

The STEM Lab Notebook

A Monthly Newsletter of the STEM Lab Podcast

Produced by the South Carolina Governor's School for Science and Mathematics

Edition 2: November 30, 2023

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Letter from STEM Lab Host Dr. Michael A Newsome

Dear STEM Lab Listeners,

This month has been a remarkable journey through diverse and thought-provoking discussions. Our November episodes offer insights, strategies, and inspiration for STEM teachers and administrators. We've delved into topics ranging from innovative teaching methods in math to the challenges of rural STEM education, all with the aim of enhancing our understanding and practice in this ever-evolving field. Let's recap the highlights of our November episodes.

In Episode 5, "The Secret Sauce: Physics, AI, STEM Ed, and Swing Dancing," I interview Dr. Kemper Talley, a senior scientist at Raytheon BBN and an expert in synthetic biology. Talley discusses the critical role of physics in developing critical thinking and foundational scientific understanding. He advocates for an experiential learning approach in physics education, emphasizing real-world applications and experiments. Additionally, Talley highlights the importance of interdisciplinary collaboration and soft skills, drawing parallels between his professional experiences and lessons learned from swing dancing. He also delves into the potential and ethical considerations of AI in education, envisioning AI as a tool for personalized learning and practice, yet emphasizing the enduring value of the mentor-student relationship.

Episode 6, "Pickles, Puzzles, and Board Games in Elementary School Math," features Dr. Gordon Hamilton, Director of MathPickle.com. He is interviewed by my co-host Dr. Nicole Kroeger. Hamilton introduces an innovative approach to math education through puzzles and board games. He emphasizes the importance of problem-solving and using the scientific method in math classes, suggesting that these strategies are more effective in a controlled math environment than in science classes. Hamilton's philosophy encourages teachers to embrace uncertainty and create a learning environment that fosters exploration and discovery. His focus on emotional engagement and ownership of the learning process offers a fresh perspective for STEM educators, particularly in elementary settings, highlighting the value of creative teaching strategies in inspiring a love for mathematics.

In Episode 7, "Rural STEM Education and Workforce Development," I talk with Dr. Matt Irvin, Professor at the University of South Carolina, about the unique aspects of rural STEM education. Dr. Irvin emphasizes the need for authentic learning experiences and aligning education with local workforce demands, especially in sectors like electric vehicles and AI. He discusses the challenges in rural education, including teacher recruitment and professional development, and the potential of virtual learning communities and public-private partnerships to enhance educational experiences. The episode also explores the shifting trends in student preferences towards certifications or associate degrees in STEM, underlining the importance for educators to stay updated and integrate technology effectively in teaching.

Episode 8, "Student Success in the Virtual STEM Classroom: Individuals Matter," features Kristal Martiez, Virtual Student Success Coordinator at the South Carolina Governor's School for Science and Mathematics. Dr. Nicole Kroeger and I interview her. Martiez shares her expertise in supporting STEM students in a virtual learning environment, emphasizing the need for understanding and connecting with students on an individual level. She highlights challenges such as transitioning from traditional to virtual classrooms and the importance of organization, time management, and addressing diverse student backgrounds and needs. The episode underscores the significance of personalized learning strategies and teacher awareness, offering valuable insights for STEM educators in enhancing student engagement and success in virtual settings.

In Episode 9, "Integrative STEM Education: Leading Experiential Learning," Dr. Mary Annette Rose, an Associate Professor at Ball State University, joins Dr. Crystal McGee to discuss her book on fostering a STEM-literate population. Dr. Rose emphasizes the need for integrating various disciplines in education to solve real-world problems and overcome the challenge of disinterest in STEM fields in the U.S. She advocates for a cultural shift towards problem-solving, innovation, and evidence-based decision-making in classrooms. Highlighting practical examples like shared classrooms for math and science teachers, Dr. Rose underlines the importance of making learning engaging, extending STEM principles to non-STEM disciplines, and a systemic approach to educational transformation. Her insights offer valuable strategies for STEM educators in promoting integration and collaboration.

As we wrap up this month's podcast series, I want to extend my heartfelt gratitude to our guests and listeners for contributing to such engaging and insightful discussions. It's clear that the world of STEM education is rich with possibilities and challenges, and each episode has brought us unique perspectives and solutions. I hope you'll continue to join us for the full conversations in each episode. Stay curious, keep exploring, and let's continue to transform the landscape of STEM education together. Sincerely,
Michael A. Newsome, Host of STEM Lab

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Guest Quotes from Episodes 5-9

Quotes from Dr. Kemper Talley in Episode 5

"I think physics does this uniquely – it trains people to think about the first causes and why a certain phenomenon happens. It's about understanding the very basic questions that Aristotle even asked thousands of years ago. Physics is a discipline that allows people to ask those early and first questions, and that understanding is critical for basically everything we do in science."

"...it's interacting with people who don't know what you know, and who think about problems differently than you think about problems. That is what I think is core to creativity. I do approach things like a physicist, but it's often very helpful to think like an engineer or a business developer. When I think about those moments, it's essential to step outside the bubble. Creativity often comes from the outside, and placing ourselves there can be transformative."

"...[AI] will be used, and it actually will be, a learning tool going forward. Khan Academy is already starting to use this tool to enable [us] to write like new equations sets, new problem sets, right? Write a new word problem. It is one of the best word problem generators that you could possibly hope for in some of these ways. It can generate different problems for students to work through....You know, these capabilities are going to be able to endlessly generate problems for students to hone their skills. And I do think that that will happen."

Quotes from Dr. Gordon Hamilton in Episode 6

"I think it's actually fantastically liberating for teachers to not know the answers... It is so liberating then to go into classrooms and to just always go in unprepared... Instead of practicing 'Oh, let's find all of the answers to what I'm going to present tomorrow.'"

"And I asked you what is the fewest number of walls that you need to use to create that hundred room mansion? And by the way, I don't know the answer for that. These are extremely tough problems, and that's what makes me interested in them. I don't want to be presenting problems that I know the answer to; how boring."

"And so by far the better venue to learn the scientific method is in a universe that has been designed for to be discovered so that the laws are simple and that they are meant for kids to discover. And that is done in math class... the scientific method is best not taught in science class for the first time, but in math."

Quotes from Dr. Matt Irvin in Episode 7

"I think providing authentic experiences that really engage kids in workforce opportunities in industry, and especially around many of the opportunities we have here in South Carolina, STEM and advanced manufacturing in particular, is a really growing area in our state."

"Kids are more and more questioning the value of the traditional four-year degree and there's a lot of great...STEM opportunities with associate degrees. There are STEM technician jobs that pay really well, and even just with some certifications, like drone pilots, can make really good money without requiring a college degree."

Quotes from Kristal Martinez in Episode 8

"It's the old saying that you always hear and I've heard it 1001 times: They don't they don't care what you know until they know that you care. And that is true. It's just 100% true. I think classrooms, the culture of the classroom, can be student-centered in getting to know your students and letting them know that it is it's okay to be exactly who they are and let learn some science."

"I'm still working with underserved communities because our students are virtually across South Carolina. They are in rural school districts that are also Title 1. They have limited access. Their technology goes down. Just being aware as teachers and being able to understand those different circumstances that come up, being aware of different cultures is and maybe your own personal biases you may have throughout this process, is incredibly important for our students."

Quotes from Dr. Mary Annette Rose in Episode 9

"Integration, as you know, requires a deep collaboration among people with different expertise. And our system is set up into, as you know, little silos that where students study science for 50 minutes or an hour and 15 minutes and then they move over and they go to their mathematics classes."

"So that's one of the driving forces by putting this book together with Christa Stith and Rachel Busa, is this idea that you have to have school leaders beyond teachers, principals, superintendents, curriculum directors, STEM coordinators that are really focused in on how do we build a culture? How do we build that culture that's going to promote problem solving, innovation, evidence-based decision making, and as part of what we do in every classroom."

"Evidence-based decision making is certainly a goal that we have when we talk about civics education, we talk about social studies and of course in prior to 2023, this is certainly something we see as an important practice across our entire nation, in our world. How in the world are we ever going to be able to live and innovate and have high quality lives if we cannot all agree on a process by which to make decisions when we live in a pluralistic society where we have people of different cultures with different values."

Longform Episode Summaries

Episode 5: The Secret Sauce: Physics, AI, STEM Ed, and Swing Dancing

Dr. Kemper Talley, a senior scientist at Raytheon BBN, joins Dr. Michael A Newsome on the fifth episode of STEM Lab, titled "The Secret Sauce: Physics, AI, STEM Ed, and Swing Dancing." Kemper not only has a Ph.D. in energy science engineering but also works in the field of synthetic biology with a focus on biodefense, security, and bioethics issues. Before his time at Raytheon, he contributes to the development of numerous radiation detection products at Teledyne Technologies. Outside of his professional life, Kemper indulges in swing dancing with his wife, both of whom are alumni of the South Carolina Governor School for Science and Mathematics, competing and teaching dance together.

Kemper's passion for STEM education is the main reason he is on the show today. When asked by Michael what type of learning he would choose to increase in high schools today, Kemper selects physics-based education. He emphasizes the importance of strong mathematics and the ability to think critically about the underlying science as the reasons behind his choice. According to Kemper, physics uniquely trains people to question first causes and why certain phenomena occur, and he believes this foundational understanding is crucial for all scientific endeavors.

In terms of difficulty, Kemper acknowledges the challenging nature of physics but argues that the learning environment and teaching method are key to students' success. He calls for a shift from equation-focused teaching to a more experiential learning approach, incorporating experiments and real-world applications. For Kemper, understanding the relationships between physical objects is essential to truly grasping the principles of physics.

Kemper's personal journey with physics begins with a love for mathematics and a series of teachers who nurtured his interest. These experiences cultivate his curiosity about the physical world, ultimately leading him to pursue a career in the field. When asked what he would suggest a 16-year-old study in college for an exciting, cutting-edge career, Kemper leans towards biotechnologies and computer sciences, citing their current relevance and potential for significant advancements in personalized medicine and other areas in the next 10 to 20 years.

According to Kemper, the "secret sauce" of creativity is to always strive to be surrounded by people who are smarter than you in different fields, and to understand that there is value in different perspectives and knowledge areas. It is important to engage with people who think differently and have different expertise, as this can lead to innovative solutions and advances.

Kemper also stresses the importance of developing soft skills and understanding that successful projects are often the result of teamwork. He shares his personal experience of learning the value of collaboration and the benefits of letting others take on roles in which they excel. Kemper encourages STEM teachers and administrators to foster environments that promote teamwork, and to emphasize the importance of working with others, both within and outside of one's field.

Furthermore, Kemper discusses his experience with swing dancing and how it taught him the importance of collaboration and communication. Through dancing, he learned to connect with others on a human level, and this skill has been valuable in his professional life as well. He emphasizes the

importance of adapting to different learning styles and being able to communicate effectively with a diverse group of people.

Kemper shares his thoughts on artificial intelligence (AI), stating that he sees AI as a tool that can be used for good or for ill, depending on how it is leveraged by people. He highlights the potential of AI as a productivity tool and a way to explore new ideas. However, he also acknowledges the potential risks and ethical considerations associated with AI, and emphasizes the need for responsible use and open discussions about how to integrate AI into society.

Kemper shares his perspective on the integration of artificial intelligence (AI) in education and its potential to revolutionize learning experiences.

Kemper believes that AI is a valuable learning tool in the future, drawing parallels with how Khan Academy uses AI to generate word problems and equation sets. This, he suggests, enables an endless stream of practice problems for students, catering to those who may need additional assistance. He also highlights AI's potential in generating true/false questions, which can often be challenging to create. Furthermore, Kemper sees AI as a facilitator in the writing process, helping students express their ideas more effectively.

Looking ahead, Kemper envisions a future where AI provides individualized learning experiences, catering to the specific needs and preferences of each student. This includes accommodating various learning styles and assisting those with learning disabilities. However, he also cautions that reliance on AI could lead to a decline in certain skills, such as writing, if not used judiciously.

When asked for advice for STEM teachers and administrators, Kemper emphasizes the importance of embracing technology and not fearing it. He likens the emergence of AI to past technological advancements such as calculators and the printing press, highlighting the enduring importance of the mentor-student relationship. He urges teachers to be creative in their approach to AI, finding its limitations and using them as teaching moments. The ultimate goal, he suggests, is to foster a deep and meaningful learning experience, leveraging AI as a tool to facilitate and enhance this process.

So, Kemper says the integration of AI in education holds significant potential to transform the learning experience, providing individualized support and accommodating various learning styles and needs. However, it is important for educators to approach this technology with an open mind and a creative approach, using it as a tool to enhance the teaching and learning process rather than replace it. By doing so, they ensure that the mentor-student relationship remains at the core of the educational experience, fostering a rich and meaningful learning environment for all students.

[Episode 6: Pickles, Puzzles, and Board Games in Elementary School Math](#)

Dr. Gordon Hamilton, a math educator and Director of the website MathPickle.com, joins Co-host Dr. Nicole Kroeger and shares his innovative approach to teaching math through puzzles.

Gordon's intriguing work in mathematics education, especially for elementary students, is the focal point of the discussion. He has not only designed several board games, such as Santorini, but also created hundreds of original puzzles for his website, mathpickle.com. These puzzles are not just academic exercises but are cleverly crafted to revolutionize how math is taught and understood by young learners.

One of Gordon's recent favorite puzzles, described as a type of "infinite pickle," challenges students to determine the minimum number of walls required to construct a series of rooms on graph paper. The beauty of this puzzle, and others like it, is that they do not come with fixed answers. This feature makes the problems infinitely scalable, from simple to complex, offering "little baby bear" puzzles for novices to "Poppa Bear" challenges for advanced problem-solvers.

Gordon's philosophy is both refreshing and slightly radical: he believes in the power of not knowing the answers as an educator. Rather than presenting problems with known outcomes, he encourages teachers to embrace the unknown and approach classroom teaching with a spirit of exploration. This approach not only removes the stigma of failure but also enriches the educational experience by fostering a genuine inquiry-based learning environment where both students and teachers search for solutions together.

The idea is to emotionally engage students, giving them ownership of the problem-solving process and encouraging them to learn through both success and failure. Gordon illustrates this by interacting with students in ways that might involve feigned ignorance or playful disagreement, ultimately aiming to boost the confidence and joy of learners, especially those who might struggle with math.

Gordon Hamilton advocates for introducing problem-solving and the scientific method within math classes rather than science classes. He believes that the controlled environment of a math class provides a clearer model of the universe for children to discover its laws, which are intentionally designed to be accessible. According to Gordon, these mathematical objects spark curiosity and experimentation, making math class the ideal venue for teaching the scientific method, even as early as grade one.

His experience has shown that even young students are capable of tackling complex problems, as evidenced when grade five students outperformed mathematicians and educators on a puzzle from his publication, "The Infinite Pickle."

Gordon is driven by his passion for mathematics, crafting puzzles and board games. Regular interaction with students ensures his educational tools are effective and engaging. The key to a successful puzzle, he explains, lies in its ability to differentiate on the fly, allowing teachers to adjust the difficulty level to meet individual students' abilities without making the differences obvious. He actively seeks to blur the lines of academic hierarchy to combat ego and promote a more equitable classroom environment.

He challenges mathematicians to reconsider the term "recreational math," suggesting that it undermines the pedagogical value of these engaging problems that often shine brightest in the classroom. Gordon insists that these puzzles should be appreciated as brilliant educational tools rather than being dismissed as merely recreational.

For STEM teachers and administrators, Gordon's insights offer a fresh perspective on how to teach math more effectively. His approach could be particularly enlightening for elementary educators seeking to inspire a love for mathematics in their students from a young age. Moreover, his methods could serve as a powerful tool for professional development, suggesting ways to mentor teachers in adopting more creative and engaging teaching strategies that align with the best practices of STEM education.

[Episode 7: Rural STEM Education and Workforce Development](#)

Dr. Matt Irvin, Professor of Educational Psychology and Research at the University of South Carolina, joins host Michael Newsome to discuss the nuances of rural STEM education. He highlights the need for

authentic learning experiences that align with local workforce needs in STEM and advanced manufacturing sectors. With South Carolina's growth in areas like electric vehicles and AI, Dr. Irvin points out the importance of making students aware of these opportunities to retain talent in rural communities.

Dr. Irvin touches on the breadth of STEM careers and the importance of early literacy for foundational STEM education. He outlines significant challenges in rural education, such as teacher recruitment and retention, and the necessity for professional development contextualized for rural settings. To combat the isolation often felt by rural teachers, he underscores the development of virtual professional learning communities.

He elaborates on the IMMERSE Project, funded by the NSF, which aims to enhance rural STEM education research and policy development. Dr. Irvin remarks on the advancement of statistical methods and machine learning, tools that are reshaping education research.

Virtual education, according to Dr. Irvin, is essential for extending STEM education access in rural areas, though it comes with its own set of challenges, such as high dropout rates due to lack of engagement. However, he indicates that virtual and in-person education outcomes can be comparable if student course completion is achieved.

Dr. Irvin and Michael discuss the impact of STEM camps and outreach programs in fostering interest among young students through interactive activities like robotics and drones. Additionally, Dr. Irvin sees promise in public-private partnerships, like those with Boeing and Goodyear, to enhance STEM educational experiences.

A shift in student preference from traditional four-year degrees to shorter certifications or associate degrees in STEM is noted, signaling a change in workforce development. Dr. Irvin reflects on his tenure at the University of South Carolina, taking pride in his role in research and the impact of NSF-funded projects on student learning.

Closing the discussion, Dr. Irvin advises STEM educators to keep pace with emerging trends, thoughtfully integrate technology into teaching, and pursue continuous learning for professional enhancement. The episode concludes with Michael thanking Dr. Irvin for his insightful contributions.

[Episode 8: Student Success in the Virtual STEM Classroom: Individuals Matter](#)

Kristal Martiez, Virtual Student Success Coordinator at the South Carolina Governor's School for Science and Mathematics (GSSM), joins hosts Michael Newsome and Nicole Kroeger. Kristal works remotely and in-person with students participating in a statewide synchronous-online Virtual Engineering Certificate Program. The episode focuses on academic success and how to help STEM students succeed in a virtual learning environment.

Kristal emphasizes the importance of understanding and connecting with students, even in virtual settings. She discusses the challenges students face when transitioning from traditional to virtual classrooms, highlighting the need for strong organization, time management, and study skills. Kristal's approach is centered on listening to students and understanding their unique situations, whether they are dealing with academic or personal challenges.

An important aspect of Kristal's work involves bridging the gap between the virtual and physical worlds. She notes the significance of having students across South Carolina in various environments, from rural to urban, and how this diversity impacts their learning experience. Kristal stresses the need for teachers to be aware of different circumstances and cultures, as well as their own biases, to effectively support these students.

Michael and Nicole also touch upon Kristal's background in secondary English and Spanish education and her transition to working in a STEM-focused environment. Kristal shares insights into how this shift required a change in mindset and approach, especially in understanding the specific needs of STEM students.

Kristal shares a success story of a student struggling with chemistry labs due to personal issues at home. Through effective communication and collaboration with the student's school, Kristal helped facilitate a solution that allowed the student to complete lab work at school, leading to the student's academic improvement.

The conversation also delves into Kristal's work with underserved communities, emphasizing the unique challenges these students face, such as limited technology access and different cultural backgrounds. Kristal advocates for teacher awareness and sensitivity to these challenges in promoting student success.

One of the key messages from Kristal is the importance of personalized learning strategies. She encourages students to find what works best for them, acknowledging that not all strategies are universally effective. Kristal shares her own experience with discovering an unconventional but effective time management strategy, illustrating the need for flexibility and adaptability in learning methods.

Overall, the podcast highlights the critical role of understanding, communication, and tailored support in fostering student success in STEM education, especially in a virtual learning environment. Kristal's insights are particularly relevant for STEM teachers and administrators looking to enhance student engagement and achievement.

[Episode 9: Integrative STEM Education: Leading Experiential Learning](#)

Dr. Mary Annette Rose, an Associate Professor of Educational Studies at Ball State University, joins Co-host Dr. Crystal McGee, to talk about her recent book and the importance of fostering a STEM-literate population. Dr. Rose, with extensive experience in public schools focusing on technology education, emphasizes the value of integrating different disciplines to address real-world problems. She identifies a major challenge in the U.S. educational system: the lack of interest in STEM fields. Dr. Rose points out that the compartmentalization of subjects into silos in schools limits opportunities for integration as students progress through grades.

Dr. Rose and her coeditors, Krista Stith and Rachel Geesa, advocate for a cultural shift in education that promotes problem-solving, innovation, and evidence-based decision-making in every classroom. She stresses the importance of breaking down belief barriers and fostering a collaborative mindset among school leaders, teachers, principals, and other education stakeholders.

To encourage collaboration across different disciplines, Dr. Rose suggests making time in school schedules for teachers from various subjects to work together, understand each other's curriculum goals, and identify commonalities. She proposes peer observation as an effective learning tool and emphasizes the importance of continuous improvement through regular feedback and data analysis.

A key example Dr. Rose provides is a school in Lafayette, where math and science teachers share classrooms to facilitate integration and collaboration. The school organizes a year-long problem-solving activity focused on real-world issues, such as improving accessibility at a community swim park. This approach not only changes schedules but also encourages students to apply their learning in practical, innovative ways.

Addressing the perception of STEM subjects as boring or unwelcoming, Dr. Rose highlights the need to make learning engaging and relevant. She advocates for phenomenon-based learning, outdoor education, and bringing community experts into classrooms. She underscores the importance of exposing students to a wide range of career possibilities and the role of various school professionals in enhancing learning experiences.

Dr. Rose also discusses the need to extend STEM principles into non-STEM disciplines, emphasizing evidence-based decision-making as a critical skill across all areas of study, including civics, social studies, and even extracurricular activities. She argues that this approach is essential for living in a pluralistic society and making informed decisions.

The podcast concludes with Dr. Rose detailing seven themes identified in her research, essential for moving towards an integrative STEM-focused educational model. These themes include mission, culture, evaluation, and the roles and responsibilities of different individuals in the education system. She advocates for a systemic approach to transform education, emphasizing the collective effort needed to achieve this goal.

Overall, Dr. Rose's insights provide valuable strategies for STEM teachers and administrators, emphasizing the importance of integration, collaboration, and making learning engaging and relevant to prepare students for future challenges.