STEM Learning in the Middle School Classroom
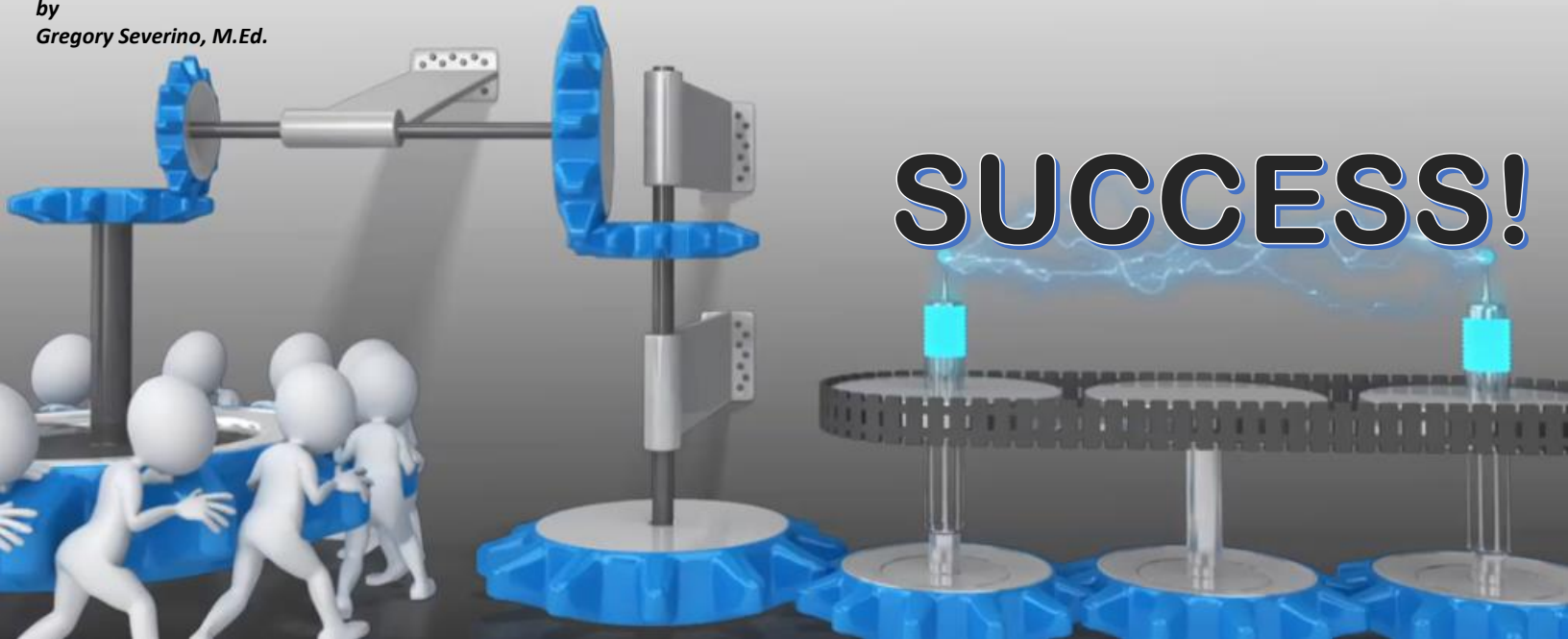
Practical Considerations for Implementation

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SUCCESS!

TEACHER RESOURCE PACKET

-Teacher Readiness
-School Readiness
-Building Project Based STEM Lessons
-Criteria for Evaluting STEM Lessons
-Branding a STEM-School
-Online Resources

Teacher Readiness

Keep the following point in mind as you practice STEM instructional pedagogy:

- STEM represents a change in thinking and instructional methods; it is not a passing fad. It represents an emphasis on integrating all subject knowledge toward problem-solving.
- Be aware that educational standards can reinforce a separation of subject areas. Create ways of bridging gaps. Avoid thinking that STEM is just another word for science education—this leads to insular thinking.
- Avoid thinking that STEM learning can be taught solely in a lecture environment; rather it relies heavily on project-based-assessments.
- Read everything on how STEM education fits into your subject matter. Thoroughly know the subject you teach.
- Practice differentiated learning with all learners, and ensure that you can explain something in a different way multiple times.
- Understand that STEM lessons require more preparation. Plan accordingly.
- Commit to teaching your students deeply in a wide range of subjects. Since STEM learning is a multidisciplinary approach to education, involve your colleagues whenever possible.
- Focus on STEM topics that have strong relevancy to the needs of present and future society.
- Clearly explain to your students that complex problems exist in the world today, and solving them requires creativity and innovation.
- Demonstrate the Engineering Design Process for your students. Your aim is to create a problem-solving paradigm for your students to observe in you and then practice for themselves.
- Make connections with other subjects in your lecture. Bridge gaps across the curriculum whenever possible. When we focus on subject-specific content only, we elicit narrow understanding.
- You can build up to a STEM lesson over time portions of the curriculum are completed.
- Your motivation level will do much to promote STEM learning. You can elicit curiosity and intrigue just by choosing STEM issues that are interesting to you.

School Readiness

Becoming a STEM school is steady building process that utilizes the entire talent pool of faculty members and administrators. Here are some tips for transforming your school into a STEM school:

- Department coordinators should meet to discuss how their subject area can be used to complement another's subject area. Outline overlapping content and draw up meaningful lessons.
- Create school-specific STEM curriculums. Base some content on individual faculty member strengths.
- Avoid implementing any kind of STEM policy from the "top-down." Faculty collaboration is absolutely essential to have any kind of buy-in.
- A clear vision with clearly defined STEM-learning objectives must be established before any kind of STEM-policy is implemented.
- Establish criteria to achieve your STEM-objectives. Always ask: *Are we accomplishing our goals?*
- Develop levels of STEM learning and build curriculums based on them. Make them unique to your school in demonstrable, easily perceived ways.
- Identify sources for teacher training in STEM content.
- Invite guest speakers to your school with STEM expertise. Be wary, however, of "STEM-experts" who are attempting to sell you something that will "enhance student STEM learning."
- If seeking financial assistance from businesses or government sources, be prepared to offer a convincing argument on just why an investment should be made in your school. A clearly written STEM mission statement backed up with good examples of student achievement will go far.
- Every school community should aim to make itself distinctive. STEM Education offers a perfect opportunity to accomplish such a distinction. You want parents to realize that your school has something that no other school has, and with all the talk about STEM today, parents *want* their children to be in an environment of STEM learning.

Building a Project-Based STEM Lesson

Ready to go with collaborative STEM learning? Here are some tips:

- Full-fledged STEM lessons pose a challenge or problem to overcome and require a collaborative effort to succeed.
- A great source for relevant topics is current events. Kids can relate to these issues and have a good background coming into the lesson.
- Identify the talent in your classroom. Begin organizing teams based on this talent pool and the challenge or task you intend to assign.
- Issue clearly defined expectations and scoring standards.
- Chart how your student teams are to move through the design-process cycle. Get them started with some essential questions or tasks, but then allow them time to research and plan their next move. Set scheduled deadlines for the teams, if necessary.
- Teach your students that in the real world, every situation, experiment, design, or test is subject to constraints. Design projects that call attention to these issues. Require your students to make decisions while observing constraints—this will give them a great idea of what problem-solving is like in professional circles. Train them to weigh variables.
- Pick projects that require your students to look outside the boundaries of our own nation to see how other countries solve some of the very problems we face.
- Develop authentic assessments for your students that feature clearly stated, realistic objectives, procedures, standards, and numerous examples to jump-start their STEM investigations.
- Keep in mind that you are tasking students, not actual engineering professionals. Have patience and perseverance with your students as they practice STEM design process skills.
- Feel free to utilize STEM lessons of varying depth. Always align STEM learning with your grade level.
- Change the way your students perceive failure. Thomas Edison once said, "I have not failed. I've just found 10,000 ways that won't work." Teach them to learn from designs that don't work by finding weaknesses, and then improvising on qualities that might lead to an eventual solution.

What makes a good STEM Lesson?

STEM lessons come in all shapes and sizes. (A recent internet search for "stem lessons for middle school" revealed over 5 *million* hits.) Some are more immersive than others, but if you want lessons that are going to generate a deep appreciation for what you're teaching, you need to select your STEM lessons carefully. Whether your crafting an original STEM lesson or selecting one from other sources, employ lessons that will build a "technical, critical mind." You want your students to display some level of innovation.

Here's some criteria to keep in mind when evaluating a STEM lesson for its closeness to an Engineering design-process approach:

- The lesson will pose an authentic challenge or task to be completed. Building a model to satisfy a task is a great way for students to understand the necessity of testing ideas on a small scale.
- The lesson requires a collaborative team effort. Every person should be expected to make a meaningful contribution.
- Technology should be used in a meaningful way to make constructs, test ideas, adjust variables, test designs, and interpret conclusions.
- The lesson encourages students to seek help from one another.
- The lesson requires a timely completion of tasks, with each stage bringing new light onto the challenge.
- The lesson requires ideas to be supported by mathematical analysis.
- The lesson requires students to practice brainstorming, reflection, evaluation, testing, and deciding upon ideas. Furthermore, ideas or decisions must be defended through logical arguments.

Lessons which hit on some of these points are fine. Remember to *always align a lesson with your grade level.*

A word on STEM Lesson complexity:

- STEM Learning can occur at different levels of immersion. Check out the "STEM Immersion Guide for Schools and Districts" published by the Arizona STEM Network. It offers one of the best, plain-English frameworks for implementing STEM Education.

What does a STEM School convey?

A STEM School should convey the following characteristics:

- Exemplary student achievement that demonstrates STEM approaches to problem-solving. Student work should illustrate how research was conducted, include summarized accounts of information found, analyzation of constraints, prototypes or theoretical model introduced, and a defense of accepted solutions. Innovative student builds or solutions to complex STEM challenges or issues should be extoled for their creativity and feasibility.
- Teacher and Administrator Quality: Faculty accomplishments in STEM learning approaches (and in any other area) should be made known to the community.
- A "STEM-DISTINCTIVE" School Brand: Illustrate *why* your school is the best choice for a child's education. Fascinating STEM projects, programs, or any kind innovative teaching practice should be made known to the community through websites and social media. Parents want quality school programs that focus on developing STEM skills for their children.
- Extracurricular STEM Programs: After-school STEM programs can go a long way toward making your school a true STEM school. Keep in mind, however, that the program should require students to practice real engineering practices of design, revision, implementation, and follow-up.
- STEM Philosophies for Learning: A culture of STEM learning should be evident throughout the school. Student displays and school-specific STEM learning curricula are good starters.
- Professional Partnerships and Sponsorships: Always seek out professional contacts for school visitations, trips, guest speaking engagements, and funding opportunities. Many professional entities and businesses financially support STEM learning.

http://rocketcontest.org/
Get involved in the Team America Rocketry Challenge!

http://www.usnews.com/opinion/articles/2016-06-20/its-time-to-invest-in-stem-education-and-build-a-nation-of-makers
Well written article on the need to promote building skills in our students.

https://www.youcandothecube.com/math-twist/stem.aspx
STEM lessons and Rubik's Cube! Pretty cool!

http://blog.learningsciences.com/2014/11/18/incorporating-literacy-in-your-stem-classroom/
Tips for building scientific literacy in your classroom. (ELA or Science applications.)

http://www.scholastic.com/teachers/article/stem-k-8-engineering
More food for thought about STEM Education

http://www.dreambox.com/blog/girls-math-more-stem-women
Dreambox produces some good articles and interactives designed to get kids to think. This link contains additional STEM resource links.

http://www2.ivcc.edu/mimic/nsf/Middle%20School%20Activities/STEM%20Activities%20Handbook.pdf
Good resource with STEM activities aimed at the middle grades.

http://stemchallenge.org/
Challenge your students to build a video game. Ideal for grades 7-8.

https://scratch.mit.edu/
Great introductory site for young programmers. Ideal for computer clubs and integrating art into STEM.

https://www.edutopia.org/blog/arts-are-essential-in-stem-mary-beth-hertz
Excellent article explaining why art is essential to STEM education.

http://www.eie.org/overview/engineering-design-process
Nice simplification of the Engineering Design Process for kids. Wonderfully rich STEM site with curriculum and planning ideas.

http://stemguide.sfaz.org/
The STEM Immersion Guide

http://www.ncsl.org/research/education/no-time-to-lose-how-to-build-a-world-class-education-system-state-by-state.aspx
Related to STEM Education, this recently completed report (August 2016) by the National Council of State Legislatures offers more insight into the necessity STEM Learning.

http://eie.org/sites/default/files/bayer_compendium.pdf
If you're building a school-STEM program, check out this report. It examines 38 STEM programs from across the nation and cites their best use of STEM practices. Excellent criteria is outlined for measuring the rigor of STEM programs.