Journal of Vocational and Technical Education

Editor:
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Volume 16, Number 1 **Fall 1999**

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CONSTRUCTIVISM: THE CAREER AND TECHNICAL EDUCATION PERSPECTIVE

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Abstract

For over three-quarters of a century, the implicit learning theory underlying the curriculum and pedagogy of career and technical education has been behaviorism, but the emerging theory of constructivism may have implications for career and technical education practice in the future. Preparation of workers for entry into and advancement in the workplace of the next decade requires an educational program that provides not only job skills, as career and technical education did throughout the 1900s, but also higher order thinking, problem solving, and collaborative work skills. Classical behaviorist theory does not adequately address the latter kinds of learning, but constructivist theory may. Constructivist principles are examined in light of the fundamental requirements of career and technical education as we move into the new century with a new name for a redesigned profession. Of the three basic types of constructivism discussed, cognitive constructivism is most compatible with career and technical education. The authors recommend a more thorough examination of the relative efficacy of behaviorism and cognitive constructivism to serve as the learning theory on which to base career and technical education in the future. To embrace such a foundational change, leaders in the profession must re-think many of the fundamental assumptions underlying the mission, curriculum, and pedagogy of career and technical education. Perhaps such a rethinking is due.

Constructivism:

The Career and Technical Education Perspective

Domains of study and practice, such as career and technical education, are founded upon both implicit and explicit theoretical frameworks. Theoretical frameworks allow scholars to organize and synthesize knowledge and conjecture within a field and serve to describe, explain, and predict behavior and experience. The established theoretical framework that still guides career and technical education is based primarily on the work of David Snedden and Charles Prosser (Camp & Hillison, 1983; Doty & Weissman, 1984) from the early 1900s. Both Snedden and Prosser were concerned principally with broad political and policy issues and seem to have given little consideration to a learning theory to undergird their vision for career and technical education. Even in his later years, Prosser omitted any mention of a learning theory for career and technical education (Prosser & Allen, 1925). Nevertheless, the implicit learning theory underpinning career and technical education, since before the Smith Hughes Act, has been behaviorism (Dobbins, 1999; Wirth, 1972). The foundational work on which career and technical education in America was built is more than three-quarters of a century old. Much has changed since the heated, sometimes rancorous, debates between David Snedden and John Dewey from 1910 to 1920 that polarized the educational community in the United States (Wirth, 1972).

Since the late 1800s, t hree learning theory metaphors have dominated education, as a whole: learning as the acquisition of stimulus-response pairs (behaviorism), learning as the processing of information (information processing), and learning as the construction of knowledge (constructivism) (Mayer, 1992). These changes in explanatory metaphors have resulted from, and have allowed for, new insights concerning the nature of learning and knowledge. As researchers began to see that complex learning was difficult, if not impossible, to explain using complicated chains of SOR pairs, and as the computer began to enter the academic consciousness; information processing theory emerged to explain how mental structures affect behavior. Then, after several years of productive research into the components of memory and cognition, it became apparent that context and culture influenced the representation of these components; and constructivism emerged to explain personal meaning and the nature of reality and representations.

In the remainder of this article, we will demonstrate that, in spite of a broad change in the philosophical orientation of general education away from behaviorism and toward information processing and constructivism, the structural realities of career and technical education have precluded a similar fundamental shift in this field. We will then explore whether a constructivist framework might reasonably provide an appropriate theoretical undergirding for the practice of career and technical education.

The Past: Theoretical Foundations of Career and Technical Education

The unifying theory underlying career and technical education in the United States in the first part of this century, as envisioned by David Snedden and effectuated by Charles Prosser, was the so-called social efficiency doctrine (Camp, 1982, 1983). Proponents of social efficiency held that only an efficient society could create a positive environment in which the individual could prosper and find satisfaction. Social efficiency advocates went on to contend that public schools were an arm of the social system; and, as such, they had an inherent mission to further the good of society by contributing to its efficiency. Clearly, career and technical education, as envisioned by Snedden and Prosser, made up one of the bulwarks of social efficiency, in that the preparation of a well-trained, compliant workforce was a sine qua non of an efficient society (Wirth, 1972).

Theoretical Framework Underlying Social Efficiency

Six fundamental theories formed the basis for social efficiency as Snedden and Prosser applied the doctrine to career and technical education in the early 1900s (Camp, 1983):

1. Socioeconomic stratification. Sociologists held that in all societies, the development of social classes was a natural, indeed an essential phenomenon. Movement between social classes was possible, but a stable social system rightfully made vertical social mobility difficult.
2. Probable destiny. The theory of probable destiny was an intrinsic corollary of socioeconomic stratification. According to the theory of probable destiny, social classes are inherently stable, so that a person born into a working-class family will probably live and die as a member of the working class. A young person's "probable destiny" could be determined by a combination of factors, including socioeconomic class at birth, aptitudes, and interests.
3. Psychometrics. Psychological measurement, an emerging science at the time, was seen as capable of determining each student's probable destiny as a simple matter of testing. Classification into the academic or vocational tracks would then be both reliable and scientifically based.
4. Social control. The theory of social control posited that for any society to exist, its members must adhere to both the implicit and explicit norms of that society. For society to endure over time, such adherence must be voluntary and near automatic on the part of the citizenry.
5. Pedagogy. Although never formulated as a single, coherent theory, pedagogy involved the systematic study of teaching and learning that was rapidly developing at that time. According to Wirth (1972), Albert Shaw's study of the administration and teaching methods used at Hampton Institute, combined with Snedden's own dissertation, Administration and Educational Work of American Juvenile Reform Schools, led Prosser and Snedden to conclude that the pedagogy for career and technical education must be based on an organized, rigidly sequenced, hands-on approach to teaching.
6. Behaviorism. As the emerging learning theory of the early 1900s, behaviorism provided the final foundation for social efficiency. In particular, the research of E. L. Thorndike (Thorndike, 1932) contended that learning consists of the formation of links between specific stimuli and responses through the application of rewards (Wirth, 1972). This emphasis on S R pairing reflected behaviorism's positivistic philosophical base. That is, an analysis of the human condition that relies on only verifiable observations of behavior and not on untenable mentalistic constructs. Further, behaviorists believed that most human behavior could be understood as basic reflexive learning mechanisms or "laws" that operate on one's experience within the environment.

Snedden and Prosser's reasoning was that psychometrics and sociology would allow schools to guide students into their ideal educational tracks based on their probable destinies (Wirth, 1972). Behavioral science provided the mechanism and pedagogical science provided the processes by which the schools would teach students the right work and moral habits. Those habits would lead to a voluntary compliance with social norms in compliance with social control theory. That compliance, in turn, meant that members of all social classes would benefit from a healthier society and economy and, eventually, a more humane workplace. By providing a scientifically based mechanism for teaching and learning, the science of behaviorism is, thus, seen as a lynchpin of the educational system's contribution to social efficiency.

Contemporary Career and Technical Education

The discussion described in the previous section took place during the period from 1910 to 1920 while career and technical education, as we have known it, was being designed and put into place in America under the name of vocational education. Those early debates would seem to have little to do with the realities of early 21st century career and technical education. But, as

Dobbins (1999) argued, behaviorism remains the learning theory undergirding current career and technical education thinking. To illustrate his contention, he pointed to the links between behavioral learning theory and the competency-based approach to programmatic decision-making and curriculum structuring, which is still pervasive in career and technical education (Finch & Crunkilton, 1999). According to Dobbins, the use of performance objectives to provide structure for lesson plans, criterion-referenced measures to measure task completion (Newcomb, McCracken, & Warmbrod, 1993), and reliance on incumbent worker task lists for the primary source of curriculum (Finch & Crunkilton, 1999), derive directly from behavioral learning theory. Following that logic, it seems clear that a curriculum designed to provide specific, pre-determined skills demonstrated to industry standards does not represent knowledge constructed internally by the student, but rather knowledge and skills externally imposed on the student.

Leaders in general education have moved to embrace information processing and constructivism over recent decades, as will be shown later. Numerous theorists in career and technical education have advocated similar change in the underlying theoretical framework of this profession (e.g., Hill, 1994; Gregson, 1997). Grubb (1997), long an advocate of curriculum integration as a mechanism for better serving students by providing context for all learning, lamented the slow progress in career and technical education toward real reform. He noted, indeed, that leaders of the profession have become weary of what he disparagingly referred to as a reform de jour mentality and may suspiciously regard even fundamental shifts in theory as "the latest fad." In a reply to Grubb, Gregson (1997) made an impassioned plea for career and technical educators to move toward critical pedagogy, which is anchored in constructivist philosophy. He argued that such a reorientation might serve as a means of pursuing Dewey s (1916) much earlier vision that education through occupations could be a liberalizing influence on American education as opposed to a tool of the status quo. Moore (1999) even attempted to formulate a comprehensive theory of work-based learning, building on many of the same concepts discussed in the current paper.

Nevertheless, as Bragg (1997) reminded us, calls for reform notwithstanding, real change can be excruciatingly slow in this profession. Indeed, the single most pressing impediment to fundamental theoretical change in career and technical education has been the requirement that the profession provide trained workers for occupations based on definable worker competency lists and to document the success of those workers through placement followup and reporting. That regulatory and structural constraint has tended to militate against a fundamental break from the historical behaviorist perspective (Dobbins, 1999). Career and technical education at the local level remains oriented toward a competency-based curriculum, structured from the perspective of industry needs and standards, and delivered using a pedagogy that relies on pre-determined performance objectives that include condition, task, and standard (Finch & Crunkilton, 1999). Regardless of structural reforms such as Tech Prep, School to Work, and High Schools That Work, as long as the local curriculum derives from worker task lists, is delivered using incremental teacher-directed instruction, and is evaluated based on criterion referenced measures, behaviorism remains the de-facto theoretical foundation.

Time for Reconsideration

We have seen that behaviorism was one of the primary theoretical foundations of the social efficiency doctrine at the time of the Smith Hughes Act (Camp, 1983). Indeed, to this day, behaviorism remains the primary basis in learning theory for both the curriculum and pedagogy of career and technical education as practiced in the local classroom and laboratory (Dobbins, 1999). A competency-based approach to career and technical education has been the dominant curriculum model for the profession for many years, and remains so today (Finch & Crunkilton, 1999). That dominance is still reflected in instructional systems in which skills are "checked off" when accomplished, and assumed to be permanently held by the student thereafter. Thus, behaviorism is fundamental to the way we do business in career and technical education; yet, as

the state of knowledge in education and psychology advances, it is incumbent on scholars to reexamine all aspects of our profession's theoretical foundations.

Doty and Weissman (1984) called for a new look at the theoretical framework for career and technical education. More recently, Lynch (1996, 1997) issued yet another series of compelling calls to define a new and "clearly focused conceptual framework." Even more recently, Osborne (1999) issued yet another plea for scholars to work toward a reasoned, intellectually sound conceptual framework for research in the career and technical education profession. With the rapid development in occupational, educational, and computer technologies, the old instructional model of transmitting to students a discrete and well-established set of skills and knowledge must be called into question. Within this uncertain environment of change, the student's ability to construct viable knowledge and to adapt is paramount.

Emerging Theories of Learning

The concept that learners construct their own knowledge from experience is termed constructivism (Fosnot, 1996). Recent educational reform efforts by the National Council of Teachers of Mathematics (1989, 1991), The National Academy of Science (1996), and the National Council for the Social Studies (1994) have all embraced constructivist principles within their theoretical frameworks. In addition, recent research concerning career and technical education has discussed the usefulness of constructivist principles without specifically positioning those principles within the framework of a constructivist perspective (see Cash, Behrmann, Stadt, & Daniels, 1998; Herrick, 1996; Roegge, Wentling, & Bragg, 1998; Schell & Black, 1997).

Can constructivism provide a clear and valid theoretical framework for career and technical education? Can it provide a framework that coherently organizes and synthesizes knowledge (e.g., psychological, technical, vocational), and serves to describe, explain, and predict thought and behavior within career and technical educational? To consider those questions, we must first examine the basics of constructivist learning theory.

Constructivism

Constructivism is a theory of learning that has roots in both philosophy and psychology. The essential core of constructivism is that learners actively construct their own knowledge and meaning from their experiences (Fosnot, 1996; Steffe & Gale, 1995). This core has roots that extend back through many years and many philosophers, including Dewey (1938), Hegel (1807/1949), Kant (1781/1946), and Vico (1725/1968). Philosophically, this essence relies on an epistemology that stresses subjectivism and relativism, the concept that while reality may exist separate from experience, it can only be known through experience, resulting in a personally unique reality. Von Glasersfeld (1984, 1998) proposed three essential epistemological tenets of constructivism, to which a fourth has been added in light of recent writings.

1. Knowledge is not passively accumulated, b ut rather, is the result of active cognizing by the individual;
2. Cognition is an adaptive process that functions to make an individual's behavior more viable given a particular environment;
3. Cognition organizes and makes sense of one's experience, and is not a process to render an accurate representation of reality; and
4. Knowing has roots both in biological/neurological construction, and in social, cultural, and language-based interactions (Dewey, 1916/1980; Garrison, 1997; Larochelle, Bednarz, & Garrison, 1998; Gergen, 1995; Maturana & Varela, 1992).

Thus, constructivism acknowledges the learner's active role in the personal creation of knowledge, the importance of experience (both individual and social) in this knowledge creation

process, and the realization that the knowledge created will vary in its degree of validity as an accurate representation of reality. These four fundamental tenets provide the foundation for basic principles of the teaching, learning, and knowing process as described by constructivism. As will be seen, however, these tenets may be emphasized differently, resulting in various "degrees" or "types" of constructivism.

The Constructivist Continuum

Constructivism is not a unitary theoretical position; rather, it is frequently described as a continuum. The assumptions that underlie this continuum vary along several dimensions and have resulted in the definition and support for multiple types of constructivism (Moshman, 1982; Phillips, 1995). Typically, this continuum is divided into three broad categories: Cognitive Constructivism (e.g., Anderson, 1993; Mayer, 1996), Social Constructivism (e.g., Cobb, 1994; Vygotsky, 1978), and Radical Constructivism (e.g., Piaget, 1973; von Glasersfeld, 1995).

Cognitive Constructivism. Cognitive constructivism represents one end, or extreme, of the constructivist continuum and is typically associated with information processing and its reliance on the component processes of cognition (Dole & Sinatra, 1998). While emerging from the four epistemological tenets mentioned previously, cognitive constructivism emphasizes only the first two tenets: that knowledge acquisition is an adaptive process and results from active cognizing by the individual learner. These particular epistemological emphases lead to defining principles that maintain the external nature of knowledge and the belief that an independent reality exists and is knowable to the individual (Moshman, 1982; Spiro, Feltovich, Jacobson & Coulson, 1995). Knowledge then, from the cognitive constructivist position, is the result of the accurate internalization and (re)construction of external reality. The results of this internalization process are cognitive processes and structures that accurately correspond to processes and structures that exist in the real world. This claim, that reality is knowable to the individual, differentiates cognitive constructivism from both social and radical constructivism.

This process of internalization and (re)construction of external reality is learning. That is, learning is the process of building accurate internal models or representations that mirror or reflect external structures that exist in the real world. This perspective on learning focuses on (a) the procedures or processes of learning, (b) how what is learned is represented or symbolized in the mind, and (c) how these representations are organized within the mind (Mayer, 1996).

Cognitive constructivism, as a learning theory, is often considered a "weak" form of constructivism, within the constructivist community, since it embraces only two of the four epistemological tenets (von Glasersfeld, 1984). "Weak" in this case is not a value judgment, such as better or worse, but rather merely an indication of adherence to foundational assumptions. Thus, knowledge construction is considered primarily a technical process of creating mental structures, but has little bearing on the nature of the subjective knowledge within the mind. However, cognitive constructivism, and its historical association with information processing, has led to a multitude of significant empirical findings regarding learning, memory, and cognition (Anderson, 1995; Bruning, Schraw, & Ronning, 1999), including schema theory, working memory models, computational models of learning and memory, and neurological models of brain function. In addition, each of these theoretical advances has led to successful instructional applications, such as the use of advanced organizers, concept maps, teaching for transfer, elaborative practice, teaching for automaticity, and the use of reading strategies (e.g., SQ3R; Survey, Question, Read, Recite, Review), and problem solving strategies (e.g., IDEAL; Identify problems, Define goals, Explore strategies, Act, Learn). Thus, while the cognitive constructivist perspective has proved to be quite beneficial to the understanding of learning and instruction, it remains the "black sheep" of the constructivist community since its focus does not include the subjective nature of knowledge.

An example of the cognitive constructivist perspective of learning would include a student learning to problem solve. The student, within a cognitive constructivist classroom, might be exposed to a problem solving heuristic, such as IDEAL. The student would learn to identify and define each step, as well as to use the steps in the attainment of the "correct" problem solution. The student's learning would be assessed according to his or her ability to define, describe, and explain IDEAL, in the same way as the textbook or teacher, and the student's ability to use the IDEAL strategy to attain correct problem solutions. The focus of cognitive constructivism, and this example, is the construction of mental structures that mimic and function effectively within a knowable reality.

Radical constructivism. Radical constructivism represents the opposite end of the constructivist continuum from cognitive constructivism. Radical constructivism fully embraces the first three epistemological tenets, that is, that knowledge acquisition is an adaptive process that results from active cognizing by the individual learner, rendering an experientially based mind, not a mind that reflects some external reality. In addition, there is a current movement within radical constructivism to more fully accept the fourth epistemological tenet, thus, recognizing social interactions as a source of knowledge (see Larochelle, Bednarz, & Garrison, 1998). These particular epistemological emphases lead to defining principles that maintain the internal nature of knowledge and the idea that, while an external reality may exist, it is unknowable to the individual (von Glasersfeld, 1998, 1996). Reality is unknowable since our experience with external forms is mediated by our senses, and our senses are not adept at rendering an accurate representation of these external forms (e.g., objects, social interactions). Therefore, while knowledge is constructed from experience, that which is constructed is not, in any discernible way, an accurate representation of the external world or reality (von Glasersfeld, 1998, 1995).

The adaptive nature of knowledge underscores that knowledge is not objective "truth;" that is, internal knowledge does not match external reality, but rather is a viable model of experience (von Glasersfeld, 1995). These viable models are created within an individual, influenced by the context within which an activity was experienced, and relative to the accomplishment of a particular goal. Thus, according to Staver (1995), "knowledge is knowledge of the knower, not knowledge of the external world; improving knowledge means improving its viability or fit in, but not match with, an external world" (p. 1126).

An evaluation of radical constructivism results in radical constructivism being considered a "strong" form of constructivism, as it fully embraces three of the constructivist epistemological tenets and at least partially embraces the fourth. That is, radical constructivism is concerned with the construction of mental structures, the position of cognitive constructivists, and the construction of personal meaning. In this sense, radical constructivism involves a greater degree of construction than does cognitive constructivism, involving two planes of construction, structure and meaning, rather than only one, structure.

An example of radical constructivism's emphasis on both structure and meaning can be seen in a student learning to problem solve. The student might be exposed to a problem solving heuristic, such as IDEAL. The student, through interacting with the IDEAL heuristic, would come to a personal understanding of the various IDEAL steps. This understanding of the various steps may not match the textbook or teacher understandings, but the understandings would be internally coherent and would make sense to the student. In addition, the student, in applying the IDEAL heuristic, would not be seeking a "correct" problem solution, as determined by the textbook or teacher, but rather would be seeking a viable problem solution that works. The focus of radical constructivism, and this example, is the student's personal understanding and his or her viable mental model of the problem solving process.

Social constructivism. Social constructivism lies somewhere between the transmission of knowable reality of the cognitive constructivists, and the construction of a personal and coherent

reality of the radical constructivists. Social constructivism, unlike cognitive and radical constructivism, emphasizes all four of the previously mentioned epistemological tenets. These particular epistemological emphases lead to defining principles that maintain the social nature of knowledge, and the belief that knowledge is the result of social interaction and language usage, and, thus, is a shared, rather than an individual, experience (Prawatt & Floden, 1994). In addition, this social interaction always occurs within a socio-cultural context, resulting in knowledge that is bound to a specific time and place (Gergen, 1995; Vygotsky, 1978). This position is exemplified by Bakhtin (1984), "truth is not to be found inside the head of an individual person, it is born between people collectively searching for truth, in the process of their dialogic interaction" (p. 110). Truth, in this case, is neither the objective reality of the cognitive constructivists nor the experiential reality of the radical constructivist, but rather is a socially constructed and agreed upon truth resulting from "co-participation in cultural practices" (Cobb & Yackel, 1996, p. 37).

Like radical constructivism, social constructivism would be considered a "strong" form of constructivism, emphasizing all four of the epistemological tenets. However, social constructivists generally downplay the mental construction of knowledge (not because social constructivists do not believe in mental construction but because it is seen as relatively trivial) and emphasize the co-construction of meaning within a social activity. In this sense, social constructivism is more concerned with meaning than structure.

Continuing the example of the student learning to problem solve, the student may again be introduced to the IDEAL strategy. Within a social constructivist perspective, the IDEAL strategy would be experienced socially, through teacher-student interactions, cooperative learning groups, or classroom discussions. The strategy would be explored socially, such that group members and the teacher negotiate the meaning and application of each step. As with the radical constructivist perspective, the student would attain a personal understanding of the IDEAL steps; however, this personal understanding would be mediated by the social milieu of the classroom. In addition, this personal understanding would not be measured against the textbook or teacher, nor would the application of the strategy be designed to attain the "correct" problem solution; rather, the understanding would be measured as to its personal and social coherence and its ability to generate viable solutions. Thus, the focus of social constructivism, and this example, is on shared social experience and social negotiation of meaning.

Constructivist Pedagogy

Cognitive constructivists emphasize accurate mental constructions of reality. Radical constructivists emphasize the construction of a coherent experiential reality. Social constructivists emphasize the construction of an agreed-upon, socially constructed reality. Is there room for common pedagogy?

Constructivist pedagogy, the link between theory and practice, suffers from the breadth of its theoretical underpinnings. Many theorists and practitioners (Brooks & Brooks, 1993; Driscoll, 1994; Jonassen, 1991) have generated constructivist pedagogies with an array of results. While these pedagogies share a set of core design principles, the peripheral principles tend to vary greatly. The general theoretical and practical constructivist consensus, however, across all three types of constructivism, indicates that eight factors are essential in constructivist pedagogy (Brooks & Brooks, 1993; Larochelle, Bednarz, & Garrison, 1998; Steffe & Gale, 1995). It should be noted, though, before the discussion of these principles begins, that these principles are not solely constructivist in nature. Indeed, all of these principles have been proposed by other theories/theorists in other times. What makes this list "constructivist" is the assemblage of these specific principles and the basis/rationale for their inclusion.

Essential Factors of Constructivist Pedagogy

Learning should take place in authentic and real-world environments. Whether building accurate representations of reality, consensual meanings in social activities, or personally coherent models of reality, experience is paramount. Experience, both socially oriented and object oriented, is a primary catalyst of knowledge construction. Experience provides the activity upon which the mind operates. In addition, knowledge construction is enhanced when the experience is authentic. For the cognitive constructivist, authentic experiences are essential; so the individual can construct an accurate representation of the "real" world, not a contrived world. For the social and radical constructivists, authentic experiences are important; so the individual may construct mental structures that are viable in meaningful situations.

Let us consider an example from career and technical education. When an Automotive Technology student learns to operate a micrometer in the course of solving an authentic problem, such as the construction of a solar-powered car, the knowledge constructed will be more accurate and viable than if the student merely practiced using the micrometer in isolation. Wirth (1972) made the same comparison in describing the "Russian system" of teaching mechanical skills in isolation versus the "sloyd system" of teaching mechanical skills within the context of usable projects, such as crafts. This idea was discussed by von Glasersfeld (1984), "Our knowledge is useful, relevant, viable...if it stands up to experience and enables us to make predictions and bring about or avoid...certain phenomena" (p. 24).

Learning should involve social negotiation and mediation. While only social constructivism emphasizes social interaction as a basis for knowledge construction, both cognitive and radical constructivism assign social interaction a role. Social interaction provides for the development of socially relevant skills and knowledge, as well as providing a mechanism for perturbations that may require individual adaptation. In some cases, such as cultural mores and culturally arbitrary rituals (e.g., greetings, gender relations, dress), knowledge can only be attained through social contact. In addition, as an individual gains experience in a social situation, this experience may verify an individual's knowledge structures or it may contradict those structures. If there is contradiction or confusion, then the individual must accommodate this contradiction in order to maintain either an accurate model of reality or a coherent personal or social model of reality. Finally, an integral component of social mediation is the use of language. Language is the medium through which knowledge and understanding are constructed in social situations (Spivey, 1997).

To elucidate this principle, let us consider another career and technical example. When a student is actively involved as an employee/trainee in a cooperative education workstation, the student must learn the language of that domain, as well as the skills necessary to perform the job efficiently and effectively. Smooth functioning as an employee in a training station is predicated on the student/trainee becoming a functioning member of the workplace milieu. An extreme example of the importance of social negotiation and mediation comes from Gergen (1995), "All that we take to be the case...gain their legitimacy not by virtue of their capacities to map or picture the world, but through processes of social interchange" (p. 24).

Content and skills should be made relevant to the learner. All three types of constructivism emphasize the concept that knowledge serves an adaptive function. If knowledge is to enhance one's adaptation and functioning, then the knowledge attained (i.e., content and skills) must be relevant to the individual's current situation, understanding, and goal. This relevancy is likely to lead to an increase in motivation (Pintrich & Schunk, 1996), as the individual comes to understand the need for certain knowledge. Ultimately, experience with relevant tasks will provide the individual with the mental processes, social information, and personal experiences necessary for enhanced functioning within one's practical environment.

In agricultural education, for instance, a problem-solving approach to teaching (Hammonds & Lamar, 1968) has long emphasized the importance of personal relevance in learning. The

concept of the farm project program, called for in the Smith Hughes Act, was designed specifically to provide a real-world, personal application for each student for the direct purpose of making the in-class instruction more relevant to the student (Camp, 1982). In the same light, cooperative education programs in career and technical education emphasize the importance of the teacher providing classroom instruction to meet the student-trainees' on-the-job needs. Vygotsky (1978) emphasized need and relevancy in learning to read and write, "Teaching should be organized in such a way that reading and writing are necessary for something...writing must be 'relevant to life'" (pp. 117-118).

Content and skills should be understood within the framework of the learner s prior knowledge. All learning begins within an individual's prior knowledge, regardless of constructivist affiliation. Understanding a student's behavior requires an understanding of the student's mental structures, that is, an understanding of the student's understanding. When a student replies that the answer to 54 - 38 is 24, the teacher must not think "Oh, that is wrong," but rather "What is the student's understanding of subtraction that has led to this answer?" In this case, the student appears to be using the following rule of subtraction, "subtract the smallest from the largest." While this rule is "incorrect" given our current system of mathematics, it is, none-the-less, the rule the student is using. Understanding the student's rule usage makes it much easier for the teacher to demonstrate, using manipulatives of some type, the non-viability of the student's understanding (e.g., have the student count out 54 blocks, then take away 38 blocks from that pile, and finally count the remaining 16). Only by attempting to understand a student's prior knowledge will the teacher be able to create effective experiences, resulting in maximal learning.

A business education student, who systematically solves a series of similar data analysis problems with similar errors, has probably built an inappropriate mental structure of the processes involved. The teacher must provide the student with a set of experiences that will allow him or her both to deconstruct the maladaptive concept and then to (re)construct the appropriate concept. Another student who produces a series of seemingly unrelated errors on the same problem set has probably not yet developed a clear mental structure of the processes involved. The appropriate educational experiences for the latter student might not be the same as those needed by the former student.

Students should be assessed formatively, serving to inform future learning experiences. Cognitive, social, and radical constructivism all assert that the acquisition of knowledge and understanding is an ongoing process that is heavily influenced by a student's prior knowledge. Unfortunately, knowledge and understanding are not directly visible, but rather must be inferred from action. Thus, to take into account an individual's current level of understanding in this ongoing teaching and learning process, a teacher must continually assess the individual's knowledge. This formative assessment is necessary to accurately create the next series of experiences and activities for students.

One of the fundamental concepts of competency-based education, a hallmark of career and technical education, is ongoing criterion-referenced evaluation until a task, whether cognitive or psychomotor, is mastered. One would never expect a student's first efforts at any learning activity to be accomplished at the mastery level. The welding student's first bead will certainly be rough, exhibit excessive splatter, and be either too deep or too shallow. Only through normative evaluation by both the teacher and the student, followed by modifications on the part of the student in successive efforts, will the student be able to master the skill of laying a bead.

Students should be encouraged to become self-regulatory, self-mediated, and self-aware. The underlying tenet of constructivism, and the main thread that holds together this array of theoretical positions, is the claim that learners are active in their construction of knowledge and meaning. This activity involves mental manipulation and self-organization of experience, and

requires that students regulate their own cognitive functions, mediate new meanings from existing knowledge, and form an awareness of current knowledge structures. Within a cognitive constructivist perspective, self-regulation, self-mediation, and self-awareness would be subsumed under the construct of metacognition. Metacognition is considered an essential aspect of learning and consists of (1) knowledge of cognition (i.e., knowing what one knows, knowing what one is capable of doing, and knowing what to do and when to do it) and (2) regulation of cognition (i.e., the on-going task of planning, monitoring, and evaluating one's own learning and cognition) (Brown & Palincsar, 1987).

While cognitive constructivism would emphasize self-regulation and self-awareness, social and radical constructivism would emphasize self-mediation. Self-mediation is represented within social and radical constructivism by Vygotsky's (1978) concept of the psychological tool, and Piaget's (1977) concept of reflective abstraction, respectively. Vygotsky (1978) believed that students construct mental signs, or psychological tools, to represent concepts and relationships, and that these tools are used to mediate "intermental" cognition. Similarly, Piaget (1977) theorized that students mentally reflect on the use and nature of objects and then construct new knowledge by generalizing, or abstracting, new relationships. The importance of the thought and self-regulation relationship was expressed by Vygotsky (1978), "The system of signs restructures the whole psychological process and enables the child to master her movement" (p. 35).

To illustrate this principle in terms of career and technical education, one of the important lessons career and technical educators have learned over the past several decades is that employers want more from our graduates than simple entry-level job skills. The report of the United States Department of Education Secretary's Commission on Achieving Necessary Skills, the so-called SCANS Report (McNabb, 1997), made clear that students must be ready to function in collaborative settings, interpret complex requirements, and exhibit self-directed, self-assessing behavior on the job. The generalized skills advocated in the SCANS report stand in stark contrast to the job-specific skills that are generated using such models as the V-TECS "catalogs" and the DACUM process as described by Finch and Crunkilton (1999).

Teachers serve primarily as guides and facilitators of learning, not instructors. The role of the teacher in the learning process has often been a major factor in the apparent division between cognitive constructivism and social/radical constructivism. Teachers, in the cognitive constructivist perspective, are usually portrayed as instructors who "transmit knowledge." The teacher instructs, while the learner learns. In actuality, in the cognitive constructivist perspective, the role of the teacher is to create experiences in which the students will participate that will lead to appropriate processing and knowledge acquisition. Consequently, cognitive constructivism supports the teacher as a guide or facilitator to the extent that the teacher is guiding or facilitating relevant processing. Contrarily, since social and radical constructivism eschew any direct knowledge of reality, there is no factual knowledge to transmit and the only role for the teacher is to guide students to an awareness of their experiences and socially agreed-upon meanings. This teacher as guide metaphor indicates that the teacher is to motivate, provide examples, discuss, facilitate, support, and challenge, but not to attempt to act as a knowledge conduit.

In his call for reform in career and technical teacher education, one of Lynch's (1997) basic premises was that career and technical education teachers must be taught to be more reflective in their professional practice and to be more inquiry-based in their instructional delivery. The importance of reflective practice and inquiry-based instruction are not new in career and technical education. Hammonds and Lamar's (1968) Teaching Vocations, which served as the predominant teaching methods book for career and technical teacher education for many years, formalized an inquiry-based problem-solving approach to teaching. The role of teacher as guide was described by von Glasersfeld (1996), "From this point of view, then, the task of the educator is not to dispense knowledge but to provide students with opportunities and incentives to build it

up" (p. 7).

Teachers should provide for and encourage multiple perspectives and representations of content. The relationship of multiple perspectives and multiple representations is one of cause and effect within cognitive constructivism. Experiencing multiple perspectives of a particular event provides the student with the raw materials necessary to develop multiple representations. These multiple representations provide students with various routes from which to retrieve knowledge and the ability to develop more complex schemas relevant to the experience. In addition, in social and radical constructivism there is no privileged "truth," only perceptual understandings that may prove to be more or less viable. This being the case, a student's understanding and adaptability is increased when he or she is able to examine an experience from multiple perspectives. These perspectives provide the student with a greater opportunity to develop a more viable model of their experiences and social interactions.

Competency-based instruction in career and technical education frequently promulgates a common misconception that application of this principle would correct. In almost all settings, there is more than one solution to any problem, more than one way to accomplish any task. A fundamental assumption of inquiry-based instruction (Lynch, 1997) is that multiple solutions to any problem are possible (Hammonds & Lamar, 1968). If only one solution exists to a particular problem, inquiry-based instruction may not be appropriate. Wertsch (1985) emphasized the role of multiple perspectives stating, "that every single person has the capacity to adopt a whole range of perspectives on objects, events, and states of affairs and is in that sense an inhabitant of many 'possible worlds'" (p. 186).

These eight principles provide the essence of constructivist pedagogy, emphasizing the student's role in knowledge acquisition through experience, puzzlement, reflection, and construction. Pedagogy is based on the dynamic interplay of mind and culture, knowledge and meaning, and reality and experience. Does constructivism offer career and technical education a foundation from which to describe, explain, and predict?

A Constructivist Caveat

This article is an exploration of the possible efficacy of a constructivist perspective for career and technical education. Thus, it is essential that the negative side of constructivism be addressed, if only briefly. Two articles will be discussed in this critique: Garrison (1997) addressed an alternative epistemological perspective to the subjectivism and relativism of mainstream radical constructivism, while Anderson, Reder, and Simon (1998) addressed the psychological shortcomings of constructivism.

According to Garrison (1997), radical constructivism is too subjective, relying on unknowable "mental operations," and reeking of an untenable mind/body dualism. That is, mental operations, or more precisely mental metaphors, are not needed in the explanation of learning and behavior, since it is known that thought resides in neurophysiological constructions (Dewey, 1916/1980). In addition, the mind/body dualism, or internal/external dualism, is unnecessary. Again, according to Garrison, there is no separation between our internal existence and external experience. Our adaptive nature is such that our neurophysiological constructions are intimately intertwined with our social, language-based experiences, such that one cannot exist without the other. Although not mentioned by Garrison, these criticisms would also apply to cognitive constructivism. Garrison, in turn, emphasized a social constructivism that relies on Dewey's notion of social transaction as the source of knowledge construction. That is, knowledge is gained through social discourse such that two (or more) individuals neurologically construct a common understanding of a shared context.

While Garrison focused on the philosophy of constructivism, Anderson et al. (1998) focused on

the psychological. The authors elucidated five main criticisms regarding social and radical constructivism, citing empirical evidence for each. Firstly, knowledge does not have to be acquired through active "discovery" learning, as purported by constructivists, but can be acquired through direct instruction. Secondly, not all knowledge is contextualized, as constructivists promote, rather useful knowledge is often abstract and decontextualized. Thirdly, direct practice, often eschewed by constructivists as artificial and non-motivational, is actually extremely beneficial to skill acquisition. Fourthly, whole and authentic activities are not always necessary for knowledge construction, as posited by constructivists, rather practicing a sub-component of the whole is often more beneficial to knowledge construction. Finally, not all learning must take place in social situations; a mainstay of the social constructivist perspective; rather, learning is regularly attained during individual experience. These criticisms focus more on the extremism of constructivism than on its core concepts. For example, while constructivism may assert that "all" learning is social, Anderson et al. assert that "some" learning is social (and, thus, "some" learning is individual).

These philosophical and psychological caveats regarding constructivism do not discount constructivism. On the other hand, they do emphasize the need for continued diligence in the pursuit and application of constructivist ideas.

Career and Technical Education and Constructivism

The philosophical debates of the early 1900s settled the question of the role of career and technical education for many years (Wirth, 1972). The profession would prepare workers for skilled positions in the workplace through a public system of pre-employment, on-the-job, skill-upgrading, and worker-retraining programs. To the extent that that role remains central in career and technical education today, even in a changing society and workplace, certain practices must remain central to practice in the profession. In order for career and technical education to meet its obligations to society, to the education community, to business and industry, and to its student-clients, we must continue to identify employability and workplace skills and to transmit those skills to students. The precise nature of those skills may have changed from repetitive, manipulative tasks to problem-solving, collaborative tasks (McNabb, 1997), yet the fact remains that providing employability and workplace skills is a fundamental task for career and technical education. The classical approach to identifying those skills has been, and remains today the identification and prioritization of competencies needed on the job using community input and job or task analysis (Finch & Crunkilton, 1999).

Viewing this employability and workplace approach through a constructivist lens, however, adds new dimensions of interest. Indeed, while there is a base set of knowledge and skills that a student needs to understand and perform today, the student must also be prepared to adapt to the knowledge and skills that will be needed in the future. In addition, the concept that teaching involves the transmission of knowledge and skills from teacher to student must be replaced by a new understanding of student knowledge construction and the reciprocal relationship between teacher and student. That is, students are not the "behavior machines" of the behaviorists; rather, students are the self-regulated, mental model building, socially interacting, meaning-making individuals of the constructivists (Grubb, 1997). Therefore, a new question must be asked, "How does career and technical education merge the traditional need for learning core knowledge and skills with the modern emphasis on adaptability, knowledge construction, and self-regulation?"

Answering this question would seem to rely on theorists in career and technical education acknowledging and embracing five central concepts:

1. All teaching within career and technical education must begin and end with an appreciation of the student's understanding.
2. The student must be facile with a core set of currently accepted knowledge and skills

within career and technical education.
3. Career and technical knowledge and skills are dynamic; thus students must have the skills necessary to adapt.
4. Student's idiosyncratic understandings of career and technical knowledge and skills must be valued, as these understandings may lead to new discoveries, insights, and adaptations.
5. The goal of career and technical education must be an occupationally self-regulated, self-mediated, and self-aware individual.

These five concepts are certainly not new and, moreover, are not unique to the present discussion. They do, however, provide a framework within career and technical education that values historically reliable domain-specific knowledge, future innovation and change in domain-specific knowledge, and the thoughts and perspectives of the individual student and teacher. Given these fundamental concepts, an epistemological contradiction arises between career and technical education and both radical constructivism and social constructivism. While radical constructivists posit a personal reality that is viable for the individual (but that may not match another's personal reality), career and technical education emphasizes a commonly accepted and knowable reality, a reality within which students must function effectively. For example, the proper wiring of an electrical switch is well known and is quite easily taught to students. In addition, this wiring knowledge reflects the way electricity actually works, not the way the student thinks it might work. Thus, radical constructivism does not support career and technical education's teaching of specific solutions to specific problems.

While radical constructivism fails to support career and technical education's teaching of an historical, domain-specific knowledge base, social constructivism's overemphasis on the social origin of knowledge is likewise unacceptable. Social interaction, negotiation, and consensus are certainly aspects of a quality career and technical education; however, they are not the entirety of it. For example, the fact that a group of career and technical education students might decide that the solution to poor high school student achievement in automotive repair is the implementation of an internet-based automotive repair course, does not make this solution effective. Social constructivism has much to offer career and technical education; however, its extremism limits its full adoption.

Finally, cognitive constructivism strikes a balance not attainable through radical and social constructivism. Cognitive constructivism recognizes that individuals construct unique mental models based on differing experiences, a concept that is central to radical constructivist beliefs. However, cognitive constructivists also emphasize the ability of individuals to construct similar, if not identical, mental models based on similar or identical experiences. This ability to construct similar mental models supports the career and technical education requirement of students learning a core set of historically reliable knowledge and skills. In addition, cognitive constructivists agree with the social constructivists that social interaction is a source of knowledge; however, cognitive constructivists emphasize that social interaction is only one source, of many, for the acquisition of knowledge and skills. Thus, cognitive constructivist do not get caught in the trap of "consensus = truth."

Furthermore, cognitive constructivism fully addresses each of the five career and technical education concepts listed earlier. That is, cognitive constructivists embrace and advocate (1) the role of prior knowledge in cognition, (2) the benefit of expert-based, domain-specific problem solving strategies, (3) the flexibility of domain-general problem solving strategies, (4) the importance of recognizing the influence of individual differences, and (5) the ultimate goal of an autonomous life-long learner.

Conclusions

Career and technical education remains, in fact if not expressly, founded on the learning

principles of behaviorism. Many scholars and reformers in the profession have advocated changes that implicitly relied on cognitive constructivist principles. Indeed, many of the changes we have seen in recent years implicitly rely on constructivist principles. Nevertheless, scholars in the profession have yet to explicitly address the shift from behaviorism to constructivism. The path of reform the profession has followed over recent years places a strain on the degree to which behaviorist learning theory can adequately describe, explain, and predict the pedagogy needed by career and technical education as we move into the new millennium.

The time has come for scholars in the profession to conduct a serious examination of the learning theory underlying career and technical education. It may be that cognitive constructivism will be found to be a better solution than behaviorism to serve as the learning theory foundation for career and technical education curriculum and pedagogy. If that is the case, significant rethinking may be in order for how we determine, structure, and deliver the content of education for workforce preparation in the future. For the reforms sought by proponents of such movements as Tech Prep, School to Work, and High Schools That Work to be successful, such a rethinking may be absolutely essential.

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