

# HOW CAN WE MAKE STEM SUBJECTS MORE ENGAGING FOR STUDENTS?

At **Point Park University** in Pittsburgh in the US, education researchers **Dr Ginny Chambers**, **Dr Kamryn York** and **Dr Mark Marnich** are helping pre-service teachers develop their skills in STEM subjects to make learning more enjoyable and effective for their future students. The team is using the principles of maker education to create hands-on, interactive STEM and maker experiences.



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## Fields of research

Education, Teacher Training

## Research project

Developing and transforming STEM teaching spaces and pre-service teaching programmes

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## TALK LIKE AN ... EDUCATOR

**Collegiality** — the cooperative relationship between work colleagues

**Interdisciplinary** — including two or more branches of knowledge

**Learning styles** — the preferred way that different students learn and absorb information

**Pedagogy** — the method and practice of teaching

**Pre-service Teacher** — a trainee teacher. This usually means a university student who is in training to become a teacher

**Self-learning** — an approach to learning where students teach themselves by following instructions and figuring out answers on their own

**STEM** — subjects related to science, technology, engineering and mathematics

**W**hen did you last make something in school? When have you taken a hands-on approach in a lesson? What skills does being creative in your learning demand of you and, more importantly, how does it enable you to develop them further?

Maker education, a term coined in 2013, is an approach to teaching where students are encouraged to try things themselves, share ideas, ask questions and make mistakes. “Maker education involves working with your hands and incorporating various tools, materials and technologies,” says Kamryn. Makerspace teaching methods can be particularly useful for teaching STEM subjects. “This is because they require students to become more aware of the design of the world around them and see themselves as people who can test their ideas, make changes and improve their results,” Kamryn explains.

Maker spaces are collaborative workspaces inside schools, libraries or public spaces, where maker-centred learning takes place. In a maker-centred classroom, maker spaces around the room might allow students to create small electrical circuits, figure out how to build bridges or create structures, or do similar activities that put what they have learnt into practice and build their problem-solving skills. “Maker education promotes creativity, collaboration and critical thinking skills through applying new ideas, asking questions and synthesising information,” says Ginny.

## How are maker spaces good for students?

Makerspace activities are student-led, which means that students do things themselves and can learn information in a way that suits their own learning style best. Students are also encouraged to ask a lot of questions during the activities. “Our research indicates students retain more information and are



better at adapting that information when inquiry-based instruction is used,” says Kamryn.

As students get older, maker education often results in them being better at applying their knowledge to the real-world. Since maker education activities show how information can be used in different scenarios, students can directly link what they are learning in the classroom with what they might need to know outside the classroom.

Maker spaces can be particularly beneficial for teaching mathematics as the fun, hands-on approach has been shown to increase children’s confidence and lessen any anxiety they have surrounding the subject. Mathematical activities in maker spaces might include students designing and measuring things themselves or working out how to fit different shapes together to create new shapes. “Maker education develops skills in mathematics such as measurement, data analysis, spatial reasoning, counting and geometry,” explains Mark.

### Sounds great! How can maker spaces help teachers?

Teachers using maker spaces have said that it increased their confidence in their own understanding of STEM topics. In maker spaces, teachers listen to the questions their students are asking and see what their students come up with on their own. “Educators often become learners in a maker space,” says Mark. “These new roles often help teachers gain insight into STEM pedagogy.”

Maker space activities allow teachers to engage differently with STEM materials and connect better with STEM content. “Teachers using maker spaces indicated increased aptitude in self-learning, leadership, technological literacy, collegiality, adaptability, and ability to serve diverse groups of students,” says Mark.

### What is the Park Point team working on?

Despite the fact that makerspace education is becoming popular in schools across the US, teachers are still often underprepared to teach in maker environments as these are quite different from traditional teaching environments. To combat this

problem, Ginny, Kamryn, and Mark started a project called T.I.M.E for STEM, where T.I.M.E stands for Transforming Integrative Makerspace Education.

The project works with pre-service (student) teachers at Point Park University who are focusing on elementary education, with the goal to improve the way they teach STEM subjects and better prepare them for maker education methods.

“Our students participate in activities and design lessons that create a cooperative learning environment which integrates technology and connects learning outside of the classroom,” says Kamryn. The students are also encouraged to do their own scientific investigations to help improve their understanding of STEM subjects. “Through these experiences, students gain a better understanding of how STEM education is an integrated, interdisciplinary and student-centred approach to learning that encourages curiosity, creativity, artistic expression, collaboration, computational thinking, communication, problem solving, critical thinking and design thinking!” says Kamryn.

### Who else is the team working with?

The T.I.M.E for STEM project mainly takes place within the School of Education faculty at Point Park University, but it also works with various organisations such as the Children’s Museum of Pittsburgh, Matt’s Maker Space Organization, the local educational administration unit, the Natural Science, Engineering and Technology Department at Point Park University, Mount Lebanon School District and Manchester Academic Charter School. “Four classroom teachers from our project’s partner schools participated in our training, and our pre-service students will soon visit and teach in their classrooms and maker spaces too,” explains Ginny.

### What has T.I.M.E for STEM achieved so far?

The partnerships that T.I.M.E for STEM have created have strengthened relationships both on campus and within the local community. “We have met so many people interested in our research, proud of what we are doing and keen to learn more about interdisciplinary STEM education for pre-service elementary teachers,” says Ginny.

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**EDUCATORS OFTEN  
BECOME LEARNERS  
IN A MAKER  
SPACE.**

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As well as fostering links within the local community, the T.I.M.E for STEM project has run 14 professional development sessions for faculty and teacher participants. The sessions have been on a range of topics including Recyclable Materials, Fabrication, Metal Work, Technology Resources in Maker Labs, and Human-Centered Design Thinking. “Our research has shown that teachers are more confident in STEM questioning and assessment after doing these sessions,” says Mark.

### What are the next steps for T.I.M.E for STEM?

Throughout the next year, the programme’s pre-service students will learn maker education pedagogy and curriculum development. “They will also have the opportunity to teach interdisciplinary STEM lessons in maker space classrooms at our partner schools,” says Ginny.

Kamryn, Ginny and Mark will also talk to lots of different people – including teachers, administrators and educators – about makerspace education to find out what has been working in elementary STEM teaching and what could be improved. After this, they will develop a maker education planning template and observation rubric to serve as a guide for elementary teachers and teacher educators. This means that even those who are not enrolled in the programme at Point Park University will be able to benefit from their work and help make STEM subjects more interesting and engaging for more children.





## Meet Sophie

Sophie Jebose is a pre-service teacher at Point Park University from the Netherlands. Training in elementary education, she is using the maker space to develop her STEM teaching skills and prepare for her teaching career.

When I left gymnastics after practising the sport for almost 10 years, I was asked to stay on to coach. I immediately fell in love with teaching and knew I wanted to do this for the rest of my life.

I felt excited at the start of my teacher training. I am not nervous about speaking in front of people; I really get into a 'role', and it seems to flow naturally. However, when I started taking upper-level classes in college, I realised the responsibility that comes with teaching, which can be daunting at times.

I think the challenges of teaching STEM subjects to children is sparking and then maintaining excitement for STEM. Often, I think that children are intimidated and think they are not good at math or science and, therefore, cannot like STEM. However, STEM is so much more than that! It is important to tackle this, so that every child knows they have a place within STEM.

I remember being one of those students who thinks they are not good at any of the STEM subjects and ruled it out before even giving it a shot. It's my goal to provide plenty of opportunities for my future students to become familiar with all aspects of STEM and help them

discover their talents within the fields. Hopefully, that way, they will get excited about it!

The maker space allows me to practise lessons exactly how I want to teach them because of the many materials available. This practice builds confidence and helps me when going into schools to work with students during field experiences. Also, it enables the professors to give us interactive and hands-on learning experiences, which makes learning fun.

**“ YOU JUST HAVE TO HAVE THE PASSION TO WANT TO LEARN AND GROW, SO THAT YOU CAN TEACH STUDENTS TO LEARN AND GROW WITH YOU. ”**

Learning in the maker space with my classmates has helped me a lot. The room allows for a lot of flexible seating opportunities. As a result, I got to know and work with all my classmates. This creates supportive relationships and makes

us more comfortable acting like children when participating in lessons that our classmates practice with us!

For me, the highlight so far has been getting to learn in the maker space and seeing the professors make great use of the space by providing hands-on activities. I believe it is the future of teacher training, as it is helpful to learn about all the opportunities of a maker space before working as a teacher in a school. My favourite parts of the maker space at Point Park University are the white board tables. They allow for quick notes that really help during discussions and project planning.

My proudest education achievement is passing the Teaching Certification Exam. This exam tests you on all the knowledge you have gained throughout your college career. At first, this sounded rather intimidating, but I knew that I could do it if I persisted, and I did!

My ambitions for the future are to keep on studying to get my master's and my doctorate degree. I would love to be a university professor and teach students how to be great teachers.

My advice to younger students considering a career in teaching is to follow your heart, and do not get discouraged. You do not have to be an expert in every single subject to be a great elementary teacher – you just have to have the passion to want to learn and grow, so that you can teach students to learn and grow with you.”



# ABOUT *EDUCATION*

**E**ducation is an area that is changing all the time. With the huge number of new technological advances, children entering school are tech-savvy in a way that they have never been before. “Teachers have a great opportunity to tap into these background experiences and use technology as a compliment to their lessons to make the content innovative, applicable and relevant,” says Kamryn.

However, the advancement of technology brings challenges too! Many young students spend a lot of time on screens and find it difficult to be as engaged by anything else, and so

choosing to work in education will mean finding ways to tackle these problems. “Teachers will need to offer their students a variety of classroom experiences that strengthen their collaborative and communication skills,” explains Kamryn.

Working in education can be an extremely rewarding career as teachers have the opportunity to make massive differences in young people’s lives. “Experiencing an authentic learning moment with a student is such a special experience,” says Ginny. “Watching students learn, grow, and explore is truly fulfilling,” agrees Mark.

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## Explore careers in *education*

- If you are interested in teaching, Kamryn recommends having a look at your state’s Department of Education website. “These webpages typically include information about certification, educational initiatives and resources for teachers and students,” says Kamryn. “Other organisations that offer educational resources, conferences and networking opportunities include The National Education Association ([www.nea.org](http://www.nea.org)), National Council of Teachers of Mathematics ([www.nctm.org](http://www.nctm.org)), Next Generation Science Standards ([www.nextgenscience.org](http://www.nextgenscience.org)), and International Society for Technology in Education ([www.iste.org](http://www.iste.org)).”
- If you are in the UK, advice for careers in teaching can be found at the government education site: [www.getintoteaching.education.gov.uk/train-to-be-a-teacher](http://www.getintoteaching.education.gov.uk/train-to-be-a-teacher)
- Mark recommends talking to principals and teachers about their work. “These are the people who know about the everyday experiences of teaching,” he says.
- Point Park University offers a pilot programme for high school students who are advanced in mathematics to take college math courses: [www.pointpark.edu/academics/undergraduateacademics/collegeinhighschool/index](http://www.pointpark.edu/academics/undergraduateacademics/collegeinhighschool/index)
- Amongst other summer camps, it are also re-introducing its Engineering Summer Camp for high school students: [www.pointpark.edu/about/aboutpittsburgh/livingandlearninginpittsburgh/community-and-summer-programs/youth-and-high-school-students/index](http://www.pointpark.edu/about/aboutpittsburgh/livingandlearninginpittsburgh/community-and-summer-programs/youth-and-high-school-students/index)
- According to USA Facts ([www.usafacts.org](http://www.usafacts.org)), the average annual salary for a public-school teacher in the US is \$65,000.

## Pathway from school to *education*

- All certified elementary teachers in the US must have a bachelor’s degree. Consider a degree in elementary education or a related field such as early childhood development. You could also study a subject specific degree (such as physics or English) and then enrol in a teacher education programme afterwards.
- To become a high-school teacher in the US, the most common route is to first earn a bachelor’s degree in the subject you would like to specialise in and then earn a teacher certificate afterwards.
- To become an education researcher or professor like Ginny, Kamryn and Mark, it is likely you will need to complete a master’s degree and a PhD.
- “Education students should be able to problem solve, demonstrate creativity and write clearly,” says Ginny. When choosing a teaching programme, Ginny recommends looking for ones that have a detailed structure and allow for student choice. “Think about the subject and age level you might be interested in teaching and look for a programme that meets those needs,” she says.
- “I recommend students take a mixture of courses that teach content and methods,” says Kamryn. “It will be important for students to be competent in the skills needed to teach their future students in addition to pedagogical methods and strategies to best teach these skills.”
- If you are interested in becoming a mathematics teacher, Mark recommends taking some data analytics and statistics classes at college, as well as traditional mathematics and education courses.



# Meet the T.I.M.E. for STEM team



## Q&A

### Meet Ginny

#### What were your interests when you were growing up?

I have always been interested in sports, animals, art and travel.

#### Who or what inspired you to become an educator?

When I was young, I worked as a camp counsellor, and I knew I had a passion for working with young students. Working on my undergraduate degree, I connected well with my education professors, and I thoroughly enjoyed my time volunteering in the elementary classrooms. I also coached tennis, which made me realise that I enjoyed working with students of all ages.

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**I LOVE ADAPTING MY TEACHING TO WHAT IS CURRENT IN EDUCATION. I ESPECIALLY LIKE USING MY CREATIVITY IN MY TEACHING AND COLLABORATING WITH COLLEAGUES AND EDUCATORS.**

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#### What experiences have shaped your career?

When I was an elementary teacher, I had the opportunity to work with amazing teachers and administrators. I have taught in a large public school system and a small private school. Likewise, I have worked at a large university and a smaller university. All of these experiences have helped shaped who I am as an educator and a leader.

#### What attributes have made you successful?

As a former elementary teacher, and now as a college professor, I am always striving for excellence and trying to best meet the needs of my students. I am passionate about teaching and learning and am always interested in new ideas and research. I love adapting my teaching to what is current in education. I especially like using my creativity in my teaching and collaborating with colleagues and educators. Throughout my teaching career, I have always focused on the needs of the students. My courses incorporate collaboration, communication, creativity and growth-oriented learning. I implement a constructiveness approach to teaching, and attempt to present material in a structured, yet engaging manner.

#### What are your proudest career achievements so far?

I am proud of the work I have completed as a faculty member at Point Park University. I

have learned about programme assessment, curriculum and programme development, and leadership roles within higher education. I am thrilled to be able to provide our students with unique opportunities as they complete their teacher certification programmes. Specifically, I am proud to offer our students enrichment opportunities such as student teaching abroad and creative learning experiences within maker education.

### Ginny's top tips

1. Go for it! A career in education has proven to be the perfect balance of challenging and rewarding.
2. Find something that resonates with you in education and use that as a springboard for goal setting and achievements. As an elementary teacher, I fell in love with children's literature. I am passionate about finding the perfect book to open ideas to my students. This passion led me to both my master's and doctoral programmes. I currently focus on how literature can be used in maker education with STEM learning. Bring your own passion into your teaching!



## Q&A

### Meet Kamryn

#### What were your interests when you were growing up?

Sports, babysitting, leadership opportunities like the student council, band, spending time with family and friends, travelling and crafting!

#### Who or what inspired you to become an educator?

I always enjoyed working with children as a babysitter and camp counsellor. I had great teachers growing up that made school and learning enjoyable and fun, so I knew I wanted to contribute to the great field of education.

#### What experiences have shaped your career?

Throughout my career, I have been surrounded by good mentors. As opportunities presented themselves to me personally and professionally, I was willing to take risks and explore new experiences that stretched my skill set and deepened my understanding of innovative ideas. I value the gift of learning!

#### What are your proudest career achievements so far?

I am most proud of earning my doctorate in education and becoming an assistant professor. My faculty position allows me to contribute to the training of pre-service teachers as we get them ready to take on the role as a classroom teacher. I also have the privilege to work on innovative projects such as developing Point Park's student teaching abroad programme and our School of Education makerspace initiative. These experiences strengthen my love

for learning and keep each day exciting as we establish new opportunities for our students.

#### Kamryn's top tips

1. Be open to change and new opportunities for learning.
2. Find good mentors throughout your career that will help guide your learning and facilitate new career opportunities.
3. Never be afraid to try – we learn from our experiences.
4. Discipline and hard work pay off!
5. If you become an educator, always stay focused on serving your students.
6. Never stop learning – it is important to stay relevant in your teaching practices and methods to best meet the needs of students.



## Q&A

### Meet Mark

#### What were your interests when you were growing up?

Sports, mechanical devices (cars, motorcycles, lawnmowers, etc.) and history.

#### Who or what inspired you to become an educator?

I guess for twelve of my first eighteen years of life education was the focus and what I knew best!

#### What experiences have shaped your career?

The teachers I have had (good and bad), colleagues I have worked with (again, good and bad) and taking advantage of every opportunity that has come my way.

#### What attributes have made you successful?

My willingness to help, remembering what it was like to be a student and working harder than expectations have helped me as an educator.

#### What are your proudest career achievements so far?

Helping students who never thought they could earn a degree achieve their goals, earning a doctorate and becoming a professor.

#### Mark's top tips

1. Don't follow in my footsteps, blaze your own path.
2. Learn from mistakes and successes along the way.
3. Be kind to people along your journey – bring others along with you.