Teaching Computer Control using Cause and Effect Relationships Hands-On

4.	Using a wiring diagram or pinout chart for the EM-330-1, identify the MAF Sig pin at the ECM. Connect channel A or 1 to the pin.
	Pin number ______

5.	Using the wiring diagram or pinout chart for the EM-330-1, identify the fuel injector signal pin on the breakout box. Connect channel B or 2 to the pin.
	Pin number _______

6.	Start the EM-330-1 and set RPM to the 12 o’clock position

7.	Adjust the DSO so both the fuel injector pattern shows completely and the MAF

8.	Print or show your instructor.

9.	Move the adjustment switch up to the adjust position. Turn the adjustment slowly counterclockwise. Capture, print or show your instructor.

10.	Turn the adjustment slowly clockwise. Capture, print or show your instructor.

11.	What is the relationship between MAF and Fuel Injection?

The result of this lab should be:
TEACHING COMPUTER CONTROL

TEACHING COMPUTER CONTROL USING CAUSE AND EFFECT RELATIONSHIPS HANDS-ON

Frequently, technicians or students will have difficulty putting all the pieces of Computer Control or inputs vs outputs into a context that they easily understand. Staring at the scanner screen or wondering what piece of diagnostic equipment will result in a successful repair is normal day to day. However, there are technicians that have a grasp of inputs vs outputs or cause and effect. These technicians/students understand how things work making diagnosis much easier.

Within this handout and in the accompanying class we will attempt to review or teach how inputs function and what the result of their changing input should be. This is slightly different from how you may have been taught or how you are teaching, but is a successful series of concepts that are being practiced in some automotive programs. Take it a piece at a time: once you understand the relationship or cause/effect, you will find your understanding or your student’s understanding will increase quickly.

Make sure, if you decide to utilize this method, that you rely on the students performing various labs. As they fill in the blanks they will only be getting part of the picture. It is the questioning or discussion and the utilization of some other piece of equipment that will get at the effect part of the equation. Students must realize that something will change when an engine warms up, or the throttle is opened. They must realize that frequently the cause will be viewed on a DMM (digital multi-meter) and the effect on a scanner or a DSO (digital storage oscilloscope) The DMM, DSO and scanner are the mainstays of teaching computer control cause and effect. Let’s look at each separately.
INTRODUCTION TO THE USE OF A DIGITAL MULTI-METER

The digital multi-meter is the tool that is in every technician’s tool box. Its ability to check voltage, current and resistance make it the go to tool that may be the first one in use. It does, however have its limitations especially when dealing with circuits that have varying levels of voltage, current or resistance.

From the manual for the EM-330: Within this first section, we will introduce the use of the DMM mostly in the voltage setting. We have included a chart showing all the relevant pin voltages at the Breakout Box. The Breakout Box is conveniently located on the front panel of the EM-330-1. It connects to all the ECM pins in use. There are some lab activities within this handout and we have included a template for a general lab which would have the student look up the function and application of a specific pin. He then can take a reading and interpret the reading. The answer key is by no means exact. Based on certain conditions in your shop, your voltage readings might not be the same as ours. Use ours as a guideline and a discussion point with the student.

The student must understand what the DMM is telling him before going on. As a minimum have the students look at some inputs and outputs with a dual purpose. Learning about the circuit and learning what a typical voltage reading might be and why.

Some students might not find the DMM as a great “modern” tool, however its information is basic and extremely important to the understanding of a circuit and its function. Use as many labs as you think necessary to get at the function and interpretation of the voltage. There are 69 active pins at the Breakout Box on the front of the EM-330-1. This means that you could in theory have 69 separate labs just by duplicating the template and filling in different pin numbers on each sheet. However, we do not believe that students can be actively engaged by copying down voltages. It will probably be better for your students and you to identify certain key circuits, have the students measure the voltage KOEO and KOER and then begin a discussion. Better still use an adjustable sensor input like ECT. Put a DMM set on voltage in the correct pin and talk about the circuit on the vehicle. You or the students can then “see” the voltage change. Use a future lab to show how the ECM interprets the voltage as an actual engine temperature displayed on a scanner.

Introduce the DMM to your students after defining what Voltage, Current and Resistance is. After basic circuits are under their belt, take them into computer management. They should have a working knowledge of this circuit with multiple DMM’s. The most important concept for a student to have a good grasp of is voltage division. The majority of the analog computer circuits use voltage division to indicate, position, temperature, pressure, etc. The statement that current flowing through resistance causes a voltage drop must become an important concept that they understand. Teaching this concept hands-on is the best method since students who “experience” voltage division will be less likely to forget it.
INTRODUCTION TO USING THE SCANNER

The scanner has become the “go to” tool of the industry and needs to be taught as what it is. It is the first line of defense within the electronics repairs. Students need to know that the scanner can give them valuable information and generally more than they will need. DTC (Diagnostic Trouble Codes) are only part of the picture. Frequently the system will have the ability to self-diagnose, but can also send a technician off in the wrong direction.

To teach the use of a scanner, it is suggested that the first thing is teach the connection to the DLC or preferred to the DLC Breakout Box. Protecting the DLC pins should be a priority especially with school owned shop cars. The DLC can become intermittent with frequent connect disconnect by many students in many classes. Use a Breakout Box. All scans taken for this manual were taken through a LineSpi Breakout Box. Consider connecting the box to the DLC and use the LED lights as a teaching moment.

The first Scanner Lab might be to look at the meaning of the lights, so a student will be introduced to using the Breakout Box and see the advantages to it. Then, introduce the scanner from a DTC (Diagnostic Trouble Code) standpoint. The EM-330-1 will generate some DTC’s because of missing equipment. There is no transmission on the 330 and so it may generate a transmission code. You may also experience a U code or communication code such as “unable to communicate with transmission module”. Explain to the student that there will be some instances of impossible DTC’s.

Additionally, if the students start turning the adjustment knobs beyond normal conditions, the EM-330-1 may go into a default mode. Once in default, the scanner may show some DTC’s that prevent normal operation of the trainer. For example, it the ECM/PCM sees an impossible combination such as a cold engine coolant temperature and a warm intake air temperature, it may prevent the adjustment of the injector pulse width creating a DTC of inability to adjust pulse width. In no way is this the fault of the EM-330-1. Move all the switches back to sensor position, clear the DTC out of memory and the system will be back in normal operation. You need to expect that students will turn the adjustment knobs from time to time, putting the system into a default mode. Teach them to write down the DTC’s and clear the memory. Make sure that the student never gets in the habit of clearing codes without writing or copying down DTC’s. One of the intro scan labs should be clearing codes.

As you teach using cause and effect, remember that virtually anything that you can do with a vehicle engine management system can be done on the EM-330. One last point: Teach the students to adjust the ECT to a “normal” reading. Use the trainer with the ECT switch in the adjust position and have them turn the adjustment knob until a normal engine coolant temperature is achieved (180-200 °F)as shown on the scan data. This will prevent many of the default mode problems. Unless directed by the lab sheet leave the other switches in the sensor position. Leave the HO2S in the normal position also.

It is not the intent of this manual to give you all the possibilities of using a scanner. These 7 labs will get your students into the basics of a scanner. They should pull up a data stream, measure, graph, and see changes that occur in close to real time data. As the students get better, give them mini assignments to go to the EM-330-1 and capture additional data. It is imperative that they can use a scanner on modern vehicles. They should also realize that sometimes the data stream is a bit slow in comparison to the actual data changes. This will get them prepared for using a Digital Storage Oscilloscope (DSO) which will give more accurate close to real time data.
INTRODUCTION TO THE USE OF A DSO

Perhaps the tool which has changed the technician’s job more than anything else is the Digital Storage Oscilloscope (DSO). You should always insure that your student knows how to set voltage and time before trying to use the tool to capture patterns. It is frustrating to a new student/technician if he cannot get a pattern on the screen much less interpret it from a cause and effect standpoint. The purpose of the labs is to first introduce the DSO and how to read it.

During the continued labs, the student will change the voltage settings and the time settings. He/she will print, if possible, the patterns captured. Looking at the pattern with the student will give you the opportunity to guide the student in an understanding of the DSO. It is not the intent of this manual to give extensive training in the diagnosis and repair of the various components, but rather to allow an instructor to show the advantage to the use of a DSO, and show what good patterns look like. Once a known good is shown, patterns that are not good are easy to identify. Thinking back to the MAF voltage readings that did not change will give you the opportunity to discuss with the students that in the case of MAF, it is the frequency or pulse width and not the voltage that will change.

As the student gets deeper into the DSO labs, they will be using cursors to indicate measured values of voltage or time. Make sure your students know how to turn on and move the cursors on the screen. Since every DSO is slightly different, it is not the scope of this manual to cover every different manufacture. Teach, using what DSO’s you have available, so your students can maneuver around the important screens.

We will be using a PICO 2 channel DSO during the screen captures. If your DSO’s allow for screen printing, have the students print up the various screens that are called for in the labs. After grading them, return them, so the student has a reference for the future. If you are following this manual in sequence, this is the final section. We started with the DMM, which can give some great information, but is limited since it cannot interpret the readings. We then used the scanner as a device that can interpret readings and put them in easily understood terminology. Lastly, we are going to use the DSO as a device that can look at extremely fast signals. Signals that cannot be looked at by any other means. CAN Bus signals are a good example of a signal that is so fast that no DMM can capture the varying voltages. The DMM can only average the readings whereas the DSO can show them.

We will also use a current probe to look at some current signals. We will use the dual trace capability to show a voltage waveform and a current waveform on the same screen. The labs will identify the why and how of using the dual trace function of the DSO. As you teach the various components that the GM Fuel Injection and Engine Management Trainer has, start off with the voltmeter, move to the scanner and finally end with the DSO. This is a proven method to teach how the various components and systems function. This trainer will allow you to teach the basics of the system, the use of a DMM, scanner and the DSO. We hope you enjoy teaching using the EM-330-1 trainer in your classes. We are confident that you will find many ways to utilize the trainer in your classroom especially since it is complete and yet generates no exhaust.
Some additional information on having a printer available. If possible, have a printer available that can be connected to whatever equipment the student will use. The printer serves multiple objectives. The first is having the ability for you to discuss with the student the results of his testing. Second, it will allow you something to grade and, third, the student can 3 hole punch the printed result and keep it in a notebook for future reference.

We will start our discussion with a simple input sensor that will use a thermistor. Students need to recognize that a computer or module cannot measure temperature directly. A computer or module will most frequently only recognize, power, ground, or variable voltage. We need to begin our discussion with voltage drops through a fixed resistor.

Resistors are in use in many of the circuits found in modules. They are usually soldered onto a printed circuit board and then sealed to prevent water shorting them out. Whenever a resistor is used, it will create a voltage drop as current flows through it. Teach your students/technicians that a voltage drop occurs when current flows through resistance. These nine words will carry them through many diagnostic situations. Let’s look at how this works using a very simple series circuit.

This simple circuit contains one power source, one fuse, and three loads. Start the students off with each load being the same resistance. Use different resistance to show that the same voltage division will occur. 3 equal resistance loads will divide the 12.6 V in thirds so the voltage drop across each resistor will be 4.2 V. Start students off with low easily understood values like 1 Ω or 2 Ω's. Eventually put a ridiculous number like 2,126 Ω. Ask the question “does it matter what the resistance is?” With the answer being “no”.

Next, change around the circuit so there are different resistances like: Have the students add them together and calculate the current flow. 12 Ω divided by 12 V = 1 A. Now walk them through the calculated voltage drops 1 Ω X 1 A = 1 V (drop) 2 Ω X 1 A = 2 V. Etc. Add them all together to prove that the sum of all voltage drops in series will equal the total applied voltage. Hint: Use the CL-1919 Ohm’s Law Trainer and this becomes a piece of cake!

The next principle to look at is the use of a variable resistor. Again, if you are using the CL-1919, use the potentiometer on the board and show how the voltage drop varies with adjustable resistance in series with a fixed resistance.
Next we move the student into thermistors or a variable resistor that varies the voltage drop with temperature changes. Next comes the circuit with one fixed and one variable. The total resistance will vary the current which will vary the voltage. Again, if you have the CL-1919 available wire one fixed and one variable resistance together, feed 5 volts to it and walk the students through the voltage division circuit. Convert voltage to temperature.

Ask questions to engage the students. If the 5 Volts were to divide evenly what temperature would this indicate? What would the resistance of the sensor be? Etc. Switch the students over to a vehicle or the EM-330.

Before starting the vehicle measure the resistance. _____ Ω

What temperature does this indicate? _______ °F.

Start the vehicle after connecting a scanner to the DLC. Set the scanner to measure ECT.

The following two labs are examples of the type of lab that will facilitate a thought process that will be cause and effect oriented. Re-do these labs with IAT or any other thermistor circuit until the student understands that it is the engine temperature, that changes the resistance, that changes the voltage drop, that causes the scanner to “see” the temperature.
1st DMM vs Scanner Lab

Name __________________________________________ Date __________ Class __________

Introduction: In the next series of labs we will look at a cause and effect condition. The DMM will give us the opportunity to look at the cause and the scanner will show the effect. At this point if you are having difficulties operating the scanner, ask your instructor for help.

1. Check out a DMM from the tool room. Insure that it has sufficient battery power.
2. Check out a Scanner with an OBD connector.
3. Connect the negative lead from the DMM to the ignition negative terminal near the ignition switch. Do not use any other ground.
4. Turn on the power supply switch. The battery light should come on.
5. Connect the positive DMM lead to the ignition positive terminal. What voltage do you see? __________V DC
6. Connect the scanner to the DLC and power it up.
7. Program the scanner so it is capable of reading the scan data stream and look at intake air temperature (IAT).
8. Move the positive DMM lead over to pin #58 of the X-1 connector breakout box (next to the ignition switch).
9. Switch the IAT switch up to the adjust position.

10. Record:
    Pin # 58 Voltage ____________V  
    IAT scan data temperature ________ °F

11. Turn the sensor adjust knob slowly until 2.5 V shows on the DMM.  
    What temperature does the scanner read? _______ °F

12. Turn the sensor adjust knob until 1.25 V shows on the DMM.  
    What temperature does the scanner read? _______ °F

13. Turn the sensor adjust knob slowly until 3.75 V shows on the DMM.  
    What temperature does the scanner read? _______ °F

14. The readings should have shown you a relationship between the voltage and the temperature. What is this relationship?  
__________________________________________  
__________________________________________  
__________________________________________

15. Set the IAT switch back to the Sensor position.

Instructor signature _____________________________________ Date ______________
TEACHING COMPUTER CONTROL

2nd DMM vs Scanner Lab

Name ______________________________________________ Date__________ Class __________

Introduction: This lab is a continuation of the cause and effect lab. The DMM will give us the opportunity to look at the cause and the scanner will show the effect. At this point if you are having difficulties operating the scanner, ask your instructor for help.

1. Check out a DMM from the tool room. Insure that it has sufficient battery power.
2. Check out a Scanner with an OBD connector.
3. Connect the negative lead from the DMM to the ignition negative terminal near the ignition switch. Do not use any other ground.
4. Turn on the power supply switch. The battery light should come on.
5. Connect the positive DMM lead to the ignition positive terminal. What voltage do you see? __________V DC
6. Connect the scanner to the DLC and power it up.
7. Program the scanner so it is capable of reading the scan data stream and look at intake air temperature (IAT).
8. Move the positive DMM lead over to pin #58 of the X-2 connector breakout box (next to the ignition switch).
   Note there are two pin 58’s. One on X-1 and one on X-2.
9. Switch the ECT switch up to the adjust position.
10. Record:
    Pin # 58 Voltage ___________V
    ECT scan data temperature ________ °F
11. Turn the sensor adjust knob slowly until 2.5 V shows on the DMM.
    What temperature does the scanner read? _______ °F
12. Turn the sensor adjust knob until 1.25 V shows on the DMM.
    What temperature does the scanner read? _______ °F
13. Turn the sensor adjust knob slowly until 3.75 V shows on the DMM.
    What temperature does the scanner read? _______ °F
14. The readings should have shown you a relationship between the voltage and the engine temperature. What is this relationship?
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________
15. Rotate the ECT adjustment knob until engine temperature reads about 180 °F.

Let’s change over to an input that is variable and causes something to change. We will use a MAF (Mass Airflow) sensor. The signal generated is a frequency modulated signal. What does this mean? It means the pulse width does not change and is usually fixed at 50% but the number of pulses changes with the volume of airflow. The EM-330 is a perfect device for this type of cause and effect since it can show changes to the pulse width of the fuel injector as the input of the MAF changes. If you do not have an EM-330, use a vehicle in the shop. With a scanner showing pulse width, vary the throttle and the load on the engine. The changing airflow will cause a corresponding change in the FI pulse width. Here are some labs to accomplish this task from the EM-330 manual.
DSO Lab # 1

Name __________________________________________ Date __________ Class __________

Introduction: Modern engines need to know how much air is actually flowing through the throttle. In one of the scanner labs we looked at the Mass Air Flow (MAF). On the EM-330-1 MAF is adjustable. Follow the directions exactly since if you get the MAF too far from a real value, the ECM will go into a default mode. Once in default mode, you must clear codes with a scanner to accomplish this lab. The MAF will generate a different type of signal.

1. Check out a DSO from the tool room. Insure that it has sufficient battery power or that you have an AC adapter present.
2. Connect the DSO leads to the DSO.
3. Connect the negative lead of the DSO to the engine ground terminal near the ignition switch.
4. Using a wiring diagram or pinout chart for the EM-330-1 and identify the MAF Sig pin at the ECM.
5. Make sure the MAF adjustment switch is in the sensor position.
6. Connect the DSO ground to the ground pin.
7. Connect the DSO input to the _____ pin.
8. Turn on the EM-330-1 and set the RPM control to about the 12 o’clock position.
9. Expand the pattern to fill the screen with at least 10 patterns.
10. Print or show your instructor the pattern.
11. Switch the adjustment switch to the adjust position and slowly move the knob. What happens as you increase the amount of MAF?

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

12. What happens as you reduce the amount of MAF?

_____________________________________________________________________________________
_____________________________________________________________________________________

13. What type of a signal is the MAF generating?

_________________________________________________

Instructor signature ________________________________ Date __________________________
DSO Lab # 1

Students should be able to capture and hopefully print a pattern such as this:

Use the pattern to introduce digital sensors as devices that generate on off signals. Ask them to look at the pattern and decide whether it is a pulse width modulated or a frequency modulated signal. Vary the amount of air, capturing signals so they can see what changes as airflow changes. The above pattern is a MAF signal and will have a variable frequency that corresponds to the amount of air flowing.

Next: Bring in the cause and effect concept by asking the question, if the MAF signal changes and it is the cause what will the effect be? This brings us to the next lab. One, that will show the cause and effect between the MAF and the fuel injector.
DSO Lab # 2

Name ___________________________________________ Date__________ Class __________

Introduction: In this lab, you will show the effect of changing MAF by looking at a fuel injector pattern. The MAF and Fuel Injector pattern will be dual traced on the DSO.

1. Check out a DSO from the tool room. Insure that it has sufficient battery power or that you have an AC adapter present.
2. Connect the DSO leads to the DSO.
3. Connect the negative lead of the DSO to the engine ground terminal near the ignition switch.
4. Using a wiring diagram or pinout chart for the EM-330-1, identify the MAF Sig pin at the ECM. Connect channel A or 1 to the pin. Pin number ________
5. Using the wiring diagram or pinout chart for the EM-330-1, identify the fuel injector signal pin on the breakout box. Connect channel B or 2 to the pin. Pin number ________
6. Start the EM-330-1 and set RPM to the 12 o’clock position.
7. Adjust the DSO so both the fuel injector pattern shows completely and the MAF.
8. Print or show your instructor.
9. Move the adjustment switch up to the adjust position. Turn the adjustment slowly counterclockwise. Capture, print or show your instructor.
10. Turn the adjustment slowly clockwise. Capture, print or show your instructor.
11. What is the relationship between MAF and Fuel Injection? ____________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

Instructor signature _____________________________________ Date ______________
DSO Lab # 2

The result of this lab should be:

Re-do the lab with the scanner.
Introduction: This lab is a continuation of the cause and effect lab. The DMM will give us the opportunity to look at the cause and the scanner will show the effect. At this point if you are having difficulties operating the scanner, ask your instructor for help.

1. Check out a DMM from the tool room. Insure that it has sufficient battery power.
2. Check out a Scanner with an OBD connector.
3. Connect the negative lead from the DMM to the ignition negative terminal near the ignition switch. Do not use any other ground.
4. Turn on the power supply switch. The battery light should come on.
5. Connect the positive DMM lead to the ignition positive terminal. What voltage do you see? __________V DC
6. Connect the scanner to the DLC and power it up.
7. Program the scanner so it can read the scan data stream and look at Fuel Injector Pulse Width.
8. Move the positive DMM lead over to pin #37 of the X-1 connector breakout box (next to the ignition switch).
9. Switch the MAF switch up to the adjust position.
10. Record:
    Pin # 37 Voltage __________V
    Fuel Injector Pulse Width ________mS
11. Turn the sensor adjust knob ¼ turn clockwise (to the 3 o’clock position).
    Fuel Injector Pulse Width ________mS
12. Turn the sensor adjust knob ½ turn counterclockwise (to the 9 o’clock position).
    Fuel Injector Pulse Width ________mS
13. The readings should have shown you a relationship between the Fuel Injector Pulse.
14. Width and the MAF Voltage. What is this relationship? ________________________________
    ________________________________________________________________________________
    ________________________________________________________________________________
15. Set the MAF switch back to the Sensor position.

Instructor signature ____________________________ Date ______________
By this point students should be getting the cause and effect concept. It will make sense to them because they can “see” the changes. If you teach in this manner you will be able to see the light bulb go on in your students head as comprehension ramps up.

Let’s look at one more example of cause and effect. The relationship between the APP (accelerator pedal position sensor) and the position of the throttle. This is easily done on the EM-330 or you can use a live vehicle KOEO (Key On Engine Off). Start students off watching the throttle position change as they move the accelerator pedal. The following lab follows the analog AP sensor and the digital throttle movement and is a great example of using both analog and digital in the same circuit.
DSO Lab # 3

Name ___________________________________________ Date__________ Class __________

Introduction: In this lab, you will look at the Accelerator Pedal Position Sensor (APP). You may use a capture feature that most DSO’s have called single trigger. This allows the DSO to capture one single trace and then activate the hold feature. You instructor can help you set up the DSO to utilize this feature.

1. Check out a DSO from the tool room. Insure that it has sufficient battery power or that you have an AC adapter present.
2. Connect the DSO leads to the DSO.
3. Connect the negative lead of the DSO to the engine ground terminal near the ignition switch.
4. Using a wiring diagram or pinout chart for the EM-330-1 find the APP and identify the 6 wires:
   A ______
   B ______
   C ______
   D ______
   E ______
   F ______
5. Connect the DSO lead to the APP sig (either 1 or 2).
6. Turn on the EM-330-1. Note: it is not necessary to have it spinning. Use in the KOER position.
7. Move the accelerator pedal through its full motion and capture a pattern.
8. Save or print the pattern or show your instructor.
9. Use cursors and answer the following questions.
10. What is the closed throttle voltage? ____V
11. What is the open throttle voltage? ____V
12. Does the pattern show any glitches or bumps? ___Yes ___No.

Instructor signature ___________________________________________ Date ______________
DSO Lab # 3

The resulting pattern should look like this:

Have the student now look at the effect of the above cause.
Introduction: In DSO Lab # 3 we looked at the APP signal and saw how it went from a low voltage at closed throttle to a higher voltage at wide open throttle (WOT). The result of this voltage change is a change in the throttle valve. The throttle valve motor is pulse width modulated, which is another way of saying that the signal to the motor is on and then off many times a sec. The longer each pulse is the more the motor moves. After dual tracing both the APP and the Throttle Actuator you will need to expand the pattern to see the individual pulses.

1. Check out a DSO from the tool room. Insure that it has sufficient battery power or that you have an AC adapter present.
2. Connect the DSO leads to the DSO.
3. Connect the negative lead of the DSO to the engine ground terminal near the ignition switch.
4. Using a wiring diagram or pinout chart for the EM-330-1 find the Motor connection for the Throttle Actuator Control (TAC) circuit.
5. Connect Channel A to the APP.
6. Connect channel B to the TAC.
7. Move the throttle from closed throttle to WOT and capture the pattern. Print or show your instructor.
8. If your DSO allows for expanding the pattern, show the actual pulses to the TAC. Print or show your instructor.

Instructor signature _____________________________ Date ____________
DSO Lab # 4

The resulting pattern should look like this:

Use the expand feature that most DSO’s have to show that the throttle is actually moving because of varying pulses.

Hopefully you can utilize these cause and effect relationships in your teaching. Once you try it you will be impressed at how much better the comprehension of these difficult concepts is.

Good luck and if ConsuLab can assist you please feel free to contact us directly.