
What is STEM? By Dr. Carla C. Johnson, University of Cincinnati

National policy makers have argued that the key to “future prosperity of the United States” is strengthening STEM teaching and learning in our public schools (Committee on Prospering in the Global Economy of the 21st Century, 2007). Interestingly enough, policy makers, administrators, funding agencies, and other members of the public use the term “STEM” loosely – assuming that educators especially, understand what they are speaking about. Unfortunately, the term STEM emerged from policy makers, not educators, and a great deal of funding has been placed behind making the United States more competitive in STEM without really explaining exactly what their conceptions of STEM are.

As a STEM Teacher Educator and Director of a university-based STEM Center and leader of a regional STEM partnership, I began to ponder the notion of public and science teacher understanding of the term STEM. In March, 2009 our FUSION Center at the University of X administered a nationwide survey to 150 randomly selected K-8 science teachers (65 teachers responded). Each teacher was given two questions to respond to that included: “What is STEM?” and “How does STEM impact your life?” In the analysis of the results, we found that the majority (76%) of science teachers responded “I don’t know”, only 18% of responders could spell out what the acronym STEM stands for as “science, technology, engineering, and mathematics” and only 6% mentioned various combinations of science, mathematics, and technology in the definition.

Sample K-12 Science Teacher Responses

- *I don't know.*
- *I am not familiar with this term.*
- *Part of a plant that transfers nutrients to the rest of the plant.*
- *I have never heard of it.*
- *Perhaps it is Science Teachers Educational Media.*
- *I have no idea!*
- *It deals with science and math education.*
- *If I know, I don't realize it yet!*
- *Science, Technology, Engineering, and Math.*

This study followed up a similar one conducted with all faculty at a large research intensive university (272 faculty responded) which, interestingly enough, produced similar results in January, 2009. Only 48% of university faculty could spell out what STEM stands for, 23% got one to three disciplines correct, and 27% listed “I don’t know” or similar as a response (Author and others 2009).

Sample University Faculty Responses

- *No idea.*
 - *I have no clue.*
 - *Stem is a cell that is extracted from its' original DNA block?*
 - *An initiative to increase the enrollment in science, technology, engineering, and math.*
 - *I am not familiar with it.*
 - *I thought STEM had something to do with promoting science and technology in the community.*
 - *Stimulus for the fields of science and technology.*
 - *Program in Science, Technology, Engineering, and Management.*
 - *I haven't the foggiest idea.*
 - *Something about science technology engineering – just saw the phrase a few days ago.*
 - *Science, Technology, Electronics, and Mathematics.*
 - *I would like to skip this question.*
 - *I don't know – I had to ask a co-worker.*
 - *I think it stands for Science, Technology, Engineering, and (I forget what the M is for...Medical?)*
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From the STEM teacher preparation perspective, we see STEM as the meaningful, real-world, contextualized implementation of the disciplines without boundaries – meaning teaching science, technology, engineering, and mathematics not as disciplines in isolation – rather teaching them in a purposeful, integrated fashion. The jobs of the past are fading and the careers of the future are ones that we cannot even describe today. What we do know is that the workforce of the future will need strong, integrated approaches to STEM challenges requiring contextualized instruction (taught in the context of the real-world) that is easiest to accomplish through the science classroom. Strategies such as problem-based and project-based learning, as well as inquiry-based experiences that incorporate technology, engineering, and mathematics disciplines used during the concurrent teaching of science are what science teachers of today will need to employ to ensure students are ready to meet the challenges they will face in college and beyond. Most importantly, students will learn how the STEM disciplines impact their lives on a daily basis – from brushing their teeth to washing clothes, getting to school/work, and innovations in healthcare, etc. The science teachers in our survey were asked “How does STEM impact your life?” It was very difficult for those who had an incomplete understanding of STEM to articulate a connection with their personal or professional lives.

How Does STEM Impact Your Life – Science Teacher Sample Responses

- *Provides educational opportunities.*
- *I can't answer this because I don't know what STEM is.*
- *Frankly little. I'd like more time to see what they have going, just not yet...*
- *It studies and discusses real world issues that cross over the various disciplines.*
- *I like to eat celery!*
- *It is what I do every day with my students, with my life!*
- *STEM impacts all areas of our lives.*

- *I'm not sure except for the fact that I teach science and math and use technology in many ways.*
 - *Can lead to the cure for many diseases and chronic conditions.*
 - *It does not impact my life since I have never heard of it.*
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Interestingly, many similar responses were collected from our university faculty group that was surveyed. Those who connected STEM to their work at the university and/or their personal life were able to state more meaningful impact in their responses.

How Does STEM Impact Your Life – University Faculty Sample Responses

- *I am not sure....very little I think....I am in nursing and I am unsure our college's link.*
 - *These concepts influence everything that we have around us.*
 - *It hasn't...I don't think so, anyway.*
 - *It's everywhere. That seems like a dumb question. it does that?*
 - *I make my living in a STEM discipline.*
 - *The stem cell part keeps me interested in the development for curing diseases.*
 - *Cannot answer since I do not know what STEM is.*
 - *Apparently minimal.*
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Evidence revealed in our two surveys points to a more systemic problem that the U.S. has been talking STEM for several years now but has failed to produce a common understanding across the stakeholders of STEM Education. It seems that the learning curve is quite steep for those involved in the educational system. This may be due to a two-fold problem: 1) schools are set up in “boxes” where each discipline is treated as a separate entity in most cases, as students earn “units” of science, mathematics, etc., 2) there is no streamlined way to bring existing teachers and schools, as well as pre-service preparation programs up to speed in timely fashion – as programmatic changes can take months to years. Fortunately, the federal and state governments have provided some funding for STEM initiatives such as Teacher Quality programs, funding for STEM programs, and teacher professional development support. Science teachers should check with their state school system website, as well as local universities to learn about STEM opportunities in their area.

So, if you are wondering to yourself about your conceptions of “What is STEM” and are also thinking that your own students may not have a clear understanding of STEM, we may have a place for you to start together with your students. Some suggestions for teachers who are grappling with the notion of incorporating more STEM experiences into their teaching of science that we have include:

1. Incorporate more problem-based learning experiences for your students where you pose a question for them to solve that includes having them construct something requiring use of all STEM area skills in an integrated manner. An example of this that I have used many times with students, teachers, and principals is the “Building Contest” where you provide the group with four to five index cards, 30 centimeters of tape, and challenge them to build a structure that will be at least 30 centimeters tall

- and will support as much weight (washers from Home Depot) as possible. Give your students 40 minutes to complete the construction of their building and to test the final products. This will spark a rich discussion of the properties of buildings that are most durable and provides also a great opportunity to engage in further discourse around the interdisciplinary nature of STEM. Participants in my workshops and in my science class have built structures so strong that they hold all ten washers, a water bottle, and sometimes textbooks.
2. Incorporate real-world STEM careers into the context of teaching science. As a matter of fact, a scientist would be hard pressed to do his or her work without incorporation of mathematics, technology, and engineering on a regular basis. Start pointing out the many ways that these fields intersect and support the work of those in the primary field of science.
 3. Collaborate with your mathematics and technology colleagues in your school and consider bringing in engineers to work with students on STEM interdisciplinary units of instruction.
 4. Turn your “science fair” into a “STEM fair” and challenge students to demonstrate the strong ties between the inter-related disciplines and ties to real-world issues/concerns.
 5. Participate in one of many STEM sponsored student challenges such as Lego Robotics, Toshiba Exploravision, Toyota Tapestry, etc.
 6. Partner with a local university to further enhance what you do in your classroom. Many universities have established STEM education or science and mathematics education centers that house multiple faculty who are constantly writing proposals to obtain grant funding to offer STEM teacher professional development. Reach out to your local partners to see what new things they have to offer your district.
 7. Start talking “STEM”. Be an advocate within your building and district to generate more awareness and understanding of STEM. Many states have begun creating STEM coalitions and networks to support your work. One example is the Ohio STEM Learning Network (www.osln.org) that coordinates five STEM hubs across the state.

Some of the next steps for local school districts and higher education stakeholders to take to further incorporate STEM as an integrated strategy for teaching the disciplines of science, technology, engineering, and mathematics include: 1) providing all teachers (especially science teachers) opportunities to gain an awareness and understanding of STEM for themselves and their colleagues within their school and district, 2) revising teacher preparation programs to provide integrated STEM experiences and coursework for future science teachers, 3) developing integrated STEM professional development programs for current teachers K-12 so students can begin early in their exposure to STEM as an interdisciplinary approach, 4) generating a stronger voice for districts in policy and funding decisions in regards to STEM programs.

REFERENCES

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Space Camp

