BEING RELEVANT MATTERS

Integrated Academic Skills

A correlation of Automotive Technician & Integrated Academic Skills in English, Mathematics and Science

ASE | Education Foundation

Acknowledgements

A publication of this nature doesn't just happen. It requires vision, experience regarding the topic at hand, resources, and the process of consolidating and organizing thoughts and ideas. The sequence of such events was realized at an ASE Education Foundation sponsored three-day workshop during the week of July 14, 2014 in Leesburg, VA.

Although the ASE Education Foundation had traveled a similar pathway previously in terms of academic integration, circumstances have changed and new perspectives are warranted due to lessons learned, the adoption of a new automobile program accreditation model and the advent of recent national education initiatives such as the Common Core State Standards and STEM (Science, Technology, Engineering, and Math).

Through a grant program created by the ACT Foundation for members of the National Network of Business and Industry Associations, the ASE Education Foundation hosted a workshop on academic integration in career/technical education, and are indebted to those who contributed much time, thought, energy and counsel to the contents of this publication. The ASE Education Foundation staff is sincerely appreciative and express their gratitude to the following individuals: James Anderson, automotive technology instructor at Greenville High School in OH and member of the ASE Education Foundation Board of Trustees; Beth Bachtold, associate professor (reading) at Parkland College in Champaign, IL; Robert Batty instructor (mathematics) at Greenville High School in OH; Jeannie Burgess instructor (english/applied communications) at Caddo Career & Technology Center in Shreveport, LA; Jana Gaddis instructor (integrated mathematics) at Eastern Oklahoma County Technology Center in Choctaw, OK; Ken Mroczek, instructor (integrated math/science) at Van Buren Technology Center in Lawrence, MI; Lyle Taylor, former automotive technology instructor at Grant Career Center in Bethel, OH and instructor/program developer at ATech Automotive Technology in Walton, KY; Gary Weese, secondary automotive technology instructor at Caddo Career & Technology Center in Shreveport, LA; and Michael Vivona, local marketing manager at Universal Technical Institute and STEM consultant in Lisle, IL.

Appreciation is also extended to Gayle Flowers, director of career, adult and alternative education at Caddo Parrish Public Schools in Shreveport, LA; Michael Mulvihill, CTE supervisor at the Mississippi Department of Education; and James Pressly, CTE trade & industrial specialist at the Department of Public Instruction in Raleigh, NC who were all actively engaged and contributed to this project but were unable to be in attendance at the workshop.

And finally, recognition and gratitude are extended to Allison Davis in Westerville, OH for her timely assistance and support in coordinating project logistics and technological expertise.

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A Case for Academics/CTE Integration

Recent research projects[1][2][3] have touted the merits of teaching English/language arts, mathematics, and science in the context of the real world of work, particularly as the subject matter content is integrated into career and technical education (CTE). And to further promote the notion of integrated or applied academics, the National Research Center for Career Technical Education at the University of Louisville is committed to providing evidence-based solutions to the most challenging problems confronting CTE today, including how to better engage students in the school experience, how to improve academic as well as technical achievement, and how to improve the transition of career-ready young people from high school to work and continuing education beyond high school.

But while the concept of integrating academics into CTE has been around for some time and the results of such integration have been relatively positive, it is not a widely spread phenomenon. In most high schools that offer CTE programs, English/language arts, mathematics and science are still being taught in separate, sterile environments that afford little opportunity to apply the knowledge gained to real-life challenges and problem-solving opportunities.

Career/technical education is customized to make education more relevant, more interesting and more meaningful for literally thousands of youth who have specific career goals or who may have been disenfranchised from the more traditional college prep pathway. However, the idea of steering youths into a potential career track, is something the U.S. educational system has largely moved away from in recent decades. The emphasis has been on sending more students to college to prepare for work in the new "knowledge economy" rather than the skilled trades.

Along the way, however, manufacturing has made a comeback. The demand for auto technicians and health-care workers are strong. And career/technical education is preparing students for jobs in the booming fields of engineering and computer science. These 21st Century jobs are highly sophisticated and require a combination of strong "head and hand skills," especially in the applied academic disciplines of communications, math and science, if CTE students are to use, diagnose and service modern-day technologies that comprise the everyday world or work.

Check the views of one city school superintendent who has facilitated high school academic/CTE integration for fifteen years. Acknowledging that such a practice is a little more costly and perhaps a little more tricky to work into the high school master schedule, he justifies the added costs and effort by looking at the return on investment (ROI). Over the past fifteen years, he has seen:

- Over-all improvement in student performance in high school
- Improved attendance
- Improved graduation rates
- Better job placement following program completion, and
- The matriculation of satisfied graduates back into the community who become advocates for the school, easing the way to pass tax levies and bond issues in support of the district.

And even the academic teachers who teach integrated subject-matter content see educational benefits of integration when teaching non-integrated classes. A math instructor at the same high school noted that when teaching a mathematical principle or concept to non-CTE college prep students, he has fingertip examples of how the principle or concept works in the real world.

So, although academic/CTE integration is not universal in high schools across America, perhaps it is time for its implementation. The demand for skilled workers in the fields of transportation, health care, construction trades and information management is on the upswing. All of these jobs have become more skilled and specialized, leading to what is often referred to as the "skills gap" between what employers need and what potential job candidates possess. And from all indications, academic/CTE integration is not just another educational fad; it's a concept that is proving to be beneficial to students, to the work place, and to the community at large.

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1 Pathways to Prosperity: Meeting the Challenge of Preparing Young Americans for the 21st Century, Harvard Graduate School of Education, 2014.

2 The Pew Research Center, Washington, D.C., 2014.

3 The National Research Center for Career Technical Education, 2014.

Introduction

Most educational standards aren't derived from an analysis of what students need, but rather from a collective opinion of educators and policy makers regarding what students should be required to know.

Consequently, we have a "one size fits all" educational system that focuses on college prep, notwithstanding the facts that:

- only 60 percent of the nation's high school graduates go to college;
- only 30 percent of those who start college finish their preferred career pathways with a four-year degree;
- our economy requires that only 25 percent of its employees have a college degree; and
- we, as a nation, are facing a serious "skills gap."

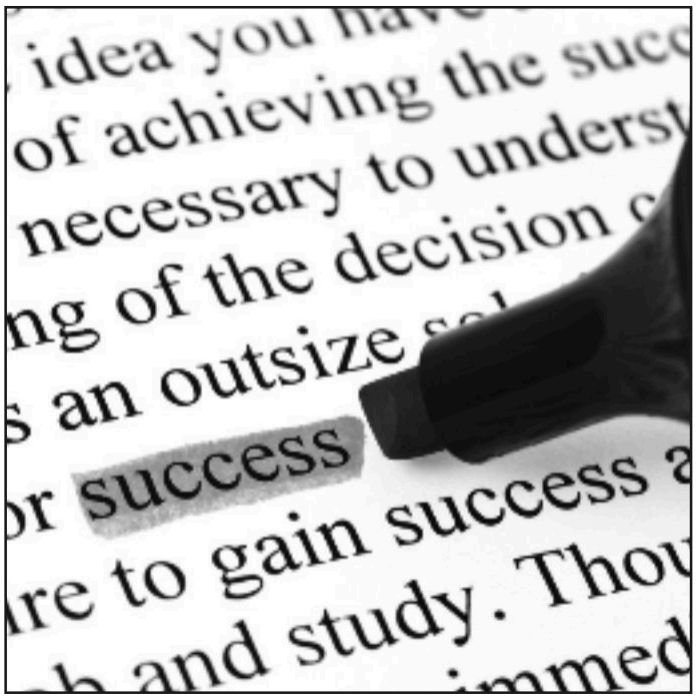
While few would question the need for an education, as a society, we have evolved into a culture that believes that all students should be prepared to go to college. And if we settle for a route that doesn't include college, we've somehow killed the American dream. But the American dream isn't about college. It's about climbing the economic ladder and providing a better life for our children, and career/technical education offers a viable alternative to students who prefer a combination career ready/college prep option upon high school graduation.

This document provides a road map for high school students who might prefer a career/technical education option over college prep, if they could meet ever-increasing high school graduation requirements. Not only does the CTE option provide many high school students a choice, but often times it is the incentive to stay in school and optimize their educational opportunities.

Teams of automotive and academic teachers, representing the content areas of English, mathematics and science, identified academic principles and subject matter content from their respective disciplines that are embedded in various ASE Education Foundation automotive tasks. Automotive students must demonstrate academic mastery of these requirements in order to be successful and advance in their chosen career. These principles and subject matter content were then formatted into content descriptions that include templates for crafting credit-worthy integrated academic or stand-alone classes in English/applied communications, mathematics and/or science for students enrolled in automotive technology at any of the three ASE program accredited levels of maintenance and light repair (MLR), automobile service technology (AST), and master automobile service technology (MAST).

In addition to highlighting the academic content embedded in the various ASE Education Foundation tasks, to the extent possible, each task and its related academic content have been aligned with Common Core State Standards and STEM connections. For detailed information regarding the connection of tasks and the respective academic content, see www.ASEeducationfoundation.org.

This publication also contains a listing of Employability Skills that were added to the ASE Education Foundation's 2013 Program Standards.



This document provides a road map for high school students who might prefer a career/technical education option over college prep, if they could meet ever-increasing high school graduation requirements

Getting Started

In most cases, the automotive technology instructor will be instrumental in initiating the consideration of integrating academic and career/technical education at the local level. That's probably due to the auto instructor's awareness of the significant academic content embedded in the various ASE Education Foundation tasks and an assessment of matriculating automotive students' level of understanding of the related academic disciplines that are relevant to being a successful automotive technician.

For example, if it is apparent that students who traditionally enroll in automotive technology are deficient in understanding mathematics principles and their application to automotive science, perhaps a starting point would be to explore the possibility of integrating applied math into the automotive technology program.

Using the content description and suggested course outline on page 12 of this publication, arrange an informal meeting with the high school's curriculum director, teachers from the mathematics department, a high school counselor, and a representative from the automotive program's advisory committee to discuss the merits of an integrated math/auto tech initiative. Note that the mathematics principles to be taught are aligned with the Common Core State Standards for Mathematics and should be worthy of a general or applied mathematics credit. Emphasize the students' educational benefits to be derived from such a concept and point out that operationally it could be a team-teaching arrangement, a stand-alone automotive math class, or some other option that would accommodate both program and student needs in applied math. Regardless of the instructional logistics, be sure to point out the importance of regular planning meetings between the math and automotive instructors to coordinate and synchronize instructional content to the extent possible.

Assuming that the discussion moves in a positive direction, organize a committee to meet with school administrators and policy advisors to solicit their views and thoughts regarding the integration concept and suggest that a formal proposal be crafted to present to the board of education for its consideration.

The aforementioned strategy focuses on integrated math, but similar strategies can be employed when considering the integration of English/applied communication and/or applied science. For example, pages 7-11 describe, in some detail, sample technical speaking, listening, research and writing assignments and exercises for automotive students. These assignments are compatible with selected English Common Core Standards and worthy of English credit consideration. Implementation strategies are also noted on page 8.

Pages 22-29 include an overall course content description; this section highlights specific STEM and Next Generation Science Standards to illustrate the applied science that is embedded in teaching the various automotive systems. Sample lesson plans and student assignment examples are also included to emphasize the relevance of science in teaching automotive technology. Detailed information regarding the connection between specific tasks and science principles is included on the designated ASE Education Foundation website.

Caution should be exercised, however, to guard against too much integration at the expense of encroaching on the teaching and skill development time required of a quality ASE accredited automotive technology program.

Integrating English/Language Arts and Automotive Technology

Content Description

This instructional package is designed to connect Common Core Standards in language arts to the ASE Education Foundation's maintenance and light repair task lists. Using material assigned in the automotive technology program, this enhanced instructional strategy is intended to integrate reading, writing, language, speaking and listening assignments into an automotive technology course worthy of one English credit and two automotive technology credits. For detailed information regarding the connection of tasks and language arts content, see www.ASEeducationfoundation.org.

Spanning the eight automotive specialty areas, automotive technology assignments pertaining to the ASE Education Foundation tasks include:

- Textbook and service information research and reading
- Lab worksheets and repair orders
- Quizzes
- Exams

English/Language Arts assignments pertaining to Common Core Standards include:

- Six to eight written summaries of assigned readings (200 words each)
- Eight short-answer assignments
- Four essays or projects of 500 to 750 words
- Essay questions on exams
- One research project of 1250 words

MLR Course with 1 English/Language Arts Credit

In its present state, an MLR automotive technology course requires students to demonstrate the 10 *Common Core Reading Standards for Literacy in Science and Technical Subjects for grades 11-12* and the three Standards for Language for grades 11-12 in its assignments and activities.

In addition, an MLR automotive technology course requires students to demonstrate this Speaking and Listening Standard for grades 11-12:

- Present information, finding, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to the purpose, audience, and a range of formal and informal tasks.

Finally, an automotive technology course requires students to demonstrate these Common Core Writing Standards for Literacy in Science and Technical Subjects in grades 11-12:

- Write arguments focused on discipline-specific content
- Write informative/explanatory text, including the narration of technical processes
- Produce clear and coherent writing in which the development, organization, and style are appropriate to the task, purpose and audience.
- Draw evidence from informational texts to support analysis, reflection, and research

However, in order to meet the demands for a recognized ELA credit, these assignments should be added to the course work annually:

- Six to eight written summaries of assigned readings (200 words each)
- Eight short-answer assignments
- Four essays or projects of 500 to 750 words
- Essay questions on exams
- One research project of 1250 words

Education Foundation

Integrating English/Language Arts and Automotive Technology

The additional components should be taught, guided and evaluated by a certified ELA teacher utilizing ELA standards. (The automotive technology-specific content would be evaluated by the automotive technology teacher.) Both teachers would develop an evaluation rubric.

The following *Common Core Writing Standards for Literacy in Science and Technical Subjects in grades 11-12* would be addressed by the addition of the writing assignments:

- Develop and strengthen writing as needed by planning, revising, editing or rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- Use technology, including the internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- Conduct short as well as a more sustained research project to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- Gather relevant information from multiple authoritative print and digital sources, using advance searches effectively, assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, proposes and audiences.

Implementation strategies may include:

- The ELA teacher is assigned the automotive technology course as a team teacher with the responsibilities as part of his/her load.
- The ELA instructor receives a stipend.
- The automotive technology teacher and the ELA teacher switch classrooms for a specific number of class periods per year, with the ELA teacher providing writing instruction in the automotive technology course, and the automotive technology instructor presenting sessions on the relevance of workplace writing.
- The automotive instructor takes the ELA students on field trips on the days that the ELA instructor is in the automotive technology classroom.

Integrated English/Language Arts Sample Student Assignment

NAME: _____ CLASS: _____ DATE: _____

TOMORROW'S TECHNICIAN ARTICLE REVIEW

LESSON GOALS AND OBJECTIVES

STUDENT WRITTEN ASSIGNMENT - TOMORROW'S TECHNICIAN November 2013 issue • "COOL RUNNINGS" page 12 thru 20

a. Read article.
b. Summarize article.
c. Using the following format - (first line) Writing Assignment - Your Name (second line) Tomorrow's Tech - Cool Runnings (third line) Introduction, then summarize that section; then take each section of the article - Write down the section title, then summarize that section; Continue with the rest of the sections (100 points).
d. The writing assignment will be evaluated not only by proper summarization but also sentence structure, paragraph development, spelling, and other items as detailed in the assignment rubric.
e. The writing assignment will be saved on the student's g-mail account for review and updating the suggestions for final grading.
f. An evaluation rubric will be given to describe in detail, what the assignment should include with a grading scale.
g. This assignment will be reviewed by an ELA instructor and given back to the students to be redone before final grading by the ELA teacher.

EVALUATION

___TEACHER OBSERVATION ___PROBLEM SOLVING ___SUMMARY REVIEW
___FORMAL TEST ___STUDENT WORK ___REPORT
___HANDS ON SKILLS

HOME LEARNING ASSIGNMENT: COMPLETE ASSGNMENTS GIVEN IN CLASS

AUTOMOTIVE TECHNOLOGY NATEF TASKS: ER.D.1, ER.D.4, and ER.D.7

COMMON ENTRY LEVEL TASKS AND NATEF TASKS DEPENDING ON THE CONTENT OF THE ARTICLE

CORE SUBJECTS

MATH: CONVERSION OF HOURS OF WORK INTO STUDENT'S MONEY, TOOLS WITH FRACTIONS
LANGUAGE ARTS: READING SERVICE INFO AND WRITTEN DESCRIPTION OF COMPLETED WORK
SCIENCE: PROPERTIES OF CHEMICALS USED IN THE AUTOMOTIVE SERVICE FIELD

IEP AND IAP ACCOMMODATIONS

___PEER TUTORING ___EXTENDED TIME ___READ ASSIGNMENTS ALOUD
___SPECIALITY HELP ___ASSIGNMENT NOTEBOOK

Education Foundation

Integrated English/Language Arts Sample Student Assignment

Review the rubric and answer the following questions in complete sentences

Rubric would have number of words/sentences as well as need for key terms

NAME: _____ CLASS: _____ DATE: _____

WHAT'S IN YOUR HEAT EXCHANGER?

1. How does the heat exchanger work?

2. What happens to the Freon in the condenser to create the heat exchange process?

3. What happens to the air inside the passenger compartment to make it cold during air conditioning operation?

Integrated English/Language Arts Sample Student Assignment

4. If the pressure of the Freon on the high side of an air conditioning system increases by 40 pounds of pressure, what happens to the temperature of the same Freon?

5. If the radiator overheats because of a low level of coolant, what would be the effect of the air conditioning system's cooling quality?

Education Foundation

Integrating Mathematics and Automotive Technology

Content Description

This instructional package is designed to connect STEM initiatives and Common Core State Standards in mathematics to the ASE Education Foundation's MLR/AST/MAST task lists.
The material could be presented as a standalone course in integrated career tech mathematics or as a mathematic component of an automotive curriculum worthy of one high school math credit. For detailed information regarding the connection of tasks and math content, see www.ASEeducationfoundation.org.

Suggested Course Outline

I. Engine repair
- Engine size conversions
- Cylinder volume
- Cams and timing

II. Automatic transmission

III. Manual transmission
- Simple gears
- Gear trains

IV. Suspension and steering
- Steering
- Alignment angles
- Handling

V. Brakes
- Levers (brake pedal)
- Area of braking components
- Hydraulics (Pascal's Law)

VI. Electrical systems
- Simple circuits and Ohm's Law
- Meter reading and trouble shooting in electrical/electronics

VII. Heating and A/C

VIII. Engine performance
- HP and torque, air flow, compression ratio
- Required supplemental tasks
- Number sense
- Measurement, drill bit and bolt sizes
- Work orders (repair order) tires

Sample Lesson Plan Outline - Week View

Automotive Integrated Mathematics

	Monday	Tuesday	Wednesday	Thursday	Friday
Concept to be taught	Intro to electricity	Intro to circuit software	Ohm's Law (inquiry)	Ohm's Law	Series & parallel simulations
Student Learning Target(s) Addressed	**I can...** - Describe electrical terms and concepts through a water or traffic jam analogy - Demonstrate understanding of the units of current, voltage, resistance and power. - Use correct symbols to describe circuit components	**I can...** - Use PHET interactive software to create and adapt simple circuits	**I can...** - Use PHET interactive software to create and adapt simple circuits. - Describe the relationships between resistance and current. - Develop a model (Ohm's Law) to describe the interaction between Voltage, Current, and Resistance	**I can...** - Use Ohm's Law to solve for missing values in a circuit. - Read a simple wiring schematic	**I can...** - Set up and measure series and parallel circuits on a simulator. - Describe relationships between voltage, current and resistance in series and parallel circuits
Activities/ Materials/ Technology	Lecture and discussion	Computer Lab Activity Circuit Simulator http://phet.colorado.edu/ en/ simulation/circuit-construction-kit-dc	Computer Lab Activity Circuit Simulator http://phet.colorado.edu/ en/ simulation/circuit-construction-kit-dc	Lecture and discussion	Computer Lab Activity Circuit Simulator http://phet.colorado.edu/ en/ simulation/circuit-construction-kit-dc
Common Core Standards for Math	N-Q1 N-Q3	N-Q1 N-Q3	N-Q1 N-Q3 A-CED1 A-REI3	N-Q1 N-Q3 A-CED1 A-REI3	N-Q1 N-Q3 A-CED1 A-REI3
ASE Area	VI-A	VI-A	VI-A	VI-A	VI-A
Assignment/ Lab Activity/ Extended Practice		Circuit Exploration Intro	Circuit Exploration (Ohm's) Part 1	Electrical #1	Circuit Exploration (Ohm's) Part 1

Education Foundation

Integrated Mathematics Sample Student

Auto Math
Circuit Exploration Number 1

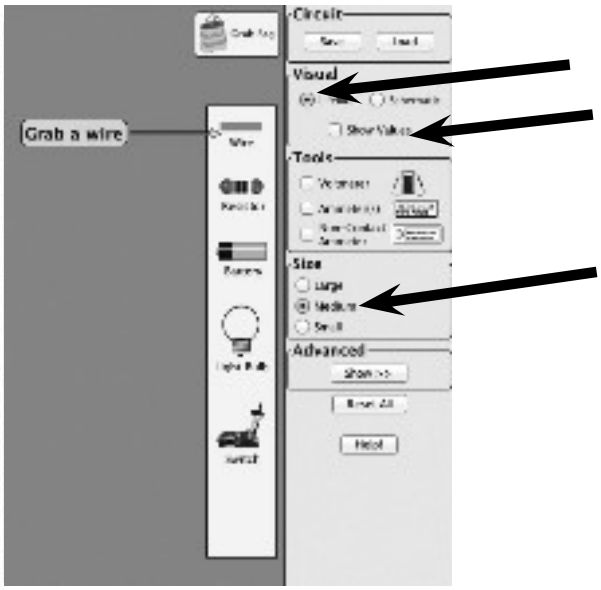
Name _____
Date _____

Go to Google and search for circuit construction kit (dc) or type in this URL

http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc

Your job today is to build these types of circuits and sketch them

Start with these settings clicked:



1) Build a circuit with one light bulb, one switch, and one battery so that it lights up!

   Have your instructor sign off on your success _____

   Sketch your circuit on the paper!!!!!

Integrated Mathematics Sample Student

2) Build a circuit with two light bulbs, one switch, and one battery so that it lights up! The circuit will stop working if I remove a light bulb.

Have your instructor sign off on your success _____

Sketch your circuit on the paper!!!!!

3) Build a circuit with two light bulbs, one switch, and one battery so that it lights up! The circuit will continue working if I remove a light bulb.

Have your instructor sign off on your success _____

Sketch your circuit on the paper!!!!!

4) Build a circuit with two light bulbs, two switches, and one battery so that it lights up! Set it up so that each switch controls a light bulb

Have your instructor sign off on your success _____

Sketch your circuit on the paper!!!!!

Integrated Mathematics Sample Student

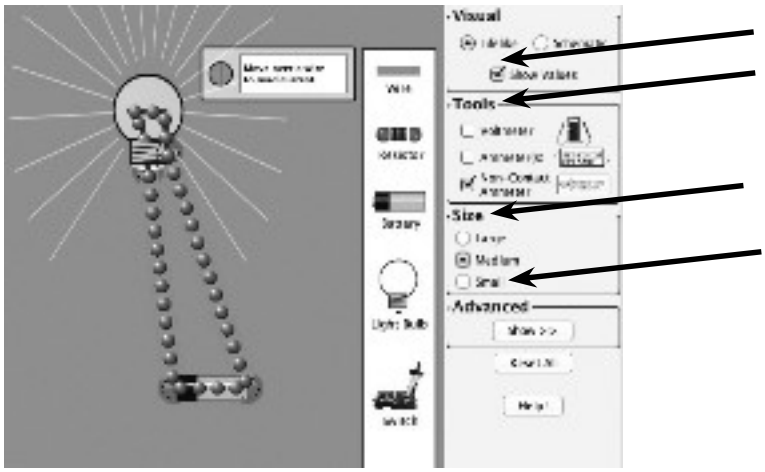
Auto Math
Circuit Exploration Number 2

Name _____
Date _____

1) Go to Google and search for circuit construction kit (dc) or type in this URL

http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc

2) Build this circuit and check these settings:



3) Use the right click button to change the voltage on the battery to 12 volts, and change the ohms on the light bulb to 12 ohms.

a) Is current flowing slowly or quickly?

b) Measure the current by dragging the "Non-Contact Ammeter" over the wires.

_____amps

4) Use the right click button to change the voltage on the battery to 12 volts, and change the ohms on the light bulb to 6 ohms.

a) Is current flowing slowly or quickly?

b) Measure the current by dragging the "Non-Contact Ammeter" over the wires.

_____amps

Integrated Mathematics Sample Student

5) Use the right click button to change the voltage on the battery to 12 volts, and change the ohms on the light bulb to 2 ohms.

a) Is current flowing slowly or quickly?

b) Measure the current by dragging the "Non-Contact Ammeter" over the wires.

_____amps

6) Use the right click button to change the voltage on the battery to 12 volts, and change the ohms on the light bulb to 24 ohms.

a) Is current flowing slowly or quickly?

b) Measure the current by dragging the "Non-Contact Ammeter" over the wires.

_____amps

7) Use your answers from 3-6 to fill in this chart

Problem Number	Current (Amps)	Resistance (Ohms)	Voltage (Volts)
3			
4			
5			
6			

8) What do you get if you take the number of amps and multiply it by the number of ohms for all of the problems above?

9) This property is called Ohm's Law "The voltage in a circuit is equal to the current times the total resistance" or

$$V = I \cdot R$$

Use this equation to find the missing value in these scenarios

a) A _____volt circuit with 9 ohms of resistance will have 1 amp of current.

b) A 12 volt circuit with 3 ohms of resistance will have _____amps of current.

c) A 12 volt circuit with _____ohms of resistance will have 1.5 amps of current.

Integrated Mathematics Sample Student

10) Circle the correct choice to fill in the blank

a) Lowering the resistance _____ the amount of current flow.
Increases / Decreases

b) Raising the resistance _____ the amount of current flow.
Increases / Decreases

11) Use the right click button to change the voltage on the battery to 12 volts, and change the ohms on the light bulb to 1 ohm.

a) Is current flowing (are the blue circles moving) slowly or quickly?

b) Measure the current by dragging the "Non-Contact Ammeter" over the wires.

_____ amps

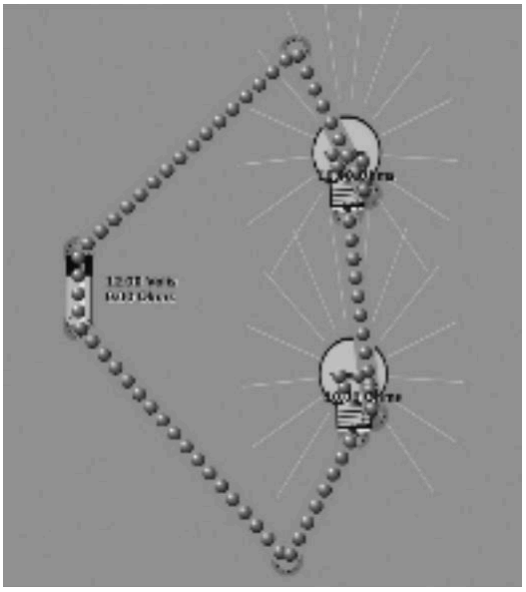
c) What happens? Why?

12) Build this circuit and change the battery voltage to 12 volts and the resistance of the two light bulbs to 3 ohms each.

a) Use the non-contact ammeter to determine the current.

_____ amps

b) If I swapped out the two light bulbs for one light bulb, how many ohms would it need to be set at to get the same current?



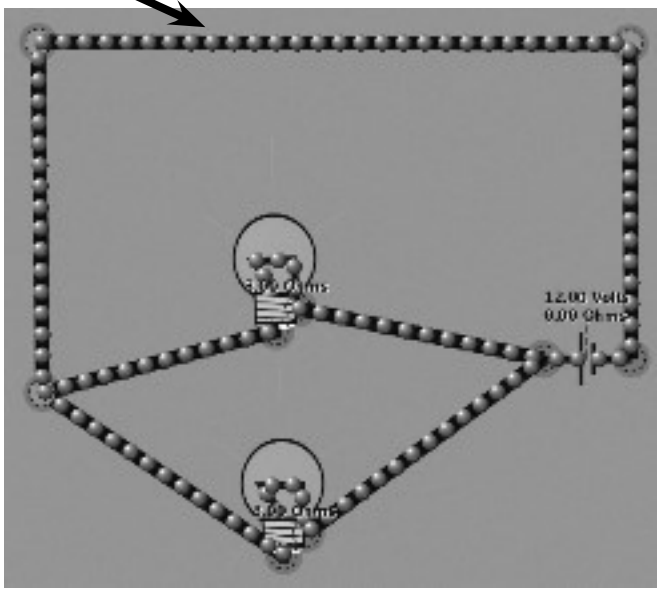
Integrated Mathematics Sample Student

13) Build this circuit and change the battery voltage 12V and the light bulb resistances to 3 ohms.

a) Find the current along the top wire with the non-contact ammeter.

amps

b) If I swapped out the two light bulbs for one light bulb, how many ohms would it need to be set at to get the same current?



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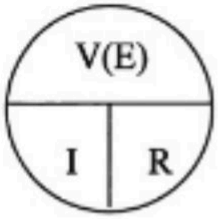
Integrated Mathematics Sample Student

Auto Math
Ohm's Law

Name _____
Date _____

1) The following symbol is often used to simplify Ohm's Law. Explain how to use it.



2) What are the standard units for the following measurements (words and symbols)

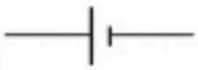
Voltage _____(___) Resistance _____(__) Current _____(__)

Fill in this chart using Ohm's Law **(Show a set up!!!!)**

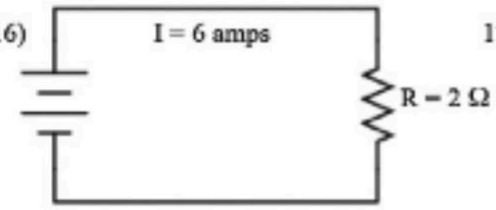
	Voltage	Current	Resistance
3	12V	4A	
4	6V		2Ω
5	3.6V	1.1A	
6		.3A	14Ω
7		10A	1.67Ω
8	12V		215Ω
9	1.5V	8A	
10		8A	.25Ω

Integrated Mathematics Sample Student

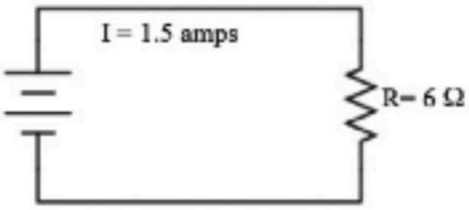
Name these circuit symbols

11)  12)  13)  14)  15) 

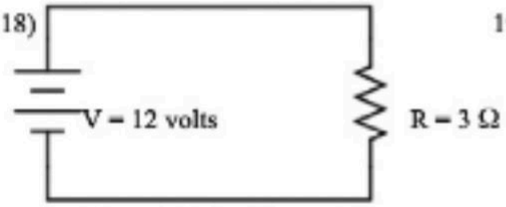
Find the missing value in each circuit diagram.

16) 

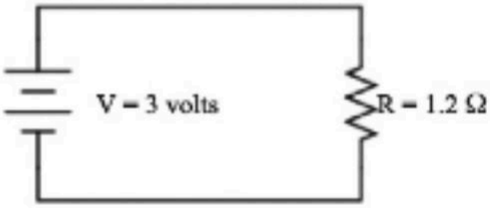
V = _____

17) 

V = _____

18) 

I = _____

19) 

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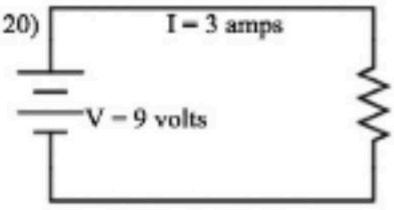
20) 

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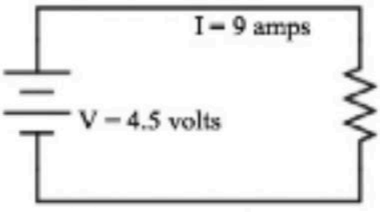
21) 

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Education Foundation

Integrating Science and Automotive Technology

Content Description

This instructional package is designed to connect STEM initiatives and Next Generation Science Standards into the ASE Education Foundation's MLR/AST/MAST task lists. The material could be presented as a standalone course in the integrated career tech sciences or as a science component of an automotive curriculum worthy of one high school science credit. For detailed information regarding the connection of tasks and science content, see www.ASEeducationfoundation.org.

Integrated Science Lesson Objectives

I. Engine Repair

- Engine operation 4- stroke engine theory
- Compression & expansion of gas
- Propagation, flame spread
- Cylinder head type & construction & effects on airflow
- Types of switches
- Sending units & switches
- Environmental issues handling waste products
- Chemistry of sealants
- Metallurgy
- Torque to yield
- Proper lifting techniques (Kinetics)
- Clamping force, on time use of fasteners
- Chemical identification of cracks
- Warpage issues, friction & wear
- Chemical solvents & environmental issues
- Antifreeze chemistry
- Heat transfer (Thermodynamics)
- Pressure vs. boiling point (Boyle's Law/Charles's Law)
- Recycling coolant
- Thermostat operation properties
- Fluid coupling (Hydrodynamics)
- Oil weight, viscosity, additives, synthetics (Chemistry)

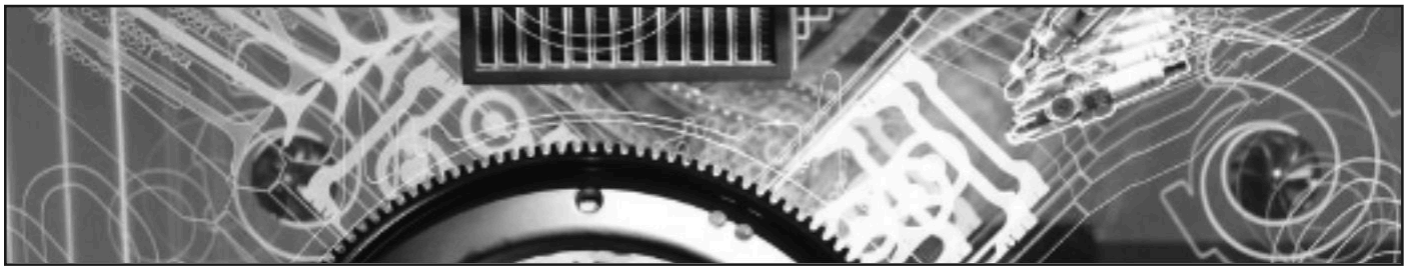
II. Automatic Transmission

- Pressure vs. volume
- Thermal effect on fluids
- Balancing & phasing of the drive line
- Fluid dynamics
- Pascal's Law
- Chemistry of sealants
- Basic principles of electrical circuitry
- Ergonomics (science of lifting properly)
- Rotational inertia
- Power conversions
- Chemical reaction with metals
- Types of gasket materials
- Hydraulics & pneumatics
- Sequential torquing
- Torque effect on fasteners

III. Manual Transmission

- Coefficient of friction
- Clutch materials
- Disposal of fluids
- Balance
- Center of gravity
- Harmonic effects
- Simple machines
- Gears & levers
- Fluid types
- Thermal metal fatigue
- Definition of torque
- States of a fastener
- Chemistry of seals & sealants
- Review of fundamentals of kinetic motion
- Electrical fundamentals
- Principles of vacuum

Integrating Science and Automotive Technology



Integrated Science Lesson Objectives

IV. Suspension & Steering

- Chemical reactions
- Basic electricity
- Levers
- Properties of materials
- Chemistry of fluids
- Hydraulics
- Aerodynamics
- Pneumatics
- Bearing types
- Balancing of forces
- Material science
- Rubber & rubber compounds
- Wheel rims & corrosion issues
- Vulcanization
- Electronics diagnosis

V. Brakes

- Torque & clamping force
- Corrosion of materials
- Deformation of metal
- Chemistry of bonding agents
- Chemistry of lubricants
- Thermal effects on metals
- Leverage
- Vacuum principles
- Review 4 stroke engine theory (intake)
- Chemistry of materials (seals)
- Principles of corrosion
- Torque
- States of fasteners
- Electronic diagnostics
- Energy transfer

VI. Electrical Systems

- Electrical Fundamentals (Ohm's Law)
- Environmental Science
- Electronics Diagnostics
- Chemistry of Batteries (Electrolysis)
- Physical Science
- Personal Protection
- Computer Science
- Electromagnetic induction (Faraday's Law)
- Basic Engine Theory
- Principals of Corrosion
- Electrical Safety
- Piezoelectric effect
- Chemical reactions & accelerants
- Electromechanical Theory
- Electro Mechanic Wave Theory

VII. Heating & A/C

- Refrigerant handling & EPA concerns (environmental science)
- Electrical Fundamentals (Ohm's Law)
- Thermoelectric theory
- The Peltier effect
- Thermodynamics
- Airflow Dynamics

VIII. Engine Performance

- Electrical Fundamentals (Ohm's Law)
- Environmental Science
- Electronics Diagnostics
- Chemistry of Batteries (Electrolysis)
- Physical Science
- Personal Protection
- Computer Science
- Electromagnetic induction (Faraday's Law)
- Basic Engine Theory
- Principals of Corrosion
- Electrical Safety
- Piezoelectric effect
- Chemical reactions & accelerants
- Electromechanical Theory
- Electro Mechanic Wave Theory
- Dynamic Flow effects
- James Watt's Law of Horsepower
- Thermal Efficiencies

Education Foundation

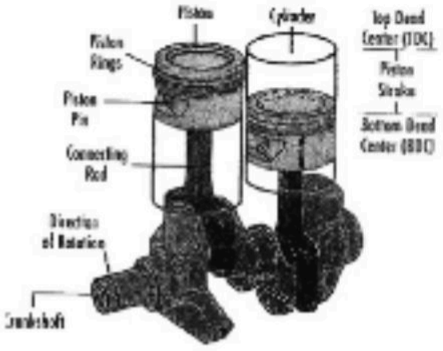
Integrated Science Sample Lesson Plan

Engine Repair

Objective: In this lesson you will become familiar with the basic operation and construction of the internal combustion engine.

An internal combustion engine is:

- **A heat exchange unit**
- **Able to produce power from the expansion of burning gasses**
- **Assembled from parts that are strong enough to contain the combustion process**
- **Also contains the parts needed to change reciprocating motion to rotary motion**

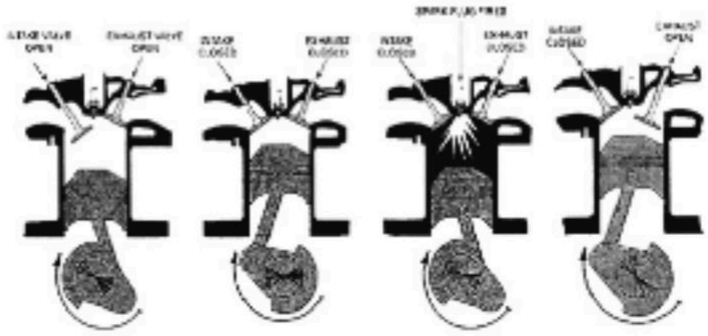


Necessary parts are:

- Cylinder
- Piston
- Connecting rod
- Crankshaft
- Camshaft and cam drive
- Valves and springs
- Cylinder head
- Block

Cycles & Strokes:

- Cycle describes an operation from start to finish
- All reciprocating engines have four events which must take place:
  - **Intake**
  - **Compression**
  - **Power**
  - **Exhaust**
- Completion of the events constitutes a cycle
  - **Events must occur in the proper sequence**
  - **A stroke is the movement of the piston from B.D.C. to T.D.C. or vice-versa**
  - **One stroke requires 180 degrees of crankshaft rotation**



Integrated Science Sample Lesson Plan

Torque and Bolt Strength

Objective: To gain a better understanding of what torque is and to be able to apply it to bolt strength and tightening limits.

Equipment required:

___ method of hanging a weight off from a pivot arm that is 1 foot long (for ease of discussion) with a socket head bolt head at the pivot point.

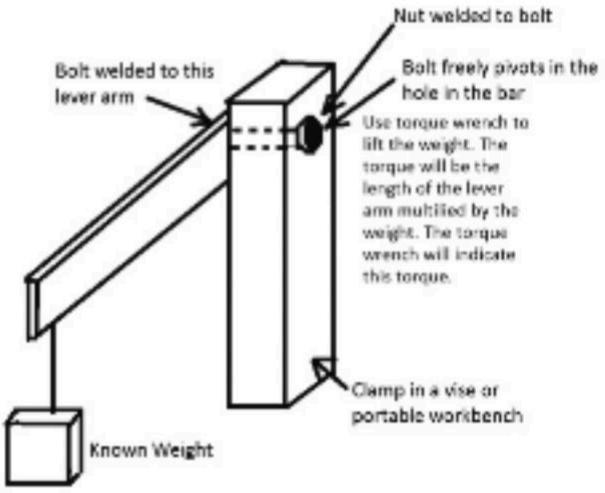
___ torque wrench and sockets

___ breaker bars of different lengths

___ several ¼ - 20 bolts and nuts of different grades

___ anti-seize

___ torque specification sheet



For this lesson:

1. Set up torque demonstration equipment.
2. Pass out "Torque Pre-demonstration questions" handout. Allow time for students to fill it out.
3. Have students predict the amount of weight by using the torque apparatus and breaker bar and allowing them to lift the weight with the breaker bar. Cover the weight with a plastic bag so they cannot see it.
4. Discuss how changing the length of a lever arm changes how heavy the weight will feel in the bucket. Have them use both short and long breaker bars. Stress that the torque will be the same regardless of how it feels to them. Define torque as length X force (weight).
5. Pass out lab/demonstration sheet.
6. Have students predict at what torque a ¼ - 20, grade 2 bolt will break. You will be surprised.
7. Demonstrate the breaking of a ¼ -20, grade 2 bolt by using a torque wrench that will indicate changing levels of torque. Repeat several times and for various grades of bolts.
9. Use a torque specification sheet and discuss the proper torqueing of bolts.
10. Apply anti-seize to the threads of a ¼-20 bolt and observe the change of torque required to break the bolt. Repeat several times and for various grades of bolts.
12. Discuss the effects of anti-seize on the tightening torque of a bolt.
13. Pass out the "Torque and Bolt Strength Follow-Up Questions".

Integrated Science Sample Student

Torque
Pre-Demonstration Questions

Name _____
Date _____

1. What is torque?
2. In what way would you be concerned with torque in your program area?
3. What type of units might torque be measured in?
4. How do the units relate to each other?
5. What physical qualities might affect the accuracy of a torque measurement?
6. How might more accurate measurements be made?
7. Does it matter where you hold the torque wrench when you use it? Explain.
8. At what torque level does a grade two (or three) ¼ – 20 inch bolt break (or begin to yield)?
9. What experiments would you like to do related to torque?

Integrated Science Sample Student Lab/Demonstration Assignment

Torque and Bolt Strength Lab/Demonstration
Date

Name _____

Objective: To gain a better understanding of what torque is and to be able to apply it to bolt strength and tightening limits.

What do you think the recommended torque specification is for a ¼ - 20 bolt (¼ inch in diameter with 20 threads per inch)? At what torque do you think the bolt will break?

Grade of Bolt	What do you think the recommended torque is for each ¼ - 20 bolt?	Actual torque recommended for tightening the bolt (from handout)	Estimate the torque you think is needed to break a bolt	Tested torque needed to break a bolt (as done experimentally in class)
2 or 3				
5				
8				

What effect do you think putting anti-seize will have on the torque level at which a bolt will break? Will it break at the same torque, a lower torque, or higher torque?

Torque and Bolt Strength Demonstration

Grade of ¼ - 20 bolt	Breaking Point **Without** Anti-Seize	Breaking Point **With** Anti-Seize
	Avg. =	Avg. =
	Avg. =	Avg. =
	Avg. =	Avg. =

Integrated Science Sample Student

Torque and Bolt Strength
Follow-Up Questions

Name _____
Date _____

1. How did the anti-seize affect the torque level at which the bolts broke?

2. Why do you think it changed the way it did?

3. What other factors might affect the torque achieved on a bolt?

4. If a wrench is 1 foot long and 45 pounds of force are applied to the end of the wrench, how much torque is being applied?

5. If you put a pipe on the end of the wrench above such that it is now 2 feet long, what would be the torque being applied?

6. What would be the torque if the wrench/pipe is 1 ½ feet long?

7. According to Tohnichi America Corp., suitable torque (recommended torque) can be achieved if the torque applied is 50% to 60% of the breaking torque. If the breaking torque of a bolt is 80 ft lbs, what would be the range for the suitable torque?

8. If the breaking torque is 110 ft lbs, what would be the range for the suitable torque?

9. If the recommended torque is 35 ft lbs, at what range of torque would you expect the bolt to break?

Integrated Science Sample Student

10. Midwest Fasteners recommends that lubricated bolts be torqued to 25% less than the recommended torque for dry bolts. What would the torque be for a bolt whose recommended dry torque is 60 ft lbs?

11. A certain tech manual recommends that spark plugs be torqued to 240 inch pounds. How many foot lbs would this be?

12. You get a flat tire on a trip and need to replace it with a spare. You know that the lug bolts must be torqued to about 90 ft lbs. If your tire wrench is 18 inches long, how much force should you apply to the end of it to obtain the recommended torque?

Education Foundation

Employability Skills

Employability skills are those traits of a non-technical nature that learners must possess to secure and maintain productive employment as an automotive technician. Employability skills are often referred to as soft skills and generally relate to the attitudinal, social and behavioral dimensions of a successful worker's profile.

This skill set has been developed with input from the automotive industry at the corporate and dealership level.

The ASE Education Foundation embeds the teaching of these skills throughout the instructional program by examples and just-in-time learning opportunities.

The ASE Education Foundation embeds the teaching of these skills throughout the instructional program by, examples, and just-in-time learning opportunities.

Workplace Employability Skills
(Required Supplemental Tasks)

Personal Standards

1. Reports to work daily on time; able to take directions and motivated to accomplish the task at hand.
2. Dresses appropriately and uses language and manners suitable for the workplace.
3. Maintains appropriate personal hygiene.
4. Meets and maintains employment eligibility criteria, such as drug/alcohol-free status, clean driving record, etc.
5. Demonstrates honesty, integrity and reliability.

Work Habits / Ethic

1. Complies with workplace policies/laws.
2. Contributes to the success of the team, assists others and requests help when needed.
3. Works well with all customers and coworkers.
4. Negotiates solutions to interpersonal and workplace conflicts.
5. Contributes ideas and initiative.
6. Follows directions and communicates (written and verbal) effectively with customers and co-workers.
7. Reads and interprets workplace documents; writes clearly and concisely.
8. Analyzes and resolves problems that arise in completing assigned tasks.
9. Organizes and implements a productive plan of work.
10. Uses scientific, technical, engineering and mathematics principles and reasoning to accomplish assigned tasks.
11. Identifies and address the needs of all customers, providing helpful, courteous and knowledgeable service and advice as needed.

Administrative Perspective

Several states and local automotive technology programs have successfully implemented integrated academics and career/technical education initiatives and there is much to be learned from their experiences.

For example, the State Education Agency in North Carolina has a State Board of Education sanctioned math options chart detailing how CTE students can earn one or more diploma endorsements via selected application-based CTE courses.

In Mississippi, the State Education Agency has a process for awarding academic credit to CTE students as follows:

1. The Mississippi CTE community works closely with the Research and Curriculum Unit at Mississippi State University. MSU R&C staff, CTE program specialists, CTE instructors, and members from the business/industry community research and design statewide curricula for all locally offered CTE instructional programs.
2. Once a curriculum has been created, a crosswalk is prepared comparing specific CTE competencies and objectives to specific academic math, science, and/or other academic courses to determine if the CTE curricular content is worthy of an academic credit.
3. A group of teachers representing their respective academic disciplines are then convened to review the crosswalk and validate it in support of such academic credit worthiness.
4. Assuming that the crosswalk is validated, the findings are then presented to the state Accreditation Commission for its review. If the Commission concurs with the recommendations of the teacher review group, a proposal is then taken to the State Board of Education.
5. Pending State Board endorsement, the proposal is then subjected to the Administrative Procedures Act process after which it receives final approval by the State Board.

To view the current CTE courses that receive academic credit in Mississippi, go to the website link http://www.mde.k12.ms.us/docs/accreditation-library/2012-standards-8-8-13.pdf?sfvrsn=2.

Other states may have less rigorous procedures for the recognition of academic credit via CTE and in some states the decision regarding the recognition of academic credit falls under the authority of the local board of education.

Regardless of the implementation process, academic/CTE integration has been quite successful where it has been put in place. Mississippi has a long history with the process and it is being utilized in every district in the state. But that's not to say there aren't issues and ongoing challenges.

Some issues and challenges include:

- Overcoming widespread views that academic offerings are for college bound students only and have no significant role in other sectors of the high school curriculum.
- Designing master schedules that will accommodate standalone and/or team taught integrated academic classes.
- Having counselors and administrators recognize the value of this educational option and helping students work through their class schedules to benefit from it.
- Assuring in-school time for academic and CTE teachers to coordinate instructional content and its application in sustaining content rigor and relevance.
- Offsetting real or perceived added costs that may be incurred through the offering of integrated academics and CTE.
- Working with community colleges and baccalaureate degree granting institutions to recognize integrated academic credits in meeting institution admission requirements.

Notwithstanding the above noted challenges and perhaps other challenges that weren't listed, concerted efforts to integrate academics and career technical education have proven beneficial to legions of American high school students. Additionally, the employment community benefits in that those who are seeking employment are better prepared to cope with a technology-driven economy that requires sophisticated research, diagnostic, problem solving and communication skills.

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BEING RELEVANT MATTERS

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www.ASEeducationFoundation.org