NORTH AMERICAN COUNCIL OF AUTOMOTIVE TEACHERS

NACAT News

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Chairman of the Board

I hope everyone has thawed out from Winter – it was certainly a cold one!

When I was in college pursuing a business degree, Organizational Behavior was one of my favorite classes. I found something fascinating about the observation and study of the human element of "work", and how environment contributed to productivity and success (or lack of).

After spending time around a few different organizations over the past 3 months, I have seen firsthand how different groups operate and interact in different ways. Some organizations I was around were very bureaucratic – following specific procedures like a road map from A to B. Other groups I have spent time with have been very aristocratic, with a small number of VERY powerful, privileged leaders making decisions on behalf of the people beneath them, without consideration of their feedback or well-being. These methods of operation were not at all welcoming to an outsider, in fact, they were cold and made me feel a bit unwanted and out of place.

One remark I constantly hear from instructors who attend the NACAT Conference and Expo is how much they feel like part of a family when they are there. I enjoy hearing that and consider it a compliment. Would you enjoy being part of a group where your input didn't matter? I believe NACAT can exploit this to our advantage.

For more than 40 years, NACAT has prided itself on providing professional training in a family-like environment. Our events are warm and inviting. We provide more structure than stuffing 200 instructors inside a couple classrooms for 4-8 hour training sessions. Our conference is meaningful, manageable, and staffed with our industry's best trainers. On top of that, most of our attendees have met at least one fellow instructor at a conference whom they regularly stay in contact with during the school year. Again, "family" is our niche.

Your voice as a NACAT member does mean something. If you ever feel like NACAT is not living up to your expectations – if you feel alienated, overlooked, or unrepresented – please pull myself or any Board member aside and let us know. The Board is here to represent YOU!

As we draw closer to Summer and our upcoming Conference and Expo, I would like you to consider running for an elected position. Come and join us on the Board. Our job as Board members is to represent the membership and steer NACAT towards a bright future. I can't begin to describe how rewarding it is to serve and build something great that benefits so many people. The only way you can know is by serving yourself.

I am looking forward to catching up with many of you in Calgary in July for the 2019 NACAT Conference and Expo. I hope to see you there!

Steve Gibson, Board Chair
Program Coordinator, K&N Engineering

Share Updates, Submit Articles!

Do you have an update on a member you would like to share? Do you have information on great or interesting happenings at a school, on a new restoration, congratulations that should be wished or condolences given? We want to hear from you!

Of course, you can also send us articles you have written or find interesting. If the intellectual property rights allow, and it is appropriate for the NACAT audience (no sales pitches, please reserve those for advertisements), we would be pleased to consider it for inclusion in an issue of NACAT News. Based upon a potential number of submissions or factors, included content will be placed in issues based upon timeliness and available space.

Please e-mail any submissions to *nacatnews@nacat.org*. Editorial privilege is implied.

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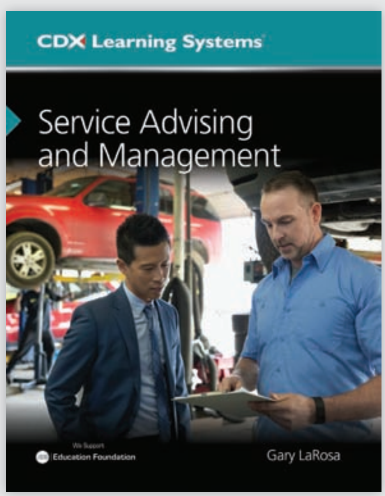

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The Touch: One hand reaches another. Statues outside a Department of Education building in Calgary.

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ADVERTISING RATES

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DEADLINE DATES

Fall 2019 - September 1, 2019

Winter 2020 - December 1, 2019

Summer 2020 - March 1, 2020

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Optimizing Technical Education Pathways: Does Dual-Credit Course Completion Predict Students' College and Labor Market Success? (Part II)

By: L. Allen Phelps and Hsun-Yu Chan

Student and School Indicators Associated with CTE Dual Credit Outcomes

Looking beyond student outcomes, studies of CTE dual credit initiatives have also revealed important school-level and student-level factors that offer preliminary insights about how dual credit learning works for particular students or students who choose selected career and college pathways. As noted in Table 2, several CTE dual credit programs include specialized student supports, such as developmental classes or campus-based engagement activities, such as new student orientations. This section briefly summarizes the research literature on student- and school-level factors or indicators that associated with positive CTE dual credit outcomes.

Some studies of local high school/two-year college dual credit programs have documented key benefits and promising practices. Harnisch and Lynch (2005) conducted in depth case studies of high school/technical college dual enrollment programs in three Georgia communities. They noted dual enrollment opportunities generated three major benefits not available in most high schools: exposure to college, increased options (i.e., seeing new possibilities for themselves), and narrowing down career choice options. More generally, dual enrollment programs forge stronger links between high schools and two-year colleges. Bishop-Clark et al. (2010) described the key observations of 64 students who participated in five physics and math dual credit courses offered at a regional, career and technical high school in Ohio. More than 94% of the students rated the dual credit course experience as excellent or good. Feedback from faculty members and students identified the most important program success factors as: creating an environment where relationships can flourish, allowing the instructors to identify the dual credit courses to be offered, and creating a strong mentoring relationship for instructors which focused on a rigorous curriculum and extensive assessment of student learning.

The empirical evidence documenting the optimal location and instructor qualifications for dual credit courses is limited. However, a recent review of current practices (Borden, Taylor, Park, & Seiler, 2013) informs the aforementioned HLC's new guidelines indicating college locations and college qualified personnel constitute the optimal delivery arrangements for dual-credit courses. Speroni (2011) examined the differences in postsecondary effects or outcomes for high school students completing Advanced Placement (AP) and academic (non-CTE) dual enrollment courses in Florida. Examining the longitudinal status of these particular student groups, Speroni found that both high school experiences were associated with positive but different outcomes. Dual enrollment students were more likely than AP students to go to college directly, and less likely to enroll in a 4-year bachelor's program. For dual enrollment students, the effects were driven by the course location. Dual enrollment courses completed in local community colleges were associated with positive outcomes, whereas there were no effects for dual enrollment academic courses completed in high schools.

In Texas an inner-city college preparation program Advanced Placement Incentive Program (APIP) provided AP courses to low-income, ethnically diverse students (Jackson, 2014). As part of the implementation design, high school instructors were provided with teacher training and 11th and 12th grade students and their instructors received payments when passing scores on AP exams were attained. Between 1996 and 2008, 58 urban high schools and approximately 138,000 students participated the AP Incentive Program. Compared to similar cohorts of students attending similar non-APIP high schools in Texas, students were more likely to pass AP exams, remain in college beyond the first and second years, and earn higher wages. By tracking two cohorts of program graduates for 10 years, the cost-benefit ratio for the program was estimated as 37:1 resulting in a lifetime earnings benefit of $16,650. The effects for Hispanic students were particularly noteworthy: 2.5% greater college completion rates and 11% greater earnings (Jackson, 2014).

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Article

Similarities in the Evolution of Plants and Cars (Part I)

By: Samantha Hartzell, Mark Bartlett, Jun Yin, & Amilcare Porporato

Abstract

While one system is animate and the other inanimate, both plants and cars are powered by a highly successful process which has evolved in a changing environment. Each process (the photosynthetic pathway and the car engine, respectively) originated from a basic scheme and evolved greater efficiency by adding components to the existing structure, which has remained largely unchanged. Here we present a comparative analysis of two variants on the original C3 photosynthetic pathway (C4 and CAM) and two variants on the internal combustion engine (the turbocharger and the hybrid electric vehicle). We compare the timeline of evolution, the interaction between system components, and the effects of environmental conditions on both systems. This analysis reveals striking similarities in the development of these processes, providing insight as to how complex systems—both natural and built—evolve and adapt to changing environmental conditions in a modular fashion.

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Competing Interests

The authors have declared that no competing interests exist.

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NACAT President

As I sit down to compose this article for NACAT News, I notice, on my desk, a stack of tests that I just finished marking and an outline for what needs to be completed for this year's Conference and Expo at SAIT (Southern Alberta Institute of Technology). I am reflecting on the similarities between teaching and NACAT. We, as educators, take time to prepare the appropriate lesson plan, and then we put everything into that lesson to ensure that our students succeed in the automotive repair industry. In addition to that, we still find the time to provide additional support to students who are experiencing difficulties. NACAT performs similar tasks: preparing learning opportunities, working on enhancing the lesson process with technology, working with industry to create a unified front, and developing ways to enhance the automotive education system.

As educators, our professional development is not just a requirement of our employment. It is critical to our development and growth, both professionally and personally. So, if you have not already begun to make plans to attend the 2019 Conference and Expo at SAIT in Calgary, AB you need to. You also need to reach out to your colleges and encourage them to attend. NACAT has listened to the membership. You requested more OEM training, and we have reached out to the OEM trainers to join us in Calgary. Look to the website for updates, and register now for the Conference and Expo in Calgary, AB July 15 –19.

As this will be my final submission to NACAT News as your President, I find myself reflecting back on the last two years. I will say that my time spent on the Board has truly aided in my personal and professional development, something that I have also enjoyed sharing with my students. As I look to the future of NACAT, I am excited for what lies ahead. Your Board of Directors has been working tirelessly and exuberantly to ensure that NACAT evolves in order to best support you, the membership. There is too much to share in an article, but I will share one exciting thing that the Board is working on right now: The Board is working to integrate our students into NACAT. Join us in Calgary where we will be happy to share more about the direction NACAT is moving towards. I would also like to take this opportunity to invite you to join the Board and help design the future of automotive repair education.

The Summer Conference and Expo is an exciting and engaging opportunity for professional development and comradery. I look forward to seeing you and your colleagues in Calgary. Together we can change the classroom and have an effect on the automotive technicians of tomorrow.

Patrick Brown-Harrison, President

NACAT Member Benefits

- NACAT members receive a discounted registration to the NACAT Conference. This annual event provides technical training and professional development classes. The sessions are presented by the industry's leading subject matter experts. The conference tradeshow provides attendees time to meet textbook authors, publishers and manufacturers of training aides. There is plenty of time for networking, fun, and industry awards in a very family friendly atmosphere.
- NACAT members are eligible to receive awards and scholarships.
- NACAT members receive three (3) issues of the NACAT News per year.
- NACAT Members receive nine (9) issues of the NACAT eNews per year.
- NACAT members receive preferred pricing on equipment, subscriptions, tools and training aides from NACAT's industry friends. This information is available in the NACAT News and the NACAT website.
- NACAT members have access to the shared resources repository at the NACAT website.
- NACAT members make life-long friendships through this network of like-minded individuals. Members are part of a family of educators preparing people for careers in the automotive industry or wherever life may lead them.

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To summarize the limited set of studies examining high school and two-year college dual credit programs:

- The empirical evidence on 2-year college retention and success is substantially limited, compared to the results for high school/4-year college sector.
- While CTE dual credit course enrollments represented nearly half of the high school dual credit offerings in 2011, the specific influence of these courses on students' postsecondary success is under-examined compared to academic dual credit courses.
- Only one study has examined the labor market experience of dual credit completers attending community and technical colleges.
- The limited evidence regarding promising practices for students and educators considering CTE dual credit partnerships is largely descriptive and based primarily on qualitative data.

Fueled by rising college costs and debates about appropriate, next-generation high school standands, several important questions remain unanswered for educators, researchers, students, and parents considering the efficacy of two-year college postsecondary options following high school.

Method

Design

We used a correlational design to examine whether completion of dual credit courses was associated with success at the technical college and in the regional labor market. In addition to exploring the relationship between dual credit history and short-term annual income, we further examined how dual credit is related to income above the federal minimum wage. This approach not only sheds light on the plausible longitudinal effect of dual credit on a more meaningful measure of employment outcome, but also rules out, though imperfectly, students who only worked a part-time job or were still enrolled in a college. As such, this outcome variable is considered as income above poverty level. Finally, to capture the multilevel nature of the study design and data, all statistical analyses were conducted under the framework of hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002; Snijders & Bosker, 2012).

Data Sources and Sample

In states with comprehensive community and technical college systems, these dual credit CTE courses provide important foundational experiences in career pathway programs that culminate in workforce credentials (certificates, certifications, and diplomas) and associate degrees. In Wisconsin, the 16 two-year technical college districts have historically served a significant segment of the college-going, career-focused population. For the high school graduation cohorts of 2011-13, 17.4% of Wisconsin public high school graduates enrolled directly in a technical college (Ann Westrich, Wisconsin Technical College System Board, Personal communication, August 15, 2015).

Our study analyzed the multilevel, longitudinal administrative and transcript data supplied by Fox Valley Technical College (FVTC), which included the complete transcript records and demographic background for each student. Specifically, the transcript record documents the three different types of dual credits high school students can earn and transfer to FVTC (see Table 1 for an explanation). These longitudinal records are matched annually with the Unemployment Insurance (UI) wage record files, housed in the Wisconsin Department of Workforce Development (2015), to provide employment and earnings data. The research team was able to access the de-identified data set for the sample, once a data sharing agreement was negotiated and signed by the institutional review board and the WTCS Office. In addition, given the nature of the transcript and administrative records, students' dual enrollment records represent the dual credits transferred to FVTC. To allow a reasonable window of program completion, which is one of the outcomes of interest in this study, we focused on students who graduated from 20 public high schools in Fox Valley area in Wisconsin between 2008 and 2010 and enrolled in FVTC between 2009 and 2012 because the wage data of fiscal year 2013 (FY13) was the latest data available to us. These 20 high school were selected because in recent academic years, a large portion of new enrollees in FVTC graduated from these high schools, and the high school-level data were derived from the Wisconsin Department of Public Instruction database. In total, 2294 students were included in the analyses (see Table 3 for a student dual credit profile and Table 4 for a description of dual credit enrollment patterns).

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Introduction

Today, plants make up the majority of living biomass on earth [1] and the automobile is by far the most popular method of passenger transport worldwide [2]. These systems, while quite different in their functions, are powered by processes which have evolved over time in a remarkably similar fashion. Both originated from a basic, highly successful scheme and improved by adding components in a process of modular evolution. Designers of cars limited by oxygen availability developed the turbocharger [3], which functions similarly to the C4 "carbon pump" by concentrating a limiting reactant to improve efficiency [4]. As demand for fuel and water use efficiency increased, designers introduced the energy storage system of the Hybrid Electric Vehicle (HEV) to address inefficiencies caused by variable power demand [5], while plants evolved the Crassulacean Acid Metabolism (CAM) carbon storage system to reduce inefficiencies caused by diurnal variability in light and atmospheric humidity [4].

The basic photosynthetic pathway uses light energy to transform carbon dioxide into three-carbon sugars which are used to power plant processes and build tissue. This is accomplished through a complex series of processes involving the light reactions, which use light energy to break up water into oxygen and protons (fuel), and the Calvin cycle, which fixes carbon dioxide into sugar (energy). The C3 pathway, so-called because of the three-carbon sugar it produces, was the first photosynthetic pathway to evolve in modern terrestrial plants. According to the endosymbiotic theory, this pathway developed in eukaryotes around 1 Ga ago when photosynthetic cyanobacteria were first incorporated into algae as chloroplasts. This development was then carried over into terrestrial plants [6]. The basic C3 pathway can be compared to the modern Otto cycle internal combustion engine (ICE), which was patented by Nikolaus Otto in 1876. Like the revolution caused by the incorporation of photosynthetic bacteria into algae, this gasoline engine was quickly incorporated into the first automobiles (see **Fig 1** for a brief evolutionary history of both systems). Since then, many aspects of the automobile design have changed, but the main agent of propulsion, the ICE, has remained remarkably consistent [7], as has the chloroplast in plants [8, 9].

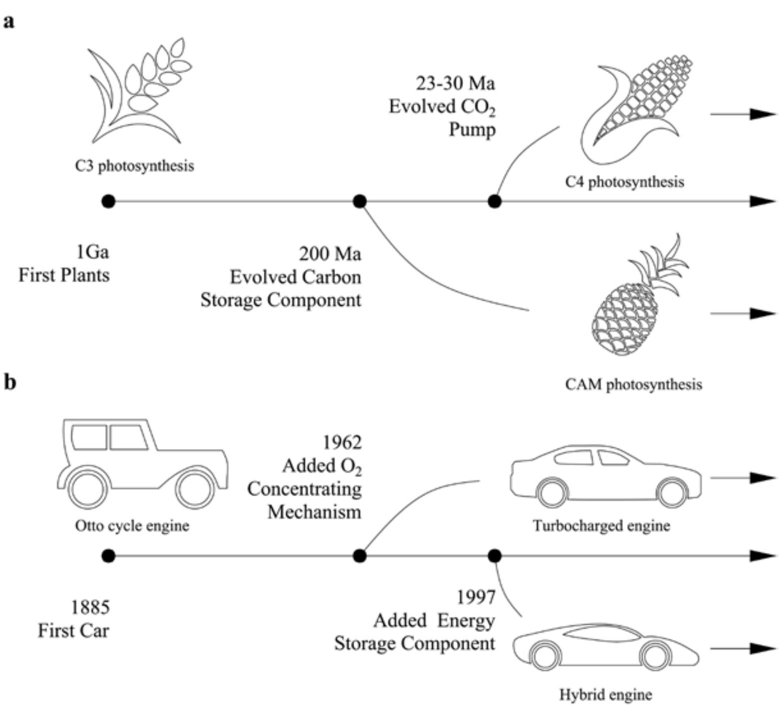

Fig 1. Comparative evolution of plants and cars.

(a) In 1885, Karl Benz was among the automobile's first producers, and in 1908, the Ford Motor Company pioneered the first mass produced automobile, the Model T [5]. The turbocharger gained popularity during World War II, when it was used in military aircraft, which had to cope with low-pressure, high-altitude air [3], and the first turbocharged passenger car, the Chevrolet Corvair Monza, debuted in 1962 [10]. Serious interest in hybrid technology arose in the 1960s when it was recognized as a means for harnessing variability in driving conditions to lower fuel use and emissions, and the Toyota Prius was introduced in 1997 as the first mass produced hybrid car [5]. (b) The first C3 plants developed around 1 Ga ago as aquatic lifeforms [6]. CAM photosynthesis evolved during the Paleozoic era and likely experienced a significant expansion in terrestrial plants in the Cenozoic era, which was accompanied by increasing seasonality of water availability [4]. C4 photosynthesis is thought to have first evolved in the mid-Tertiary period and experienced a large increase in the late Miocene, 4-7 Ma, which brought decreasing CO2 levels [4].

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Both the Otto cycle and the C3 photosynthetic pathway have limited efficiency under typical operating conditions. The internal combustion engine works by combusting fuel with an oxidizer (air). The power produced is limited, among other factors, by the amount of air taken into the engine. This is characterized by the volumetric efficiency, i.e., the ratio of the actual to the theoretical maximum amount of air which could be taken in [7]. ICEs also experience a large decrease in fuel efficiency under variable traveling speed (particularly stop-and-go traffic), as the engine is constantly running and the braking process dissipates kinetic energy.

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However, for the analysis of annual income in FY13, only students enrolled in FVTC in school year 2009-10 were included so that we allowed a three-year window, or 150% of the program duration of associate degree or two-year technical diploma, for students to complete a program. Therefore, the results should be understood as short-term educational or employment outcomes. For the sake of consistency, we adopted fiscal year (FY) as the unit of time in the analyses.

Table 3. Incoming FVTC students with dual credit from 20 WI high schools, 2009-2012 (N=2295)

Type of Dual Credit	Students Entering FVTC 2009-12	% Completing Dual Credit	No. of Dual Credits Earned
Youth Options (YO)	219	9.5%	1840
Advanced Standing (AS)	176	7.7%	772
Transcripted Credit (TC)	358	15.6%	1319
Any Type	662	28.8%	3931

Table 4. Amount of dual credit earned by type of credit, 2008-10 cohort

Dual Credit	No Credit	1-3 Credits	4-6 Credits	7+ Credits
YO	2076 (90.5%)	78 (3.4%)	65 (2.8%)	76 (3.3%)
AS	2119 (92.3%)	103 (4.5%)	50 (2.2%)	23 (1.0%)
TC	1937 (84.4%)	257 (11.2%)	66 (2.9%)	35 (1.5%)
YO + AS	1929 (84.1%)	162 (7.1%)	100 (4.4%)	104 (4.5%)
AS + TC	1792 (78.1%)	316 (13.8%)	119 (5.2%)	68 (3.0%)
TC + YO	1929 (84.1%)	162 (7.1%)	100 (4.4%)	104 (4.5%)
All three	1929 (84.1%)	94 (4.1%)	107 (4.7%)	165 (7.2%)

Note. The percentage does not add up to 100% because of rounding.

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New Partnership Supports Innovation and Talent Development for North America's Automotive Industry

The Automotive Industry Action Group and Conestoga College Institute of Technology collaborate to support talent development of current and emerging automotive industry professionals.

A new partnership between the Automotive Industry Action Group (AIAG) and Conestoga College Institute of Technology will help bolster North America's automotive purchasing and supply chain networks through education and talent development initiatives that will support innovation and competitiveness.

The collaboration will bring together industry and academic resources for the development and delivery of integrated educational programming for current and emerging automotive industry professionals.

"AIAG is excited about the opportunity to partner with a world class academic institution like Conestoga College to accelerate the development of the next generation of supply chain talent," said J. Scot Sharland, CEO of AIAG. "Our collaboration will focus on automotive industry purchasing and supply chain management strategy and practice innovation that both anticipates and helps mitigate emerging global challenges and threats."

AIAG is a member-driven not-for-profit association where automakers and suppliers across the global supply chain – along with partners from academia, government and other sectors – work collaboratively to develop and implement solutions to common industry pain points.

The organization delivers training and certification courses through its headquarters in Southfield, Michigan, and partners with universities and colleges to offer additional educational and professional development programs to serve the sector's purchasing and supply chain networks.

Among its initiatives is the Global Automotive Purchasing and Supply Chain Network (GAPSCN), established through a collaboration with Wayne State University. The network supports students and professionals through educational programming designed to advance knowledge and experience in automotive supply chain management.

As part of the new partnership, Conestoga will explore the potential of joining the network.

"Conestoga is committed to working with industry partners to develop career-ready graduates with the skills and knowledge to address real-world needs," said Brian Watson, Director of the Magna Centre for Supply Chain Excellence at Conestoga. "The collaboration with AIAG will support the development and enhancement of supply chain management programming as we work together to support the competitiveness of Ontario's automotive sector through education and applied research."

Conestoga is a leader in polytechnic education, delivering a comprehensive range of career-focused education, training and applied research programs to support workforce needs, prepare students for success, and contribute to stronger, more competitive businesses.

About AIAG
Established in 1982, AIAG is a not-for-profit association where professionals from a diverse group of stakeholders – including retailers, suppliers of all sizes, automakers, manufacturers, service providers, academia and government – work collaboratively to streamline industry processes via global standards development and harmonized business practices. To learn more about AIAG, visit www.aiag.org.

About Conestoga College Institute of Technology and Advanced Learning
Established in 1967, Conestoga serves approximately 55,000 full and part-time learners each year through a network of campuses and training centres in southern Ontario. The college delivers a comprehensive range of career-focused programs and applied research to meet workforce needs and promote economic growth across the communities we serve. For more information, visit www.conestogac.on.ca

Are Light-Duty Diesel Fuel Delivery Systems Difficult to Diagnose?

One of the reasons individuals are hesitant to work on diesel performance concerns is they don't fully understand the diesel fuel delivery system. In this article I hope to remove some of the mystery and show that on a modern light-duty diesel engine fuel system, it is not that different then a gasoline direct-injected engine.

Any modern light-duty diesel engine has a low pressure and a high pressure fuel delivery system. A problem with either system can lead to a lack of power, a hard starting condition, or a no-start condition. A problem may or may not set a diagnostic trouble code depending on its origin. Before diagnosing the fuel system ensure the batteries and charging system pass their respective tests. Low system voltage can lead to a variety of fuel delivery concerns. Let's begin with the low-pressure system.

When diagnosing the condition of the low pressure fuel system, the technician should be concerned with four items: fuel quality, fuel pressure, fuel volume, and any air in the fuel system. The manufacturer may provide fuel volume or fuel pressure specification, not necessarily both, depending on the system. The first test is relatively simple. Obtain a fuel sample from the tank. Is the fuel clean and does it smell OK? Fuel that is dirty or smells bad may be contaminated and need to be replaced. On some models, it is surprisingly easy to put diesel exhaust fluid in the fuel tank on accident. It should be noted that contaminated fuel may cause other failures within the high pressure and low pressure systems besides not having the needed BTUs to start the engine.

Refer to the service information for the proper location and procedure for measuring the low pressure fuel system pressure and volume. If the pressure or volume is low, check the conditions of the fuel filters. Many systems have a primary and secondary filter that may need to be replaced. Some manufacturers are now recommending the fuel filters be replaced every 10,000 miles. If a compatible scan tool is not able to energize the low pressure fuel pump, the fuel pump relay may need to be bypassed to allow the system to run long enough to get an accurate pressure reading. If a specification is not given, most modern low pressure fuel systems will pump a quart of fuel in about 15 seconds. When running a volume test, look for air in the fuel sample. Low volume or air in the sample is an indication of a failing low pressure pump.

The diagnosis of the high pressure fuel system can begin with the scan tool. Most systems have a fuel pressure sensor PID that can be viewed with a scan tool. Many high pressure fuel system components will set a code if there is a failure. Some common codes that will be seen include P0087 (fuel rail pressure low) and P0093 (fuel system large leak). Although the high pressure fuel system cannot be tested with a traditional gauge. Many scan tools have an actuator or system tests that will cycle the high pressure pump through different operating levels and report the results.

The fuel pressure at the rail is maintained by the fuel volume control valve and the fuel pressure control valve. In many cases these components will fail to operate properly if they are contaminated. The failure may result in too much fuel being returned to the tank on the low pressure return line. Temporarily blocking the return line to the tank can be used to diagnose this problem. If a vehicle, which previously failed to start, now starts this is an indication one of these components has failed.

When removing the fuel volume control valve or the fuel pressure control valve from the high pressure fuel system, inspect the inlet screen for the presence of debris. If metal particles are present there is a high probability the high pressure pump is failing. There is also a high probability that the metal particles have made their way to the high pressure injectors. If there are no metal particles present, it is likely the injectors will not have to be replaced.

When diagnosing or replacing any high pressure fuel system component, it is important to follow the manufacturer's procedures. The failure to properly relieve high pressure fuel can damage the vehicle or cause personal injury. After any of the high pressure fuel system components are replaced, be sure to complete the appropriate repair verification test to ensure there will not be any repeat repairs.

If any high pressure fuel system has to be replaced, it is important to emphasize to customer the importance of quality diesel fuel. In addition to powering the engine, diesel fuel is used to lubricate, cool and seal the injection system. Improperly treated or contaminated diesel fuel can lead to expensive fuel system repairs.

When comparing the processes in this article with a vehicle that has a gasoline direct-injected engine there are many similarities. Like the diesel engine, the gasoline direct-injected engine high pressure fuel system can only be diagnosed with a scan tool and contaminated gasoline can have a similar negative effect on high pressure fuel system components. With a bit of research and understanding, an individual can effectively repair either system with the same level of success.

eSCOPE ELITE4 (ESL3100)

eSCOPE ELITE4 with Surface Pro 6 Tablet (ESL3000)

eSCOPE ELITE4 Handle Articulation

Continued from page 10

In the C3 photosynthetic pathway, carbon dioxide diffuses into the leaf and reacts with ribulose-l,5-bisphosphate (RuBP) to produce sugars, which are ultimately used to form carbohydrates (see **Fig 2**). Efficiency is strongly impacted by photorespiration, a process by which RuBP reacts with oxygen, rather than carbon dioxide. Under the modern atmospheric composition, the high concentration of oxygen relative to carbon dioxide leads to significant photorespiration, reducing the overall efficiency of C3 plants by about one-third [11]. Plant efficiency is also limited by considerations of water availability. Water use efficiency, i.e., the ratio of carbon assimilated to water vapor lost, is a key determinant of plant performance in water-limited conditions [12, 13]. Plant water use efficiency decreases strongly when certain atmospheric conditions (high temperatures and low humidity) cause a high evaporative demand.

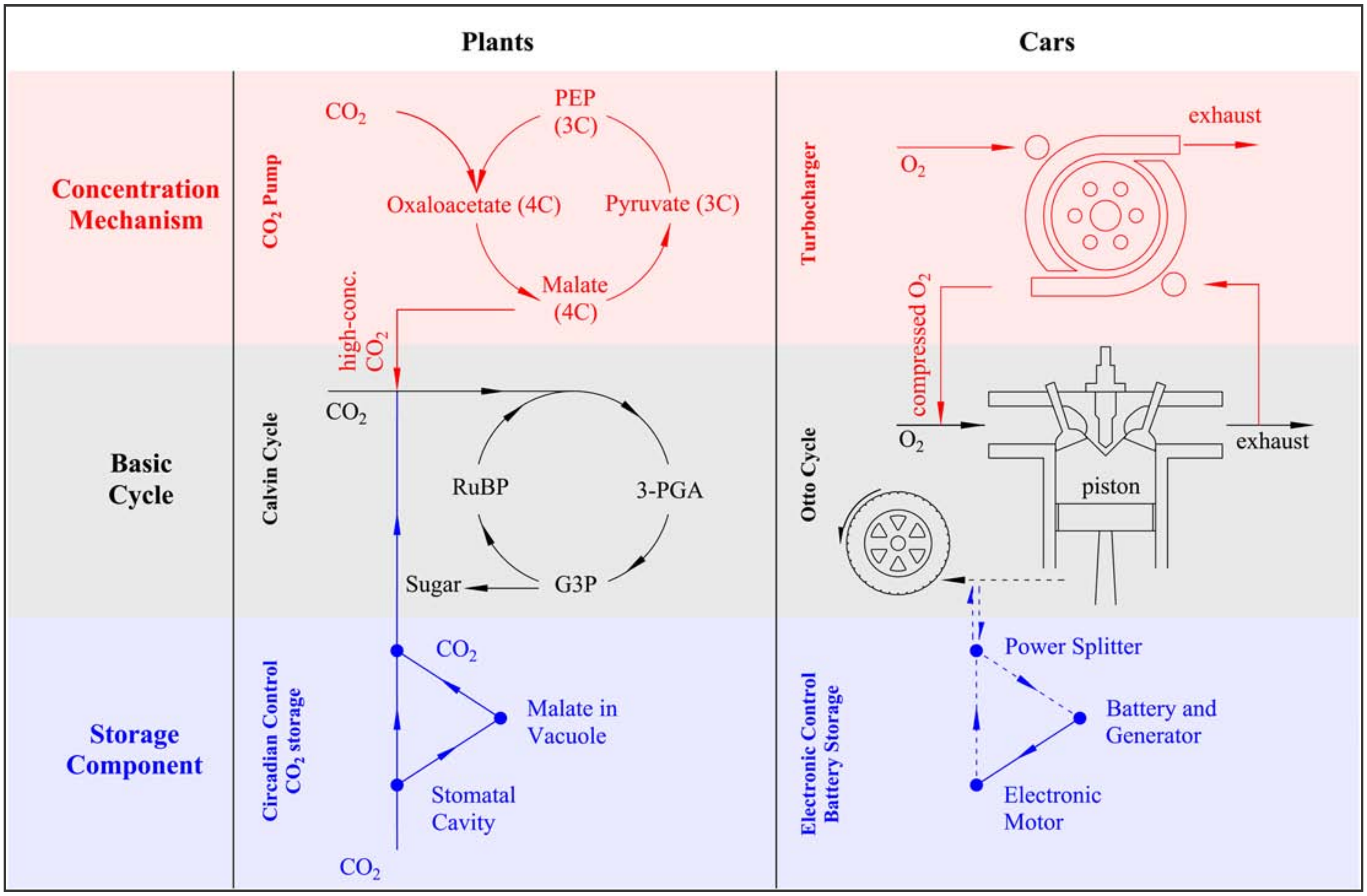


Fig 2. A comparison of plant photosynthesis and car engine functioning illustrates how the core processes interact with the additional components.

The core processes in each system are the Calvin cycle and the ICE (middle row). A concentrating mechanism in C4 plants and turbocharged cars provides concentrated CO2 and oxygen, respectively, to the core cycle (upper row). A storage mechanism in CAM plants allows carbon dioxide to be stored as malic acid at night and then passed to the Calvin cycle during the day, while a storage mechanism in HEVs allows energy to be stored in the battery during braking and then passed to the motor to power the drivetrain in parallel with the engine (bottom row).

https://doi.org/10.1371/journal.pone.0198044.g002

Materials and methods

Turbocharged vs. conventional ICEs

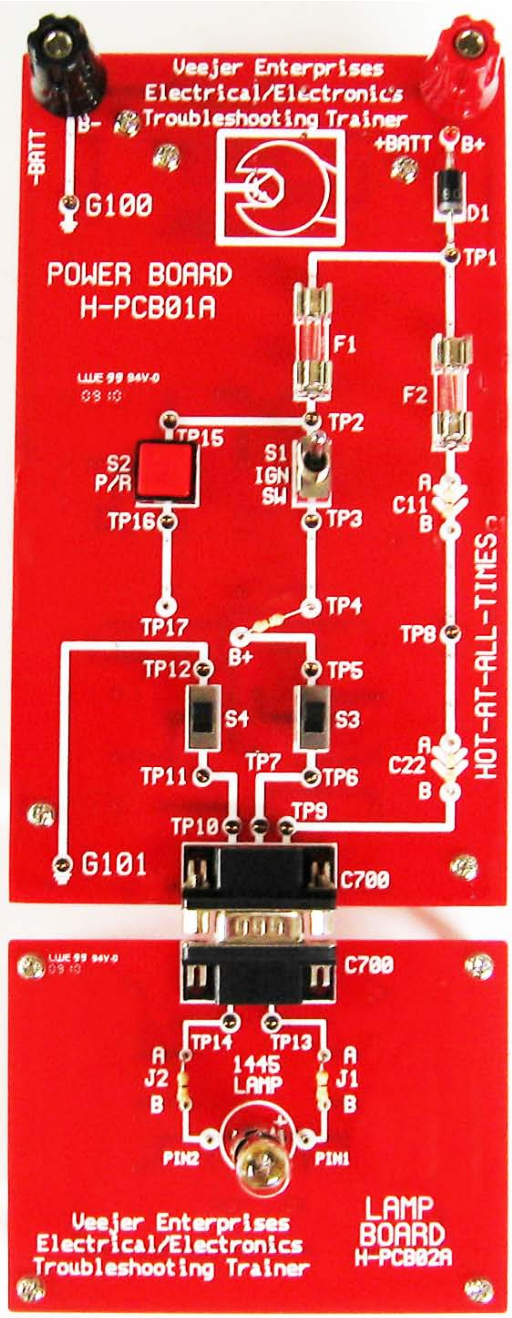
In order to illustrate the advantages of turbocharged and supercharged engines in environments with low substrate (oxygen) concentration, we compared the power output of these engines with conventional ICEs under decreasing oxygen concentration caused by increasing altitude in airplanes. In the case of the supercharged engine, data were obtained on power output with altitude for the Merlin III aircraft during World War II [14]. Power output for conventional ICEs is plotted using an estimate of 3% power loss per thousand foot altitude gain [15].

Continued on Page 23

Hands-On Vehicle Electrical Troubleshooting Training Program

by Vince Fischelli, Veejer Enterprises Inc., Garland, Texas

Phone: **972.276.9642** Web Site: **www.veejer.com**



H-111A(S) The Starter Kit

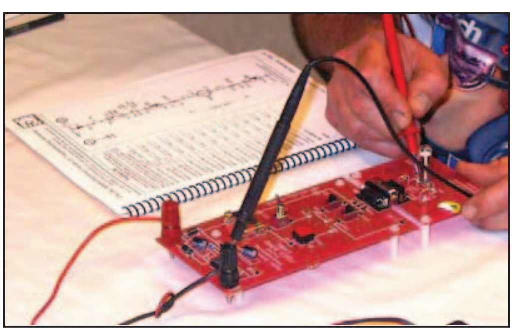
Introducing an effective Hands-On Electrical Troubleshooting Training Program that teaches automotive, truck, diesel and heavy-duty future service technicians how to troubleshoot vehicle electrical-electronic circuits with "hands-on" Electrical Troubleshooting Trainers designed by Vince Fischelli, Veejer Enterprises Inc.

These Troubleshooting Trainers begin with the H-111A(S) shown at the left. They are completely constructed circuit boards that snap together to simulate a live vehicle circuit. Using the Student Workbook, H-WB111A, a student is guided through a series of circuit voltage tests, voltage drop tests and resistance measurements to learn how to test a live vehicle circuit using a DMM. This focuses electrical training time on actual testing of circuits, how they work and how they fail, rather than consuming valuable classroom time building circuits.

Once a technician understands essential circuit measurement skills with a DMM, the Instructor Guide, H-IG111A, explains how to insert electrical problems on the bottom of the circuit boards. Then the student troubleshoots from the top of the circuit boards while documenting his troubleshooting steps in the Student Workbook, H-WB111A, to compare with answers provided in the instructor guide.

Problems are inserted in seconds at various points in the voltage side or the ground side of the circuit to keep technicians busy troubleshooting. By removing a wire jumper on the bottom, an open circuit is created at some point in the circuit. By inserting a fixed resistor, a voltage drop problem is created. Inserting wire jumpers at various points create shorts-to-ground. Students learn to successfully troubleshoot vehicle electrical-electronic circuits by doing it rather than watching someone else do it or just by talking about it. Students successfully troubleshoot electrical problems by themselves, over and over 32 times until they get it right and electrical circuit troubleshooting becomes second nature.

Students practice hands-on troubleshooting a live circuit with real problems to develop self-confidence and convince students they can troubleshoot vehicle electrical circuit problems. The benefits of this electrical troubleshooting training will last for the rest of their careers. It's a great way to master electrical troubleshooting skills as students become confident electrical circuit troubleshooters who won't troubleshoot by changing parts but first troubleshoot by testing a circuit with a DMM to identify the problem. The student below is troubleshooting a problem and recording troubleshooting steps with DMM readings in a student workbook to be reviewed later.



The Starter Kit: Part # H-111A(S) is the first troubleshooting trainer. Comes with 2 circuit boards with step-by-step troubleshooting training. ("S" is the school version) Each Starter Kit contains the two Troubleshooting Trainers shown at the left; Power Board, H-PCB01A and Lamp Board, H-PCB02A. Each H-111A(S) is purchased without books. A bag of fixed resistors for inserting problems is included. Student workbooks, H-WB111A are purchased separately, as well as the Instructor Guide, H-IG111A and the Power Point for H-111A. Other trainers connect to The Starter Kit: H-113(S) DC Motor Circuit Troubleshooting; H-115(S) Troubleshooting Relay Circuits; H-116(S) Wire Harness Troubleshooting and H-200(S) CAN Bus Troubleshooting.. Each circuit board develops a student's understanding of advanced circuit troubleshooting and builds self-confidence.

Live circuit repetitive troubleshooting practice is the only way to learn and develop electrical troubleshooting skills!

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Measures

Academic and employment outcomes. There are four academic and three employment outcome variables. The four academic outcome variables include whether the students transferred any dual credit to FVTC, overall course completion rate, second-year retention for those who enroll in programs lasting longer than one year, and graduation status three years after the first-time enrollment. In particular, courses that students withdrew were not included when calculating the course completion rate. These variables were derived from students' transcript record. The three employment outcome variables include students' full-time employment status (defined by whether students' annual income in FY13 exceeding $15,080, based on the federal minimum hourly wage: $7.25 × 40 hours per week × 52 weeks per year = $15,080), annual income in FY13, and annual income for those who are considered employed full-time (i.e., earning annual income greater than $15,080 in FY13). These variables were extracted from the UI wage record file, and the annual income was the summation of the four quarterly income in FY13. Moreover, we applied logarithmic transformation using nature log as the base to transform the dollar amount into logarithmic value given the distribution of wage data (skewness = 1.05, kurtosis = 1.62, mean = $16,431.55, median = $14,757.00, SD = $10,724.97; minimum = $52.00, maximum = $76,164.00), in that the presence of outliers may influence the normality of the distribution of the wage variable and further affect the estimate of standard error. See Table 5 for a summary of the descriptive statistics.

Dual credit record. We created three new variables that each represents students' cumulative transferred dual credit in Transcripted Credits (TC), Youth Option (YO), and Advanced Standing (AS) courses from the transcript record as continuous variables as a response to the three distinctive types of dual credit implemented by the Wisconsin Department of Public Instruction (see Table 1 for the definitions). These credits were all successfully transferred to FVTC, and were regarded as key independent variables in the analyses except the model using dual credit as the outcome.

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"Every great dream begins with a dreamer. Always remember, you have within you the strength, the patience, and the passion to reach for the stars to change the world."
– Harriet Tubman

Summer Elections - 2019

North American Council of Automotive Teachers (NACAT) is currently accepting nominations from individuals to fill a number of board positions and vital officer position.

NACAT is a family-centered organization comprised of member educators who provide mentoring, educational support, and voice for automotive educators in secondary and post-secondary schools throughout North America. The organization is investing in the repair industry of tomorrow, and is recognized for the exemplary cutting-edge conference it provides to educators each year in different regions of the United States or Canada.

Are you an individual who currently works in the field of automotive education? Do you want to contribute to the industry that has become your profession? Are you an individual that has the desire and intent to use your unique qualities and talents to make the automotive repair industry a better place for the technician and industry of tomorrow? Do you work well with others in efforts to create a common good? If you answered "yes" to those questions and you are currently a NACAT member of record, and have been for a minimum of 24 months, you are certainly an individual who should consider our open positions.

Positions for 2019:

- Board Member *(Three seats open, each with a 3 year term)*
- Vice-President / President-Elect *(2 year term as Vice-President followed by 2 year term as President)*

If you feel that you have something to offer NACAT, automotive education, and the automotive industry, please consider running for one of the open positions. ***You can help us continue to make a difference.***

For more information on the open positions, or to learn how to submit a nomination form for one of the open positions, please go to http://www.nacat.org/index.php/general-election-information.

NACAT 2019 Conference Hotel Information

Accommodation information for the 2019 NACAT Conference & Expo is available. There are four hotels available for use. Registration links, when applicable, are provided at http://www.nacatconference.org/index.php/2019-accommodations.

Holiday In Express Hotel & Suite Calgary University (July 14 - 19, 2019)

- Includes parking, Wi-Fi, and breakfast

Standard room: One king or two queen beds

- $149.99 per night

Suite: One king or two queen beds

- $159.99 per night

How to reserve:

- Call Direct (587) 390-6100 and quote the block code "CAT" or group name "North American Council of Automotive Teachers"
- Please note a credit card will be needed to guarantee your reservation.
- *All reservations must be made by 6:00pm MDT on June 14, 2019.*

Best Western PLUS

- Room rates vary based upon date
- Includes buffet breakfast

Standard Double: Two queen beds

- $179 per night July 13 & 14
- $139 per night July 15-18

King Atrium: One king bed + pull out sofa

- $199 per night July 13 & 14
- $159 per night July 15-18

How to reserve:

- Call 403-289-0241 Option #7 group code "NACAT"

Hampton Inn (July 14 - 18, 2019)

- Includes parking, Wi-Fi, and breakfast

2 queen beds or 1 king bed + pull out sofa

- $159 per night

How to reserve:

- Call 403-289-9800 group code "NAC"

Aloft Calgary University

- Complimentary parking, Wi-Fi, and breakfast

Standard Queen – 2 queen beds

- July 14 $179 per night
- July 15-18 $139 per night

Standard King – 1 king bed

- July 14 $179 per night
- July 15-18 $139 per night

How to reserve:

- Call reservations at 888-627-8557 group code "NACAT"
- *Reservations must be made by June 13, 2019*

Book your room early to ensure availability and to lock-in the discounted rate!

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Table 5. *Descriptive statistics and selected correlation coefficients (N = 2,295, 2008-10 HS grads entering FVTC)*

Variables	%/ Mean (SD)	Dual Credits	Course Completion %	2nd-Year Retention	Graduation w/in 3 Years	Employed in FY 13	FY13 income	FY 13 income above $15,080
Dependent variables								
Dual credits	28.8%	N/A						
Course completion rate	72.0% (32.7%)	$.15^{***}$	N/A					
2nd-year retention	64.7%	$.08^{**}$	$.42^{***}$	N/A				
Graduation within 3 years	27.5%	$.10^{***}$	$.44^{***}$	$.22^{***}$	N/A			
Employed	58.3%	$.04^{*}$	$.04^{*}$	$-.06^{*}$	$.07^{**}$	N/A		
FY13 income	$16,431.00 ($10,724.97)	$.09^{***}$	$.09^{*}$	-.03	$.09^{***}$	$.77^{***}$	N/A	
FY13 income above $15,080	$24,987.72 ($8,795.14)	$.10^{**}$	$.09^{**}$	$-.08^{*}$	$.09^{*}$	N/A	N/A	N/A
Demographic background								
Male	50.7%	$-.05^{*}$	$-.10^{***}$	-.03	$-.11^{***}$	$.11^{***}$	$.23^{***}$	$.30^{***}$
Racial/Ethnic White	83.5%	-.004	$.04^{+}$	.04	$.05^{*}$	.02	$.05^{*}$	.10
Dual credits								
Transcript Credit (TC)	.58 (1.67)	$.54^{***}$	$.10^{***}$	$.05^{*}$	$.06^{**}$	$.06^{**}$	$.10^{***}$	$.07^{*}$
Youth Option (YO)	.80 (3.58)	$.35^{***}$	$.07^{**}$	$.05^{*}$	$.05^{*}$	.02	.02	.03
Advanced Standing (AS)	.34 (1.33)	$.40^{***}$	$.09^{***}$	$.04^{+}$	.02	.03	$.06^{**}$	.05
College major								
Engineering & manufacturing	11.7%	.02	.01	$.04^{+}$	.001	$.10^{***}$	$.22^{***}$	$.26^{***}$
Other STEM	4.4%	-.01	-.001	.01	$-.04^{+}$	-.001	.03	$.07^{+}$
Health	23.6%	$.09^{***}$	$.16^{***}$	$.08^{***}$	$.30^{***}$	$-.05^{*}$	$-.15^{***}$	$-.23^{***}$
All other CTE programs	60.3%	$-.09^{***}$	$-.14^{***}$	$-.09^{***}$	$-.24^{***}$	-.02	-.04	-.05
College readiness								
Accuplacer Score-Arithmetic	72.30 (35.80)	$.05^{*}$	-.01	$.06^{**}$	$-.16^{***}$	$.05^{*}$	$.11^{***}$	$.07^{*}$
Accuplacer Score –Reading	73.13 (28.12)	.02	$-.06^{**}$	$.05^{*}$	$-.24^{***}$	.02	$.08^{***}$	.03
Program type								
Tech diploma: <1 Year	14.7%	$.05^{*}$	$.15^{***}$	N/A	$.47^{***}$	$-.06^{**}$	$-.14^{***}$	$-.12^{***}$
Tech Diploma: 1- & 2-Year	14.3%	.004	$.07^{**}$	N/A	$.11^{***}$	$.13^{***}$	$.20^{***}$	$.16^{***}$
AAS & Transfer	71.0%	$-.04^{+}$	$-.17^{***}$	.02	$-.45^{***}$	$-.05^{*}$	$-.05^{*}$	$-.06^{+}$

Note. Descriptive statistics include the percentage (for categorical variables) or mean (standard deviation). The rest of the columns include the Pearson correlation coefficient.
$^{+}p < .10$ $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

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Continued from page 20

Academic backgrounds. Using the transcript record, we controlled for students' Accuplacer arithmetic and reading score, the length of the FVTC programs, and college major. These are mostly dichotomous variables except the Accuplacer scores, so this variable was coded as 1 if the students met the criteria of the particular variable; otherwise it was coded as 0. Also, we created two sets of new variables to identify students' field of major and the type of degree program based on the transcript record. The field of major was divided into four categories: engineering and manufacturing, other STEM-related fields, health-related fields, and all other fields (served as the reference group). The type of degree program is defined by the length of the program, which includes shorter-than-one-year technical diploma, one- and two-year technical diploma, and associate of applied science and transfer program (treated as the reference group). These variables are all dichotomous indicators, so this variable was coded as 1 if the students met the criteria of the particular variable; otherwise it was coded as 0.

Demographic backgrounds. According to the administrative data, we controlled for students' gender and race/ethnicity. Both of them are dichotomous, dummy-coded variables, which were accounted for consistently throughout the analyses.

School characteristics. We further considered possible school-level factors that may be related to high school graduates' success at FVTC above and beyond the student-level factors. More specifically, we considered three sets of factors using public data available on the Wisconsin Department of Public Instruction website: (a) academic factors (as reflected by the average 10th grade standardized test scores in reading and mathematics), (b) school poverty (i.e., percent of students from low socioeconomic status [SES]), and (c) FVTC-attending culture among dual credit students (percent of attending FVTC and transferring dual credits). These are all continuous variables that are modeled as school-level data (i.e., level-two) in all the following HLM analyses.

Analysis

All statistical analyses were conducted under the HLM framework. HLM is an extension of linear regression (Raudenbush & Bryk, 2002; Snijders & Bosker, 2012). However, different from linear regression that requires independence among observations, HLM is an appropriate technique when the observations are nested (Niehaus, Campbell, & Inkelas, 2014). In the case of the current study, students are nested within high schools where they shared the learning environment before attending FVTC. This characteristic is particularly relevant in the present study as we explore the way students' academic effort in high school is related to their postsecondary academic and career achievement. HLM is deemed necessary, therefore, to account for this dependency of learning environment and to further examine how high school characteristics are related to students' post-secondary learning outcomes, in addition to the individual-level characteristics. First, we examined whether the variance in the outcome variables is attributable to the school-level variables vis-à-vis individual-level variables by calculating the intraclass correlation (ICC; Niehaus et al., 2014) for the models with a continuous outcome variable. As a result, the low level of ICC indicates that the variance of the outcome variables was not strongly associated with these school-level variables (see Table 6). However, given that dual credit programs are highly contextualized within each high school or district, we proceeded with HLM analysis despite the low ICCs.

Second, HLM with random intercept, which is the basic form of HLM that allows the variance of school-level variables to be freely estimated, was conducted for models with a continuous outcome variable, whereas a generalized HLM analysis (GHLM) with random intercept was estimated with dichotomous outcome variable to explore the relationship of students' dual credit record, academic backgrounds, college major, and demographic characteristics to different academic and employment outcomes.

Missing Data

Wage data is the only variable that contained missing data that 437 students' UI wage data (19.0%) were not matched successfully with their administrative and transcript records. Possible reasons include that the students may not be employed in FY13, have moved out of Wisconsin, or be employed in the occupations that do not report UI data (e.g., farmers, railroad workers). Since we were not able to decide the reasons of the missing data, listwise deletion was used in the analyses of annual wage as the outcome.

Continued on page 24

"Success is not final; failure is not fatal: It is the courage to continue that counts."
– Winston S. Churchill

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C4 vs. C3 photosynthesis

We compared the yield of "supercharged" C4 crops (corn and sorghum) with conventional C3 crops (soybeans and wheat) under varying substrate (CO_2) concentration. Data for each of the four crops was obtained from a synthesis presented by Long et al. [16] and represents those grown at ambient CO_2 levels and at elevated CO_2 levels in chamber experiments. These included 155 measures of soybeans, 211 of wheat, and 14 of corn and sorghum. Solid lines represent a least-squares fit to the data.

Hybrid electric vehicles vs. ICEs

In order to show how the advantages of hybrid cars increase with variability in driving speed, we analyzed data on gas mileage in model year 2007 vehicles subject to the Environmental Protection Agency (EPA)'s Federal Test Procedure (FTP) cycles. Variance in speed was calculated for both city and highway cycles and mileage information was obtained from model year 2007 vehicles, which have hybrid and conventional counterparts with the same engine: the Toyota Camry, Ford Escape, Nissan Altima, GMC Sierra, and Mercury Mariner. Mileage data was obtained from U.S. Department of Energy and U.S. EPA [17]. Data on speed variance were extracted from city and highway FTP cycles [18].

CAM vs. C3 crops

To demonstrate how the advantages of CAM photosynthesis depend on variability in transpiration demand, we compared the water use efficiency for C3 and CAM plants with increasing diurnal variability of the vapor pressure deficit. The results were obtained using the Photo3 model [19], which is based on the the Farquhar et al. C3 model [20] and a recently introduced CAM model [21, 22], for one representative species of each photosynthetic type: winter wheat (Triticum aestivum) for C3 and prickly pear (Optuntia ficus-indica) for CAM.

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Continued from page 22

Results

As noted in Table 3, about 30% of the students had transferred one or more Youth Options credits, Advanced Standing credits, or Transcripted Credits. The typical prior-credit completing student transferred 5.94 credits. Table 4 provides a detailed analysis of the number of dual college credits transferred to FVTC. The descriptive statistics and the Pearson correlation coefficients are summarized in Table 5, and the results of the seven HLM analyses were provided in Table 6. The three types of dual credits are largely correlated with the outcomes of interest positively, with a few exceptions. Nevertheless, the magnitude is small, probably due to a large number of students who did not have any dual credits. Given the space limit, in the following paragraphs we briefly summarized the predictors that were significantly related to the outcome variable in each model.

Because we were interested in six different college success outcomes, seven models (two models were estimated when the annual wage was the outcome variable) were proposed and estimated. In the first student outcome model we addressed the Research Question 1: *What specific factors are related to transferring dual-credit?* When considering all types of dual credit, we found that females on average had 20.1% higher chance to transfer any kind of dual credit to FVTC than males. High schools which sent more students to FVTC with dual credits, unsurprisingly, tended to send more students with dual credit to FVTC. The 20 high schools differed in the probability of graduating students who later attended FVTC with dual credits. However, high schools that enrolled more students from low SES backgrounds tended to have students with a lower chance to graduate students and later attend FVTC with dual credits.

In the second Research Question we asked *what types of dual credit were related to students' early academic success in terms of course completion rate and second-year retention?* Coined as academic momentum by Adelman (1999, 2006) and followed by Attewell, Heil, and Reisel (2012), it is important that students complete college courses in which they enroll, especially in the first year. In Table 6, all three types of dual credit were positively related to course completion rates. More specifically, students completing one more TC, YO, or AS credit are estimated to have a 2.0%, 0.3%, and 2.0% higher course completion rate, respectively. Higher course completion rates were experienced by several specific groups of dual credit completers, including those who were female and students with higher Accuplacer arithmetic scores. Also, students in short-term technical diploma programs, or those in health-related and other non-engineering/manufacturing STEM majors (e.g., information technology), tended to have higher course completion rates than students in the reference group.

Nevertheless, students with a higher Accuplacer reading score tended to have a lower course completion rate. Students coming from different high schools also differed in the overall course completion rate. In the model of second-year retention, we found that transferring one more TC credit to FVTC is associated with 8.5% greater chance to be retained in the second year. Also, dual-credit students in engineering/manufacturing and health-related programs were more likely to be retained in the second year than their counterparts. No school-level variables were related to the probability of second-year retention.

Next, through Research Question 3 we sought to determine *what types of dual credits are related to students' three-year graduation/completion status.* In the fourth GHLM model, students with more TC and AS credits have a significantly higher chance to graduate in three years. Students transferring one more TC and AS credit to FVTC would be 9.0% and 11.6% more likely to complete the degree in three years, respectively. Beyond dual credit completion, those graduating within three years tended to be racially/ethnically White or were enrolled in technical diploma programs. In addition, students in the health-related majors would have a lower probability of graduating in three years than those in the reference group. Finally, students with a higher Accuplacer arithmetic score, but a lower reading score, tended to be more likely to graduate within three years. Students from different high schools shown different probabilities of graduating in three years.

The fourth Research Question centered on the *types of dual credits are related to students' labor market success in terms of employment status and annual income.* In this case, the fifth model probed the factors related to employment using the UI Wage Records of FY13, and we found a pattern of uneven results. Specifically, in this analysis of employment status, TC and AS are positive predictors of being employed that transferring one more TC and AS credit to FVTC is associated with a 7.8% and 8.6% greater likelihood of be employed in three years, respectively. Males, students in STEM-related majors, and one- and two-year technical diploma programs were more likely to be employed than their counterparts. However, students from the shorter-than-one-year technical diploma programs would have a lower probability to be employed.

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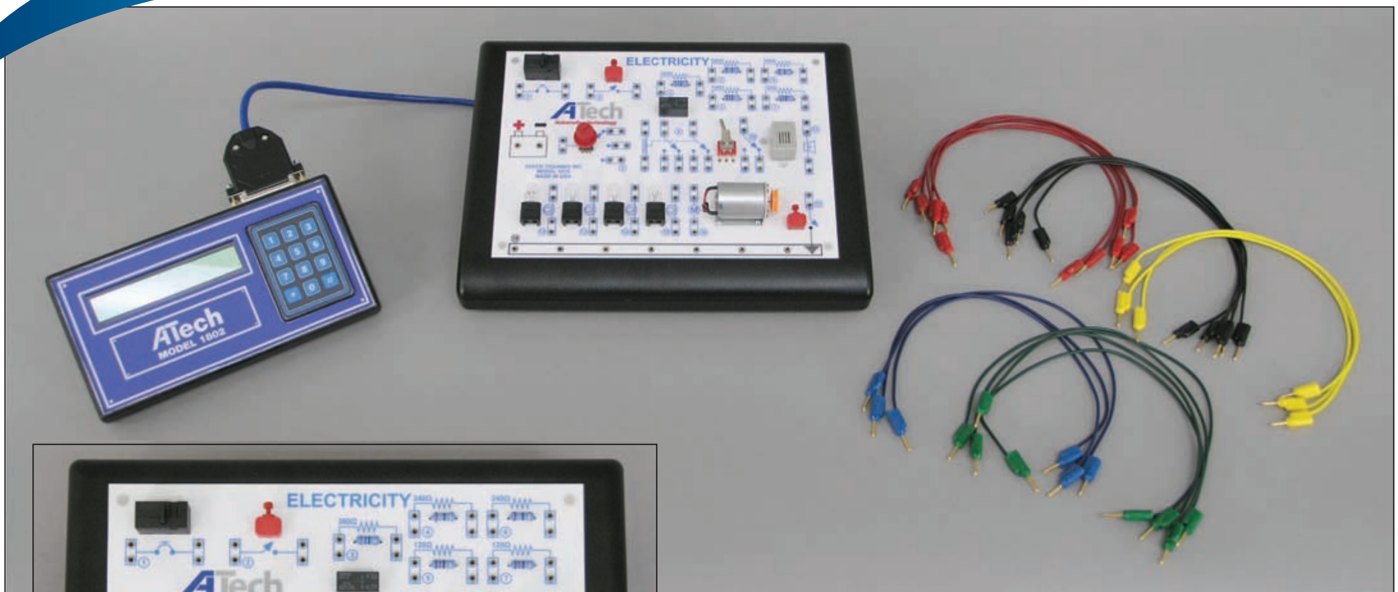
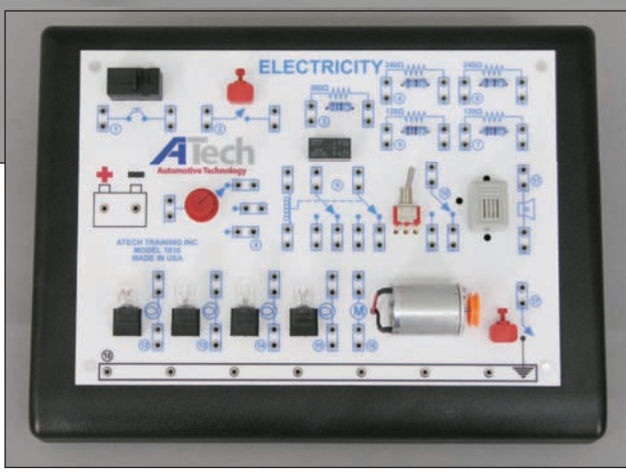
ATech
Automotive Technology

Electricity Trainer

model 1810





The Electricity Trainer (model 1810) is a hands-on study of basic automotive electricity. The trainer features real fixed components, wire terminals, 12-Volt power supply. Fault insertion capability with optional Keypad (model 1802) or with Class Management Program (CMP) and CBI. Includes Instructor Guide and Student Manual (on a USB Drive with an on-site copy license).

Optional Storage Case available. (Stores 2 Trainers)

Program Activities

- Meter Usage (Volts, Ohms, Amps)
- Series, Parallel, and Series-Parallel Circuits
- Vehicle Automotive Circuits
- Service Information Schematics
- Troubleshooting Practice
- Competency Testing

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Table 6. *Summary of hierarchical linear modeling analyses*

Variables	Dual Credits	Course Completion %	2nd-Year Retention	3-Year Graduation	Employed in FY 13	Wages in FY 13	Wages Above $15,080
Level-1							
Male	-0.22 (0.28)	-0.06 (0.01)***	-0.18 (0.10)$^{+}$	-0.20 (0.12)$^{+}$	0.36 (0.18)*	0.12 (0.08)	0.11 (0.04)**
Racial/ethnic White	-0.19 (0.16)	0.02 (0.02)	0.17 (0.15)	0.27 (0.13)*	0.14 (0.15)	-0.03 (0.07)	-0.04 (0.02)$^{+}$
TC		0.02 (0.01)***	0.08 (0.04)*	0.09 (0.03)**	0.08 (0.04)$^{+}$	0.03 (0.01)**	0.002 (0.003)
YO		0.003 (0.001)*	0.03 (0.02)	0.03 (0.01)$^{+}$	-0.01 (0.01)	< 0.001 (0.003)	0.003 (0.004)
AS		0.02 (0.003)***	0.02 (0.05)	0.11 (0.04)**	0.08 (0.05)$^{+}$	0.04 (0.01)**	0.01 (0.01)*
Major-Engineering & manufacturing		0.03 (0.03)	0.44 (0.20)*	0.24 (0.22)	0.84 (0.20)***	0.31 (0.07)***	0.12 (0.05)***
Major-Other STEM		0.05 (0.03)$^{+}$	0.26 (0.24)	0.19 (0.22)	0.54 (0.35)$^{+}$	0.22 (0.12)$^{+}$	0.09 (0.08)
Major-Health		0.04 (0.02)$^{+}$	0.64 (0.14)***	-0.39 (0.17)*	0.15 (0.24)	-0.04 (0.09)	-0.13 (0.05)**
Accuplacer-Arithmetic		0.001 (< 0.001)*	0.001 (0.002)	0.01 (0.002)**	0.001 (0.003)	< 0.001 (0.001)	< 0.001 (0.001)
Accuplacer-Reading		-0.001 (< 0.001)*	0.003 (0.003)	-0.01 (0.003)$^{+}$	-0.001 (0.004)	0.001 (0.002)	< 0.001 (0.001)
<1 Year TD		0.12 (0.03)***	N/A	3.49 (0.15)***	-0.71 (0.30)*	-0.21 (0.10)*	0.01 (0.05)
1- & 2- Year TD		0.09 (0.02)***	0.20 (0.17)	1.37 (0.15)***	0.68 (0.19)***	0.27 (0.09)**	0.11 (0.03)***
Level-2							
(intercept)	4.02 (1.68)	0.36 (0.18)*	0.77 (0.69)	5.07 (1.26)***	0.75 (0.84)	9.37 (0.29)***	9.66 (0.13)***
WKCE-Arithmetic	0.05 (0.06)	< 0.001 (0.01)	0.001 (0.03)	-0.005 (0.04)	-0.02 (0.03)	-0.01 (0.01)	-0.01 (0.003)$^{+}$
WKCE-Reading	-0.004 (0.05)	0.004 (0.004)	0.01 (0.03)	0.05 (0.04)	0.02 (0.03)	0.01 (0.01)	0.01 (0.003)**
% attending FVTC with dual credits	0.03 (0.01)*	-0.002 (0.001)	-0.01 (0.01)	-0.01 (0.01)	0.01 (0.01)	< 0.001 (0.003)	0.001 (0.001)
% of economically disadvantaged	-0.02 (0.01)$^{+}$	-0.001 (0.001)	-0.01 (0.01)	-0.01 (0.01)	0.01 (0.01)	0.001 (0.002)	< 0.001 (0.002)
ICC	N/A	2.0%	N/A	N/A	N/A	0.2%	0.8%
N	2294	2294	1709	2294	1047	1047	566
Number of free parameters	8	19	17	18	18	19	19
Loglikelihood	-1289.57	-601.84	-1077.42	-1044.80	-674.21	-1304.49	-117.35
Variance component							
Level-2 variance	0.22	0.001	0.03	0.02	0.02	< 0.001	< 0.001
z-test	1.67	2.01	0.94	0.98	1.02	0.003	0.001
p-value	0.10	0.04	0.35	0.33	0.31	0.97	0.99

Note. ICC = intraclass correlation. TD = technical diploma. WKCE = Wisconsin Knowledge and Concepts Examination. Students in "other" FVTC programs and in AAS/transfer degree programs served as the reference group, so they were not entered into the model.

$^{+}$ $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

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How can you help NACAT?

Have you ever wondered what you can do for the NACAT organization?

If you have been a member of record for two or more years, you are eligible to run for a board or officer position.

The Vice-President/President Elect is a four year commitment: Two as Vice-President, two as President. The Vice-President spends two years learning the ropes and assisting the President with various projects/activities. The President sets the course and acts as CEO of the organization.

The Secretary/Treasurer is a two year commitment in which the successful candidate will take minutes of meetings as well as record and distribute changes to core documents including minutes, bylaws, and resolutions. As the treasurer, the successful candidate works in conjunction with the Executive Manager to distribute and collect funds as required. The successful candidate will also be required to give a report at the annual members' meeting.

Board Members are required to make a three-year commitment. The board members of the organization provide the approval to implement the actions of the officers, and yet, they do much more! They pitch in to make things happen, they serve as committee members to bring recommendations to the board, and they serve as advocates for the organization.

If NACAT has benefitted you in any way, we would ask you to give back to the organization by running for a vacant position. This summer in Calgary, NACAT members will vote to elect three board members and a Vice-President/President Elect. We are asking you to either nominate yourself, or contact me or one of our other members, and your name will gladly be put forward. In 2020, more positions will be vacant, but don't wait--***do it NOW!***

If you would like to discuss these or any other opportunities within the NACAT organization, please contact me at the email address below and I will be happy to answer any questions that you have.

Jim Voth, Secretary / Treasurer
jvoth@rrc.ca

Article: Evolution

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The model was run with a soil moisture of 0.56, soil type of loamy sand, carbon dioxide concentration of 400 ppm; daytime temperature of 303.15 K, solar radiation of 500 W/m2, and vapor pressure deficit of 2.89 kPa; and a nighttime temperature of 288.15 K, solar radiation of 0 W/m2, and varying nocturnal vapor pressure deficit. Water use efficiency (WUE) is given as a function of decreasing nocturnal vapor pressure deficit, with daytime vapor pressure deficit held constant.

Results

Evolution of the substrate concentration mechanism

Over time, both car engines and plant photosynthetic pathways have added components to improve efficiency while leaving the original structures (the ICE and the C3 Calvin cycle) intact. The turbocharger and the C4 carbon pump are added components, which improve performance (engine power output or photosynthetic yield) when low levels of oxygen and carbon dioxide, respectively, limit the efficiency of the core process. The turbocharger adds a turbine and an air compressor to the original ICE. The turbine, driven by the engine's exhaust gases, powers a compressor which forces more air into the combustion chamber, increasing the available concentration of oxygen (see **Fig 2**). This improves the volumetric efficiency of the engine and allows a greater power output with less fuel use. Similarly, the C4 photosynthetic pump adds a second carbon fixation process which raises the CO2 concentration in the chloroplasts by an order of magnitude. The first pathway functions by carboxylating phosphoenolpyruvate (PEP) to produce a 4-carbon sugar (hence the term C4). The 4-carbon sugar then enters the bundle sheath cell where it is decarboxylated and fixed by RuBisCO in the Calvin cycle (see **Fig 2** for a comparison of car and plant components). Because C4 photosynthesis concentrates the CO2 at the site of the Calvin cycle, it is able to effectively eliminate photorespiration. This allows the plant to assimilate more carbon with less stomatal opening and water loss.

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Summary and Discussion

In summary, important insights about student factors associated with dual credit learning outcomes are evident. For example, the location and instructors of dual credit courses are clearly associated with all the assessed college success outcomes. TC and AS courses, which were delivered by FVTC-endorsed high school CTE instructors in high school labs, produced more favorable college outcomes than the YO courses. TC and AS course completion was also associated with modestly higher wages in FY 13, which is three to five years after the high school CTE courses were completed.

Moreover, students' subsequent choice of career pathway program and the length of program selected were both factors that are associated with students' academic and career success. Students who chose longer-term technical diploma programs (e.g., 1- and 2-year technical diplomas) and students choosing engineering/manufacturing majors had significantly higher FY 13 employment rate and annual wage, when compared to students choosing shorter-term technical diploma programs, or health and other program pathways. While students pursuing short-term certificates (less-than-one-year technical diplomas) had significantly higher graduation rates, they also experienced lower employment rates and wages than others.

As foreshadowed by the low ICCs across the statistical models, school-level variables were seldom salient in predicting students' academic and employment outcomes, though students from different high schools differ in most of the outcome variables. This result indicates that students' effort and decisions (e.g., choice of major) play an important role in predicting these achievements. Moreover, our models did not capture the school-level characteristics that induce such student-level differences, with the only exception of annual wage beyond federal minimum, in which the average WKCE reading score is positively related to students' earnings five years or so beyond high school.

Overall, these findings point to the importance of using locally focused labor market and college success data to assist students in making informed choices regarding the returns to postsecondary technical programs. While these findings cannot be generalized beyond the participating technical college and 20 high schools, these results highlight the insights to be gleaned for improving dual credit partnerships, career and college counseling, and supporting student decision-making:

- Of the three high school CTE dual credit practices explored, Transcripted Credit and Advanced Standing were positively related to college success and annual earnings at age 22.
- Students of varying demographic backgrounds showed different chances of achieving academic success. Male students outperformed females in employment and the annual income above minimum wage.
- The relationship between dual credit completion and college and labor market outcomes was influenced, most likely, by several variables associated with student decisions and academic choices after high school graduation. However, the dual credit learners who experienced better success chose to: (a) enroll in longer technical diploma programs and avoid short-term certificate, and (b) select manufacturing and engineering program pathways over health and other non-STEM, non-health programs.
- Two additional factors were associated with dual credit arrangements and higher levels of college and labor market success. Students with higher Accuplacer arithmetic and reading scores tended to have moderately better performance in college. Compared to dual credit courses completed on the college campus (YO), the courses offered in high school and taught by high school CTE instructors (TC and AS) consistently predicted greater levels of college student success and better labor market outcomes.

As both the review of literature and current, on-line information provided by national organizations and think tanks suggest, a key next step in addressing the national college completion goals is gaining a better understanding of the policies and practices associated with the promising outcomes (see, for example, the Complete College America initiative at http://completecollege.org/). Those associated with dual credit programs and partnerships are especially important (Giani et al., 2014; Karp, et al., 2012). This study highlights how local data-driven findings can broaden the current understanding about CTE dual credit courses and students' postsecondary and labor market outcomes. Additionally, we identify some of the student factors associated with students' subsequent success.

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The turbocharger and the C4 carbon pump developed under limiting oxygen and carbon dioxide conditions, respectively, and both show the greatest advantages over their traditional counterparts in such conditions. **Fig 3a** compares the power output of the Merlin III, a supercharged jet from WWII, to that of a conventional, non-supercharged airplane, as oxygen pressure changes at altitude. The Merlin III outperforms its conventional counterpart by over 100% at altitudes over two thousand feet, where the oxygen pressure is one-twentieth of that at sea level, but it is limited at lower altitudes due to the power required to run the supercharger. Today, highly developed turbochargers enable decreased fuel consumption and emissions even at sea level and increasingly stringent emissions regulations have caused an increase in the popularity of turbochargers in passenger cars and especially in trucks. Similarly, C4 plants outperform their C3 counterparts most strongly under conditions of low CO2. Because of decreased photorespiration they are able to assimilate more carbon and are 2-3 times more water efficient [11]. At the same time, C4 photosynthesis comes with a slight energetic drawback because of the cost of the additional chemical reaction. Thus, the advantages of C4 plants increase strongly at low carbon dioxide levels, and drop off at high CO2 levels, where these plants require more solar radiation to assimilate the same amount of carbon (see **Fig 3b**).

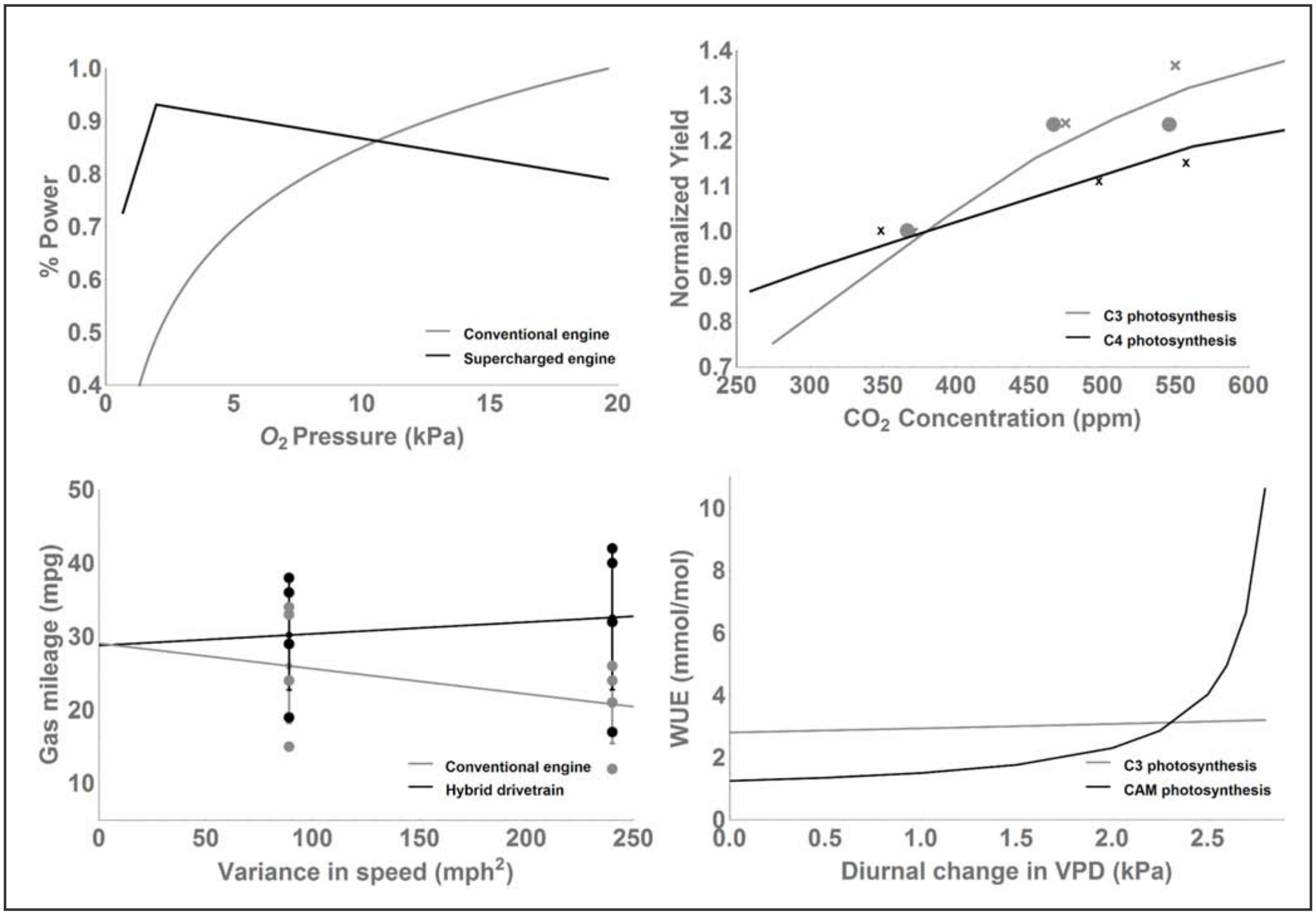

Fig 3. Additional components allow more newly developed photosynthetic systems and car engines to outperform conventional ones under specific conditions.

(a) Supercharged engines outperform conventional ICEs with increasing altitude (decreasing O2 concentration). (b) Likewise, "supercharged" C4 crops (corn and sorghum combined data) outperform "conventional" C3 crops (soybeans (o) and wheat (x)) with decreasing CO2 concentration. (c) Hybrid cars strongly outperform their traditional counterparts under conditions of high variability in driving speed, while they perform similarly under conditions of low variability. (d) In a similar fashion, CAM plants strongly outperform their C3 counterparts in conditions of high variability in vapor pressure deficit, while they are less efficient in the absence of variability.

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CTE Dual Credit Student Outcomes

In 2008, Lewis and Overman (2008) reviewed the status of three major CTE-focused high school dual credit studies and concluded that once students enter postsecondary education, they generated only marginally better (4-5% higher) student success rates compared to non-dual credit completers. After reviewing the work of Karp et al. (2007), Kotamraju (2005), and the early evidence on Early College High Schools (American Institutes for Research and SRI International, 2006), they argued that student self-selection bias and other unmeasured factors account for the unexplained variance. Despite the investment of many states in dual credit-driven programs of study (Zinth Dounay, 2014), the predicted gains for dual credit courses "… may not be sufficient to justify the effort to develop and implement such programs" (Lewis & Overman 2008, p. 189). Since Lewis and Overman's cautionary observation, this investigation and others have documented and generated more nuanced findings regarding the influence of CTE dual credit courses on students' postsecondary success.

The present study demonstrates that high school CTE dual-credit courses are salient predictors of college success and labor market outcomes for technical college bound students. Clearly, dual credit learners outperformed their non-dual credit peers by substantial margins in college retention and completion. The earnings outcomes were particularly promising for those selecting longer-term career pathway programs in higher wage sectors.

Our results, which include additional measured factors and additional success outcomes, suggest that both the college and labor market success rates of dual credit students, could, in some communities or regions, be substantially higher than Lewis and Overman (2008) argued in their review (7.8% to 11.6% higher when transferring one more dual credit in the current study).

School Implementation Factors and Practices

Most studies of dual credit programs are centered on courses delivered on college campuses, which require students to meet admission standards and in some states to possess personal resources to cover transportation costs, tuition, books, and other expenses. In our study, the positive results for selected dual-credit courses taught by high school teachers (TC and AS) versus the campus-based arrangement (YO) contrasts directly with the findings and recommendations of prior studies. Speroni (2011), for example, found positive student outcomes from dual enrollment programs only when the courses were completed on a college or community college campus rather than in Florida high schools. Moreover, the prospects for high school students completing dual enrollment courses in high school versus college campus settings favors the high school setting: 62% against 52% for academic courses, and 42% against 25% for CTE courses, according to the U.S. Department of Education (Thomas et al., 2013).

Current college accreditation policies regarding faculty credentials for dual credit instruction (e.g., master's degrees in content areas) pose some significant barriers for scaling up CTE dual credit offerings in several areas (Zinth Dounay, 2015a). In 2008, only 45% of CTE high school instructors held a master's degree or higher credential (National Center for Education Statistics, 2015). As noted in the review of literature, these findings contrast directly with the recent HLC institutional accreditation review policies indicating that dual credit programs and courses should be reviewed to ensure that "comparable course pre-requisites, course rigor, faculty qualifications, and access to learning resources" are available. Clearly, research studies are needed to explore more fully the design, delivery, and effectiveness of dual credit instruction offered in both high school and two-year college settings. However, results from rigorous local program evaluations, such as the present study, can also be used to inform state and regional higher education accreditation practices and policies.

Other factors associated with college readiness, including students' choices in college, also appear to be associated with higher levels of college and labor market success. In high school and early college settings, students need to develop in depth knowledge about their education and its potential influence on their future success in the labor market. This study and many others illustrate the difference in earnings at age 22-23 for longer rather than shorter (less than 1-year) certificate programs and program pathways.. Specific information about the regional education-labor market dynamics can be valuable resources for educators, parents, and leaders who want to help students develop appropriate and viable individual career plans in high schools. For example, the sharing of labor market and college success data are part of FVTC dual credit partnership's Summer Teacher Certification courses. Through these courses, high school instructors are encouraged to arrange multiple campus orientation visits, as well as industry observations for students, as part of dual credit high school instruction.

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Frequent workshops for high school counselors also feature data that helps schools and counselors to isolate factors and practices that offer promising, indirect evidence of impact on student success. By using similar data analytics, high school and two-year college partnership leaders can design, implement, and measure the influence or effects of innovations and interventions that are potentially effective.

Finally, we would like to remind readers that the results presented and discussed in the current study are correlational instead of causal, despite the temporal order between the predictors and the outcomes, since some unobserved factors may be at play. Also, because of the inherent limitation of a single-site study, applying the results to other state and local context should be done with caution. We encourage future researchers and practitioners to conduct contextualized research, in that dual enrollment is deeply interwoven into state and local policy and economy contexts. One promising way is to include an array of relevant variables, such as the school-level factors controlled for throughout the present study, so that the unique relationship between students' effort and their academic outcomes can be uncovered.

Conclusion and Recommendations

This single-college analysis offers some useful insights to guide the local development and continuous improvement of CTE programs of study between high schools and local two-year colleges. More specifically, the study demonstrates strategies for using longitudinal, student administrative records to document college retention, college completion and labor market outcomes. By controlling for several student and school-level factors to predict short- and longer-term outcomes, the analysis revealed both promising and problematic outcome patterns, which, in turn, generated robust information for promoting, as well as improving and strengthening CTE dual credit practices and policies.

Overall, the evidence revealed strong postsecondary completion and earnings returns at age 22 for students completing more dual CTE credits in high school. Congruent with previous research, dual-credit CTE courses predict various patterns of college and labor market success when student and school-level factors are taken into consideration. College success and labor market outcomes varied based on students' diversity, including gender and race/ethnicity. The student-level variables revealed that introductory technical college courses, when offered in high school settings by college-certified CTE instructors, are more frequently associated with students' college success than when similar courses were completed on-campus by high school students. In summary, the study illustrated how these data analyses processes can collectively: (a) improve college success and labor market outcomes at the individual, program, school, or regional levels, (b) contribute directly to the national college completion agenda (White House, 2009), and (c) enhance the continuous improvement capacity of two-year college, high schools, and their partner organizations.

Recommendations for Practice and Research

For CTE leaders and instructors, these results provide a regionally-focused, evidence-based foundation for implementing programs of study between high schools and two-year colleges that are anchored in dual-credit courses. To support these efforts, state leaders need to advance the development of and access to K-16 education data systems that include real-time labor market information generated by State workforce development agencies. The Data Quality Campaign and the Workforce Data Quality Campaign websites (2015) provide success stories and resources from several leading states illustrating how high school, college, and workforce participation data can be integrated and used to improve outcomes for students, schools, and communities. To support these efforts, college and university teacher education/research faculty must develop partnerships with local CTE providers. By developing regional, Institutional Review Board-approved data-sharing agreements, regional learning alliances can be formed that allow CTE instructors and faculty to identify appropriate, high demand courses to be offered for dual credit. For existing dual credit partnerships, the college and labor market success patterns for CTE students and their high school-to-college spanning programs of study can be documented, evaluated, refined and improved, as informed by students' retention and success rates. For example, California's Cal-PASS PLUS initiative (see: www.calpassplus.org) has created an accessible and actionable pre-K through 16 system of student data, which provides ". . . actionable data to help improve student success along the education-to-workforce pipeline." Regional Learning Councils foster collaboration within and between educational institutions using data to inform better instruction, help close achievement gaps, identify scalable best practices, and improve transitions.

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As suggested earlier, several key issues relative to CTE dual credit learning merit further research. With the limitations of the present study in mind, the following priorities for future research merit consideration: (1) experimental studies of dual credit learning experiences using random assignment protocols, (2) studies examining student and instructor perspectives on the key attributes of dual-credit learning experiences that make them effective, (3) studies that examine the efficacy of similar dual credit courses offered to advanced high school students in high school, college, and on-line settings, (4) studies examining the factors supporting, facilitating, and inhibiting the college success of dual-credit learners with disabilities, and (5) studies of the dual credit, integrated CTE-academic courses (e.g, Digital Electronics) and companion courses (e.g., Technical Mathematics and Manufacturing Processes).

References

1. Adelman, C. (1999). Answers in the tool box: Academic intensity, attendance patterns, and bachelor's degree attainment. Washington, DC: Department of Education.
2. Adelman, C. (2006). The toolbox revisited: Paths to degree completion from high school through college. Washington, DC: US Department of Education.
3. Allen, D., & Dadgar, M. (2012). Does dual enrollment increase students' success in college? Evidence from a quasi-experimental analysis of dual enrollment in New York City. New Directions for Higher Education, 2012(158), 11-19. doi: 10.1002/he.20010.
4. American Institutes for Research and SRI International (2006). Early college high school initiative: 2003-2005 evaluation report. Washington, DC: Authors. Retrieved May 27, 2008, from http://www.earlycolleges.org/Downloads/ECHS_Eva_2003-2005.pdf.
5. An, B. P. (2013). The influence of dual enrollment on academic performance and college readiness: Differences by socioeconomic status. Research in Higher Education, 54(4), 407-432. doi: 10.1007/s11162-012-9278-z.
6. Attewell, P., Heil, S., & Reisel, L. (2012). What is academic momentum? And does it matter? Educational Evaluation and Policy Analysis, 34(1), 27-44. doi: 10.3102/0162373711421958.
7. Barnett, E., Andrews, H. (2002). Dual credit/enrollment in Illinois: A status report. Urbana-Champaign, IL: Office of Community College Research and Leadership, University of Illinois at Urbana-Champaign.
8. Becker, G. S. (1964). Human capital: A theoretical and empirical analysis, with special reference to education. New York, NY: Columbia University Press.
9. Bishop-Clark, C., Hurn, J., Perry, S. A., Freeman, M. B., Jernigan, M., & Weldy, N. (2010). High school teachers teaching college courses to career technical education students: A story of success. Journal of Career and Technical Education, 25(2), 78-93. doi:10.21061/jcte.v25i2.716.
10. Borden, V., Taylor, J., Park, E., & Seiler, D. (2013). Dual credit in US higher education: A study of state policy and quality assurance practices. Chicago, IL: Higher Learning Commission. Retrieved December 8, 2015 from http://education.illinois.edu/sites/default/files/news/documents/4-Dual%20Credit%20H-Final.pdf.
11. Brown, C., Boser, U., Sargrad, S. & Marchitello, M. (2016, Janurary). Implementing the Every Student Succeeds Act: Toward a coherent, aligned assessment system. Washington, DC: Center for American Progress. Retrieved Feburary 28, 2016 from https://cdn.americanprogress.org/wp-content/uploads/2016/01/28135858/MendIt-ESSA-report-SUMMARY.pdf.
12. Carnevale, A.P., Cheah, B. & Hanson, A.R. (2015). The economic value of college majors: Executive summary. Washington, D.C., Center on Education and the Workforce, Georgetown University. Retrieved August 28, 2016 from https://cew.georgetown.edu/wp-content/uploads/The-Economic-Value-of-College-Majors-Exec-Summ-Web.pdf.
13. Cellini, S. R. (2006). Smoothing the transition to college? The effect of Tech-Prep programs on educational attainment. Economics of Education Review, 25(4), 394-411. doi: 10.1016/j.econedurev.2005.07.006.
14. Community College Research Center (2012). What we know about dual enrollment. New York, NY: Teachers College, Columbia University. Retrieved February 10, 2014 from http://ccrc.tc.columbia.edu/publications/what-we-know-about-dual-enrollment.html.
15. Cowan, J., & Goldhaber, D. (2015). How much of a "running start" do dual enrollment programs provide students? Review of Higher Education, 38(3), 425-460. doi: 10.1353/rhe.2015.0018.

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Standard Motor Products to Recognize Aspiring Diesel Technicians During Its Standard 'Bigger, Better Diesel' Scholarship Contest

Standard Motor Products, Inc. (SMP) announces the start of its Standard® 'Bigger, Better Diesel' Automotive Scholarship Contest. Running through May 31, 2019, the second-annual competition will present four up-and-coming diesel technicians with a $5,000 scholarship each. For more information, watch the promotional video on youtube.com/StandardBrandParts.

Students can enter by visiting BiggerBetterDiesel.com, completing an online questionnaire, and submitting a recent photo of themselves. Judges will evaluate entries based on relevance, creativity, and thoughtfulness relating to the automotive industry with an emphasis on diesel technology.

Commenting on the contest, Phil Hutchens, Vice President Engine Management Marketing, SMP, stated, "As a leader in the diesel aftermarket, Standard is dedicated to supporting future diesel technicians with these four exciting scholarship opportunities."

The contest is open to legal residents of the 50 United States and the District of Columbia. Eligible entrants must be between the ages of 18 and 34 and currently enrolled full-time in high school or in an accredited two- or four-year college, university, or post-high school educational program. Complete rules and program information can be found at BiggerBetterDiesel.com.

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Standard® Diesel offers thousands of diesel parts in hundreds of unique diesel categories. Standard® Diesel is committed to supplying professional technicians with comprehensive coverage for genuine diesel parts, which is evident from its extensive offering of new and quality remanufactured products.

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In its 100th year in business, Standard Motor Products, Inc. supplies independent professional auto technicians and automotive do-it-yourselfers with high quality replacement parts for engine management ignition, emission and fuel systems as well as temperature control products for domestic and import cars and light trucks. SMP products are sold through both traditional and non-traditional distribution channels. For more information, download the SMP® Parts App 2.0 or visit www.smpcorp.com.

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16. Darling-Hammond, L., Wilhoit, G., & Pittenger, L. (2014). Accountability for college and career readiness: Developing a new paradigm. Education Policy Analysis Archives, 22(86). doi: 10.14507/epaa.v22n86.2014.
17. Data Quality Campaign (2015). State analysis by essential elements. Washington, DC: Author. Retrieved August 25, 2015 from http://dataqualitycampaign.org/your-states-progress/10-essential-elements/element-nine/.
18. Every Student Succeeds Act of 2015. P.L. 114-95, 20 U.S.C. 6301.
19. Fox Valley Technical College (2015). High school articulation reference guide. Appleton, WI: Author. Retrieved August 30, 2015 from: http://www.fvtc.edu/Portals/0/PDFs/Parents%20&%20Family/ FVTC_ArticulationReferenceGuide_2015-16.pdf.
20. Gamoran, A. (2011, October 12). What makes for successful K-12 STEM education. Written testimony before the U.S. House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Research and Science Education. Washington, DC: Author.
21. Giani, M., Alexander, C., & Reyes, P. (2014). Exploring variation in the impact of dual-credit coursework on postsecondary outcomes: A quasi-experimental analysis of Texas students. The High School Journal, 97(4), 200-218. doi: 10.1353/hsj.2014.0007.
22. Harnish, D., & Lynch, R. L. (2005). Secondary to postsecondary technical education transitions: An exploratory study of dual enrollment in Georgia. Career and Technical Education Research, 30(3), 169-188. doi:10.5328/CTER30.3.169.
23. Higher Learning Commission (2014, April). Dual credit guidelines: For institutions and peer reviewers. Chicago, IL: Author. Retrieved August 24, 2015 from: https://www.hlcommission.org/Accreditation-Processes/dual-credit-programs-and-courses.html.
24. Hughes, K. L., Rodriguez, O., Edwards, L., & Belfield, C. (2012). Broadening the benefits of dual enrollment: Reaching underachieving and underrepresented students with career-focused programs, New York, NY: Community College Research Center, Teachers College, Columbia University.
25. Independent Advisory Panel of the National Assessment of Career and Technical Education (2014). Putting “career” in “college and career ready”: The report of the Independent Advisory.
26. Jackson, C. K. (2014). Do college-prep programs improve long-term outcomes? Economic Inquiry, 52(1), 72–99. doi: 10.1111/ecin.12040.
27. Jepsen, C., Troske, K., & Coomes, P. (2014). The labor-market returns to community college degrees, diplomas, and certificates. Journal of Labor Economics, 32(1), 95–121. doi:10.1086/671809.
28. Kazis, R. (2005). Remaking career and technical education for the 21st century: What role for high school programs? Boston, MA: Jobs for the Future and the Aspen Institute.
29. Karp, M. M. (2013). Dual enrollment for college completion: Policy recommendations for Tennessee. New York, NY: Community College Research Center, Teachers College, Columbia University.
30. Karp, M. M., Calcagno, J. C., Hughes, K. L., Jeong, D. W., & Bailey, T. R. (2007). The postsecondary achievement of participants in dual enrollment: An analysis of student outcomes in two states. New York. NY: Community College Research Center, Teachers College, Columbia University.
31. Kotamraju, P. (2005, April). The Minnesota Post-Secondary Enrollment Options Program: Does participation in dual enrollment programs help high school students attain career and technical education majors and degrees in college? Paper Presented at the 47th Annual Council for the Study of Community Colleges Conference, Boston, MA.
32. Lewis, M. V., & Overman, L. (2008). Dual and concurrent enrollment and transition to postsecondary education. Career and Technical Education Research, 33(3), 189-202. doi:10.5328/CTER33.3.189.
33. Mincer, J. A. (1974). Schooling, experience, and earnings: Human behavior and social institutions No. 2. New York, NY: National Bureau of Economic Research.
34. National Center for Education Statistics. (2015). CTE Statistics, 2015. Retrieved October 23, 2015 from: https://nces.ed.gov/surveys/ctes/tables/h121.asp.
35. National Conference of State Legislatures. (2016). Performance-based funding for higher education. Washington, DC: Author. Retrieved Feburary 28, 2016 from http://www.ncsl.org/research/education/performance-funding.aspx.
36. Niehaus, E., Campbell, C. M., & Inkelas, K. K. (2014). HLM behind the curtain: Unveiling decisions behind the use and interpretation of hlm in higher education research. Research in Higher Education, 55(1), 101–122. doi:10.1007/s11162-013-9306-7.

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37. Raudenbush, S. W., & Bryk, A. S. (2002). Hierarchical linear models: Applications and data methods (2nd ed.). Thousand Oaks, CA: Sage.

38. Snijders, T. A. B., & Bosker, R. J. (2012). Multilevel analysis: An introduction to basic and advanced multilevel modeling (2nd ed.). Thousand Oaks, CA: Sage.

39. Speroni, C. (2011). Determinants of students' success: The role of Advanced Placement and dual enrollment programs. New York, NY: National Center for Postsecondary Research.

40. Steinberg, L. (2014). Age of opportunity: Lessons from the New Science of Adolescence. New York, NY: Houghton, Mifflin, Harcourt.

41. Stevens, A., Kurlaender, M & Grosz, M. (2015, May). Career-technical education and labor market outcomes: Evidence from California Community Colleges. A CAPSEE Working Paper. New York, NY: Community College Research Center, Teachers College, Columbia University. Retrieved August 21, 2016 from http://capseecenter.org/wp-content/uploads/2015/05/career-technical-labor-marketoutcomes.pdf.

42. Swanson, J. (2008). An analysis of the impact of high school dual enrollment course participation on post-secondary academic success, persistence and degree completion. Iowa City, IA: Institute for Research and Policy, Acceleration at the Belin-Blank Center for Gifted Education, University of Iowa.

43. Thomas, N., Marken, S., Gray, L., & Lewis, L. (2013). Dual credit and exam-based courses in U.S. public high schools: 2010-11. Washington, DC: National Center for Education Statistics. Retrieved February 10, 2014 from http://nces.ed.gov/pubsearch.

44. U.S. Department of Education (2014). National assessment of career and technical education: Final report to Congress. Washington, DC: Author.

45. U.S. Department of Education (2015, July 1). Fact sheet: Obama administration increases accountability for low-performing for-profit institutions. Washington, DC: Author. Retrieved February 28, 2016 from http://www.ed.gov/news/press-releases/fact-sheet-obama-administration-increases-accountability-low-performing-profit-institutions.

46. U.S. Departments of Education, Labor, and Health and Human Services (2012). Joint career pathways letter. Retrieved from: http://wdr.doleta.gov/directives/attach/TEN/ten_36_11_att. Pdf.

47. Venezia, A. & Jaeger, L. (2013). Transitions from high school to college. Future of Children, 23(1), 117-136. doi: 10.1353/foc.2013.0004.

48. Wang, X., Chan, H.-Y., Phelps, L. A. & Washbon, J. I. (2015). Fuel for success: Academic momentum as a mediator between dual enrollment and educational outcomes of two-year technical college students. Community College Review, 43(2), 165-190. doi: 10.1177/00915522115569846.

49. White House (2009, February 24). Remarks of President Barack Obama-As prepared for delivery address to joint session of Congress. Retrieved from http://www.whitehouse.gov/the_press_office/Remarks-of-President-Barack-Obama-Address-to-Joint-Session-of-Congress.

50. Wisconsin Department of Workforce Development (2015). Current employment statistics. Retrieved on August 10, 2015 from http://dwd.wisconsin.gov/dwd/default_facts_data.htm.

51. Zinth Dounay, J. (2014). CTE dual enrollment: A strategy for college completion and workforce investment. Denver, CO: Education Commission of the States. Retrieved May 17, 2014 from http://www.ecs.org/clearinghouse/01/11/50/11150.pdf.

52. Zinth Dounay, J. (2015a). Dual enrollment-all state policies: 50-state analysis. Denver, CO: Education Commission of the States. Retrieved August 24, 2015 from http://ecs.force.com/mbdata/mbprofallRT?Rep=DE14A.

53. Zinth Dounay, J. (2015b). Dual enrollment course content and instructor quality. Denver, CO: Education Commission of the States. Retrieved October 22, 2015 from http://www.ecs.org/clearinghouse/01/17/16/11716.pdf.

*"If You Are Working On Something That You Really Care About,
You Don't Have To Be Pushed. The Vision Pulls You."
– Steve Jobs*

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Evolution of the energy storage mechanism

In a separate strategy, cars and plants both developed energy storage mechanisms, i.e., HEV technology and CAM photosynthesis, which increase efficiency in conditions of high environmental variability. HEVs add a battery and an electric motor to the existing internal combustion engine in order to enable "regenerative braking"—when the brakes are employed, some of the resulting kinetic energy is turned into electricity and stored in the battery. This energy can later be used by the electric motor to assist the internal combustion engine in a dual motor hybrid drivetrain configuration [23–25]. Similarly, the CAM photosynthetic pathway accumulates 'fuel' in the form of carbon in the enlarged plant vacuole 'battery.' In CAM photosynthesis, stomata open during the night, when transpiration drivers are low, and fix atmospheric CO_2 as a 4-carbon sugar, typically malic acid, which is stored in the cell vacuole. The malic acid then is decarboxylated during the day and fixed via RuBisCO in the C3 Calvin cycle, which requires light energy (see **Fig 2**).

Both the HEV and the CAM plant thrive under conditions where efficiency (either fuel efficiency or water use efficiency) is paramount and variability is high. The rise of the hybrid car depended on limiting fuel resources and high demand to improve automobile efficiency. This technology can provide improvements in efficiency up to 34% under stop-start and hilly driving conditions when power demand is variable [26]. At the same time, it introduces the costs of the second power system, the battery, and the more complex control system [24, 27, 28]. Due to this tradeoff, hybrid cars show much better performance than their conventional counterparts under conditions of high variability in driving speed, while they show similar performance under conditions of low driving speed variability (see **Fig 3c**). Likewise, the CAM pathway is favored in terrestrial environments limited by high costs of daytime stomatal opening due to large water losses, including many arid and semi-arid regions of the world. Because CAM allows the stomata to open at night, when there is a much lower driving force for water loss, CAM water use efficiency is up to six times higher than C3 water use efficiency under typical environmental conditions. Since there is an additional chemical reaction involved, CAM comes with an energetic drawback on the order of 10-20% compared with C3 plants, although this requirement varies depending on what percentage of CO_2 is taken up at night [29, 30]. Like hybrid cars, which strongly outperform their traditional counterparts when driving speed is highly variable, CAM plants show a major advantage over their C3 counterparts in conditions of high diurnal variability in vapor pressure deficit, a major driver of evaporative demand (see **Fig 3d**).

Continued next issue: Discussion, Acknowledgements, and References

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We are pleased to work with Cengage to provide the following educator award. The application is available at http://www.nacat.org/images/stories/awards/2019_Erjavec_Award_Nomination_Form_Final_ext.pdf

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