Enhancing Technical Literacy Through Tech Prep

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As engineering managers in both the government and private sectors, we needed staffs that could create and sustain systems that embodied cutting-edge technologies. Most of the engineers we worked with had strong analytical skills and in-depth knowledge of technical principles but were not very proficient in using measurement equipment and systems integration hardware. To support these engineers, we had technicians who were "hardware oriented" and "tools proficient." Though these skills were important, they were not sufficient. Our systems were so complex and state of the art that our technicians needed to also have a fundamental understanding of the mathematics, science, and technology principles that underscored these systems. We found a few "supertechs," and they were priceless, but they were not coming from our schools and colleges.

Academic education and technical education have been split too far apart in this country. We have become accustomed to thinking that academics are important only for university entrance; the ones who couldn't "hack it" could just learn some skills and go to work. We desperately need graduates with both hand skills and head skills --and Tech Prep was created to close this gap.

The Tech Prep focus on students begins in high school with the majority of students who, by the ninth grade, have not demonstrated high academic achievement in mathematics and science, and who do not have the interest, encouragement, or confidence to prepare for higher education. Tech Prep programs begin in the ninth grade by rebuilding the students math/science/communication foundations and developing in each student a focused interest in a technical career. In the last two years of high school, Tech Prep students select a technical core of courses in an occupational cluster, while continuing in higher levels of mathematics and science. After high school graduation, Tech Prep students are qualified to complete associate degrees specialty fields, enter a university for baccalaureate studies, or go to work and continue their education and training part time.

Tech Prep is technical education with a strong academic foundation. It embodies a standards-based, technical curriculum, designed jointly by the business and educational community. This cooperation ensures that the curriculum addresses the most current technologies and provides students the intellectual skills for staying current on future technology developments. A curriculum that is closely aligned with occupational, academic, and employability (SCANS) standards will contain the necessary mathematical, scientific, and technical content to ensure technical literacy for all students and prepare them for high technology jobs. However, curriculum only provides the opportunity for learning. For students to translate opportunity into learning, the curriculum must support effective teaching strategies.

The key to a successful Tech Prep program is enabling "average students" to achieve high levels of understanding in mathematics and science. This increase in achievement has occurred because of significant gains in applying cognitive science theories to improving strategies for teaching and learning. Research has shown that less than 25 percent of all students are abstract learners; yet most teaching strategies incorporate this mode of learning. A more effective strategy is to provide students a concrete approach to learning by presenting technical topics within the context of their use.

Contextual learning is a teaching strategy that is used widely within Tech Prep programs. It provides an alternate means of meeting student needs. The contextual learning approach is based on an understanding of learning as a complex process that cannot be addressed adequately through drill-oriented stimulus-response methodologies.[1] The assumption underlying contextual learning recognizes that the mind seeks meaning through relationships which make sense and fit with past experiences. This approach encourages educators to design learning environments that incorporate as many different forms of experience as possible—social, cultural, physical, and psychological—in working toward the desired learning outcome.[2] When knowledge is placed within the context of its use, students learn more quickly and develop a deeper understanding of how new concepts apply to the real world.

Traditional and contextual approaches differ considerably. For example, when presenting systems of inequalities, a contextual approach might place this concept within the context of manufacturing. Students would be challenged to take production data on handmade products and, using linear programming, determine the optimum production output number for each product that maximizes profits. By solving this problem, students are able to work collaboratively, using hands-on approaches to discover the meaning of inequalities and their applications in the real world. Contrast this with the traditional classroom approach of presenting systems of inequalities as meaningless graphs of shaded regions in the Cartesian plane. Students will memorize the necessary graphical steps to solve a system of inequalities, but without a context for what the graphs mean will merely be learning procedure, not developing understanding. The questions in the attached self-test further differentiate contextual and traditional approaches. When contextual learning is embedded within a standards-based curriculum, students are provided both the opportunity and means to develop a sound understanding of technical concepts.

Tech Prep is a 9th – 14th grade program. However, expanding Tech Prep strategies into elementary and junior high school could further enhance technical literacy. For instance, a key element in Tech Prep is career awareness. In the early grades of K-6, students could gain technical career awareness by using contextual learning strategies that build career context into their studies of mathematics, science, and language arts. This awareness is important since many students in these grades are familiar with only those professions they know—medicine, teaching, fire fighting, etc.. Expanding their horizons will plant seeds for future career decisions. In grades 7-8, more career awareness could take place with science and mathematics courses providing context for a more in-depth understanding of technical careers. Students could gain an elementary understanding of the technical base underlying various disciplines and build an appreciation of the academic skills required to be successful within them. With additional preparation in grades K-8, students will better understand the need to develop a strong mathematics, science, and technical base during high school. This motivation tied to the contextual learning strategies embedded within a Tech Prep curriculum will help students gain technical literacy and motivate more of them to pursue technical studies at the postsecondary level.

For Tech Prep to reach its fullest potential, educators must put aside their traditional thinking and become more open to the new ideas being spawned by educational reform. However, change is usually accompanied by resistance. The idea of driving curriculum development with standards is new and innovative. Standards may very well dictate the elimination from the curriculum of some "sacred cow" concepts (i.e. factoring high-order polynomials). Losing academic turf is tough for educators and always causes resistance. However, if these educators learn that "less is more" and students can benefit from more depth and less breadth, the curriculum will become a more effective tool for preparing future generations to meet the demands of the workplace and become more insightful citizens. Contextual learning also represents a change from traditional practice. Most instruction in high schools and postsecondary institutions is lecture based. To break this traditional mind set, teachers must first buy in to the power of contextual learning and then learn the proper techniques for implementing it. The key to overcoming these and other resistances is broad-scale

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[1] Howard Gardener, *Frames of Mind: The Theory of Multiple Intelligences* (New York: basic Books, 1983).
[2] D.A. Kolb, *Experience as the Source of Learning Development* (Englewood Cliffs, New Jersey: Prentice Hall, 1983).

professional development. Without it, change will not occur and education will not progress from its current practices.

Tech Prep can enhance technical literacy. The Tech Prep model is currently being used to design curricula to relieve future shortages in this country of photonics and information technology workers. This trend of increasing technical literacy and filling critical workplace shortages must continue if the U.S. is to maintain its position as a world power. Lester Thurow summarized it well, "In the 21st century, the education and skills of the workforce will end up being the dominant competitive weapon."[3]

Self-Test
Are You Teaching Contextually?

Contextual instruction is rich in all ten standards.

1. Are new concepts presented in real-life (outside the classroom) situations and experiences that are familiar to the student?

2. Are concepts in examples and student exercises presented in the context of their use?

3. Are new concepts presented in the context of what the student already knows?

4. Do examples and student exercises include many real, believable problem-solving situations that students can recognize as being important to their current or possible future lives?

5. Do examples and student exercises cultivate an attitude that "I need to learn this"?

6. Do students gather and analyze their own data as they are guided in discovery of the important concepts?

7. Are opportunities presented for students to gather and analyze their own data for enrichment and extension?

8. Do lessons and activities encourage the student to apply concepts and information in useful contexts, projecting the student into imagined futures (e.g., possible careers) and unfamiliar locations (e.g., workplaces)?

9. Are students expected to participate regularly in interactive groups where sharing, communicating, and responding to the important concepts and decision-making occur?

10. Do lessons, exercises, and labs improve students' reading and other communication skills in addition to mathematical/science reasoning and achievement?

[3] Lester Thurow, Head to Head: The Coming Economic Battle Among Japan, Europe, and America (New York: William Morrow, 1992)