

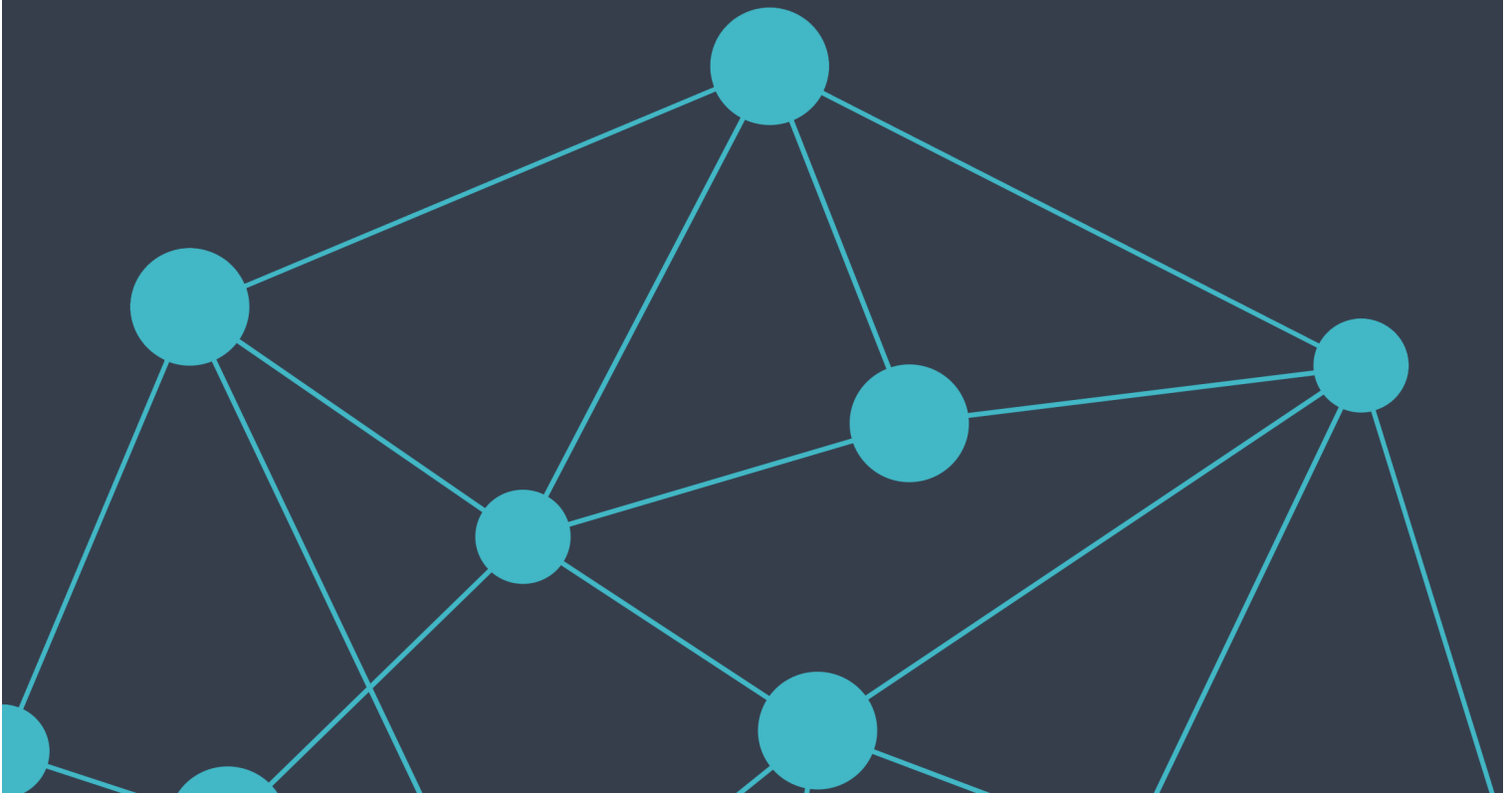


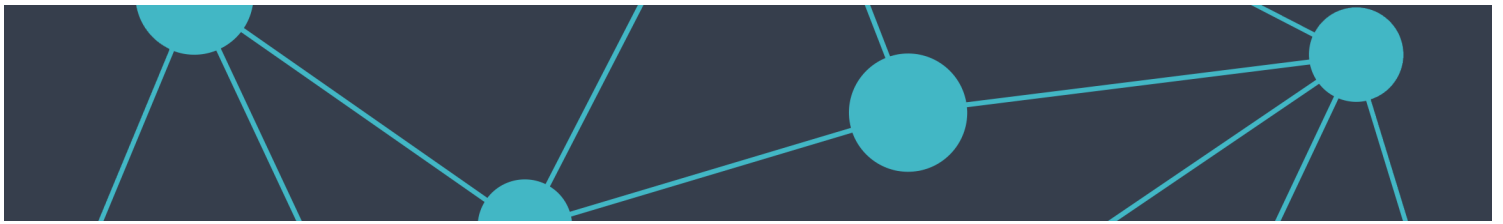
# Engaging STEM Professionals in K-12 Professional Development

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## Introduction

This document was drafted by the professional educators at the Institute for Systems Biology (ISB). ISB is a non-profit biomedical research institute located in Seattle, Washington. While ISB is internationally known for its pioneering research and perspectives on 21<sup>st</sup> Century healthcare, ISB also is recognized regionally for its strong commitment to education. The commitment to education is led by ISB's Logan Center for Education, a group of professional educators who function similar to a lab group, but whose work is in support of teacher and administrator professional development. ISB has fostered a culture and processes for its STEM<sup>1</sup> professionals (i.e., scientists, engineers, and administrative staff) to contribute to Logan Center programs. On an annual basis, the Logan Center provides professional development for over 1000 educators, and all the professional development experiences include collaboration with a STEM professional (from ISB and/or from across the region). Further, on an annual basis, one-third of ISB's STEM professionals contribute to education and outreach.

This document draws on the lessons learned at ISB. It is intended to compel and support effective collaboration between STEM professionals in K-12 professional development. Both educators and STEM professionals can use this document to launch and foster such collaborations.

Central to the lessons learned shared in this document is the recognition that successful collaborations between educators and STEM professionals must be fostered and nurtured. At the ISB, the Logan Center has allocated funding for a percentage of a staff member's time to foster collaboration between educators and STEM professionals. This staff member is recognized as ISB's "Education Liaison." Some STEM organizations have dedicated such responsibilities to Human Resources, and some education organizations have dedicated such responsibilities to staff aligned to programs such as community service and career and technology education. No matter how collaborations are fostered, it must be recognized that relationships are cultivated (they do not magically appear), guided by a premise of respect and no assumptions.

The document reflects ISB's lessons learned described across three sections: *Why Collaborate* – the need, purpose and benefits to collaborations; *Supporting Collaborations* – the preparation, fostering and follow-up of collaborations; and *Vignettes* depicting four case studies of STEM professionals' involvement in K-12 professional development.

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<sup>1</sup> STEM is acronym for science, technology, engineering and mathematics



## PART 1: Why Collaborate

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As citizens, today's students' lives will continually require their making daily STEM-related decisions such as determining whether or not to buy GMO food, voting on policy related to climate change, or engaging with their healthcare provider. Moreover, access to an increasing number of career opportunities requires foundation in the STEM disciplines. Indeed, all students today need to develop STEM literacy in order to function in our rapidly advancing world.

Accordingly, new math and science standards for K-12 teaching and learning – the Common Core State Standards for Mathematics (CCSS-M)<sup>2</sup> and the Next Generation Science Standards (NGSS)<sup>3</sup> – are purposed not only to engage students with math and science content, but also the interdisciplinary nature of STEM, as well as the real world practices of scientists, engineers and mathematicians.

In order for students' learning experiences to reflect these standards, students' teachers need foundation in STEM skills, knowledge and perspectives. Unfortunately, few teachers have a strong STEM foundation – nationally, 35 percent of grade 8 students have a mathematics teacher who majored in mathematics or mathematics education, and 41 percent have a science teacher who majored in science, engineering, or science education.<sup>4</sup>

To accommodate for teachers' understanding of the new standards, and to shore up the foundational STEM knowledge of many teachers in general, school systems must provide teachers with STEM-focused professional development. Accordingly, STEM professionals are often asked to contribute to such professional development.

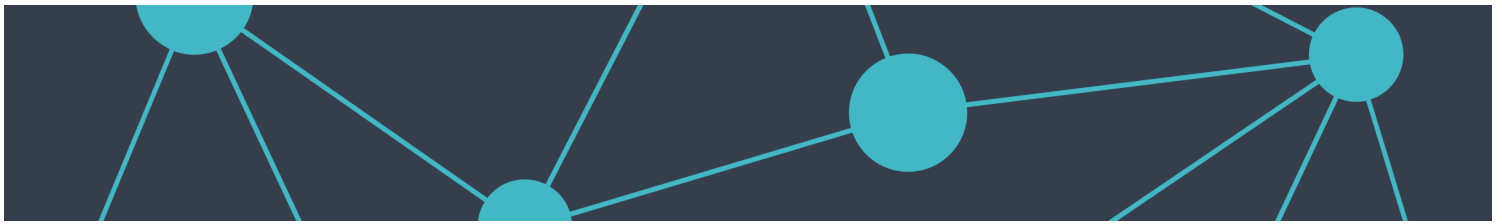
The definition of STEM professionals typically includes those careers most often depicted in the media such as doctors, rocket scientists (aerospace engineers), wet lab researchers, software developers, and often, environmental biologists. However, the definition of STEM professionals can, and should, be expanded to include a wider array of people who use STEM skills in their careers and hobbies, such as landscape planners, 2- and 4-year college faculty and students, electricians, nurses,

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<sup>2</sup> National Governors Association Center for Best Practices, Council of Chief State School Officers. 2010. *Common Core State Standards*. Washington DC: National Governors Association Center for Best Practices, Council of Chief State School Officers.

<sup>3</sup> NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

<sup>4</sup> Banilower, E.R., Smith, P.S., Weiss, I.R., Malzahn, K.A., Campbell, K.M., & Weiss, A.M. 2013. *Report of the 2012 national survey of science and mathematics education*. Chapel Hill, NC: Horizon Research, Inc.



and wastewater managers. Moreover, not all communities are home to a major technology company or research university, however most communities include health clinics, park systems, and construction companies that employ STEM professionals. Recognizing the breadth of STEM-related careers and hobbies provides wide-ranging opportunities for educators to engage with STEM professionals.

## Purpose of Collaboration

When considering the role of STEM professionals in K-12 education, traditional models have consisted of the STEM professional visiting a classroom and providing a lecture – and maybe a demonstration – about their work. STEM professionals, however, can engage in a number of roles in support of teaching and learning, notably by way of serving as an advocate, resource and/or partner.<sup>5</sup>

**Advocate:** Advocates carry the clear and consistent message that STEM is imperative to the lives and welfare of today’s students and their future. This message is purposed to rally community support and build excitement about engaging in STEM. Example activities for STEM professionals include:

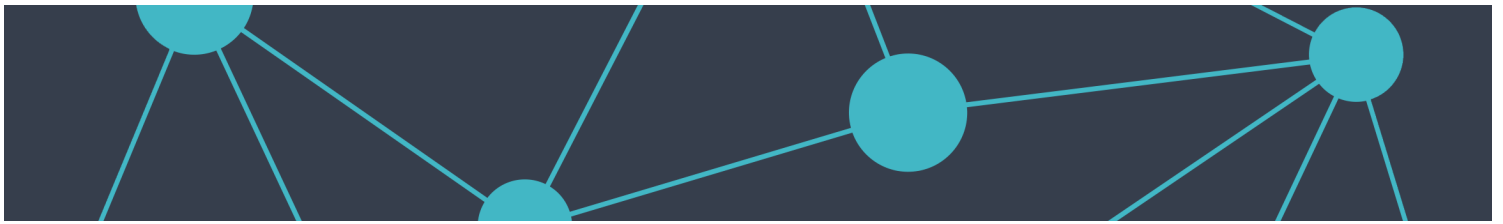
- Visible institutional commitment to supporting STEM education
- Editorials (in partnership with educators) in the media
- Testimonials and letters to PTA, school board, or state government
- Visibility and communication at community events to share the excitement of STEM
- Establish or contribute to a STEM education public relations campaign

**Resource:** Many education systems solicit cash donations from STEM organizations. But resources beyond a check can be helpful. Example activities for STEM professionals include:

- Navigating organization contributions such as unrestricted funds, grants, employee collections or sponsorships
- Support by way of collaborative grant writing, particularly to STEM-based organizations the school systems typically cannot access (e.g., National Science Foundation, National Institutes for Health, Department of Defense)
- Materials and equipment donations, such as surplus or retired materials, as well as assistance in purchase for new materials

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<sup>5</sup> Institute for Systems Biology. *STEM Education Partnership Framework*. Seattle, WA: Institute for Systems Biology. Retrieved April 2014  
[https://www.systemsbiology.org/sites/default/files/STEM\\_Framework.pdf](https://www.systemsbiology.org/sites/default/files/STEM_Framework.pdf).



**Collaborator:** First-hand STEM experience enhances student and teacher learning of STEM knowledge, skills, attitudes and beliefs. STEM professionals' expertise is vast across the disciplines and organizations, so the opportunities can be infinite. Example activities for STEM professionals include:

- Teacher externships (experience real-world application of content)
- Mentorships, catalyzing ideas of opportunities for students and providing guidance for course and careers
- School-based engagement in classroom discussion or demonstrations and/or judge science fair
- Review materials (e.g., curriculum and standards)
- Contribute to the design of curriculum, projects, and certificate/degree programs

This document focuses specifically on how STEM professionals can engage as **collaborators** with educators, specifically collaborators in support of K-12 professional development. Professional development can encompass a wide variety of activities purposed to further educators' professional knowledge, skills, and effectiveness. Examples of different types of professional development are included in the vignettes highlighted in Part 3 of the document.

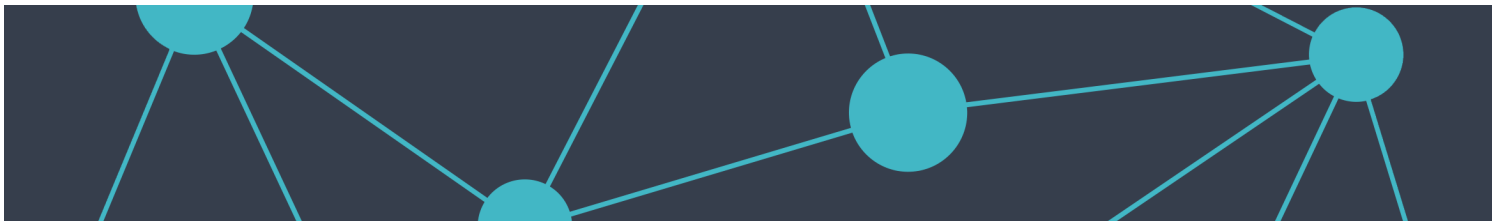
## Benefit to Educators

As STEM professionals have a broad set of knowledge and expertise, the opportunity to collaborate with STEM professionals can impact a span of educators' professional practice.

### *Pedagogical Content Knowledge*

Pedagogical content knowledge differs from the knowledge a STEM professional utilizes in his/her everyday practice, as pedagogical content knowledge is the content knowledge necessary to teach. For example, STEM-specific pedagogical content knowledge includes a teacher's ability to identify the age appropriate science content for students, predict where students will struggle with particular concepts, and create experiences that support student success in learning.

While STEM professionals may not have pedagogical expertise, they can contribute an important role in deepening educators' pedagogical content knowledge. Importantly, when educators collaborate with STEM professionals, the educators have opportunity to step out of their day-to-day classroom environment and gain a deeper understanding of the content they teach. By providing educators with a big picture view of content – clearing away the minutiae and illuminating the big and important ideas – teachers can reexamine their pedagogical strategies.



For example, a STEM professional who uses mathematics regularly might support teachers to move beyond focusing on students' ability to execute algorithms, to understanding the real world application of various mathematical tools. And a practicing biologist might help teachers move beyond students' task of memorizing facts to understanding the importance of recognizing patterns in the world as a strategy for organizing biological information. Such real world perspectives can support educators in (re)framing learning goals and activities in a manner that depict and model real world STEM content and practices.

### ***STEM Practices***

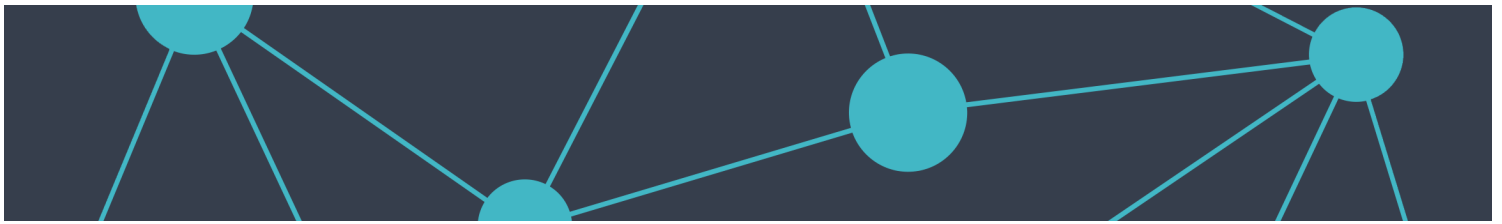
The new CCSS and NGSS include a new focus for learning STEM. As students learn science and math content, they now also are asked to learn the application of math, science and engineering *practices*. The CCSS and NGSS practices depict the work of mathematicians, scientists and engineers. For example, the NGSS state that students will learn how to ask questions and construct explanations (like scientists) and define problems and design solutions (like engineers). Inclusion of practices in STEM teaching and learning requires teachers to deepen their personal and professional understanding of STEM practices in order to shift their classroom instruction. STEM professionals can discuss and model to educators how the practices are used in STEM fields, and help educators in creating richer and more authentic learning experiences.

For example, an atmospheric scientist might model the NGSS practice of quantitative reasoning by demonstrating use of computer science to develop computer models to predict weather patterns. While a teacher may not use the same level of sophistication in his/her instruction, he/she would have a deeper understanding of how scientists use quantitative reasoning to organize and explain real world phenomena, and can incorporate such understanding into his/her teaching repertoire.

### ***Real World Examples***

On a daily basis, STEM professionals engage with current, real world STEM experiences that often are difficult for educators to access. As STEM professionals learn about the STEM content educators need to address, the STEM professionals can help to make authentic connections between the curriculum and real world application. Establishing such connections can help make classroom experiences more authentic. Collaborations between STEM professionals and teachers can draw on teachers' understanding of students' interests and on the STEM professionals' experiences with real world application, towards developing teaching and learning experiences that authentically motivate and engage students.

For example, a life science researcher might share how she is researching the genetics of Alzheimer's disease by studying isolated populations and how high school level population genetics is a central component to her work. An elementary



math educator might spend time understanding how construction professionals use math in a variety of aspects of their work. The educator would then deeply understand the importance of concepts such as measurement and fractions and in turn be able to share those meaningful connections with their students.

### ***Course and Career Readiness***

Educators serve the important role in supporting not only students' achievement and interest in STEM, but also students' aspiration for participation in future STEM courses and potentially a STEM career. In order for educators to support students' aspirations, educators need a broad understanding of the breadth of STEM career possibilities. When collaborating with STEM professionals, educators learn about STEM careers and career pathways, which in turn expands the educators' vision of possibilities for their students. STEM professionals can play the important role of making STEM careers an attainable and realistic goal for students.

For example, a group of teachers visiting a single STEM workplace might have opportunity to meet several professionals whose work requires a STEM foundation – a wet lab scientist, a computer scientist, the facilities manager, the safety officer, the communications director, and the in-house lawyer. Such experiences provide teachers an understanding of the breadth of careers available as well as the variety of pathways for achieving those careers. Teachers' understanding of course and career pathways will affect how they influence their students' aspirations.

## **Benefit to STEM Professionals**

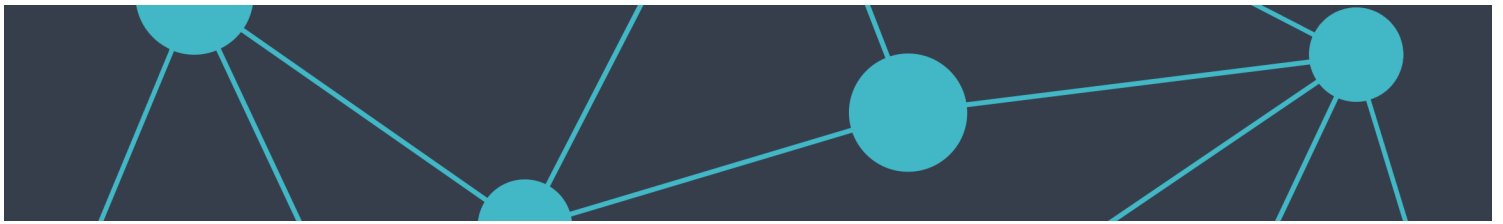
Collaborations not only benefit educators, but also STEM professionals. Understanding a STEM professional's interest in engaging with K-12 education can help foster appropriate collaborations.

### ***Fulfill Personal Interest***

Many STEM professionals are eager to share their work as a way to "give back" to the community. They understand their role as a STEM professional is to support the community in better understanding STEM fields, and to inspire students to aspire to STEM careers. As well, some STEM professionals are simply interested in knowing more about the ins and outs of the K-12 education system. This often is the case for STEM professionals who are parents, with interest in how to support STEM education at their children's schools.

### ***Enhance Communication Skills***

The practice of STEM requires STEM professionals to communicate in many ways, notably the writing of proposals and papers, and speaking with and to colleagues in both formal (professional meetings) and informal (group meetings) settings. In such cases STEM professionals are communicating with colleagues, but speaking



with educators provides an opportunity to enhance their communication skills. Educators provide a sophisticated and attentive audience for STEM professionals, yet the educators are unfamiliar with much of the STEM jargon. Preparing STEM professionals to work with teachers helps the STEM professionals in clarifying and expressing the big ideas and importance of their work.

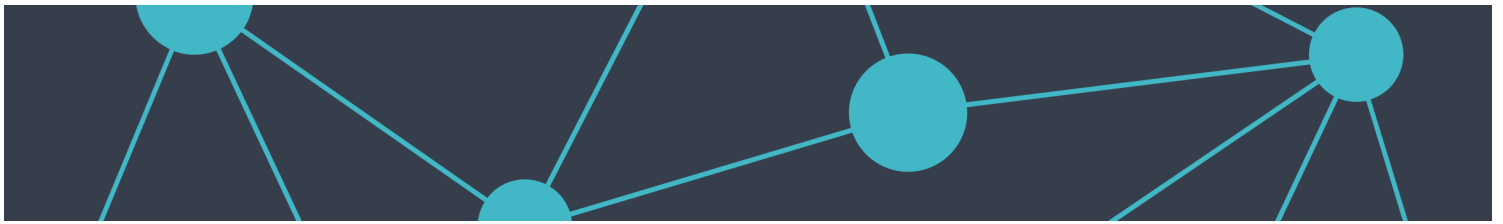
### ***Strengthening Teaching Skills***

STEM professionals, often young STEM professionals, are interested in learning more about teaching in effort to support their own professional development. Many are looking to careers that will involve teaching requirements, and engage in K-12 educator professional development provides opportunity to learn from the educators about strategies and resources for teaching and learning. Moreover, participation in K-12 professional development can be included as an activity listed in curriculum vitae. Often, collaboration with educators has a strong impact on a STEM professional's career trajectory.

### ***Satisfying Grant Requirements***

Many funding agencies – e.g., National Science Foundation and the National Institutes for Health – require the projects they fund to include a strategy for broader impact, that is, a strategy for sharing their work to audiences beyond their colleagues. Collaboration that support K-12 professional development often meets broader impact requirements, as well, such grant-funded dollars can provide for a source of support for K-12 educators' participation in professional development.





## Part 2: Supporting Collaborations

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A STEM professional can play an important role in many aspects of K-12 professional development. However, in order to assure successful collaboration with positive impact for all involved, the collaborations need to address several factors such as preparing the STEM professional, supporting the professional development experience, and follow up.

### Planning the Collaboration

Before a STEM professional is matched to a professional development experience, the STEM subject(s) addressed, required allocation of time, and role of the STEM professional must be considered in order to identify a STEM professional that will best support the objectives of the professional development.

#### *STEM Subject*

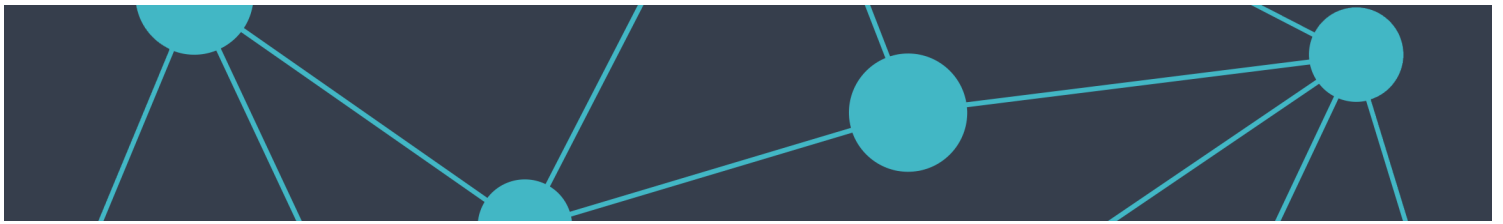
Depending on the objectives of a professional development experience, the subject of focus can vary from being quite broad (e.g., engineering as applied to elementary classrooms) to very narrow (e.g., a lesson focused on malaria in a high school global health class). STEM professionals often have a very narrow focus in their work, but typically adept at engaging more broadly with topics about their field.

#### *Time Allocation and Location*

Depending on the duration of a professional development session, the STEM professional's schedule flexibility, and the location and required distance to travel, a STEM professional can collaborate with educators in a face-to-face manner, or by way of an online platform such as Skype. Short engagements with educators, or long distances to travel, often warrant virtual/online communication.

#### *Role of the STEM Professional*

Depending on the purpose of the professional development, a STEM professional can collaborate in a variety of ways. For example a STEM professional might meet in a conversation style setting with a small group of teachers working on deepening their understanding of the content specific to the materials they are scheduled to teach; a STEM professional might give a short talk about his/her educational and career pathway to educators learning about STEM careers; or a STEM professional might lead a portion of a workplace tour for educators learning about the practices of science and engineering.



## Identifying a STEM Professional

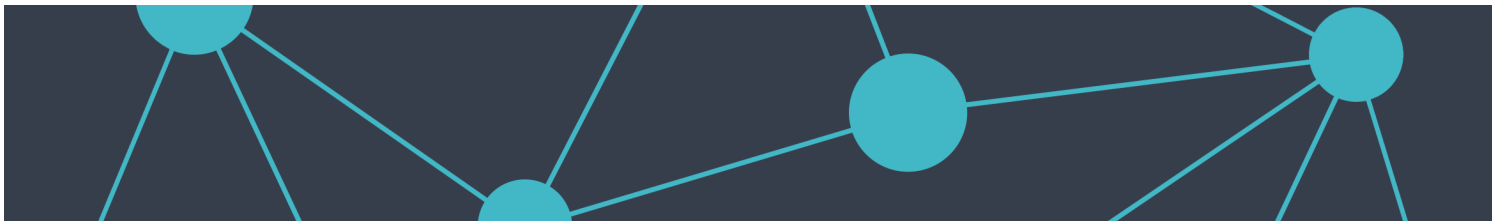
As described earlier in the document, there are a variety of STEM professionals within every community. STEM professionals work in STEM industry and research, universities and colleges, government agencies, and a variety of small businesses.

Some organizations foster STEM professionals outreach activities, and it is helpful to contact an organization's human resource office to determine if the organization has such policy. However, for the most part, identifying STEM professionals is best found by word of mouth. For example, STEM professionals at the peak of their careers often have interest in contributing to K-12 education, but they do not have the flexibility in their schedule. This person's interest can be leveraged, however, by requesting introduction to colleagues who might be of help. Senior graduate students and postdoctoral fellows typically have the knowledge and research experience that make them great collaborators, as well they often have interest in learning and practicing new skills, flexibility in schedule, enthusiasm, and, a network of campus colleagues.

## Preparing the STEM Professional

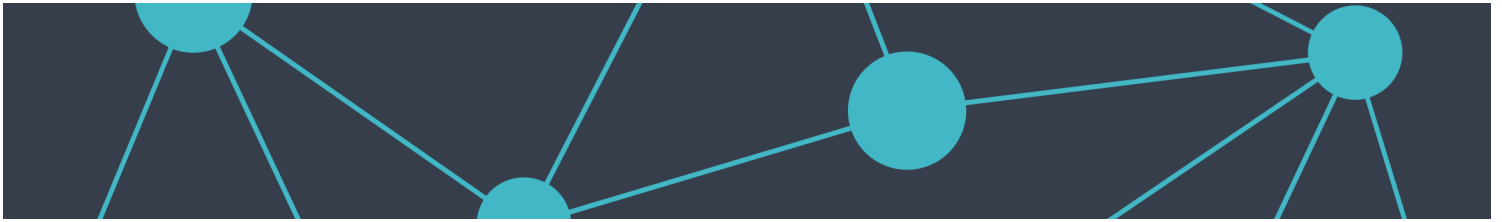
Once a STEM professional has agreed to participate in K-12 professional development, he/she must work with the professional development facilitator to prepare for the work with educators. The following steps can help in preparing STEM professionals:

- (1) ***Clearly articulate the goals or outcomes of the professional development,*** and the specific role of the STEM professional.  
Often STEM professionals are unaware of the culture and practice of educator professional development. Helping them understand the overarching goals of the professional development help them understand their role.
- (2) ***Establish understanding of the culture of K-12 professional development.***  
While there are many similarities across the cultures and practices of STEM professionals and K-12 educators (e.g., they both work long hours), there also are many differences. For example, as the role of educators is purposed to support the learning of all students, educators tend to be very nurturing to their students and colleagues. STEM professionals, however, are taught to critique ideas. Direct criticism of a colleague's idea is not the culture of K-12 educators, but a normal (and productive) interaction of STEM professionals. When working with educators, if not coached in advance, STEM professionals may be apt to ask educators very



direct questions, and not hesitate to jump into conversations with ideas, when in fact, such behavior can be off putting to educators.

- (3) ***Provide resources on teaching and learning.***  
While STEM professionals are typically quite aware of the emerging work and research in their fields, they typically are not steeped, but often curious about contemporary research and practices of education. Sharing documents such as education-focused research briefs can be very helpful, and interesting, to STEM professionals.
- (4) ***Provide contemporary science education resources.***  
STEM professionals are often unaware of education standards (e.g., CCSS and NGSS), and the role standards play in curriculum, instruction, and assessment. Share key portions of the standards and other contemporary documents with STEM professionals. In addition to providing context to the work of teachers and the learning expectations for students, the standards can provide a common language for STEM professionals and educators.
- (5) ***Provide copies of curriculum or instructional materials.***  
If the professional development is purposed to support teachers' implementation of a specific curriculum or set of instructional materials, in advance of the professional development the STEM professionals should have opportunity to review the materials and ask any clarifying questions. Often, making sense of the curricula storyline or progression helps the STEM professional to situate how he/she might best contribute to the collaboration.
- (6) ***Establish time for the STEM professional to meet with other professional development facilitators.***  
Together the collaborators should have time to review the materials mentioned above (the amount of information may seem extensive, but STEM professionals are skilled at prioritizing large amounts of literature and making sense of the big picture), as well as plan for the professional development.
- (7) ***Recognize and address imposter syndrome.***  
Often STEM professionals are hyper aware of what they do not know, and this knowledge can impact their confidence. If you sense a STEM professional is concerned due to lack of understanding of teaching and learning, reassure the STEM professional that they are successful as a practitioner and that you are asking him/her to share what they know and do (and not to be an education expert). Honestly sharing what they do

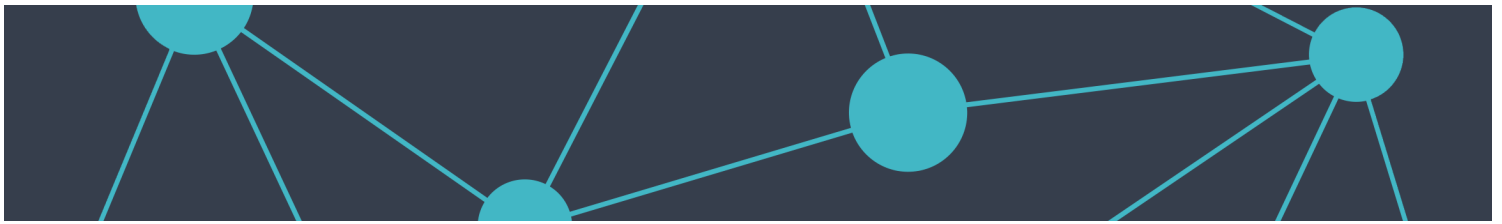


not know or do not do can be very insightful and helpful for educators to achieve an authentic view of the work of STEM professionals.

## Support During the Professional Development

As described in Part 1 of the document, STEM professionals can impact the practice of educators in many ways. The objectives of the professional development can vary and so too will the roles of the STEM professional. The following are suggestions for how STEM professionals might contribute to a professional development experience, depending on the defined objectives for the professional development.

- (1) ***Deepening pedagogical content knowledge***
  - Emphasize and clarify the big ideas – STEM professionals quickly recognize the big ideas of a lesson and in conversation with educators can help sort through the content of a lesson and identify those ideas that are peripheral to learning and those that are core and apply to the goal of the lesson.
  - Explore vocabulary – While STEM professionals will often need support in refraining from STEM jargon and understanding education jargon, a conversation centered on a specific STEM word / term or set of words can support deeper meaning and the nuances of STEM vocabulary, guiding educators on how to be clear and consistent with students.
  - Address misconceptions – While a STEM professional may not be aware of STEM related misconceptions common to students, an educator can introduce students' misconception to discuss with the STEM professional. STEM professionals often have unique viewpoints on misconceptions that not only can broaden educators' strategies for working with students, but also address their own misconceptions.
  - Answering questions – As educators are often perceived by their students as "the expert," educators often are hesitant to step out of the role of expert, and uncomfortable asking their colleagues questions about STEM. However, the educators are comfortable asking questions of a STEM professional. The dynamics of a conversation between an educator and a STEM professional fosters exploration of pedagogical content knowledge in a manner different than conversations amongst only educators.



**(2) *Introduction to and exploration of STEM practices***

The STEM practices included in the CCSS and NGSS represent the distinct ways STEM professionals approach their work. Most STEM professionals will not have had direct training, or even personal reflection on the practices in a way the standards ask educators to address the practices. However, having been introduced to the standards and with prompting, STEM professionals can consider their use of a practice in the context of their work, and then describe and discuss their work in way that highlights the practice.

**(3) *Introduction to real world STEM examples***

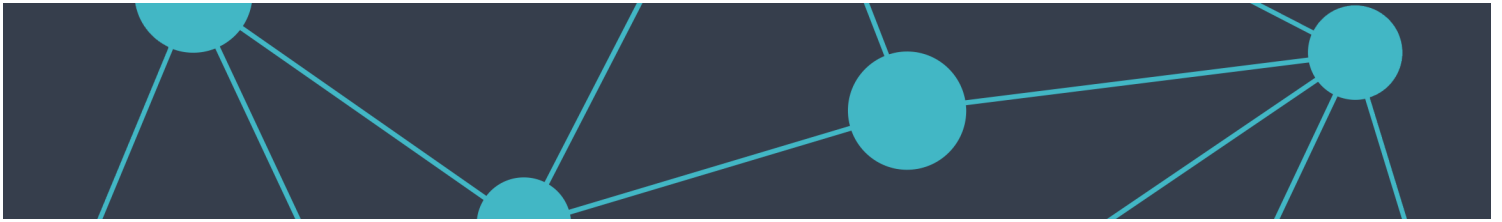
Sharing of real world STEM examples is important to most every professional development experience includes STEM professional collaboration. The repertoire of personal and professional experiences that a STEM professional can describe and connect to the content and context of a professional development experience is limitless. Some of the most important contributions of STEM professionals are to emphasize local STEM examples. As most published curriculum has been developed for national use, there rarely are local examples of STEM content. Including local STEM examples in classroom instruction can greatly impact student learning.

**(4) *Developing understanding of course and career readiness***

As most teachers have never had a career in STEM, they are largely unaware of the breadth of STEM career opportunities to share with their students. STEM professionals can share insights as related to their personal career pathway, and are often aware of emerging careers as well as opportunities in adjacent fields. Knowledge, skills and courses required to achieve these careers can lead to discussions focused on STEM content requirements, but also conversations that highlight the soft skills needed by STEM professionals. The ability to think critically typically does not surprise teachers, but teachers often are impressed by the amount of communication and collaboration required of successful STEM professionals.

## **Follow-up, Reimbursement and Recognition**

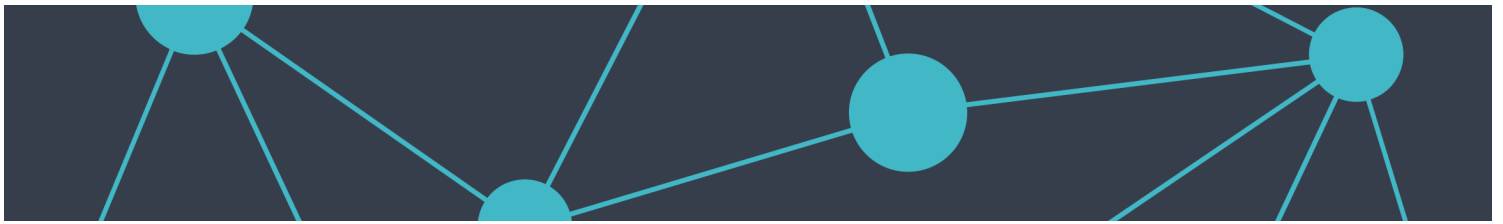
STEM professionals are often eager to understand the impact of their collaboration. If there is a product and/or evaluation from the professional development experience, share the results with the STEM professional. Knowing what aspects of the collaboration impacted the teachers and their practice helps the STEM professional feel more like a partner, and as a result they will most likely work to improve his/her contributions to future collaborations. Additionally, the feedback



will help the STEM professionals describe their work to colleagues, grow their careers, and inform their own education endeavors.

While it is not always necessary to reimburse STEM professionals for their contributions to K-12 professional development, consideration of reimbursement, and recognition should be considered.

- Recognition might be as simple as sending the STEM professional (and his/her supervisor) a thank you note, but also might include recognition in the workplace or school district newsletter, as well as encouragement to include the experience in his/her curriculum vitae.
- A STEM professional who spends several hours preparing for and participating in a professional development experience can be reimbursed at an hourly rate or by way of a set honorarium or stipend. Such reimbursement would most likely cover contributed time as well as expenses incurred from travel.
- A STEM professional who engages in many professional development experiences may require formal reimbursement for his/her salary. The STEM professional might collaborate with educators to write a grant in support of his/her time.



## Part 3: Vignettes

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The following four vignettes are brief case studies drawn from ISB's experiences in fostering collaboration of STEM professionals in K-12 professional development experiences. The purpose of the vignettes is to help readers contextualize information from Parts 1 and 2 of this document.

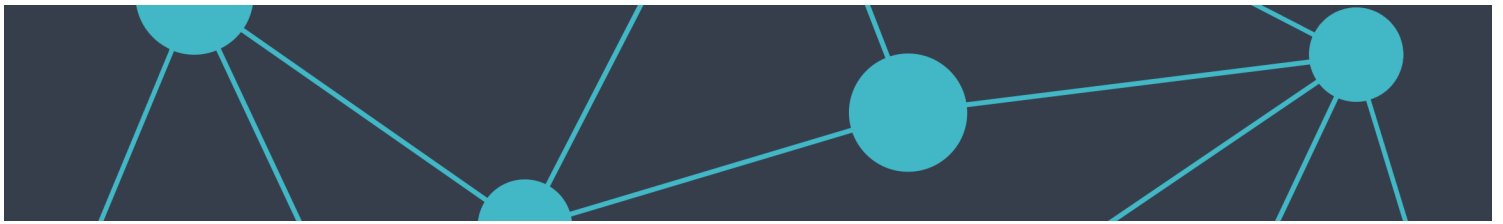
### Vignette 1 | Brian

Brian is a professor of engineering at a large research university. A favorite part of his job is working with undergraduate students to develop hybrid vehicles for competition. His research, teaching and administrative responsibilities keep him very busy, but he allocates time for outreach to K-12 students and teachers because he is passionate about making engineering course and career pathways visible to all students.

ISB was a partner on a state funded grant that partnered two local school districts. The purpose of the project was to introduce teachers to the newly adopted Next Generation Science Standards (NGSS). A core component of the teacher professional development was to develop NGSS curriculum enhancements. The project was required to include collaboration with STEM professionals, and project leadership determined the key role for STEM professionals would be to support the teachers in their understanding of NGSS pedagogical content knowledge, NGSS practices, and in conceiving real world ideas as basis for the NGSS curriculum enhancements.

ISB education staff, Leah, had the role of supporting the recruitment, preparation and participation of STEM professionals. Brian was recruited by way of mouth. ISB education staff had already collaborated with a professor in Brian's department, and when more STEM professionals were needed for the project, said professor provided introduction to Brian. One of the project's teacher groups would be working with a district-adopted curriculum focused on electricity. Knowing Brian's expertise in engineering, Leah partnered Brian with this teacher group.

Several weeks before the summer workshop, Brian and Leah meet to discuss the project and Brian's role. Leah provided Brian with NGSS readings, a copy of the electricity curriculum, as well as the tools (e.g., worksheets) teachers would use to develop curriculum enhancements. Together they spent almost an hour reviewing the materials and discussing the ways Brian might be helpful to the group of teachers. Leah suggested to Brian that he take on the role of "authenticity police," supporting the teachers in grounding their development of curriculum



enhancements in real world work aligned to real world problems. A week prior to the workshop Leah checked in with Brian. Brian had read the materials, and had conceived ideas about how to connect the content with real world issue. Leah encouraged Brian to share these ideas with the teachers.

On the first day of the workshop, Brian and other STEM professionals that would be working with teacher groups meet with Leah. Many had never worked with teachers and asked a lot of questions such as how teachers use curriculum and materials, how students are assessed, and how teachers are evaluated. Leah addressed their questions, focused them to the work of the project, and then the STEM professionals were off to work with their respective teacher groups.

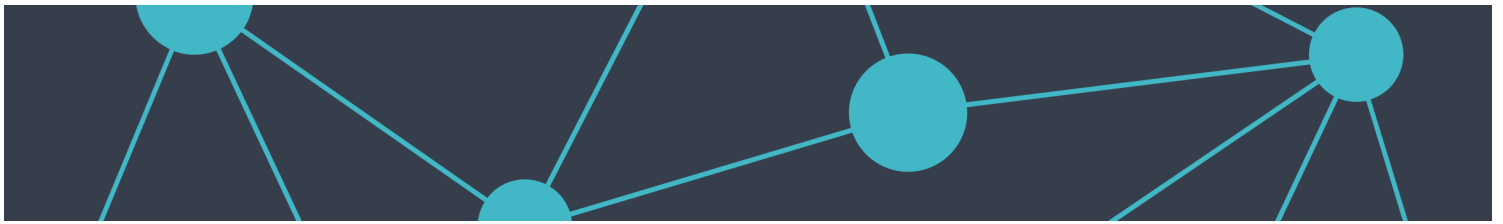
Brian worked with the teacher group for three consecutive days. After taking time to listen to the teachers, in a discussion manner, Brian helped the teachers extend and deepen their knowledge about electricity. He then described the work of engineers to the teachers. Ultimately he helped the teachers to develop a project in which students use their understanding of electricity to engineer an alarm system for a diary. Brian is satisfied with his role of “authenticity police” as the curriculum enhancement addressed a problem from the real world of students, and drew on students’ understanding of electricity. The teachers clearly appreciated the opportunity to work with Brian as they created a short video for their colleagues of Brian discussing the work of engineers.

The grant funded project included resources to provide STEM professionals like Brian with a stipend. In addition to the stipend, Leah was able to provide Brian with a brief report of his work that teachers played out in the classroom. Leah had met with teachers to learn that many had successfully implemented the curriculum enhancement and their students had successfully engineered diary alarms. As well, Leah was able to share with Brian that the project evaluation suggested that having worked with the STEM professionals, the teachers had gained a deeper understanding of science and engineering, and a stronger understanding of science and engineering practices.

## **Vignette 2 | Jessica**

Jessica is an assistant professor of math and math education at a mid-sized regional university. In addition to teaching undergraduate calculus, Jessica teaches math and math methods to pre-service elementary teachers. Jessica enjoys working with practicing K-12 teachers, and believes that working with K-12 teachers helps inform and improve her practice in preparing pre-service elementary teachers.





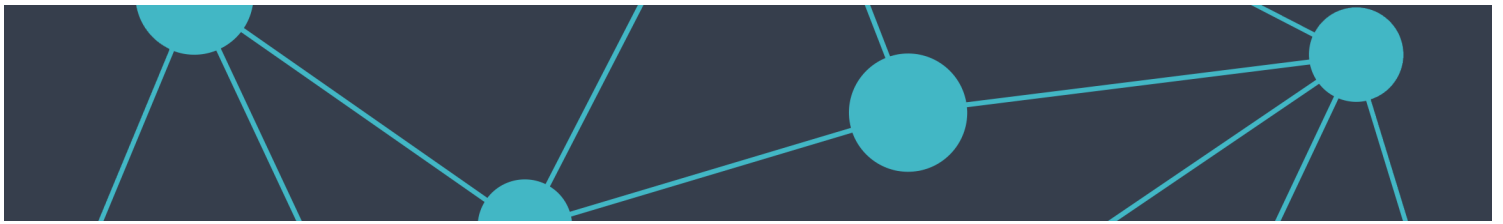
ISB educators designed a school-based professional development model that supports groups of teachers in refining lessons from the district-adopted curriculum.

A portion of the two-day professional development experience includes collaboration with a STEM professional. The purpose of including a STEM professional is to support teachers in deepening their pedagogical content knowledge. As is the case with several regional school districts, ISB's Logan Center had a contract with a regional, mid-sized suburban school district to lead the implementation of the school-based professional development model.

ISB educator Caroline was scheduled to facilitate the school-based professional development with a middle school's math department. Jessica had collaborated with ISB's Logan Center for several years, originally introduced to ISB by way of a grant-funded collaboration with a regional district. ISB educators have worked to foster their partnership with Jessica. Caroline reached out to ask Jessica to join the professional development, specifically to support teachers' work on an introductory statistics lesson.

Because Jessica was familiar with the Logan Center's professional development model, and had familiarity working with teachers around the topic of statistics, it didn't take long for Caroline to help Jessica prepare. Caroline sent Jessica a copy of the portion of the instructional materials the teachers explored, and coached Jessica to prepare to help the teachers focus on the big ideas, shifting their attention and discussion from the details of the content. Jessica read through the materials and reflected on how she teaches statistics concepts when she teaches undergraduate students.

As Jessica would need to travel more than one-and-a-half hours to join the teachers, and, since she will only be working with the teachers for approximately one hour, rather than meeting face-to-face she joins the teachers via a virtual platform (Skype). By participating virtually, Caroline knows that Jessica might miss some contextual clues so Caroline helps Jessica by subtly "reading the room." When Jessica first joins the teachers, they spend time sharing information about the statistics lesson, particularly where students typically struggle. The teachers share that the curriculum seems to emphasize calculations that bog down students, and then ask Jessica what she believes the most important content of the instructional materials. Jessica shares that she believes the most important aspect of the lesson is for students to learn the specific use of the calculations: mean, median and mode. Jessica shared how she supports undergraduates to think more deeply about these calculations and their use. As a group, the teachers decide to refine a lesson so that it more clearly emphasizes students' deep understanding of the use of the statistical calculations, mean, median and mode, and less time emphasizing practicing the calculations. After Jessica finishes her Skype session, the teachers continue to refine the statistics lesson.



After the workshop, Caroline checks in with Jessica. Caroline describes to Jessica the refined lesson designed by the teachers, and reminds Jessica the value of her participation. This particular group of math teachers is often hesitant to share content-based teaching struggles, however, that apprehension seems to disappear when Jessica joins the discussion. In addition to sharing outcomes of the workshop, follow-up with Jessica includes a modest stipend to support Jessica's time in planning for and collaborating in the professional development. ISB's Logan Center includes allocation for STEM professional stipends in the contracts established with school districts.

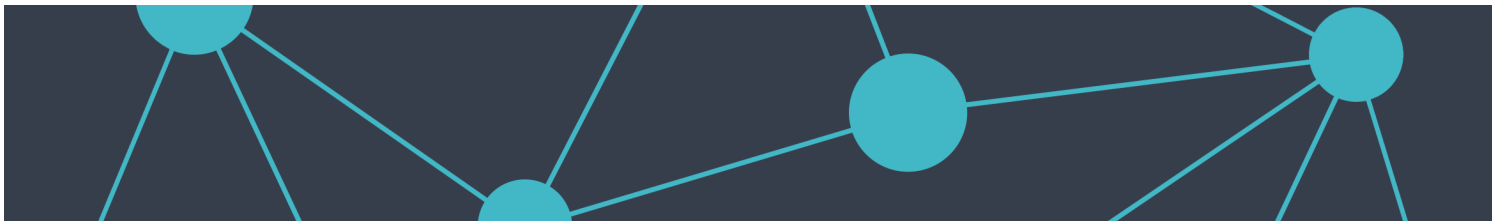
### **Vignette 3 | Sarah**

Sarah is a manager in the Parks and Natural Resources Department of a growing suburb of an urban city. She has a degree in environmental sciences and has been with the department for 12 years. The department staff, including Sarah, often hosts school age children for events and field trips.

ISB received a grant from a private science-focused foundation that supported a five-year professional development partnership with a mid-sized regional school district. While the grant did not require collaboration with STEM professionals, ISB educators structured the teacher professional development to include regular experiences with STEM professionals to help enhance the pedagogical content knowledge needed to teach the district-adopted science curriculum, as well as for educators to gain understanding of real world STEM experiences and course and career pathways.

Sarah was recruited by placing a cold call to the Parks and Natural Resources Department. This particular portion of the project was purposed in supporting teacher participants in identifying STEM professionals from their communities; STEM professionals whose work linked directly to district-adopted curriculum. One of the curricular units was entitled, Land and Water. Logan Center staff reviewed community websites to identify STEM places of work that might align to the content of the Land and Water unit, and then placed calls to the organizations with requests for teachers to visit.

Over the course of the five-year project, teacher participants had several opportunities to visit the workplace and shadow STEM professionals, however in such experiences to-date, ISB's Logan Center staff had planned for such visits in full. This experience was meant to support teacher participants in leading their one-day visit with a STEM professional. To support the teachers, Logan Center staff Maia developed a scaffold – a series of prompts to guide the teachers with pre-visit calls/emails with Sarah, discussion prompts to guide the visit (with particular focus on Sarah's career and career pathway, and how Sarah might help the teachers



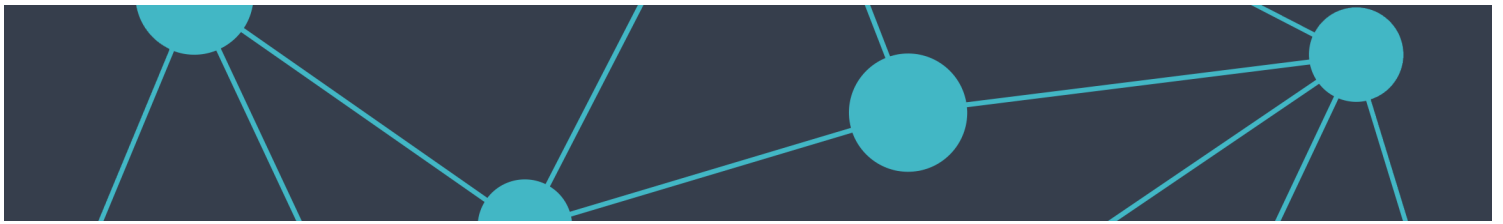
identify local examples to include in the Land and Water unit), and, suggested prompts for inviting Sarah and colleagues to continue a relationship with their schools.

On the day of the visit, six fourth grade teachers visited Sarah's office. Sarah showed them around her office and introduced the teachers to colleagues. The teachers learned about Sarah's daily work as well as her education and career pathway. The teachers then shared information about the grade four Land and Water unit, and Sarah immediately identified several connections between her work and the science students were learning. Sarah shared several maps that included the exact neighborhoods of the teachers' schools, with information on streams and water management. She was able to describe projects she had worked on with her Department that directly related to topics in the grade four science materials. Sarah confided that she had been unaware that students in her community were learning topics related to her work, and that she hoped that her Department could establish an ongoing collaboration to support the forth grade Land and Water unit.

When they finished meeting with Sarah, the teachers drafted a thank you letter to Sarah, as well as a brief summary of their visit to be shared with other fourth grade teachers. When it was time to teach the Land and Water materials, the teachers used the maps and descriptions of community projects they had learned from Sarah. They also engaged the students in short walking field trips so that students could observe the local features the teachers learned about from Sarah. At the end of the academic year, the project's external evaluator surveyed students across the school districts – including classrooms whose teachers participated in the project, and classrooms of teachers who hadn't. The evaluation results suggested that as compared to classrooms of students whose teachers did not participate in the project, the students in the classrooms whose teachers participated in the project and had annual visits with STEM professionals in their workplace were more likely to believe that science would be important in their future, and were more likely display aspiration to consider a STEM career.

## Vignette 4 | David

David is a research engineer at a physics lab studying how the sounds of marine construction can be mitigated to reduce impact on marine mammals. David recently earned his Ph.D. in mechanical engineering and is interested in education and outreach opportunities because he thinks that in the future he would like to teach undergraduate students. In addition, David is extremely enthusiastic about sharing his passion for his work with the broader community.



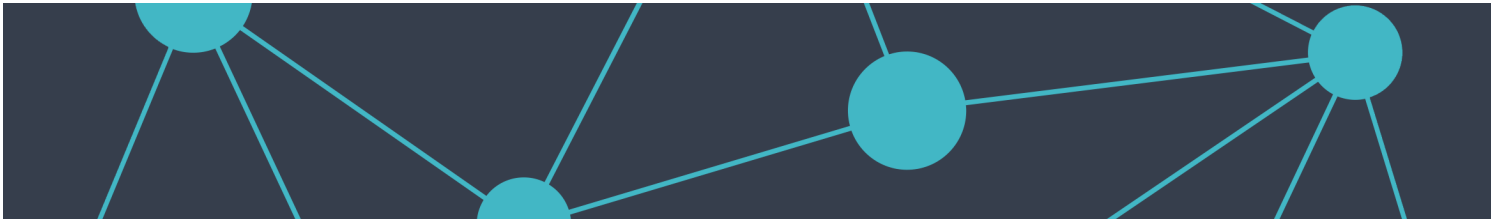
Through support of a direct contract with a modest sized suburban school district, ISB's Logan Center designed professional development purposed to support high school teachers' understanding of NGSS, particularly NGSS science and engineering practices. In addition to supporting teachers' deep review the NGSS documents, ISB educators engaged STEM professionals to help teachers explore authentic use of science and engineering practices in the STEM workplace.

David was recruited by way of mouth. His Ph.D. advisor had collaborated in ISB professional development, and knowing of David's interest in teaching, his advisor suggested that ISB's Logan Center contact David. To help David prepare for the professional development, Pat, one of ISB's educators, met with David twice.

During their first meeting, Pat shared information about NGSS and talked with David about how it would be helpful to the teachers if he shared examples of science and engineering practices in the workplace, specifically the practice of *modeling*. David found it very helpful when Pat provided examples of other work that STEM professionals had shared with teachers in similar professional development experiences. Before their second meeting, David read the NGSS materials provided by Pat, and began preparing a 45 minute presentation focused on models. As part of his preparation, David talked with his colleagues about science and engineering models and ideas for talking with K-12 educators. During their second meeting, Pat and David reviewed David's presentation and made a few changes. Specifically, Pat helped David remove scientific jargon from his presentation.

On the day of the workshop, all of the district's ten high school science teachers were present, as well as an assistant principal and the district's science leader. In the morning, Pat set the context for the day reminding teachers of the workshop objectives and why they had invited David. David then gave his presentation. Throughout and after the presentation, the teachers asked a lot of questions. The teachers were especially curious about specific details of David's research, as well as about practice of modeling in science and engineering. After David's presentation, and initial discussion with teachers, Pat engaged David and the teachers in a discussion about how science and engineering modeling in the real world relates to the practice of modeling in the classroom. Pat guided the discussion so that David and the teachers could brainstorm appropriate and authentic strategies to engage high school students. David joined the teachers for lunch and then went back to his lab for the remainder of the day.

As he was leaving, David confessed to Pat that he had been extremely nervous about his presentation. David shared that he felt he was asked to collaborate in the role of an "expert" but wasn't sure that he would have correct answers for teachers' questions. David also shared that he was quite pleased and happy to discover that he had more answers than he had anticipated. While the questions had been quite



different than the types his colleagues might ask of him, the questions were very reflective and made him think differently about his work. The whole process helped him think more deeply about education and teaching. He left more excited about opportunities to work with teachers.

After David left, the teachers worked to adapt their curriculum to include the practice of modeling, and Pat continued to remind the teachers of their discussion with David. In the post-workshop evaluation, teachers' survey results suggested that working with David had been one of the most enjoyable parts of their day. The results also suggested the workshop helped them connect real-world science to their classroom activities, and helped them feel more confident in supporting their students' use of modeling. Pat followed up with David by way of providing David with a stipend, as well as sharing with David some of the workshop outcomes, including that his contributions seemed to have helped the teachers shift their thinking to more concrete and authentic scientific practices which was represented in the adaptations they made to their curriculum.