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# Diagnosing Weakness in Basic Principles of Electricity in Motor Apprentice Education in Ireland

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# DIAGNOSING WEAKNESS IN BASIC PRINCIPLES OF ELECTRICITY IN MOTOR APPRENTICE EDUCATION IN IRELAND

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## ABSTRACT

Many Motor trade apprentice students enter the later years of their studies ill prepared for the level of material encountered. This is due to several factors including the level and knowledge of basic electricity and electrical/electronic principles.

A lot of basic material in these areas has been covered during earlier years of their training but by the time they reach the final year of their apprenticeship (Phase 6) it is not safe to assume that they have a full grasp of the basics required.

We have developed a diagnostic test to measure the level of preparedness of these students. This test covers basic electricity and electrical/electronic principles associated with motor vehicle technology.

In addition to this primary diagnostic test a series of online tests have been devised that force students to revise and master the basics from their earlier years. In addition to these tests a series of online resources have also been provided to assist students.

In this paper the test is outlined in detail. We enumerate the problem areas for the students and list the improvements that have been made by this initiative.

## INTRODUCTION

Students in Ireland may enter into an apprenticeship if they wish to once they have achieved a minimum of five passes at junior stage second level education and have reached the minimum age requirement. The subject area of basic electricity and electronic principles is not one of the subjects studied at junior stage second level but it is a subject that will be encountered by motor trade apprentice students many times both at the beginning as well as during their apprenticeship.

It is vital that all apprentice motor students have a full grasp and understanding of electricity and electronic principles in order to provide them with the necessary skills required to seek out a career in the motor industry today.

The enormous advances in electronic technology throughout the 1980s and 1990s have brought about great changes in the status of automobile electricity and electronics.

Such changes are driven by safety as well as environmental reasons. Electronic control plays a major part in the operation of the modern internal combustion engine with regards to efficiency of operation as well as vehicle emission control.

Legislation now requires vehicles to be safer than previously. Electrical and electronic systems are employed here especially in the areas of braking and steering systems.

Apart from the above mentioned, both hybrid as well as full electric vehicles are now been offered by many motor manufacturers as an alternative to the traditional internal combustion engine type vehicle.

Due to the requirement to study modern vehicle technology throughout an apprenticeship as well as electric and electronic systems now playing a paramount role in the operation of various vehicle systems both the level and standard of electricity and electronic/principles increase during an apprenticeship.

This becomes a particular problem when a motor apprentice student reaches phase 6 level as this is the highest level at which an apprenticeship may be studied at off-the-job level in Ireland. See table 1 below.

| Phase | Description |
|---|---|
| Phase 1 | On the job |
| Phase 2 | Off the job (20 weeks) |
| Phase 3 | On the job |
| Phase 4 | Off the job (10 weeks) |
| Phase 5 | On the job |
| Phase 6 | Off the job (10 weeks) |
| Phase 7 | On the job |

Table 1 : Irish apprenticeship system

At phase 6 apprentices may find the level of electricity and electronics difficult for the following reasons :

1. The duration between phase 4 off-the-job and phase 6 off-the-job maybe as much as two years.
2. Both the level and standard of the subject matter particularly electricity and electronics during an apprenticeship gets progressively harder and reaches its peak level at phase 6.

# LIGHT VEHICLE MECHANIC COURSE

The course I teach on is entitled Light Vehicle Mechanic. I teach it at phase 6 level and it is ten weeks in duration including assessments. The content is a mix of 50% theory based classroom work and 50% workshop/lab work. The course requires apprentices to study six different modules as listed in table 2 below. Each module contains an electrical/electronic element. At the end of the ten week period they will be assessed in these same areas.

| Module | Module Title |
|---|---|
| Module 1 | Petrol Engine Management |
| Module 2 | Steering and Suspension |
| Module 3 | Braking Systems |
| Module 4 | Transmission Systems |
| Module 5 | Body Electrics |
| Module 6 | Diesel Systems |

Table 2 : Light vehicle mechanic course modules

## DUBLIN INSTITUTE OF TECHNOLOGY

In the year 1992 an act was passed that saw the establishment of the Dublin Institute of Technology. Previously to this, six separate colleges existed in Dublin the origins of which maybe traced back as far as 1887 when technical education was first established in Ireland.

The Dublin Institute of Technology is a third level institute the largest of its kind in Ireland and caters for full time students studying undergraduate courses at levels that range from undergraduate, higher certificate, ordinary and honours degree.

As well as post graduate students studying courses at diploma, masters and doctoral levels apprentice education is also catered for within the Dublin Institute of Technology.

In the 21st century the Institute continues its long establishment in technical education.

## TEST DESCRIPTION

The online test is constructed from eight different sub areas of the course having an electrical/electronic content. A bank of questions has been developed and computer software generates at random one question from each sub area.

As well as the online test a series of online course materials relating to the test topics have also been developed as an aid to students. These are available on request from the author. The online test has eight questions in total. Table 3 below lists the topics covered by the online test.

| Question | Topic |
|---|---|
| 1 | Basic Electrical Circuits |
| 2 | Resistors and Capacitors |
| 3 | Ohms Law Equations |
| 4 | Body Electrics |
| 5 | Electrical Power Calculation |
| 6 | Engine Management |
| 7 | Diodes and Transistors |
| 8 | Binary Numbering System |

Table 3 : Test question numbers and topics covered

See appendix below

## OVERALL TEST RESULTS

The overall test results are presented in table 4 below. The table gives the topic associated with each question number and the results are displayed as a percentage of the number of students who got that particular question correct.

| Question | Topic | % Correct |
|---|---|---|
| 1 | Basic Electrical Circuits | 30% |
| 2 | Resistors and Capacitors | 7% |
| 3 | Ohms Law Equations | 78% |
| 4 | Body Electrics | 50% |
| 5 | Electrical Power Calculation | 0% |
| 6 | Engine Management | 7% |
| 7 | Diodes and Transistors | 50% |
| 8 | Binary Numbering System | 65% |

Table 4 : Test results

It can be seen from the table above that everyone who sat the test got the electrical power calculation wrong. This suggests that a lot of work is required in this area. While the highest percentage mark was achieved in the ohms law equation. Half of those tested got two questions correct whereas 7% of students managed the correct answer to the resistors and capacitors question and the engine management question. The information presented in table 4 highlights the fact that there is room for much improvement overall.

# INDIVIDUAL STUDENT TEST RESULTS

Table 5 shows the test results for each individual student as a percentage of questions answered correctly. As can be seen in the table one student failed to answer any of the questions correctly. The best student managed to get five questions out of a total of eight correct and this is reflected in a percentage mark of 62.5%. Six students achieved 37.5% in the test while two others answered half of the questions correctly.

| Student | % Answered Correctly |
|---|---|
| 1 | 37.5 |
| 2 | 50 |
| 3 | 37.5 |
| 4 | 37.5 |
| 5 | 12.5 |
| 6 | 37.5 |
| 7 | 50 |
| 8 | 25 |
| 9 | 25 |
| 10 | 0 |
| 11 | 62.5 |
| 12 | 25 |
| 13 | 37.5 |
| 14 | 37.5 |

Table 5 : Individual student test results

# FUTURE WORK

In order to enter into a motor apprenticeship in Ireland a qualification in electricity/electronics is not essential. However it is critical that motor students have a full grasp of the subject matter both during and towards the end of their training due to the level and complexity of electrical and electronic systems that form part of the modern motor vehicle.

Many motor apprentices therefore find the subject matter difficult because they have never studied it before. Also the level and standard of the subject area increases as student's progress through their apprenticeship.

I propose that the diagnostic test outlined above focusing on the areas of electricity and electronics should be given to all apprentice motor students at the beginning of their phase 6 off-the-job training course during the 2012 to 2013 academic year.

By allowing students to sit the diagnostic test at the start of their period of off-the-job training course they quickly understand the task facing them.

The results obtained from the diagnostic test should indicate to educator's students that may encounter difficulty with electrical related subjects.

I propose that the same test then be given to the same group of student's mid-way through the same course in order to judge progress made through the course and to better identify those who have an extreme difficulty with the subject matter.

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## APPENDIX

Question 1

If three 1 ohm resistors are placed in a series circuit that is supplied with 12 volts then the current flow in the circuit will be :

A = 1 amp

B = 4 amps

C = 12 amps

D = 11 amps

Question 2

The insulating material placed between both capacitor plates is termed :

A = An insulator

B = The dielectric

C = The diffusion gap

D = The conductor

Question 3

If a current of 8 amps flows through a circuit supplied by 12 volts the circuit resistance will be :

A = 15 ohms

B = 1.5 ohms

C = 0.15 ohms

D = 15.5 ohms

Question 4

The third brush in a wiper motor provides :

A = The fast speed

B = The slow speed

C = The earth

D = The parking mechanism

Question 5

The circuit resistance when a 29.5 watt electric motor is supplied by 14.75 volts is :

A = 7325 ohms

B = 732.5 ohms

C = 73.25 ohms

D = 7.375 ohms

Question 6

Injector duration during overrun is :

A = Greater than 10 milli seconds

B = Never greater than 10 milli seconds

C = Made to vary

D = 0 milli seconds

Question 7

The controlling section of a transistor is called :

A = The emitter

B = The anode

C = The base

D = The cathode

Question 8

Decimal 8 converted into binary is :

A = 10

B = 11

C = 110

D = 1000