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Center on Innovations in Learning

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Innovation in career and technical education (CTE) resides in the practical attempts by educators to break down the ancient divide that separates vocational training from academic learning. The ubiquitous presence of digital technology in the workplace has accelerated the need to redefine CTE, but the reshaping of the school curriculum to accommodate preparation for both college and career predates the Information Age. Over the past century, as proponents of vocational training and academic learning jockeyed for position in the school curriculum, they sought to divide the available instructional time between two worthy purposes.

This division was achieved by separating the students into different curricular tracks. More recently, as success in life has come to depend more and more on knowledge and skills drawn from both curricular strands, vocational and academic, stakeholders have acknowledged that all students benefit from schooling in both. CTE innovators strive to integrate the strands of CTE and traditional academics within the time constraints of the school days and years, without diluting the quality of either and overcoming differences in individual student capabilities.

A fresh way of thinking about CTE, emphasizing the importance of students acquiring an understanding of theories of work (general and specific to occupations) and the ethics of work, promises to shake up the world of CTE and introduce an innovative component to it. In reinventing itself, CTE is reintroducing excellence in work through an understanding of theories of work, occupational ethics, and the practical application of these mindsets. The exclusionary tendencies that traditionally exist between the workplace and school are shattered by more coherently integrating classroom learning with occupational experience.

This approach to integrating the mindsets of work and occupational ethics with the practical skills of a specific occupation is akin to the ancient practices of guilds and apprenticeships.

Background

In 1917, the United States government sought to support and promote vocational training through the passage of the Smith-Hughes Act, legislation that focused primarily, but not exclusively, on strengthening the skills of agricultural workers (Vocational Education Act of 1917). Based on Charles Prosser's earlier 1914 report to Congress (Commission on National Aid to Vocational Education), this legislation was the beginning of the "comprehensive" high school, a local institution that brought together students who anticipated entering the workforce directly upon graduation with those who would be attending college. The students typically followed separate curriculum tracks. Federal support for vocational education has since evolved through a series of revisions over the last century, but has retained the original intent of the 1917 legislation: to make vocational education available as a means of educating America's youth and bolstering economic and workforce development.

In 2006, Congress's most recent reauthorization of the act bears a title that signals a new direction: *The Carl D. Perkins Career and Technical Education Improvement Act*. The reauthorized law replaces the term "vocational education" with "career and technical education" (terms introduced in the 1998 act) and incorporates new language, such as "career pathways" and "programs of study." With the addition of the word "improvement," the Perkins Act further establishes as a priority for career and technical education (CTE) its embracing of opportunities for innovation which reflect changing demands of the workforce. The word also highlights the role that CTE can play in reshaping the purpose and structure of the American high school and in affecting the curriculum of elementary and middle schools as well.

By uniting rigorous career preparation, occupational mindsets, and rigorous academic studies, CTE will become a key element in school improvement by supporting the goal of higher student academic achievement while providing those same students with clear direction for their future careers. Providing students with relevant and interesting study connected to their career aspirations will attack the root causes of dropout and student malaise.

What does this innovation look like? When CTE and academics are effectively integrated, with a focus on occupational mindsets and ethics as well as practical skills, the result is characterized by the following:

a. academic content in CTE, and CTE content in non-CTE courses, strengthening both career and academic preparation
b. increased comprehension and retention of academic learning by applying academics to real-world, hands-on, and engaging work

c. intentional connections between the student's educational pursuits and career aspirations
d. appreciation for the attitudinal perspectives of journeymen and professionals who understand the dignity and value of their work and the ethics of occupational practice

An understanding of this integration requires examining (a) the origins of the educational divide, (b) the methodology that bridges it, and (c) the promising potential for education standards and innovative practice.

How Did the Divide Begin?

The Smith-Hughes Act of 1917 repeatedly stipulated that vocational education "shall be to fit for useful employment; that such education shall be of less than college grade" (p. 86). This division was reinforced by the typical physical separation of students and classes into separate spaces. Agricultural and industrial instruction was relegated to a separate building with differently credentialed teachers (Vocational Education Act of 1917). Students chose or were placed in one of two curricular tracks: Good vocational preparation could allow a student to enter directly into the workforce, or the successful completion of a good general education would equip a high school graduate to begin college. College-bound students were schooled in isolation from vocational course work, and vocational students were discouraged from choosing higher level, demanding academics. General education students (including the college bound) could take an occasional vocational class, such as home economics or shop class. The vocational students *per se* would have primarily purely vocational classes directed toward a specific occupation, chosen by the student from the menu of available options. Their instruction was typically isolated to the targeted technical skill itself, without linking the technical application to the general principles that supported it in the academic realm. For example, students in a blueprint reading class would not be required to have an understanding of the geometric principles behind the angles drawn, even though a fuller knowledge of geometry would have been a career asset. It was not the charge of shop class to establish "the learning of aesthetic, mathematical, and physical principles through the manipulation of material things" (Crawford, 2009, p. 31). Thus, the divide was institutionalized in the American high school and would powerfully influence future generations, not only of students but the entire American workforce: "Such a partition of thinking from doing has bequeathed us the dichotomy of white collar versus blue collar, corresponding to mental versus manual" (Crawford, 2009, p. 31), a separation of "hand and brain, mind and work" (Rose, 2008, p. 632). Coincidentally, this division reflected Henry Ford's assembly line, "the nascent two-track educational scheme mirrored the assembly line's severing of the cognitive aspects of manual work from its physical execution" (Crawford, 2009, p. 31).

This educational divide was not created by the Smith-Hughes Act: It is a longstanding schism in Western culture. It echoes an ancient distinction between *artes liberals* and *artes serviles*, wherein education in one arena would exclude its graduate from service within the other. Those trained in the servile arts would serve the common need; those educated in the liberal arts would serve the common good (Pieper, 1952). Obviously, low academic ability practically excludes students from those professions that demand high levels of that ability. The continued divide, however, reinforces the presumption that the technical or manual trades are only suitable to or desirable for those of lower raw intelligence. This presumption neglects the realities of the contemporary work world: Many manual arts are both intellectually demanding and engaging, while many "white collar" jobs are neither intellectually demanding nor personally engaging. To sustain such a dichotomy limits the possibilities for a good number of students who, in a "college-for-all" educational culture, are steered away from technical areas of study as well as from educational experiences that show practical, real-world application of academic content.

In his book *Shop Class as Soulcraft*, Matthew Crawford illustrates the effect of this dichotomy by citing the experience of one CTE instructor who had discovered that "in schools we create artificial learning environments for our children that they know to be contrived and undeserving of their full attention and engagement. Without the opportunity to learn through the hands, the world remains abstract and distant, and the passions for learning will not be engaged" (Crawford, 2009, p. 11). In continuing the traditional separation of academics and CTE in high school, educators risk reinforcing a prejudice between vocational education and lesser intellectual demand (Rose, 2008). Keeping CTE and rigorous academics disintegrated reinforces the presumption that manual work is stupid, or that the manual trades are neither intellectually demanding nor stimulating.

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Rose, 2008

Why Integration?

The desire to integrate what historically has been divided—namely academic (including theories of work and occupational ethics) and career and technical education—is not new. Unification of the two has been taking place in isolated schools or certain networks of schools for some time. The momentum toward integration of academics and CTE was first formalized in the 1990 federal vocational legislation and has gathered force in successive reauthorizations, culminating in the Perkins Act of 2006. The 2006 law requires professional development that promotes "the integration of coherent and rigorous academic content standards and career and technical education curricula, including through opportunities for the appropriate academic and career and technical education teachers to jointly develop and implement curricula and pedagogical standards" (S. 250–36). Practically speaking, the law requires a new pedagogy, one that demands collaboration among academic teachers and career and technical teachers be the norm. New pedagogy requires changes in teachers' preservice and inservice education.

This new norm is necessary for two reasons: It addresses low student achievement and widespread student disengagement. Regarding low student achievement, there is well-established concern that students are not being adequately prepared to meet the challenges of a rapidly changing economy. Indeed, school improvement has been the center of education efforts, expenditures, and policies since the publication of *A Nation at Risk* in 1983 and continues in federal initiatives to reform public education, initiatives such as the School Improvement Grant (SIG) program, waivers to requirements of the Elementary and Secondary Education Act, and the Race to the Top grant program. Career and technical education is not immune to the problem of low student achievement. For example, the Conference Board (Casner-Lotto, Barrington, & Wright, 2006) stated that employers report common applicant deficiencies in math, computer, and problem-solving skills. A wide variety of studies and indicators have demonstrated that our education system continues to fail to prepare many students for the emerging economy (Manufacturing Institute, 2011). Innovative integration of CTE with academics is key to meeting the increasing needs of industry while supporting the high academic standards necessary for success in a career and in college (Pearson et al., 2010; Institute for a Competitive Workforce, 2008).

In addition to concerns about student achievement, there is also widespread concern that high school students are increasingly disengaged from their studies and, because of this disengagement, are not finishing high school. A 2006 report, *The Silent Epidemic: Perspectives of High School Dropouts* (Bridgeland, DiIulio, & Morison, 2006), indicates that nearly half of dropouts reported that a reason for leaving was that classes were not interesting, and 7 in 10 respondents indicated that they were not motivated or inspired to work hard. Based on such student responses, the report advocates that high schools improve teaching and curricula to make education more relevant and engaging and enhance the connection between schools and work. In others words, practical application united with theories of work and occupational ethics can enliven the educational experience. The innovative, systemic merger of academics and CTE is the ideal delivery system for this kind of educational experience. Vocational education should no longer be seen as another set of subjects competing for students' time. It should be a set of activities that help students use, understand, and appreciate what they are learning in other courses (Houghlander, 1999). This kind of vocational education can increase students' long-term productivity as workers by encouraging them to understand the principles and ideas underlying the work they do (Stern, Hoachlander, Choy, & Benson, 1986).

Given the current low student achievement and high student disengagement, the standard practice of CTE classrooms is unlikely to assist the preparation of students in the higher academic skills necessary for the changing workplace. The National Assessment of Vocational Education (NAVE) reported that, on average, vocational courses as traditionally structured do not appear to contribute to an increase in students' academic achievement (Silverberg, 2002). Both low student achievement and high student disengagement are perpetuated by the continued disjunction of academic and career/technical tracks.

> ***The highest rigor for students can occur in classrooms that demand high levels of knowing and doing.***

Integration of vocational and academic studies is supported by the Rigor/Relevance Framework tool developed by the International Center for Leadership in Education. The tool illustrates the important connection between thinking and doing and the close tie between the acquisition of knowledge and its application. According to the tool's developers, the greatest academic rigor is revealed in authentic application. The highest rigor for students can occur in classrooms that demand high levels of knowing and doing; the CTE classroom that embraces such rigor should be able to demonstrate correspondingly high levels of knowledge development, application, and transfer (International Center for Leadership in Education, 2013).

How is Integration Accomplished?

The efforts to integrate career and technical education have focused on two separate but related strategies: (a) a systemic integration through "pathways" of interconnected academic and CTE coursework; and (b) the development of instructional approaches that, at the classroom level, make explicit connections between academic and technical content. These two strategies are exemplified by the work of many organizations, each approaching them for a different purpose and with its own efforts to innovate, including the following:

a. The movement to establish career-themed high school academies, "career academies" that incorporate small learning communities, deliver a college preparatory curriculum within specific career themes, and partner with business, postsecondary institutions, and the broader community to introduce students to the broader relevance of their career studies (College and Career Academy Support Network, http://casn.berkeley.edu/)
b. Linked Learning is a California initiative that seeks to integrate "rigorous academics with career-based learning and real world workplace experiences." Sixty-four California districts have joined an ongoing pilot that seeks to benefit students by creating meaningful and relevant learning experiences using career-oriented pathways that will help students

connect their classroom learning to the attainment of their academic and career goals. Participating districts realign their curriculum, schedule, and professional development to intentionally innovate their present practice to serve the goal of rigorous career-focused instruction for all students; each district will implement 6–8 Linked Learning Pathways. Integral to the approach is collaboration with local business and industry, postsecondary institutions and other community stakeholders to shape the changes taking place in the school (ConnectEd, http://www.connectedcalifornia.org/linked_learning).

c. The National Association of State Directors of Career Technical Education Consortium (n.d.) promotes statewide efforts to implement "programs of study" required by the Perkins Act of 2006. NASDCTE has also supported the recent creation of the Common Career Technical Core that provides content structure to programs of study across 16 clusters that represent most contemporary career areas.
d. The Southern Regional Education Board's High Schools That Work initiative advocates high-quality implementation of integrated CTE and academics as a driver of increased student learning outcomes and school performance (Southern Regional Education Board, n.d.a) .
e. The International Center for Leadership in Education (n.d.) focuses its services on curriculum integration.
f. Edutopia's Problem- and Project-based Learning Initiatives introduce blended instructional designs and media-rich environments (Edutopia, n.d.).

The Pathways Approach

The first method of integration seeks to join coursework to a student's future career plans by presenting to the student a choice of career pathways that reflect both the student's career interest and the curriculum that the school and other partners can provide. By examining a variety of available career pathways in collaboration with a school counselor and parents, a student can develop an individual program of study. This strategy imagines a student who is carefully weighing different career possibilities, who is actively engaged in schoolwork, and who works to achieve at a high level because the coursework is relevant to his or her career goals. In recent years, this approach has led to the design of model high schools wherein career relevance drives student engagement and achievement. These designs have become more accepted; consequently, efforts to replicate the approach have become more widespread.

Efforts like these integrative projects have been given further impetus in the recent *Pathways to Prosperity* report from the Harvard Graduate School of Education (Symonds, Schwartz, & Ferguson, 2011). This report calls for a dramatic reenvisioning of the American high school experience with the purpose of allowing all students the choice of career pathways and the rigorous, relevant instruction necessary to make every pathway a road to a student's career success. From the standpoint of innovation, this is a new way of managing curriculum and personalizing learning.

One note of caution: While presently, in some parts of the nation, considerable efforts and resources are being directed toward the creation of career pathways in high schools, it is difficult to measure the value of this approach. The initiative has many interrelated objectives: high student academic achievement, mastery of appropriate technical and career skills, successful graduation from high school, and transition into postsecondary education or training or transition directly into the workplace. These many targets make evaluation difficult, and those educators championing pathway approaches are developing a methodology to measure the quality of these efforts, which include criteria for high-quality systems and programs, quality indicators linking core elements to participant outcomes, interim participant outcome metrics, and performance outcome metrics (Alliance for Quality Career Pathways, 2013).

The Integrated Classroom Approach

More directly related to individual course curricula and teacher pedagogy, substantial research investigating the use of integrated, enhanced coursework offers insight into how to replace, not simply improve, the current standards of curricular and instructional practice. Recent evidence supports the focused integration of rigorous academics with CTE instruction and demonstrates that integrated methodology effectively eliminates the educational disconnect that results from teaching only specific skills and only low-level, minimally relevant academics to CTE students. By consistently demonstrating the practical relationship between technical skill and strong academics, this integration strengthens student acquisition of both. In addition, students who are supported in making connections between academic and real-world learning through their use of higher level mathematics, reading, and writing in their assignments are able to link their skill and knowledge, which increases continued engagement and strengthens the link between student career aspirations and daily classroom experience (Bottoms, Young, & Han, 2009). This integration encompasses explicit "strategies that connect academic and vocational content [that] usually result[s] in content that is primarily academic with vocational elements woven throughout, or primarily vocational with academic elements woven throughout. In curriculum integration, the content can be neither purely academic not purely vocational" (Johnson, Charner, & White, 2003, p. 43). In short, the integration approach consistently demonstrates a "relationship between academic and occupational or career–technical subject matter that goes beyond what would normally occur in the delivery of either the academic or occupational/career–technical subject matter alone" (Johnson et al., 2003, p. v).

Not all approaches to integration are created equal. James Stone compares two distinct modes of implementation: the context-based approach and the contextualized approach (Pearson et al., 2010). "Context-based approaches," also known as "applied academics," introduces academic content artificially situated in an *imagined* application in an *imagined* workplace setting. For example, problems in an applied math workbook published in 2004 required students to use trigonometric functions and the Pythagorean theorem to determine requested measurements of a roof rafter or the slope of a wheelchair ramp. But the problems were not part of a particular CTE course—for example, building trades—and did not relate to each other. No construction projects from a CTE class were involved, and students could not apply the problem-solving exercises to any real, hands-on work within their daily school experience. The potential for true integration was missed in this example because the rigor of trigonometry was not supported by practical application (Phagan, 2004). While this approach delivers academic instruction with a nod to occupational references, relevance to the student is negligible because the CTE context itself is neither the origin nor the focus of the instruction. The expectations of academic learning in this artificial context are typically low (Pearson et al., 2010).

In contrast, contextualized integration reflects a different strategy for delivering academically rigorous content using authentic CTE situations as the vehicle for the delivery starting point in instruction. Both the genesis and the focus are rooted in the CTE content of the lesson. Within the lesson, the embedded academic content is highlighted; it is not artificially linked to the lesson but authentically placed within the CTE learning objective. The development of the CTE skill remains primary, setting the stage for comprehension of the underlying academic content. For example, a CTE lesson with the objective of teaching students how to build roof gables using the Pythagorean theorem employs integration by beginning with a relevant CTE question: How can we calculate, cut, and assemble gable frames for a house? Note that the origin of the lesson is rooted in CTE, not the academic/mathematical concepts that will eventually be used to solve the problem. After introducing the construction/manufacturing concept of calculating cross gable framing angles, the teacher assesses student math awareness by asking relevant questions about slope and right angle trigonometry. Construction materials and techniques demonstration adds further opportunity for linking occupational relevance and academic knowledge. The students are able to visualize the math concepts embedded in the construction of a roof gable because the teacher then provides an opportunity to do something authentic and meaningful with this knowledge. As in the Geometry in Construction program, the students learn these techniques by building a house. The house provides the real world relevance for the students to not only learn by simulation but also learn in an authentic way lending itself naturally to mastery learning. In its purest form, contextualization focuses the majority of a student's learning on performing tasks using academic knowledge that is so often lost in traditional academic settings where students learn just enough to pass tests. In a true contextualized environment, students are forced to use knowledge to produce something while gaining employable skills and confidence along the way. Once students have mastered the CTE content, they are introduced to what a traditional "naked math" problem would be, using the same skills. Once they make this link between the real world and the simulated (traditional math) world, they typically report a different level of learning and confidence. Formal assessment of students is demonstrated by this successful construction (Geometry in Construction, 2011). "The academic concepts resident in authentic applications of CTE support the understanding of both; rigor resides in combining CTE and academic skills as applied to real-world problems" (Pearson et al., 2010, p. 10). Making it real links academic skills to the CTE skills, strengthening them both.

The National Research Center for Career and Technical Education (NRCCTE) conducted the first study to develop, implement, and evaluate such a contextualized approach. In this national Math-in-CTE study (Stone, Alfeld, & Pearson, 2008), CTE teachers collaborating with mathematics teachers were trained to use curriculum mapping tools connecting CTE content to academic content. The collaboration yielded enhanced CTE lessons in which math concepts were embedded in the real-world CTE lessons. The researchers identified seven elements of curriculum integration within the Math-in-CTE pedagogic framework. These elements include:

1. introducing the CTE lesson
2. assessing the students' math awareness as it relates to the CTE lesson
3. working the math example embedded in the CTE lesson
4. working through related, contextual math-in-CTE examples
5. working through traditional math examples
6. requiring students to demonstrate their understanding
7. incorporating math questions into formal assessments at the end of the CTE unit/course

Compared with a control group of teachers and students who did not use the math-enhanced CTE lessons, students in the collaborative classroom performed significantly better on two of three standardized measures of math achievement. In addition, the students retained a higher level of indicated math skills after the semester coursework. The benefits of the contextualized approach were clear: improved math performance, authentic CTE skills development, and improved retention. The researchers attributed the benefits to both the unique pedagogic framework and the professional development of both math and CTE teachers that fostered collaboration (Stone, 2013).

In subsequent years, many of the participating teachers in the Math-in-CTE project sustained the framework as well as the communities of practice. Using mapping tools, CTE and math teacher teams worked together to:

a. identify the mathematics content embedded within the technical objective;
b. create curriculum maps pinpointing the intersection of occupational content and math concepts; and
c. use a curriculum mapped by its scope and sequence by CTE teachers to guide implementation (Pearson et al., 2010).

Encouraged by the Math-in-CTE research results, Stone's team then applied an integrated approach to discipline-based literacy instruction in CTE. Using a similar framework, lessons in the Literacy-in-CTE project were developed to determine if disciplinary literacy strategies would impact CTE students' reading comprehension, vocabulary development, and motivation to read. Once again, the starting point for lesson development was the CTE objectives and the literacy demanded by the CTE discipline. Strategies employed included competition (any strategy using game-like qualities), social learning (small group discussion), prereading activities (previewing text to give direction), organization (arranging and managing text for understanding), and classroom interaction. The combination of reading with CTE activity enabled students to connect their work to the reading they had mastered. The academic relevance is essential: CTE students are expected to read technical texts that may pose an obstacle to struggling readers. Implementation of literacy strategies makes texts more accessible to these students. As a result of the Literacy-in-CTE integration, students showed a significant improvement of reading comprehension and discipline-specific vocabulary mastery (although it did not improve the students' motivation to read). Analysis of data from student focus groups revealed four themes: (a) students desired a utility value in their reading strategy; (b) they understood the importance of reading to their career; (c) they engaged in reading if they could apply the information; and (d) they desired a social aspect to reading to foster their motivation (Pearson et al., 2010).

Ongoing analysis of the Math-in-CTE and Literacy-in-CTE contextualizing approach enabled NRCCTE researchers to develop five best practices to guide the design of integrated CTE lessons in math and discipline literacy:

a. Develop and sustain a community of practice among the teachers.
b. Begin with the CTE curriculum and not the academic curriculum.
c. Understand that academic knowledge is essential workplace knowledge.
d. Maximize the academics in the CTE curriculum.
e. Recognize that CTE teachers are teachers of academics-in-CTE and not academic teachers (Stone, Alfeld, & Pearson, 2008, p. 789).

Successful implementation of these principles depends heavily upon CTE and academic teachers' collaboration in the curriculum mapping required to relate CTE content to the embedded academic content. This collaboration requires scheduled time for interdisciplinary teams to meet and develop instructional plans.

Currently, researchers are studying the effects of contextualizing science in CTE education. The Science-in-CTE study will adapt the Math-in-CTE model (Pearson et al., 2010) for the integration of science concepts with agricultural and health science curricula. While early results have not indicated an overall effect, there are promising benefits for non-White male and female students (Stone, 2013).

Since the initial Math-in-CTE studies, teachers have continued to develop enhanced CTE lessons by systematically integrating classroom coursework. An example is the Geometry in Construction program developed at Loveland (Colorado) High School. This program targets any student who has completed Algebra I and who wishes to complete a geometry curriculum via math instruction linked to the hands-on experience of constructing a house. Recorded in students' transcripts as two separate classes, the integrated coursework is team-taught by a certified math and a certified CTE construction trades teacher. Students routinely take part in team-building exercises and demonstrate mastery of geometry problems that solve a specific task associated with the building project. In the application of the contextualizing approach refined by the NRCCTE studies, participating students consistently outperform students enrolled in standard geometry classes in the school (Geometry in Construction, n.d.). Collaborating instructors identify four key factors necessary for successful implementation:

a. careful sequencing of the content to maximize contextual learning;
b. instructors teaching side-by-side to a fully integrated cohort of students;
c. explicitly highlighting each student's relative strength in both the building project and the classroom; and
d. professional interaction between participating teachers (Michigan Association of Secondary School Principals, 2008).

Ongoing research from the NRCCTE indicates integrated CTE classes can be scaled to develop entire systems of coursework that enable students to obtain higher levels of academic and technical achievement. In a 2010 summary, NRCCTE researchers suggest that the greatest impact of a contextualizing approach could move beyond CTE instruction by augmenting the overall high school education outcome when applied systemically. Such a system would be designed to accomplish the combined objectives of higher student achievement in academics and career skill readiness, higher student engagement and retention, greater student awareness of career options and command of the transition from high school into the world of work or transition to postsecondary education or training (Pearson et al., 2010).

Currently, this outcome is being manifested in the High Schools That Work (HSTW) network of schools, the largest comprehensive high school reform program in the United States, with over 1,000 schools in more than 30 states participating (Young, Cline, King, Jackson, & Timberlake, 2011). Established in 1987, the

HSTW operational framework builds on the fundamental expectation that most students can master complex academic and technical concepts if schools create an environment that encourages students to make the effort to succeed. The project's efforts to develop a secondary school environment unite high expectations and integrated academic/CTE experiences to effective implementation and student performance. The framework connects 10 identified key practices to student academic and technical skills (Southern Regional Education Board, n.d.b):

a. motivating more students to meet high expectations by integrating those expectations into classroom practices and giving students frequent feedback;
b. requiring each student to complete an upgraded academic core and a concentration;
c. teaching more students the essential concepts of the college preparatory curriculum by encouraging them to apply academic content and skills to real-world problems and projects;
d. providing more students access to intellectually challenging CTE studies in high-demand fields that emphasize higher level mathematics, science, literacy, and problem-solving skills;
e. enabling students and their parents to choose from programs that integrate high school studies and work-based learning—programs that are planned by educators, employers, and students;
f. providing multidisciplinary teams of teachers time to integrate reading, writing, and speaking instruction into all parts of the curriculum and to integrate mathematics into science and career/technical classrooms;
g. engaging students in academic and career/technical classrooms in proficient-level assignments using research-based instructional strategies and technology;
h. involving students and their parents in an advising system that ensures completion of an accelerated program of study with an academic or career/technical concentration;
i. providing a structured system of assistance to students in completing accelerated programs of study with high-level academic and technical content; and
j. using student assessment and program evaluation data to continuously improve school culture, organization, management, curriculum, and instruction to advance student learning.

HSTW technical assistance requires participating sites to conduct assessments every two years in order to determine the level of academic performance of the students and to correlate that performance with the degree of fidelity with which the 10 key practices have been implemented. Thus, member schools are able to substantiate the contextualizing approach with data which is timely and relevant.

Sites that have implemented the model with a high degree of fidelity, as evidenced by the locally self-reported indices of school practices and experiences, show the largest score gains on three NAEP-like assessments for reading, math, and science. The gains are significantly higher than the results in schools with low implementation of the model (Young et al., 2011). This correlation indicates, in a general way, that a systemic implementation of the contextualizing approach can increase student achievement.

As always, success requires both the adoption of the model and its faithful implementation. To achieve successful integration, schools must align a sequence of well-developed CTE courses with college- and career-readiness standards through relevant and intellectually challenging learning experiences, motivating students toward academic and technical mastery. The best CTE teachers equip students to connect academic and real-world learning by showing students that they are using high-level mathematics, reading, and writing in their assignments (Bottoms, Young, & Berto, 2012). Surveying its sites, HSTW observes that network schools implement the key practices in widely varying degrees; this variation impacts the CTE student's experience. A CTE student who has experienced a rigorous assignment will report having been given at least four of the following eight opportunities to

a. develop a logical argument for the solution to a problem;
b. make inferences from information provided to develop that solution;
c. use math to solve complex problems related to CTE area;
d. apply academic knowledge and skills to CTE area;
e. apply technical knowledge and skills to a new situation;
f. develop and test a hypothesis;
g. complete an extended project that requires planning and developing a solution or product and presenting the results orally or in writing; and/or
h. use computer skills to complete an assignment in CTE class at least weekly. (Southern Regional Education Board, n.d.a)

HSTW research has determined that students with CTE concentrations (at least four credits in CTE) who reported that they frequently completed intensive CTE assignments requiring them to read and write, interpret technical books and manuals, use computer skills, and apply mathematics were more likely than students not reporting these activities to meet college readiness goals in reading and mathematics (Bottoms, Young, & Han, 2009). The intensive CTE assignments encouraged by HSTW are also foundational to a related initiative of the Southern Regional Education Board for secondary CTE centers known as Tech Centers That Work (TCTW). In a recent study of TCTW student outcomes examining achievement and survey data from 2012, HSTW researchers established that, of those students who did not experience rigorous CTE assignments, only 40% met college and career readiness standards in reading, math, and science. Of those students who experienced rigorous CTE assignments, readiness was met by

60%. In addition, the report demonstrated a strong positive correlation between the percentage of students receiving rigorous CTE assignments and mean scores in reading, math, and science (Bottoms, 2013).

Whether in a tech center or a high school classroom, the contextualized approach requires enterprising educators who are prepared to articulate the systemic changes necessary for integration implementation. Committed stakeholders will help institute necessary instructional changes through professional development and other supports and provide opportunities for structured collaboration among teachers.

Lifelong Learning and the Pursuit of Excellence

The world of learning and the world of work are usually seen as mutually exclusive, with one serving as antecedent to the other. However, learning is not a prerequisite to work, but rather a kind of work itself, one that provides the satisfaction of a young mind's curiosity and the development of focused interests through a directed exposure to the unknown. Once the unknown "starts to provide feedback to the person's skills, it usually tends to be intrinsically rewarding" (Csikszentmihalyi, 1991, p. 68). If the experiences of learning and work are simultaneous and engaging, a student begins to develop a positive, personal understanding of the relationship between the two. The effort and involvement required by the interplay of learning and work presages enjoyment and intellectual growth. This type of immersion is inherent to quality instruction, in both the academic and CTE spheres.

In CTE, this immersion creates a seamless classroom–workplace continuity and an entrance into a community of others who embody lifelong learning in order to become and remain excellent in a particular manual or technical field. As Crawford writes, "craftsmanship means dwelling on a task for a long time and going deeply into it, because you want to get it right" (Crawford, 2009, p. 20). Formal education begins a practice of learning that will define how a person continues to learn and develop skills in the workplace. This habit of workplace learning will then determine much of the satisfaction that individuals will derive from work and the level of excellence sought. To this end, CTE can initiate a student into a distinct community of those who possess a high degree of skills that have objective standards of performance, forming a crew of craftsmen. This community celebrates excellence in skill itself, the habits of learning inherent in continuing that excellence, the benefit that that skill provides to a larger community, and finally the camaraderie of those who share a passion for the craft. Crawford continues, "On a crew, skills become the basis for a circle of mutual respect among those who recognize each other as peers, even across disciplines…there is a sort of friendship or solidarity that becomes possible at work when people are open about differences of rank, and there are clear standards" (Crawford, 2009, p. 160). In a CTE classroom, as novices entering a community of learning, students can develop and refine a personal standard of excellence through which they also affirm the standards of the community of craftsmen. This standard requires a perpetual state of learning and the ongoing satisfaction of inquiry.

Conclusion

The increased attention to CTE may have its origin in concern about employment or global competitiveness, but the value of CTE to students goes deeper than these expediencies; indeed, CTE brings value beyond the commodification of the individual in supplying the employment pipeline. It can foster a deeper, more satisfying approach to work and life. Because of the focus that high schools laudably place on higher education, the desire to promote learning is already present. Even if it can be demonstrated that CTE can lead to better economic outcomes, can keep kids in schools, or provide multiple pathways for a high school student to succeed, perhaps the best case for CTE is what it can offer to enlarge the lasting perspective of its students, by making connections between different domains, seeing the interrelations of the world around them, and embracing the task of lifelong learning.

Action Principles

For State Education Agencies

a. Establish incentives for high schools to participate in national student organizations that provide opportunities to learn, compete, and be acknowledged for attaining high levels of technical skill and leadership promise (such as SkillsUSA; FFA; Family, Career, and Community Leaders of America; DECA; Future Business Leaders of America; Health Occupations Student Association; National Technology Student Association).
b. Identify and incentivize the implementation of effective practices in academic and CTE integration.
c. Provide platforms for statewide collaboration between education and industry, adults, and students.
d. Discuss the incorporation of interdisciplinary approaches to instruction with teacher preparation institutions.
e. Include CTE as a full partner in school improvement efforts.
f. Establish organizational ties with national organizations seeking to implement career pathways and programs of study.

For Local Education Agencies

a. In curriculum planning, include the cultivation of employability skills, workplace ethics, and the habits of adult learning.
b. Work with local industry to identify opportunities for work-based learning and real-world problems for classroom projects.

c. Prioritize time and resources for interdisciplinary curriculum mapping and planning.
d. Establish collaboration with local postsecondary institutions regarding effective transition for career pathways.
e. Provide students with tools for development of career portfolios.
f. Discuss with local employers their practical needs for the incoming workforce and the talents and skills needed for those workers' advancement.

For Schools

a. Find opportunities to celebrate the combination of academic inquiry and craftsmanship.
b. Seek opportunities for interdisciplinary content planning and delivery.
c. Work on career awareness, planning, and development for all students.
d. Make time for teachers to collaborate within and across disciplines.
e. Create challenging assignments that help students achieve at a high level in both academic and technical skills.
f. Require students to read technical materials and write in the language of their career field.

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