UDL: A Primer for Community College CTE Instruction

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Abstract
Community college career and technical education (CTE) programs serve students from all walks of life. Students learn in their own ways, and it is the difference between each student's learning style and mental and physical ability that poses challenge for CTE instructors. When Universal Design for Learning (UDL) guidelines are used to design curricula, all learning styles are accommodated because multiple means of engagement, representation, action, and expression have been provided. In the making of a case for UDL in CTE programs, learning styles, pedagogy, andragogy, Bloom's Revised taxonomy, Dave's taxonomy, Conscious Competence, UDL, and blended instruction are explored. UDL is introduced as the ideal model for CTE curriculum design, which is demonstrated in a sample CTE assignment and rubric.

Introduction
Career and technical education (CTE) programs play a vital role in the preparation of people for rewarding careers in technical industries. CTE programs are tasked with the simultaneous training of students with diverse demographic and psychographic attributes, and they come with a wide range of personal experience that influences their inherent learning ability. While the application of child learning theory may be appropriate for K-12 CTE programs, and adult learning theory may be appropriate for adult CTE programs, Universal Design for Learning (UDL) accommodates all learners (CAST, 2019) and is therefore most appropriate for the diverse population of community college CTE programs.

Notwithstanding a variety of learning styles, the age of students and their life experiences are key components to the challenge of CTE instruction (Gawronski, Kuk, & Lombardi, 2016). In 2011, the average CTE student was 26 years old. Four in ten students were older than 25 and six in ten were younger than 25 (NCES, 2011). Most learning theories fall under the category of child learning, or pedagogy. Researchers have theorized that pedagogy is best employed when students are younger than 24. One learning theory, andragogy, is suited for students older than 24. However, this 24-year point of demarcation is highly subjective and dependent on life experience and maturity (Noor, Harun, & Aris, 2012). In reality, community college classrooms are filled with students ranging from immature to mature, and inexperienced to very experienced. At an average age of 26, neither pedagogy nor andragogy is 100% appropriate for CTE programs.

A blend of child and adult learning theory is most effective for the *almost-adult* learner, who is not entirely responsive to pedagogical and andragogic methods (Panacci, 2017). Universal Design Theory (UDL) is a learning theory that goes beyond pedagogy, andragogy, or other blended instruction modalities. UDL serves the child learner, the almost-adult learner, and the adult learner through multiple forms of engagement, representation, action, and expression. UDL also serves students with disabilities who struggle to receive, act upon, or express information

(CAST, 2019). UDL is ideal for CTE instruction because UDL serves all learners, and CTE kinesthetic activities provide opportunity for multiple forms of engagement, representation, action, and expression.

Literature Review
Peer reviewed articles, research reports, and government data were used to present facts and formulate arguments. UDL concepts were drawn from UDL guidelines (2019), which are published by CAST, a nonprofit education research and development organization. Other research highlights include Usman (2015), Loeng (2018), and TEAL (2011), who effectively define pedagogy and andragogy. Hill, Fadel, & Bialik (2018) reinforce the importance of previous experience in learning processes via their Conscious Competency theory. Other research was chosen for the purpose of reinforcing specific ideas and concepts.

Methodology
A research-based descriptive methodology was used to document instructional methods that are applicable to CTE instruction. UDL principles were applied to a lab and lecture wiring-schematic learning module, and then the attributes of five learning module assignments were mapped to the Knowles Cognitive domain, Dave's Psychomotor domain, and UDL principles.

Background
Every student learns differently (CAST, 2019) and the diversity of community college students is challenging for the CTE instructor. New CTE instructors might be experts in their respective discipline, but rarely begin their instructional careers after being trained in the art and science of instruction (Kerna, 2012); trial by fire is common, which leads to poor student engagement, retention, persistence, and success (Touchstone, 2015).

Considering the diversity of today's higher education student, and the millennial generation's preference for experiences (Talreja, Wahi, Ghosh, Marwah, Verma, 2018), there is debate among educators as to whether instructors should be equally qualified in their discipline and in the art and science of instruction (Hartsoe & Barclay, 2017). In the context of CTE, instructors are faced with the need for professional development on two fronts: (a) maintaining skill and knowledge in rapidly changing industries, and (b) learning and maintaining the art and science of instruction.

For many CTE instructors, it is difficult to maintain competency in both disciplines. Consequently, they concentrate on what they feel has the higher priority—competency in their craft. Proponents of instructional training for CTE instructors point to a decline in the completion of post-secondary, sub-baccalaureate occupational credentials from 2011 to 2015. Conversely, the award of sub-baccalaureate credentials and bachelor's degrees increased during the same time period (NCES, 2011-2015). If CTE courses were designed to naturally engage students, instructors could concentrate on instruction of their craft, which could reverse the current credential-completion trend.

In UDL, learners essentially choose their preferred learning style in each assignment and are naturally engaged as they make choices. Combined with the use of a learning management system (LMS), UDL has the potential to mitigate the need for CTE instructors to be expertly qualified in the art and science of instruction. Therefore, CTE instructors can train for what they

do best: teaching of their craft. In its purest form, UDL removes consideration for pedagogic and andragogic learning theory, focusing instead on the learner, and the result has been increased engagement and student success (NEA, 2008). UDL is a viable option for CTE programs, especially when employed with an LMS where curriculum can be consistently organized.

Learning Styles
Learning styles are habits or strategies that people inherently employ when they are actively learning. One research group identified 71 learning-style theories (Pearson, 2016), some being more popular than others. David Kolb introduced a four-part learning theory in 1984, which includes four learning styles (Tan & Laswad, 2015):

- Accommodating—the accommodating learner is a hands-on, intuitive student who does and feels through practical experimentation.
- Assimilating—an assimilating learner, who thinks and watches with minimal emotion, prefers a concise, logical approach.
- Diverging—this student is a sensitive feeler and watcher who thrives on contemplating different perspectives.
- Converging—this student is a problem-solving, jump-in doer and thinker, who prefers technicality.
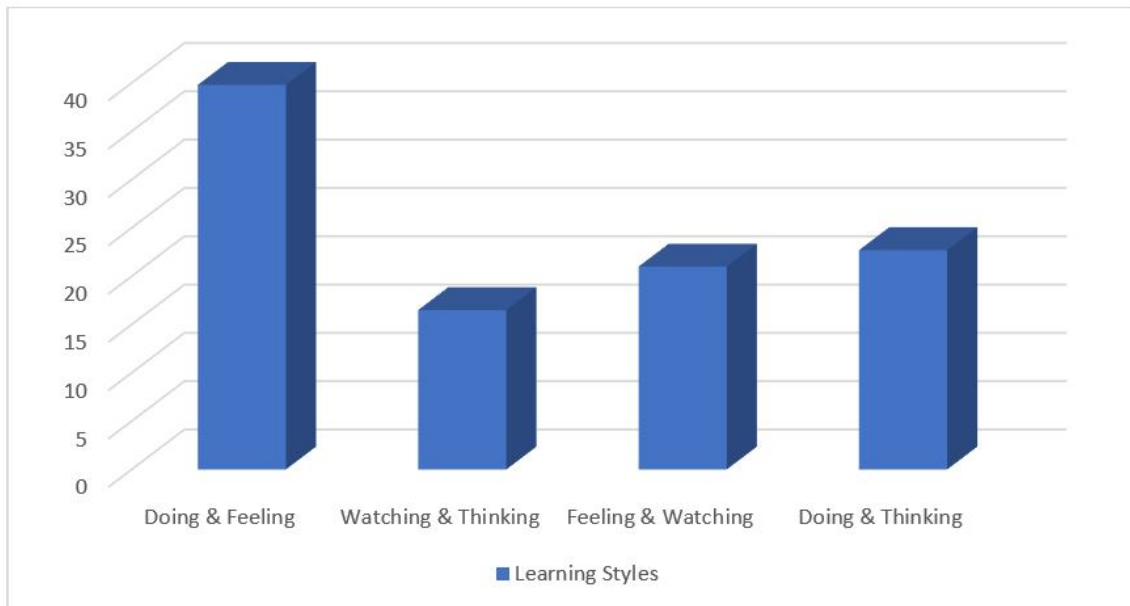

Figure 1. Kolb learning styles for automotive technology students (Threeton, & Walter, 2009)

It is logical to assume that CTE students are hands-on accommodating learners, but this is not always the case. Figure 1 demonstrates a 2009 study of 176 automotive technology students (Threeton, & Walter, 2009), where 39.8% of students were accommodating learners, 16.5% were assimilating learners, 21% were diverging learners, and 22.7% were converging learners. In total, 60.2% of 176 students were not hands-on, accommodating learners. CTE students are not always hands-on, accommodating learners.

Child Learning
Pedagogy is a widely used term among educators that has evolved in meaning over time. Pedagogy is derived from the Greek words *paid* meaning "child" and *agogos* meaning "leader of" (Usman, 2015, p. 58). Paraphrased in a modern context, pedagogy means "the art and science of teaching children" (TEAL, 2011, p. 1). However, the term is also used as a synonym for instructional design and practice.

The word pedagogy is frequently used by college faculty and administrators, which can be confusing because community college students are not thought of as children. According to Noor, Harun, & Aris (Noor, Harun, & Aris, 2012), 24-year-old college students may still be responsive to pedagogic learning theories depending on their life experience, or some 24-year old students are more mature than others. And according to the National Center for Education Statistics, about six in 10 American CTE students in 2011-12 were younger than 25 (NCES, 2011). The application of pedagogy in CTE programs is therefore appropriate, but this leaves nearly four in ten community college students who are older than 24, and less likely to respond effectively to pedagogy.

Many specific pedagogic methodologies have been theorized, but child learning theory is based on the leading of unknowing children. Having not yet fully matured, children are unknowing and prefer to be led. In pedagogy, the learner is dependent on the instructor. The instructor is responsible for what is taught and how it is learned. Child learners have limited life experience, making the instructor's experience most influential. Pedagogic coursework is sequenced and subject matter systematically introduced. Child learners are motivated to succeed by external pressures, for example, by grades, competition, and consequence of failure. Moreover, instructors tend to teach the way in which they were taught, and they have frequently been taught with pedagogical methods (Threeton, & Walter, 2009).

Adult Learning
Andragogy, or adult learning theory, is derived from the Greek words "*aner* (genitive *andros*), [which] means 'man,' while *agein* means 'to lead'" (Loeng, 2018, p. 1). When paraphrased in a modern context, andragogy means "the art and science of helping adults learn" (TEAL, 2011, p. 1). In 1980, Malcom Knowles brought awareness to andragogy while identifying differences between pedagogy and andragogy. Knowles identified five assumptions for adult learners (TEAL, 2011):

- With increasing maturity, adults move from dependency to independent self-directedness.
- By drawing on an inventory of life experiences, adults aid their learning.
- New social or life roles invigorate adults to learn.
- Adults want to immediately apply what they have learned by solving problems.
- Motivation is generated internally, not externally.

Validity of Knowles's assumptions can be found in the success of distance-learning programs, where older adults enjoy greater retention and success than young adults (Dibiase & Kidwai, 2010). Another example is self-evaluation surveys that create self-awareness as to what the adult

learner does not know; this in-turn creates motivation for the learner to fill their knowledge gap and engage (Conaway & Zorn-Arnold, 2016).

Adult learners bring life experience that may not be directly relevant to subject matter. Nonetheless, the adult learner may use life experience to connect or synthesize learning material (Conaway & Zorn-Arnold, 2016). Adult students serve as diverse resources for other students, and confident adult learners will eagerly step in as ad hoc instructors. Change for adult learners invigorates the desire to learn, and their need to know is germane to the way in which knowing will affect their lives. Adult learners want to perform and solve problems, and what they want to learn are those things that move forward their quality of life and ambitions (Zorn-Arnold & Conaway, 2016). Subject matter is irrelevant if it is not directly beneficial to the adult learner. They are intrinsically motivated by improvement of self-esteem, quality of life, self-confidence, recognition of performance, and self-actualization (Conaway & Zorn-Arnold, 2015).

The age of an adult learner should not be confused with the legal adult age of 18, or even 21. Generally speaking, by the time a student reaches the age of 24, enough life experience has accumulated to achieve maturity resulting in sense of self (Noor, Harun, & Aris, 2012). Consequently, a CTE instructor teaching mature adults will better serve students by acting in the capacity of a guide or facilitator. The facilitating instructor allows students to explore achievement of learning outcomes on their own terms, but with guidance and within boundaries set by the facilitator (Crowder, & McCaskey, 2015).

According to the National Center for Education Statistics (NCES, 2011), nearly four in ten American CTE students in 2011-12 were 25 or older. The application of andragogy is therefore appropriate in the CTE classroom, but this leaves about six in ten community college students who are younger than 25, and less likely to engage via andragogic learning theory. This creates an obstacle for the CTE instructor, who must decide whether one of the pedagogy learning theories or andragogy is best applied in the classroom. It is from this dilemma that blended learning theories are born (Worthen, 2016).

Bloom's Revised Cognitive Taxonomy
A committee of educators created Bloom's taxonomy in 1956 for the purpose
of classifying learning objectives. The committee devised three learning domains for the objectives:

- Affective (emotional or attitude)
- Cognitive (mental or knowledge)
- Psychomotor (physical or skills)

The cognitive domain is widely used by educators and includes six learning objectives that were revised in the late 1990s. Figure 2 demonstrates the hierarchical order of Bloom's revised cognitive domain, which can be used to effectively plan curricula by starting with memorization and building to creation (Burwash & Snover, 2016). CTE instruction requires curriculum in the cognitive and psychomotor domains, but the Bloom's taxonomy committee did not progressively develop the psychomotor domain, citing lack of expertise and leaving the domain for future development.
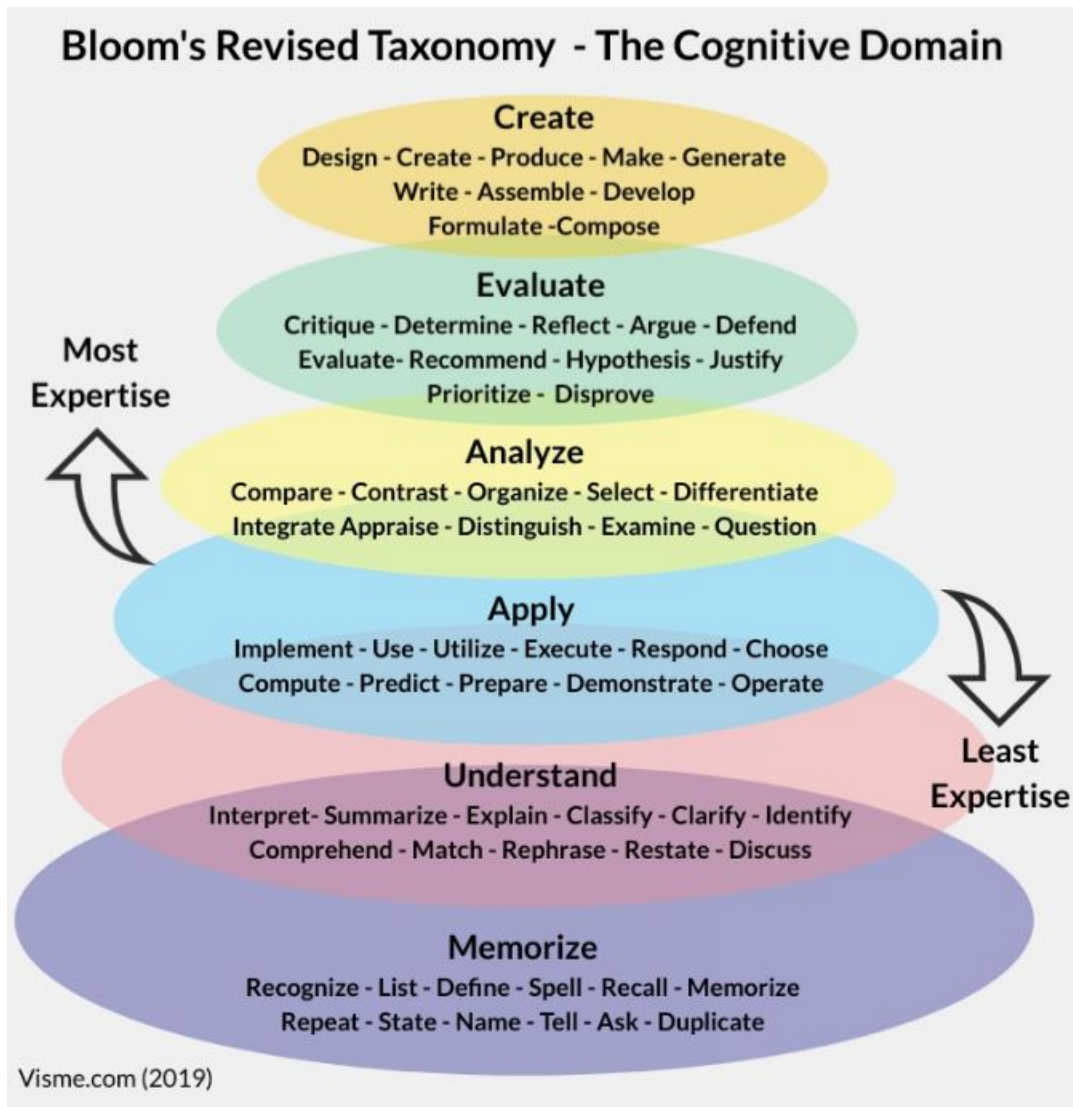
Figure 2. Bloom's Revised Taxonomy (Burwash & Snover, 2016)

Dave's Psychomotor Taxonomy

Dave's psychomotor taxonomy (Dave's) was introduced in 1975 and is one of several psychomotor taxonomy theories. Dave's can be readily applied in the development of CTE curriculum and is commonly used in the design of corporate training. Figure 3 demonstrates the hierarchical order of Dave's, where confidence is built as a pyramid of skills are assembled (Hill, Fadel, & Bialik, 2018).
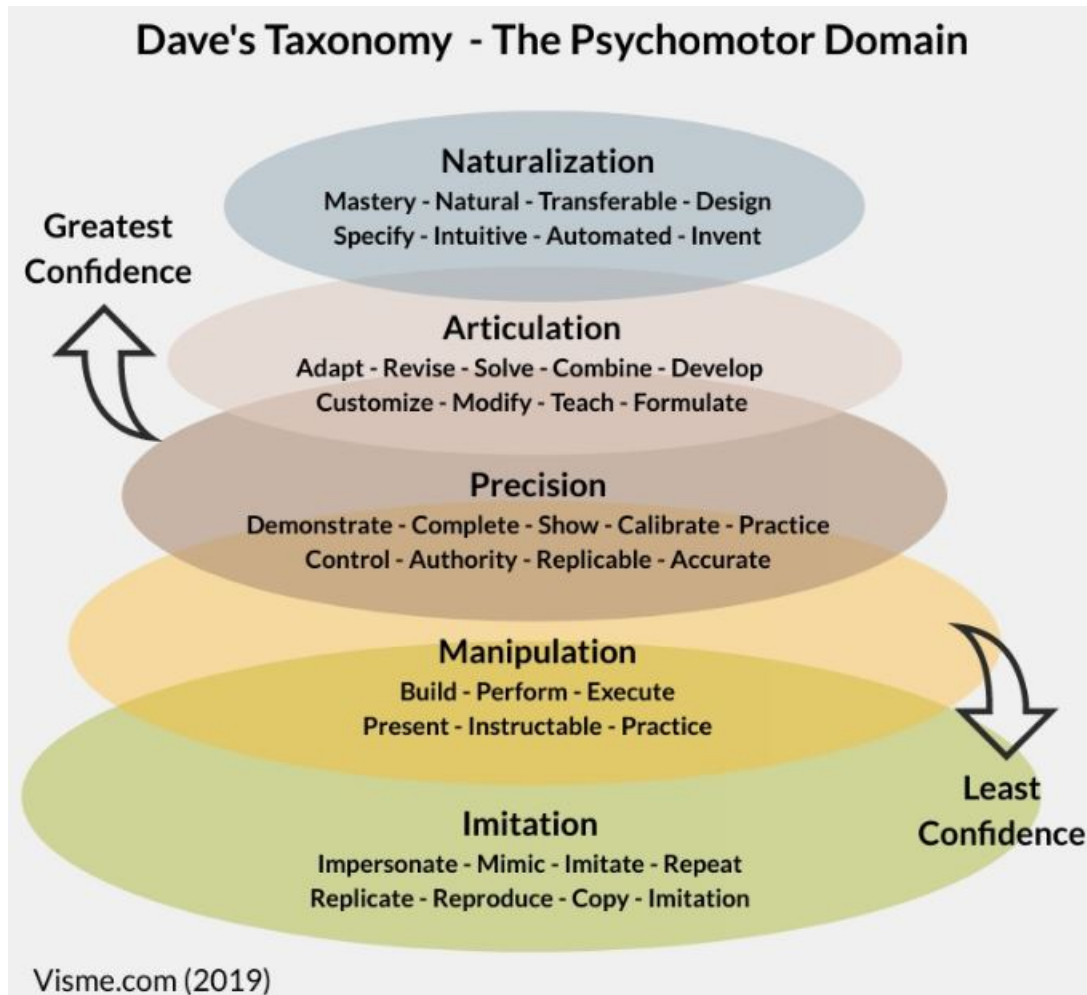
Figure 3. Dave Psychomotor Taxonomy (Hill, Fadel, & Bialik, 2018) & (Dalto, 2014)

While psychomotor taxonomies like Dave's portray hierarchical learning functions as flowing in a linear fashion, the Center for Curriculum Design (CCR) argues that psychomotor learning is not linear in the way it is portrayed by Dave's. Psychomotor learning occurs in parallel tracks depending on the learner's competence in different segments of psychomotor tasks.

In CCR's psychomotor Conscious Competence Model (Figure 4), learners begin an unfamiliar task in a state of *unconscious incompetence*, where the learner cannot yet conceptualize the goal, and feedback cannot be received because the goal is not yet conceptualized. In the second stage, the learner moves to *conscious incompetence* as the goal is understood and the learner becomes aware of their own incompetence; feedback is now received and processed. As learners practice, they become *consciously competent*, the third stage. In the fourth stage, the learner achieves *unconscious competence* through trial and error, and the psychomotor task becomes natural to the learner. This allows the learner to use unconscious competence to assist in the learning of another task segment (Hill, Fadel, & Bialik, 2018). In other words, experience builds competency, and competency lays the foundation for additional learning.
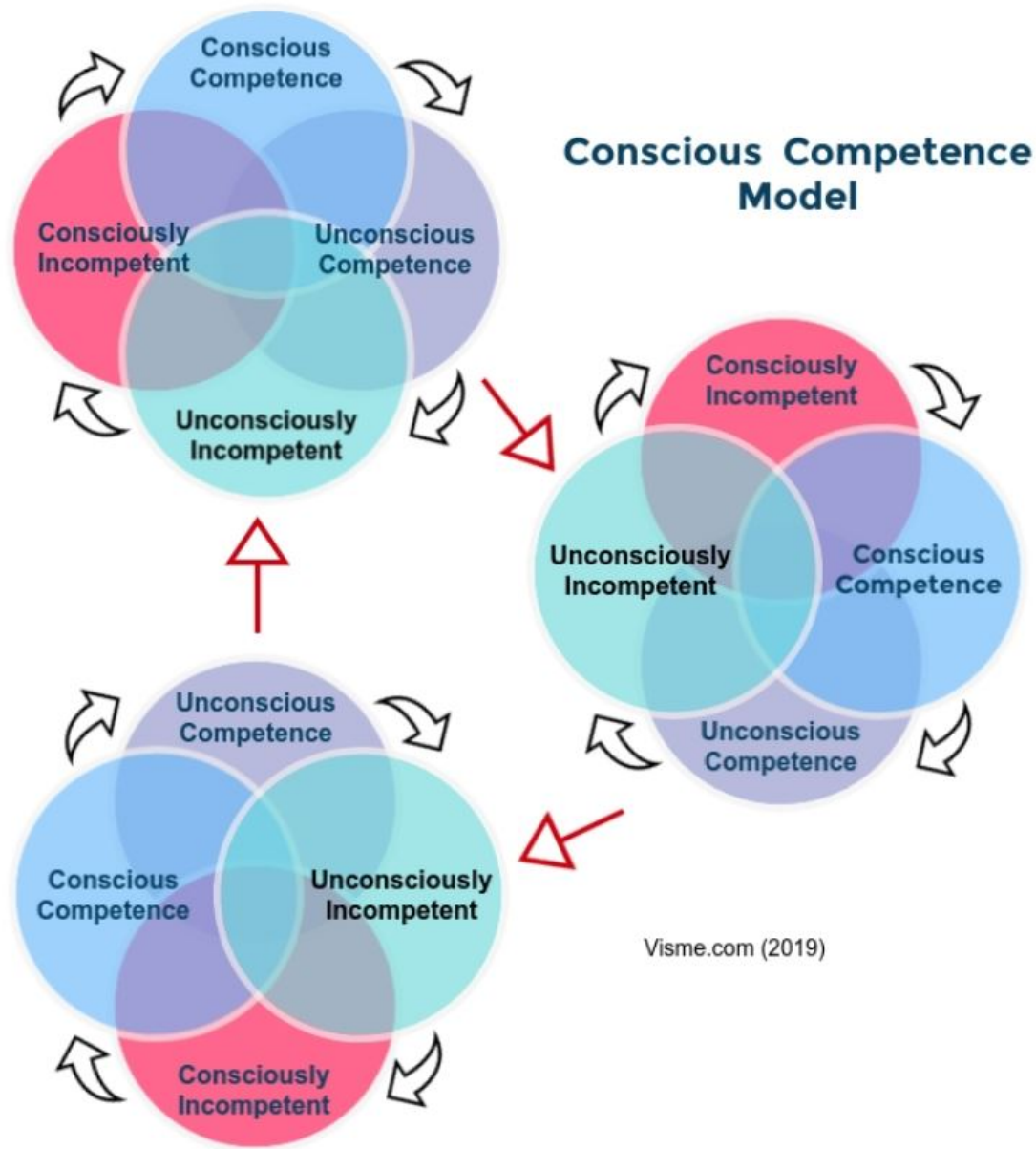
Figure 4. Conscious Competence model (Hill, Fadel, & Bialik, 2018)

Consider John, who was unconsciously incompetent in his first month as a tow truck operator, because each vehicle's spare tire was uniquely mounted and working alongside a roadway is dangerous. In the weeks that followed, John changed dozens of tires on hazardous roads and freeways. With each day of work, John found conscious incompetence as he discovered similarities between vehicles, learned which safety gear worked best, and devised ways to work faster and safer. In John's third month of work, he discovered conscious competence when he noticed that his days were less stressful. Thereafter, when John was challenged with new tasks, he quickly accelerated from unconscious incompetence to unconscious competence. He also felt safe when he worked.

Universal Design for Learning (UDL)
UDL is a framework for accommodating all learners when designing curriculum. UDL is learner-centric, providing guidance as to how all learners can be engaged to learn, how to represent so all learners have opportunity to learn, and how learners might best act or express themselves when they are being assessed. At its core, UDL is about providing choice through multiple means of engagement, representation, action, and expression. In doing so, all learners have opportunity, irrespective of their age, experience, personal learning style, cognitive ability, or disabilities (CAST, 2019). According to the National Center for Education Statistics, almost two in ten students enrolled in post-secondary institutions were disabled[1] in 2015-16 (NCES, 2019); accommodation for disabled students is important. Considering its universal capability, UDL is a logical and necessary design tool for CTE programs.

UDL Engagement
Engagement of students is the first battle to be won by an instructor. The way in-which curriculum affects a learner will define whether the learner will be motivated to learn, and learners respond markedly different to various teaching strategies (Lancaster, Lundberg, 2019). Learners are uniquely influenced by a variety of sources like background, experiences, and culture. Some learners prefer strict routine while others are engaged by novelty and spontaneity. There are learners who prefer to work with peers while others who like to work alone. Moreover, information is inaccessible to a learner when it is not attended to, or doesn't cognitively engage the learner (CAST, 2019).

For improved engagement, UDL Engagement Guidelines prescribe inclusion of multiple means of interest, sustained effort, persistence, and self-regulation. Examples include the provision of choice in learning objective pathways, reinforcement of content relevance to real-world scenarios, and clear direction in how a learner can succeed. Other UDL recommendations include reinforcement of the current goal, variance in demands and resources for optimized challenge, encouragement of community and collaboration, and provision of consistent feedback leading toward mastery (CAST, 2019a).

UDL Representation
People perceive and comprehend information in different ways. Consequently, there are dozens of learning style theories (Pearson, 2016). Some learners grasp information most efficiently through printed text, while others are more responsive to visual or auditory representation. Other challenges to curriculum representation include cultural and language differences, sensory disabilities such as blindness or deafness, and learning disabilities like dyslexia. Most important, when multiple representation methods are used, learning and transfer of information occurs because the learner has made a connection between and within concepts.

There is no single "means of representation that will be optimal for all learners" (CAST, 2019b, p. 1). Rather than be dependent on a single sensory input like sight, hearing, movement, or touch, UDL Representation Guidelines prescribe more than one means of representation in the

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[1] "Students with disabilities are those who reported that they had one or more of the following conditions: blindness or visual impairment that cannot be corrected by wearing glasses; hearing impairment (e.g., deaf or hard of hearing); orthopedic or mobility impairment; speech or language impairment; learning, mental, emotional, or psychiatric condition (e.g., serious learning disability, depression, ADD, or ADHD); or other health impairment or problem" (NCES, 2019, p.1).

curriculum. For example, an instructor lectures for no more than 20 minutes, then a lecture video [with transcript] of the same content is provided. Supplemental text with similar information from a different perspective is also provided. A web-based game can reinforce terms requiring memorization or key concepts.

Less obvious forms of representation include perception, language, symbols, and comprehension. For instance, when purchasing digital simulation software for use in a learning laboratory, a CTE instructor evaluates whether the software is capable of sound, speed, language, and text adjustments. The software should include features such as transcripts for languages that reflect learner demographics, images with text descriptions, and embedded symbol glossaries. A text-to-speech feature could open new doors for a learner with dyslexia.

Comprehension is an obvious priority for instructors, but learners who have not been exposed to a given CTE industry prior to enrollment will struggle to put information in context (Noor, Harun, & Aris, 2012). Access to background knowledge via web links can help a naïve learner establish context for subject matter. Highlighting of patterns, relationships, and big ideas drive comprehension through subject matter importance. Comprehension is achieved one component at a time, so a logical and sequential release of information is important. Last, the instructor should provide mechanisms for transfer of information, like checklists, reminder emails, and templates (CAST, 2019b).

UDL Action and Expression
Learners approach, navigate, and express themselves in different ways. When a learner has a language barrier, movement impairment, or organizational or strategic disability, their approach to learning will be very different. Some learners may best express themselves in written form, while others excel in verbal expression or demonstration. When learners act or express themselves, the learner will employ unique strategies, organization, and practice. Therefore, availability of multiple options for action and expression drives the optimization of action and expression (CAST, 2019c).

Textbooks, even software, provide for limited navigation and interaction. Software developed for technical industries can be limited in navigational function. For those learners who have physical disabilities, operation of software via a keyboard or joystick, could prove challenging. The option of navigation via keyboard or a joystick can open doors for the disabled. Ideally, software will operate by voice activation, an expanded keyboard, or even a single switch (CAST, 2019c). For the instructor who must choose among software and hardware designed by industry, choices in navigation can be limited. Nonetheless, choice in navigation should be one of the questions asked when selecting software for the CTE laboratory.

For the purpose of assessment, a medium of expression does not exist that is equally suited for all learners or communication types. However, a learner with dyslexia may struggle to write an assignment but excel in the recording of a video. Conversely, learners with limited social skills may excel in a writing assignment but struggle to produce a short video with a smartphone. In CTE, recording of a video while performing a task, and then reciting information from memory, can effectively demonstrate subject matter competence (CAST, 2019c). Fluidity of information in a video can indicate whether a student has reached a state of naturalization (Hill, Fadel, &

Bialik, 2018). In other words, the activity is second nature to the student. Also, web tools used for expression serve as excellent resources for the filling of gaps in spelling, writing, and creative skills.

Blended Instruction, UDL, and CTE
Considering the diversity of students in community college CTE programs, the adoption of either a pedagogic or andragogic instructional method may lead to undesirable student engagement, persistence, retention and success (Panacci, 2017). In blended instruction, the CTE instructor attempts to incorporate the best features of pedagogy and andragogy. When blended instruction is executed correctly, engagement of different learning styles and early connectivity is achieved (Crowder, C., & McCaskey, 2015). However, blended instruction can be difficult to competently execute (Jokinen & Mikkonen, 2013). Since the CTE lab and lecture environment provides generous opportunity for multiple means of engagement, representation, action, and expression, UDL is uniquely suited as a replacement for blended instruction.

Table 1
Sample Wiring Schematic Learning Module

Assignment	Engagement	Representation	Action Expression	Taxonomy
1. Build a load and switch electrical circuit.	Hands-on assembly; choice of circuitry type.	Instructor led lab demo; video lecture/transcript;	Assemble circuit; hand-drawn circuit diagram, or with web tool.	Dave's Imitation; Bloom's Memorize
2. How does electricity work?	Web terms game; knowledge survey.	Lecture; video lecture/transcript; text reading	Retention & comprehension quiz or video.	Bloom's Understand; Dave's Manipulation
3. Define a sequence of operation.	Choice of lab equipment; group study.	Lecture, video lecture w/ transcript	Online presentation, manuscript, or outline w/ recorded audio commentary	Bloom's Apply-Analyze; Dave's Manipulation
4. Diagram, build, & demonstrate the sequence.	Independent or group study.	Equipment lab models.	In-person demonstration or video presentation w/ transcript	Bloom's Create; Dave's Articulation
5. Demonstrate circuit dysfunction.	Independent lab study.	Lecture, video lecture w/ transcript	In person or group demonstration w/ recorded audio commentary	Bloom's Create & Evaluate; Dave's Naturalization

Table 1 demonstrates utilization of UDL in a CTE learning module that includes three kinesthetic laboratory assignments and two cognitive assignments. Moreover, the relationship between each assignment and Bloom's taxonomy, Dave's taxonomy, and UDL is demonstrated. The assignments incorporate engagement choice outline by UDL, for example, challenge, web games, knowledge surveys, and group and independent study. Choice for UDL representation includes lecture, video lecture, transcripts, and reading. UDL action and expression submissions are enhanced through the choice of text, hand drawn, web drawn, video-with-transcript, web, and group presentations.

Table 2
Sample Lecture-Lab Assessment Rubric

Dave's & Bloom's Taxonomy Alignment	Exceeds Trade Standard	Meets Trade Standard	Fails to Meet Trade Standard	Unacceptable Submission
Imitation & Understanding	10	7	4	1
Manipulation & Application	10	7	4	1
Precision & Analyzation	10	7	4	1
Articulation & Evaluation	10	7	4	1
Naturalization & Creation	10	7	4	1

Rubrics are an effective, learner-centric tool for objective assessment of knowledge and skills. Students find rubrics to be effective in the guidance of their learning processes (Leader, & Clinton, 2018). Table 2 demonstrates an assessment rubric for the cognitive and psychomotor assignments found in Table 1. The rubric ties Bloom's and Dave's taxonomies to trade standards previously represented to students. When considering this process from learning module to rubric, the application demonstrates how the use of UDL guidelines in CTE instructional design can result in multiple forms of engagement, representation, action, and expression.

Conclusion
CTE instructors are tasked with preparing diverse student populations for careers requiring formidable cognitive and psychomotor skills. Students come from no less than three generations, have unique mental and physical capabilities, and are likely equipped with a limited catalog of life experience. Fortunately, CTE instruction provides for a variety of instructional opportunity including lecture, demonstration, ad hock laboratory instruction, hands-on practice, and experimentation in the lab. The unique instructional experience found in CTE represents opportunity for development of new ways to engage students, represent information, incite student action, and cultivate student expression. UDL provides the framework for realization of CTE instruction that goes beyond the norms of pedagogy, andragogy, and blended instructional methodology. When UDL oriented curriculum has been integrated into learning management systems capable of audio, video, and other digital experiences, the stage has been set for exceptional CTE instruction that can effectively reach all community college learners. Achievement of UDL in CTE programs will require investment of time, resources, and concerted effort by faculty and administrators, but UDL holds the potential to raise the bar for CTE and is worthy of aspiration by community colleges.

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