Thank you for this opportunity to share with you ITEEA’s thinking on Computational Thinking Within Technology and Engineering Education

Introduction, Context, and Perspective/Thoughts Through Integrative STEM Education Approaches
Computational Thinking Overview

- **Clarifying Our Mission:** The development of technological literacy standards indicated that computers are but one tool in the use of technologies, rather than its sole definition or purpose.

- **Where is the fit?** Computer programming was once more closely associated with a career and technical education path than with the technological literacy of open-ended engineering design and problem solving.

- **The Tipping Point:** Greater capabilities and infusion of computational thinking in today’s work world, perhaps it is time for educational leaders to begin rethinking long-held ideas about computational thinking” (Buckler, Koperski, & Loveland, 2017).

“Our field has long been confused about educational technologies. National surveys consistently show that Americans think first of computers when asked to define technology. The development of technological literacy standards indicated that computers are but one tool in the use of technologies, rather than its sole definition or purpose. Computer programming was once more closely associated with a career and technical education path than with the technological literacy of open-ended engineering design and problem solving. With the greater capabilities and infusion of computational thinking in today’s work world, perhaps it is time for educational leaders to begin rethinking long-held ideas about computational thinking” (Buckler, Koperski, & Loveland, 2017).
References:
Computational Thinking Overview

- **Goal:** ITEEA providing fundamental resources to enable all technology and engineering educators to:

  - Take the initiative and better understand how computational thinking is operationally defined within the context of teaching technology and engineering education through an Integrative STEM Education approach. We need to be confident in our knowledge base and delivery of the content, skills, assessments, and resources associated with computational thinking.

ITEEA is providing this fundamental resource to lead our profession and enable all technology and engineering educators, along with their STEM colleagues from other disciplines, to take the initiative and better understand how computational thinking is operationally defined within the context of teaching through a technology and engineering education and Integrative STEM Education approach. The eventual goal is to operationalize “I-STEM” to provide examples that assist technology and engineering educators (and all others in the STEM field) to understand and implement computational thinking and understandings that are driven through engagement and dynamic instructional practices preK-12 and beyond to benefit ALL students!

This resource provides a launching point upon which teachers can build in their technology and engineering classrooms. The intent is to identify promising computational thinking practices as part of instructional practices and demonstrate to the entire STEM community the value of quality technology and engineering education that classroom teachers provide to students each and every day.

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References:
How We Define Computational Thinking

- In 2006, Wing argued that computational methods, concepts, and tools could be embedded in all K-12 classrooms to develop computational skills and literacy in all students. (Wing)

- Recent writing by Wing and Stanzionne (2016) focused on the potential of computational thinking to be a third pillar of the scientific method, its use in simulation of complex systems, and use by academic and STEM educators as a fundamental tool of education.

- QUESTION: To what end? Computational Thinking: What is it? How should it be taught? (Youtube Video by Wayne Lewis)

- ITEE Resources for Computational Thinking: https://www.iteea.org/Resources1507/ComputationalThinking.aspx

Jeannette Wing in 2006 published the seminal call to arms *Computational Thinking Viewpoint* in the March issue of Communications. Wing argued then that computational methods, concepts and tools could be embedded in all K-12 classrooms to develop computation skills and literacy in all students. Recent writing by Wing and Stanzionne (2016) focused on the potential of computational thinking to be a third pillar of the scientific method, its use in simulation of complex systems, and use by academic and STEM educators as a fundamental tool of education.

Computational thinking is the “thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information processing agent” (Czerkawski & Lyman, 2010). It involves the use of logic, algorithmic thinking, recursive thinking, abstraction, parallel thinking, pattern-matching, and other related processes. The College Board (2016) identifies seven big ideas related to computer science: Creativity, Abstraction, Data and Information, Algorithms, Programming, The Internet, and Global Impact.

QUESTION: To what end? Computational Thinking: What is it? How should it be taught? (Youtube Video by Wayne Lewis)

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How is computational thinking related to I-STEM Education? Should use of computers dominate our discussions and work in technology and engineering? Is computational thinking compatible with technological literacy? These questions continue to be raised by educators in our field as efforts are underway to promote computational thinking as our new focus and an equally determined group of educators wanting to keep computers as subservient to the greater goals of technological and engineering literacy. It is clear that to include technological literacy in computer science coursework at the K-12 level would be a lot harder to implement than including computational thinking in Technology and Engineering coursework.
It is clear that to include technological and engineering literacy in computer science coursework at the K-12 level would be more challenging to implement than including computational thinking in Technology and Engineering coursework . . . Like we have been doing in a significant way for well over the past twenty five years.

ITEEA will provide best practice examples on how to include computational thinking in our programs, courses, and lesson plans in a way that promotes technological and engineering literacy, and the hands-on, mind-on practices we are known for.
Many technology and engineering courses use computational thinking and practices now. These include courses using game design, computer numerical control coding, robotics, and cybersecurity. Included below are some best practice examples of computational thinking embedded within I-STEM Education.
How do you define and deliver Technology and engineering education and STEM to your students?

- STL
- Common Core State Standards
- NGSS
- National Academy of Engineering initiatives on building capacity for K-12 Engineering Education
- NAE Grand Challenges
- Maker Spaces/Maker Education

How are you defining STEM? Are we asking the right questions? We have the STL, the common core state standards, your state standards, the Next Generation Science Standards, NAE Grand Challenges, Maker labs, and much more (e.g., PBL, STEAM, etc.). What are the best practices in Science, Technology, Engineering, and Mathematics integration? I am going to share just a few with the next few slides. I am not asking you to throw the baby out with the bath water! :-)

Connections and collaboration
Where do you fit the NGSS engineering design CCC?
How do you incorporate Technology and invention/innovation – where is it taught?
The Dec/January TET theme is centered on Computational Thinking.

**Is Computer Science Compatible with Technological Literacy?** By Chris Buckler, Kevin Koperski, and Thomas Loveland, DTE.

**Integrating Computational Thinking into Technology and Engineering Education** - By Michael Hacker

**Recommendations to support computational thinking in the elementary classroom:** - Anne Estapa, Amy Hutchison, and Larysa Nadolny

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The Dec/January TET theme is centered on Computational Thinking. **Is Computer Science Compatible with Technological Literacy?** - There should be a place to include computational thinking knowledge and skills in technology and engineering education without wholesale substitution of our content. There can be a place in technology and engineering to include computational thinking. The starting point now might be to revisit **Standards for Technological Literacy** and include computational thinking benchmarks at all levels, particularly in **STL 17**, Information and Communication Technologies, and to ensure that all course and program objectives are clearly written and in alignment. There are technology courses like game art and computer numerical control currently being offered in states that incorporate computational thinking, and there are new courses in cybersecurity on the horizon. These courses are different than computer science courses. Treating technology and engineering education and computer science courses as the same content sends the wrong message to educators across the state and country.

**Integrating Computational Thinking into Technology and Engineering Education** - Michael Hacker. Integrating CS principles and CT within T&E can expand the role the discipline plays in all students’ fundamental education, can broaden participation in computing education, and can increase T&E’s status within the educational system. Presently, no discipline has taken upon itself the responsibility of being the primary instructional vehicle to teach CT in the nation’s schools. T&E can take great advantage of
this opportunity—without compromising the discipline’s core mission of teaching students about the human-made world—by integrating CS & CT principles, practices, and vocabulary with core T&E concepts. It is feasible to teach CT and computer science skills by incorporating real-world computing problems into T&E design challenges.

Elementary: The authors support claims that early access to and experiences with computational thinking will strengthen elementary students’ computational thinking abilities while enhancing their understanding of mathematics and the connection of mathematics to other disciplines. In defining computational thinking as a way for students to not only use computers to solve problems but also as a means to create and represent model solution strategies, student learning reaches beyond programming. As teachers explore options and purposefully integrate apps into their classroom following the recommendations in this article, students will be provided with the opportunities and tools they need to learn. The interest generated from such experiences has the potential to prime students for success within the classroom and in future computational-thinking-based opportunities.
The National Assessment of Educational Progress developed the Technology and Engineering Literacy (TEL) assessment for grades 8 and 11. The TEL assessment measures whether students are able to apply technology and engineering skills to real-life situations. TEL's vision of literacy in technology and engineering dovetails with skills employers value, such as the ability to apply knowledge to new situations, to identify and solve unexpected problems without a playbook, or to learn through ingenuity, failure and perseverance.
More Importantly, How Do You Define and Operationalize Technology and Engineering Literacy?

“Technology and engineering literacy” is the capacity to use, understand, and evaluate technology as well as to understand technological principles and strategies needed to develop solutions and achieve goals. (NAEP, 2014)

Are we asking the right questions? This is a definition by the NAEP that we should embrace!
Connections and collaboration
Where do you fit the NGSS engineering design CCC?
How do you incorporate Technology and invention/innovation – where is it taught?
Integrative STEM Education is operationally defined as:
"the application of technological/engineering design based pedagogical approaches to intentionally teach content and practices of science and mathematics education through the content and practices of technology/engineering education. Integrative STEM Education is equally applicable at the natural intersections of learning within the continuum of content areas, educational environments, and academic levels" (Wells & Emst, 2012/2015)
(as adapted from Wells/Sanders program documents 2006-10).

[Deliver Slide Contents] The goal for all students is to have the capacity to be innovative problem solvers using a design under constraints approach! TPSM – 7 resources – to adapt and change the world around them and for others! Be the I-STEM Education Leader for your school and district! We always and always will have the skillset and experience to take on this challenge!

MacGyverisms - MacGyver employs his resourcefulness and his knowledge of chemistry, physics,[3] technology, and sportsmanship to resolve what are often life-or-death crises. He creates inventions from simple items to solve these problems. These inventions became synonymous with the character and were called MacGyverisms by fans. MacGyver was unlike secret agents in other television series and films because, instead of
relying on high-tech weapons and tools, he carried only a Swiss Army knife and duct tape but never a gun.

This also led to the verb, "to MacGyver". "MacGyverism" was first used by Joanne Remmings (played by Pamela Bowen) in the third episode of Season 2. When MacGyver introduces himself to her, she uses the term in a manner that suggests other people had used it before:

Oh I've heard about you! You're the guy who does the whatchamacallits, you know, MacGyverisms; turns one thing into another?

In an 1989 interview with Richard Dean Anderson, Arsenio Hall said that he had heard the word MacGyver used as a verb meaning "to do the impossible." Anderson then used it as an adjective meaning "impossible." Anderson stated that his show's producers had just missed out on getting the word "MacGyverism" entered into the Webster's Dictionary and that "we" intended to try to get it in the next update.
We need to take action now and build a leadership model within our field.

Build resources with your input!

Solicit colleagues to submit exemplars.

Take the lead role in I-STEM within your schools and institutions.

The Takeaways

Jeffrey Gitomer – Customer Satisfaction is worthless – Customer Loyalty is priceless!
You are an outstanding group and I wish you success in all you do! Move to Reflection, Questions, and Feedback.
IF TIME Permits!
Take five minutes with your building group and identify those in your building that play the role of coach and then briefly talk about your role as a coach. What worked? What didn’t.

Identifying any coaching that is occurring in your buildings- list
Whose roles could lead to coaching?

1- What are some current roles in your building that would lend itself to coaching – list them
2- If they are doing coaching- describe the type of coaching they are doing