and have various experiences and knowledge they bring with them into engineering. So what does this look like?

## Considerations for Practice

- Utilize community networks
- Reveal hidden curriculum
- **Recognize and value various experiences**
  - Assume that no student has experience with advanced STEM concepts
  - Understand that expertise looks different based on contexts
  - Embrace community and community capitals

First, I would start off with the base assumption, especially in the context of something like a first-year engineering course, that no student has experience with a more advanced STEM concept (e.g. coding, robotics). Assume that you need to start off with the basics and work from there, and understand that some things that might be obvious to you are not going to be obvious to students who are hearing about a “for” loop or 3D printing for the first time. Next, recognize that expertise looks different based on context. For example, and this is particularly true for many rural students, a student might have a ton of experience working on farm equipment or a ton of experience with helping plant new fields or harvest, which may be very different from a student who has a lot of experience with something else. Encourage students to use this expertise they have in the context of your interactions with them. In class, encourage them to think about how it might connect to the concepts you are covering. In doing this, you might be demonstrating to that student and other students that their experiences do matter, and that whatever expertise they have from their prior experiences is relevant in engineering, which might also help them build understanding of course concepts.

## Considerations for Policy

What policy considerations could be made to rural support students and higher education institutions that serve rural communities and support rural students?

Moving on, I want to talk about considerations for policy, more specifically thinking about the question: what policy considerations could be made to rural students and support higher education institutions that serve rural communities and support rural students? As we think about policy considerations, it's important to recognize that policy contexts can also be challenging and are sometimes directly out of our scope. However, asking questions and considering how things might be different can be particularly useful as we work towards a different future.

## Considerations for Policy

- **Strengthening college-going cultures**

First, and again related to findings from my study and from other studies, is thinking about how we can strengthen and support college-going cultures across all communities, but in particular rural communities.

## Considerations for Policy

- **Strengthening college-going cultures**
  - Transfer pathways<sup>[17-19]</sup>
  - Enrollment and admissions
    - Holistic approaches and support
    - Different policies/futures

As we talked about previously, we know that transfer pathways from community colleges to four-year institutions can be particularly valuable for engineering, and we know that rural students often interact with a community college at some point on their educational pathways. States like Virginia have done a lot of work to make sure these transfer pathways work for students, meaning that they have agreements that guarantee students can get a spot of a four-year institution if they achieve certain requirements at their community college. Additionally, there has also been a lot of work done to ensure that, as students transfer, so will their courses. Though this is not perfect and students still experience credit loss, ensuring that as many classes as possible will transfer can help with time-to-degree and prevent students from incurring unnecessary costs. However, students may also not even know about transfer so making these pathways known to students can be crucial as it makes college-going more accessible.

Additionally, as we think about enrollment and admissions criteria and policies, I encourage us to think about two things. First, in the context of engineering, understanding more of what it means to be successful as a student in the context of their own communities and how we can support students from all places as they transition to college as soon as they accept their offers. I know many institutions



have moved to holistic admissions but considering what can be done to support students from the start is important, especially knowing that not all students will know what to plug into or how to access support resources. Second, imagining admissions policies that might open up an institution to students in different ways. For example, what happens if an institution guarantees a spot for all students who are in the top of their class at each school in the state? This might make different options more accessible for students who might not have considered it before.

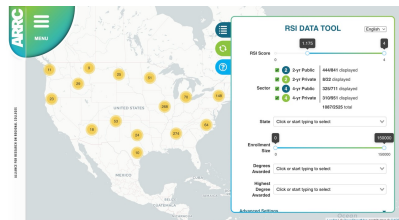
## Considerations for Policy

- Strengthening college-going cultures
- **Secure support for Rural Serving Institutions<sup>[20]</sup>**

The second point is related to securing support for rural serving institutions. The language of rural serving is related to how we use servingness in the context of Hispanic Serving Institutions, for example, and is a metric that has been developed by some scholars in higher education. These scholars have identified about 1,100 RSIs that serve 5 million students and these institutions include a range of institution types (HBCUs, Tribal colleges, land grants, community colleges). RSIs serve a wide range of students in rural areas of the US that otherwise do not have access to higher education. Understanding the role these institutions play in rural student support helps us also understand how to support economic outcomes, access to resources related to education and public health, and how to support cultural hubs in rural areas.

## Considerations for Policy

- Strengthening college-going cultures
- **Secure support for Rural Serving Institutions<sup>[20]</sup>**



<https://www.regionalcolleges.org/project/ruralserving>

These scholars have identified about 1,100 RSIs that serve 5 million students and these institutions include a range of institution types (HBCUs, Tribal colleges, land grants, community colleges). RSIs serve a wide range of students in rural areas of the US that otherwise do not have access to higher education. Understanding the role these institutions play in rural student support helps us also understand how to support economic outcomes, access to resources related to education and public health, and how to support cultural hubs in rural areas.

Here, I have just included a screenshot of the tool that the researchers developed for identifying RSIs and I encourage you to use this to think about how your institution fits in this conversation – what does it mean to be rural serving? How do we support rural students and communities? How do we think about and create policy to support rural students and communities at rural serving institutions?

## Considerations for Research

How can we acknowledge rurality in research and deepen our understanding of equity and access?

Finally, I want to talk about considerations for research, thinking about the question: how can we acknowledge rurality in research and deepen our understanding of equity and access?

## Considerations for Research

- **Consider the systemic factors that influence educational pathways**
  - Engage with the history of education in the area or the history of the place
  - Look at economics, politics, norms, culture

First, regardless of any area of research or any specific population, I think it is crucial for us to consider the systemic factors that influence educational pathways. Aligned with on-going conversations about assets-based approaches to engineering education research, recognizing that students are navigating systems is imperative. In our research, this might look like understanding more about the history of education in the areas students are from as well as economic factors that play a role in the region. For example, in our work in [blinded region], it's been so informative to understand how the coal industry has shaped the economics and politics of the region, and as such, how that has impacted various social factors including the culture of the region and education.

## Considerations for Research

- Consider the systemic factors that influence educational pathways
- **Definitions of rurality**
  - Acknowledge bounds of certain definitions
  - Ask participants to describe their communities and what makes them rural<sup>[21,22]</sup>

Next, as I previously mentioned, there are many different definitions of rural and all have their pros and cons. If we are to continue to study rurality, it is important we work toward a better understanding of rural definitions and that we are clear in how we are defining rural. This means that we should recognize what these definitions allow us to understand and what these definitions might obscure. As we work toward understanding rural, I would encourage having your participants define it. Ask them to describe their community to you and how they identify it. What, to them, makes it rural? What does rural mean to them? Put the power of defining rural back in the hands of your participants.

from campus?

## Considerations for Research

- Consider the systemic factors that influence educational pathways
- Definitions of rurality

- **Incorporating spatial justice into our understanding of equity**

"Justice...has a **consequential geography**, a spatial expression that is **more than just background** reflection or set of physical attributes to be descriptively mapped." - Soja, p.1<sup>[23]</sup>

"...the **power dynamics** governing a phenomenon [that] should be unpacked with regard to how they **may or may not differ** with regard to rural space." - Biddle et al., p. 10<sup>[22]</sup>

Finally, we can further strengthen our understanding of equity in engineering education through incorporating a lens of spatial justice. We might already have some understanding of spatial injustice when we think about things like redlining policies and housing that were a part of urban renewal projects throughout the 20<sup>th</sup> century. I tend to leverage these definition of spatial justice used by Soja, an urban planner, and a group of rural scholars. Spatial justice is a layer that can be added to our current frames of justice and equity to understand how these things might be spatial or vary across space.

Using this definition in engineering education allows us to understand that there is a spatial aspect to the education system with which we are often embedding ourselves in through outreach and engagement, and often results in the students who come to us in higher education. This is important for us to understand as we continue to research issues related to equity: where is most of our research conducted? Who are the students and what kind of schools did they go to/where are those schools? Who are we partnering with for research? – which might be particularly relevant for those of us who are interested in pre-college spaces. Are we consistently partnering with schools that have sufficient resources and infrastructure? How do we establish relationships with schools further away

## Conclusion

So with that, I would like to conclude. We've presented a lot here but I want you to leave with a few main points/questions to consider in your own context moving forward, which I hope help you consider how rurality shows up in your work.

## Conclusion

1. How do I understand place?  
What is my relationship to my place with respect to my current role?

First, thinking about this question and really trying to understand our own relationships to place. Maybe you're from a rural area and you understood a lot of what we mentioned in this presentation. Maybe you've never lived in a rural area before but now you do and you relate. Maybe you live in a city that's more urban and metropolitan – what is your understanding of the place around you?

## Conclusion

1. How do I understand place?  
What is my relationship to my place with respect to my current role?
2. How is what I do (research, teaching, policy, outreach/engagement) impacted by place?

Next, how is what you do currently impacted by place? Maybe you engage with communities in some way and that is significantly impacted by place, for example, thinking about the distance between places or and how that impacts the communities you are able to engage with. Maybe you are involved in research in some way – you could ask yourself how your work is impacted this – whether that be with respect to participants, access to resources and how those resources are acquired, or even how you're able to conduct your research. Or, maybe you teach courses and you could think about where your students are from – are they from nearby? Do most of them travel from other places? What kind of communities do your students come from and how does that impact how you approach teaching and sharing resources?

## Conclusion

1. How do I understand place?  
What is my relationship to my place with respect to my current role?
2. How is what I do (research, teaching, policy, outreach/engagement) impacted by place?
3. How can I expand my own thinking about equity through incorporating a spatial lens?

Finally, I encourage all of us to think about how we can expand our thinking about equity to incorporate a spatial lens – which is relevant for all of us regardless of if we are thinking about rurality or cities or anything in between.

## References

- [1] National Center for Education Statistics. (2021). Percentage distribution of persons age 25 and over, by highest level of educational attainment, age group, and locale: 2019 (Data table). *Rural Education in America*. Retrieved from <https://nces.ed.gov/ipeds/data/ipedsdatatools/data.aspx>
- [2] Greenwald, D. A. (2003). Foundations of Place: A Multidisciplinary Framework for Place-Conscious Education. *American Educational Research Journal*, 40(2), 419-454. <https://doi.org/10.1177/0013164403250199>
- [3] Greenwald, D. A. (2003). The Best of Both Worlds: A Critical Pathology of Place. *Educational Researcher*, 28(4), 3-12.
- [4] Schilling, M. B., & Grohs, J. K. (2020). A Conceptual Model for Engineering Education in Rural Places: Critical Reflection and Engagement. <Studies in Engineering Education>, 11(4-12-20), 201-221. <https://doi.org/10.21061/sei.v5i4>
- [5] Collins, C. A. (2013). *Voices in the mountains: A qualitative study exploring factors influencing Appalachian high school students' engineering career goals* [Doctoral dissertation, Virginia Polytechnic Institute and State University]. Blacksburg.
- [6] Romigues, S. L., Espino, M. L., Lu, B. D., & Cunningham, K. (2021). The influence of policy implementation in the Midwest: How an S2134 program broadens participation and enhances engineering identity for community college students. *Education Policy Analysis Archives*, 29(Spring 194), 29. <https://www.eapaa.org/eapaa/article.php?id=20210304>
- [7] Wright, C. J. (2019). Becoming a Woman: Community College Students and Post-Secondary Persistence in Central Appalachia. *Journal of Research in Rural Education*, 27(6), 1-11.
- [8] Ryan, S., Haines, L. L., & Aggar, C. A. (2017). Predictors of College Attendance Patterns of Rural Youth. *Research in Higher Education*, 58(6), 817-842. <https://doi.org/10.1007/s11161-017-9484-4>
- [9] Ryan, S., Haines, L. L., & Aggar, C. A. (2017). Predictors of College Attendance Patterns of Rural Youth. *Research in Higher Education*, 58(6), 817-842. <https://doi.org/10.1007/s11161-017-9484-4>
- [10] Roberts, J. K., & Grant, P. D. (2021). What We Know and Where to Go: A Systematic Review of the Rural Student College and Career Readiness Literature and Future Directions for the Field. *The Rural Educator*, 42(2), 72-94. <https://doi.org/10.1080/10607170.2021.1918144>
- [11] Roberts, J. K., & Grant, P. D. (2021). What We Know and Where to Go: A Systematic Review of the Rural Student College and Career Readiness Literature and Future Directions for the Field. *The Rural Educator*, 42(2), 72-94. <https://doi.org/10.1080/10607170.2021.1918144>
- [12] Worthington, R. E., Clayton, A. B., & Gayles, J. G. (2021). Exploring Rural Engineering Students' College-Choice Process at Two Land-Grant Universities. *The Rural Educator*, 42(3), 28-44. <https://doi.org/10.1080/10607170.2021.1918144>
- [13] Andrus, S. (2018). College aspirations and access in working-class rural communities: The mixed signals, challenges, and new language first-generation students encounter. Lexington Books.
- [14] Haines, L., & Ryan-Deffenbaugh, B. J. (2018). Should I Stay or Should I Go? Perceived Barriers to Pursuing a University Education for Persons in Rural Areas. *Canadian Journal of Higher Education*, 48(1), 128-140. <https://doi.org/10.5186/cjhe.v48i1.14024>
- [15] Peters, M. A., Craft, K. A., & Haines, L. L. (2016). Educational Sorting and Residential Aspirations Among Rural High School Students. *American Educational Research Journal*, 51(2), 284-308. <https://doi.org/10.3182/ajer.2016.51.2.284>
- [16] Peters, J. A. (2016). Social Capital and Residential Decision-Making Among Rural and Nonrural College Graduates. *Sociological Forum*, 34(4), 605-649. <https://doi.org/10.1111/socf.12260>
- [17] Ogburn, A. M., & Knight, D. S. (2003). Engineering Transfer Students' Reasons for Staying at Another Institution and Visiting Across Subpopulations. *Journal of Research in Higher Education*, 18(1), 69-93. <https://doi.org/10.1023/a:1023042400004>
- [18] Richardson, A. J. (2002). Credit Loss for Engineering Transfer Students: In-depth analysis and visualizations of patterns across students and institutions. Virginia Polytechnic Institute and State University.
- [19] Smith, D. M., Richardson, A. J., Givens, H. E., Knight, D. S., Lee, W. C., & Whitford, B. A. (2002). Engineering community college transfer pathways through pre-transfer programs. *New Directions for Community Colleges*, 2002(186), 77-94. [https://doi.org/10.1891/0892-6494\(2002\)186%3C77%3E3.0.CO;2](https://doi.org/10.1891/0892-6494(2002)186%3C77%3E3.0.CO;2)
- [20] Andrews-Kushick, (2002). Creating Better Rural-Focused Postsecondary Policy by Identifying Rural-Serving Institutions Rural-Serving Institutions. *The Rural Educator*, 43(4), 67-69. <https://doi.org/10.1080/10607170.2002.10555444>
- [21] Colwell, T. (2007). Improving the Yield of Rural Education Research: An Editor's Swan Song. *Journal of Research in Rural Education*, 22(3), 1-6.
- [22] Bellini, C., Hall-Butterland, D., & McHenry-Sorber, E. (2019). On Resisting "Swan Song" and Being a Good Reader: Early Career Scholars Resist Colwell's Swan Song a Decade Later. *Journal of Research in Rural Education*, 25(7), 1-16. <https://doi.org/10.1080/10607170.2019.1644444>
- [23] Sipe, E. W. (2010). *Seeking spatial justice*. University of Minnesota Press.

## Thank you!



**Malte Schilling**  
Assistant Professor  
Engineering Education Systems and Design  
Arizona State University  
[malte.schilling@asu.edu](mailto:malte.schilling@asu.edu)



**Jake Grohs**  
Associate Professor, Engineering Education  
Director, Center for Educational Networks  
and Impacts  
Virginia Tech  
[jrgrohs@vt.edu](mailto:jrgrohs@vt.edu)



This work is supported by the National Science Foundation Graduate Research Fellowship Program (Award No. 1840985) as well as awards 1847928 and 1843098. Any opinions, findings, and conclusions or recommendations expressed in this material are mine and do not necessarily reflect the views of the National Science Foundation.