Lesson Study

Investigating the use of switches and their application to electronic circuits

Lesson Plan

Mark Sciberras

Item	Description
Lesson Title	**Investigating the use of switches and their application to electronic circuits**
Subject	Engineering Technology
Year Group	Year 9 - A class of 15 students
Duration	Double lesson - 2 lessons of 40 minutes each (1 hour 20 mins)
Lesson Rationale	This lesson is developed on Bloom's Taxonomy of Cognitive Development as shown in figure 1. The delivery of the lesson is aimed to start from the lowest level i.e. acquiring knowledge and moving upwards towards application and analysis. The syllabus structure of the subject is also designed on the same taxonomy, therefore this methodology would help in translating the prescribed content by using mostly a hands-on approach. This will be done by starting from what is known and moving on to more complex elements to reach higher levels of the taxonomy.  *Figure 1 – Bloom's Taxonomy of cognitive Development* *Source: http://cehdclass.gmu.edu/ndabbagh/Resources/IDKB/bloomstax.htm* This lesson is also designed to use Bruner's theory of scaffolding where the teacher demonstrates to students by using images, language and action to explain how to solve a problem, and then steps back, allowing students to explore and come up with conclusions to solve the problem while offering support as needed. The lesson is based on four phases.

	The first phase is based upon pre-taught knowledge about switches which needs to be further developed by the discovery of learning and acquiring more information about them. In groups, students will discuss and construct their own learning, based on prior knowledge of electronics, circuit building and equipment related to it; such as the usage of a multimeter. The second phase which is interrelated with the third phase deals with comprehension, where students are expected to show the ability of grasping information gained from the first phase and translating it. This has to be done through collaboration between group members, where students have to individually analyse each situation and then discuss within their group to identify an appropriate switch or switches according to the given circuits. The third phase deals with application in groups and students are expected to build circuits physically which correspond with the given situations and use the appropriate switches to operate them to exhibit their acquisition of knowledge from the first phase and its interpretation from the second stage. *"What I hear, I forget;* *What I see, I remember;* *What I do, I understand."* *Chinese proverb* The fourth stage serves as a conclusion, where each group is assigned to present to the rest of the class the reasoning and the way of how they arrived to solve a particular task. Finally, the teacher presents some notes and examples of daily use to the students related to switches. The tasks presented in this lesson engage students in inquiry, thinking and problem-solving processes that make the learning experience more active by presenting a challenge through a scenario which needs to be solved. The given tasks involve participation and collaboration amongst students while catering for learners with different learning styles which include: visual, verbal, logical, social and

physical. (As defined in figure 2). Working in groups to solve the given tasks, also instigates students' sense of curiosity, courage, resilience and leadership. Instigating these characteristics, while structuring a lesson which requires students to communicate, collaborate and think critically will help them to develop 21st century skills. (as defined in figure 3)

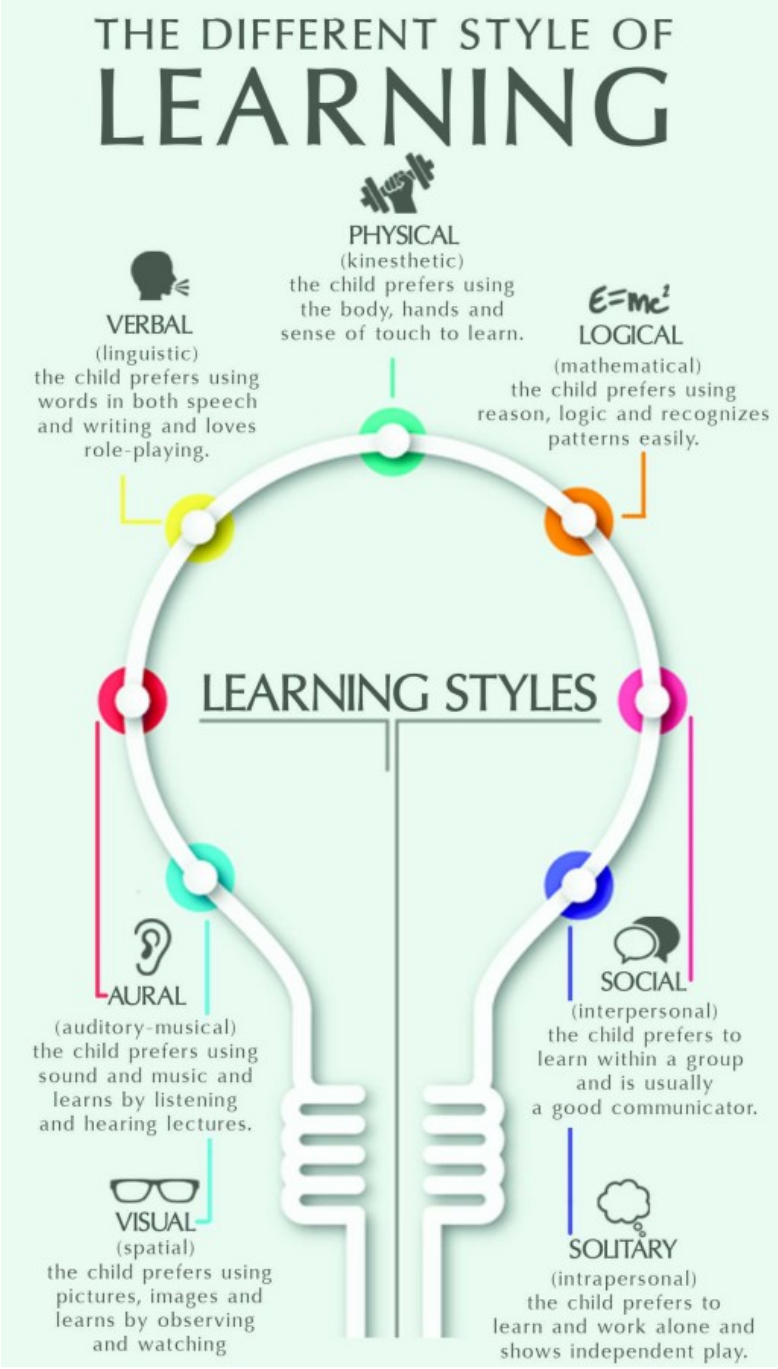


Figure 2 – The seven leaning styles

Source: https://ilslearningcorner.com/2016-02-learning-styles-one-size-fits-all-doesnt-work/

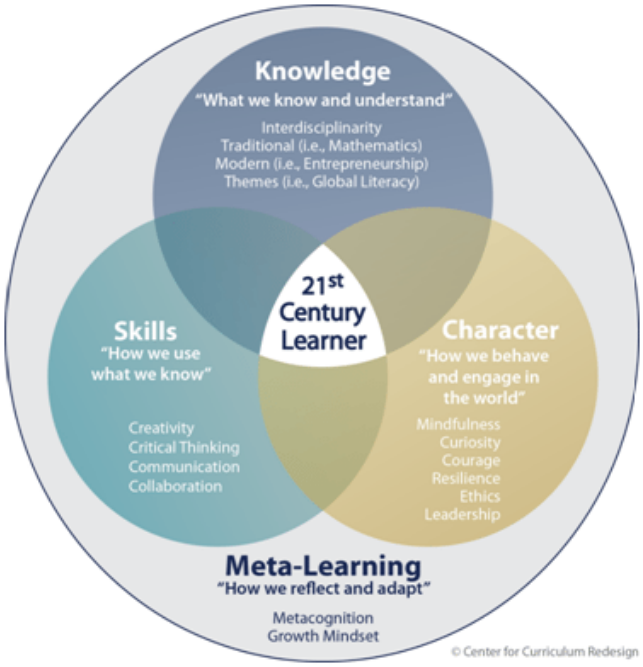


Figure 3- 21st century skills

source: https://www.uscib.org/uscib-content/uploads/2016/01/Meta-learning-chart.png

During the first task students are given the opportunity to investigate the given switches. This will be done by using 3 methods:

1. Providing students with physical switches which they are expected to investigate. This will help the students to investigate kinaesthetically, using their sense of touch to learn.

2. Tablets will be provided for students to search on the internet. Such activity encourages students to become independent learners and Digital literate. This is also highlighted in cross-curricular themes mentioned in the National Curriculum Framework (NCF). The NCF states that Digital Literacy "enhances the teaching and learning processes, the interaction among peers, and interactions between students and teachers" while it helps to "move from teacher to student-centred learning activities" and enables "children to show and create knowledge" (NCF, p.37).

3. In addition to tablets, a multimeter will also be provided, so that students can check and/or validate their findings, by testing the physical switches and comparing their findings to the information that they have found.

The research conducted in the first task enables the students to develop a knowledge on each particular switch by recording and summarising what they have found in the provided worksheet space. Recording of information does not necessarily need to be in a written format; they may present sketches or drawing of symbols and add annotations to them. This task helps the students to summarise the information that they have found and draw up their conclusions.

Students have the opportunity to improve their findings at the end of the lesson when the teacher gives more information related to the presented switches. Such improvement will be done as homework.

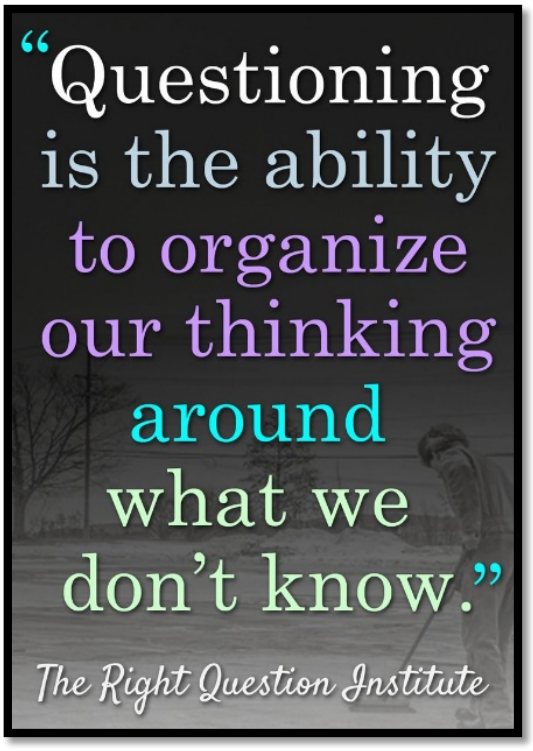
During the second task students are required to do two interrelated tasks

1. The first task is to read each given scenario, observe the given pictures/diagrams, analyse the given circuits and discuss with their colleagues within the group upon which switch they need to use to operate the given circuit.

2. The second task is to build physically the given circuit with the provided components and to use that particular switch that they have decided upon in the previous task so that they can either confirm that the circuit will operate as described in the given description or if not, rethink about another switch and try it out. Students will keep evidence of their work by taking photos of the circuits and stick them in the provided space on the given worksheet.

Working in groups while carrying out the given tasks will enable students to:

- Pool their expertise, knowledge and skills.
- Take ownership of the subject matter.
- Develop teamwork skills.
- Reinforce content since students work together and "teach" each other. This improves understanding through additional discussion and explanation (taking place during the 4th phase).
- Tackle more complex problems than they would be able to do individually.
- Hold one another responsible and accountable.
- Plan their work more effectively.

	• Allow their teacher to observe their approach on how to solve problems in novel and unique ways. This can improve the teacher's perspective and to make their future teaching more effective. The second task enables students to make connection between the knowledge that they have acquired in the first task by applying it through practical application. The circuits presented in the second task are based on real-life applications. Therefore, students can link the usage of electronics and see its relevance by relating to real world situations which make their learning more meaningful. When the students are working the given tasks, the teacher has to take the role of a facilitator while stepping back from continuously providing knowledge to students. Consequently, the teacher is there to provide the necessary support and advice as well as the necessary scaffolding and teaching of skills when necessary (Tout, 2016). Rather than simply giving answers to students who come up with questions, the teacher may also use effective questioning techniques especially if any student/s/ or groups will be observed struggling to complete a task. Such technique will enable the students to reason out, while stimulating them to listen carefully. Bearwald states that "as we craft more probing questions, we find that listening improves. The more intentional our questions become, the more intentional our listening becomes". (p.77) To do this effectively, the teacher has to remain observant while the students are doing the tasks to identify the learning taking place and observing the group dynamics while listening to their discussions and interactions. 
Lesson Overview	This lesson is to be delivered upon two lessons, ideally a double lesson. The main focus of the lesson is to tackle switches and their function, however, it is intentioned to revise other topics such as various electronics components and circuit building which are part of the engineering technology syllabus of year 11.

The first task is about switches, identifying how they function and, operate while identifying their connections. During this task through explorations students will learn about different switches and terminology (through the usage of tablets to carry out research) related to them.

This task gives the learners the possibility to recall previous knowledge about basic switches used in prior lessons while making connections with new types. Further on, students have to develop connections between the terminology used to describe the function or purpose of a switch. Such knowledge and understanding has to be translated appropriately in task 2. The second task entails real-life scenarios of things and activities which we do, which are controlled by electrical or electronic circuits. The second task will enable students to be more aware on how appropriate switches together with an electronic or electrical circuit ease our lives while becoming conscious of how they operate.

Students' Prior Learning

This lesson is planned to be delivered toward the end of Year 11, to students who are learning VET Engineering Technology.

Before carrying out this lesson, one should draw up a list of knowledge and in this case, a list of apparatus that the students need to be familiar with. These include:

- knowing basic symbol used to represent a switch
- Identifying symbols of electronic components represented in schematic diagrams
- be able to read and interpret a schematic diagram
- know about the internal connection of a breadboard
- know how and be able to use a breadboard
- know how and be able to use a multimeter especially to carry out a continuity test.

Since the focus is on switches, the students will be given various simple circuits to which they are familiar with, but which all need a different type of switch to operate. In relation to this, students will be given a written description of how each circuit is expected to function. The circuits will only behave according to the given description if

the students use the proper type of switch. The aim of providing a circuit description is not to diverge the student's thinking on the circuit operation but to use such information to remain focused on identifying and using the right switch. As a starting point, students will be given a brief description of the task and teacher will recapitulate quickly important points about the breadboard and multimeter. The aims are to:

- allow students to inquire themselves about switches and record their findings on the given worksheets.
- be knowledgeable about different types of switches and the terminology related to them.
- move on from the idea that a switch is only a button that when pressed it switches something either on or off.
- test and try out different types of switches to make the circuit function according to a given description.

Using the multimeter to test the function of each switch is an important strategy. This will help students "to articulate clearly the relationship between various kyozai and the content of a particular subject matter" (Watanabe et al., 2008, p.133) that is to relate an appropriate switch to a particular circuit. The given circuit descriptions which relate to real life situations, will increase the students' interest and understand more the validity of learning such a topic.

Some difficulties that the student may encounter are:

- Identifying the leads / connections of particular switches. This difficulty may occur since students may make assumptions about the switch connections rather than using a multimeter to identify them
- drawing up hypothesis to arrive to conclusions to identify particular switches for particular functions. Such difficulty may occur if not understanding concretely how a particular switch operates or how the circuit should ultimately behave.

Predicted mistakes are:

- Incorrect connection on the breadboard - this may be due to excitement to finish quickly and move on to the next circuit. This may also be due to negligence or incomplete understanding of the connections found inside the board.

	• Incorrect placement, orientation or polarity when connecting components to the breadboard. This may be due to wrong interpretation of the circuit diagram. When noticing such mistakes, I will notify that particular group. This will be done by stating (to the group) that the work or practice being done is incorrect. Rather than posing answers to the students, I will suggest to the group to discuss amongst themselves to try to find out what mistake/s have been made and how these could be resolved
Lesson Objectives	Students will be able to: 1. Identify switches from a pictorial, schematic (symbol drawing) and real-life representation. 2. Describe the behaviour of various types of switches 3. Discuss a circuit or parts of it (sub-circuit) to justify the selection of a particular switch, such decision should be made upon the switch characteristics in conjunction with the circuit operation. 4. Translate the given schematic (circuit) diagrams physically by building the circuit using real components
Learning Outcomes	*The following statements are extracted from the engineering technology syllabus 2018* LO1. Interpret the different representations of circuits. • K-1.Identify different electronic components from their schematic, pictorial and real life representation. • C-1. Describe the behaviour of individual components (including Switches) • C-3. Discuss the function of a sub circuit in relation to the characteristics of its individual components • A-1.Translate a schematic diagram of a circuit to its prototype equivalent both pictorially and physically.
General Resources	Interactive whiteboard Whiteboard and markers Internet access Switches worksheet (including task 1 and task 2) PowerPoint presentation about Switches (to be used during the 4th phase of the lesson)

<table>
<tr>
<td>Resources
For task 1
(taking place during the first phase)</td>
<td>The following resource list caters for four groups
X4 Multimeter
X8 Tablets
X4 Reed Switch
X4 Tilt Switch
X4 Micro Switch
X4 Toggle switch
X4 Dip Switch
X4 Slide switch
X4 Rocker Switch
X4 Push Switch</td>
</tr>
<tr>
<td>Resources
For task 2
(taking place during the third phase)</td>
<td>The following resource list caters for four groups
X4 PP3 Batteries (9V)
X4 PP3 Connectors
X12 AA batteries (1.5V)
X12 Breadboards
X4 AA battery holder which hold 3 batteries
X4 Multimeters
X1 Digital camera

Resources for Scenario 1
X8 SPDT toggle switches (single pole double throw)
X4 Bulb (lamps)

Resources for Scenario 2
X4 Reed Switches
X4 Magnets
X4 330Ω resistors
X4 LEDs (green)

Resources for Scenario 3
X4 Rocker Switches
X4 NE555 timer
X4 Push Switches
X8 330Ω resistors
X4 DIP Switches
X16 2MΩ ohms Resistors
X4 Diodes 1N4007
X4 Green LED’s
X4 47uF Capacitors
X4 Red LED’s

Resources for Scenario 4
X4 Slide Switches
X8 Micro Switches
X4 Motors</td>
</tr>
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Classroom organisation	**Classroom setting** The lesson ideally should be delivered in an Engineering Workshop. The reason for this choice is that additional apparatus and components will be available in case some of the components malfunction. Students are divided into four groups of 3 or 4 students in each groups. (This depends on the amount of present students when the lesson is taught). Desks in the workshop will be pre-set as shown below.

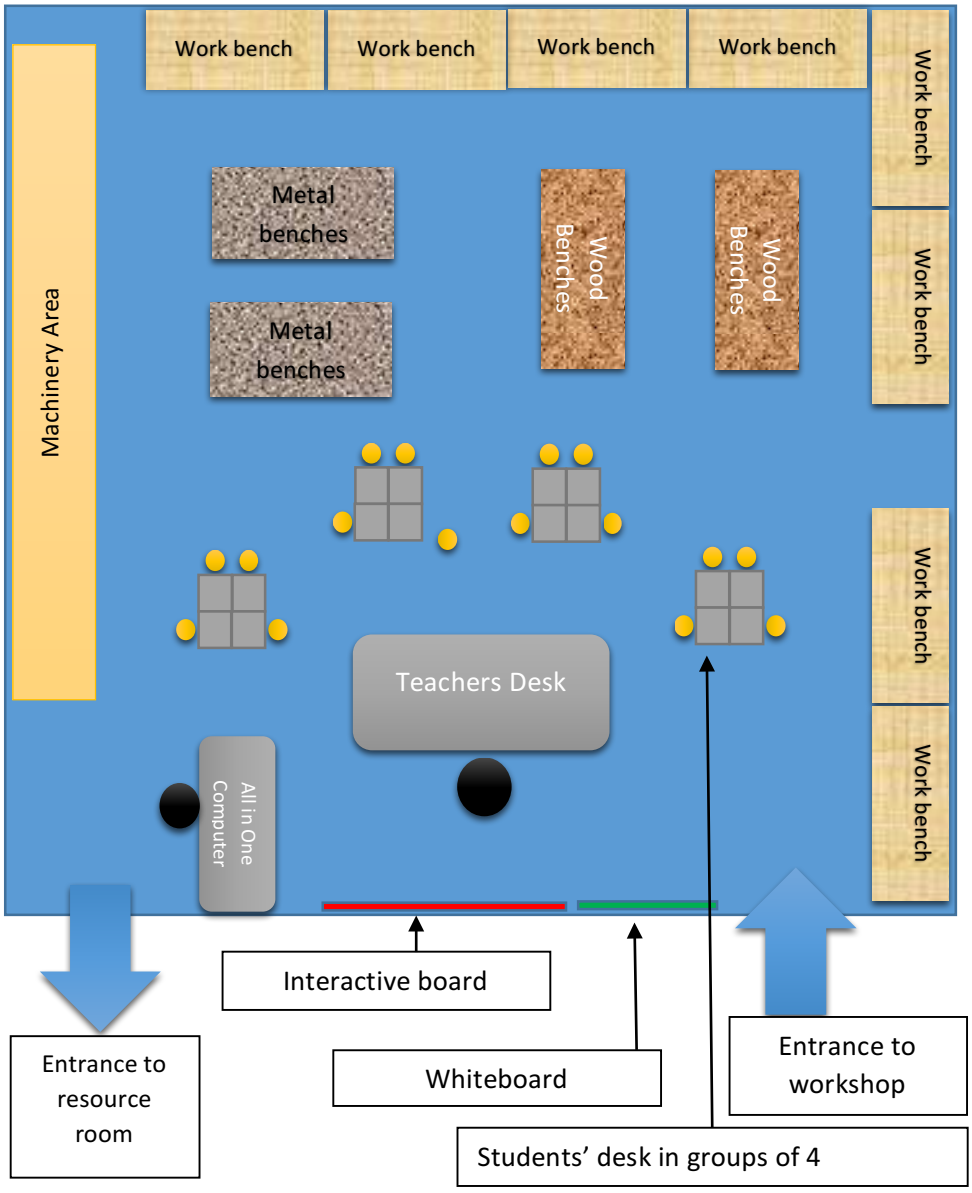


Figure 4 - Classroom setting

LESSON PLAN

Lesson Phases

This lesson is about understanding electronic switches and relating them to electronic circuitry. As an introduction, the students are given an overview of the lesson and explain what is expected out of them. In the preliminary phase, students are divided in groups and presented with eight different switches which they need to investigate to identify their behaviour and understand how they operate. In this phase students can make use of a multimeter and tablets which will help them to investigate!

This is then followed by the second phase, where students in the same group have to read the given scenarios and analyse the given information related to them. After they discuss each scenario they have to identify a particular switch/es which relate/s to the given circuit which corresponds to each scenario.

In the third phase, students have to use the provided electronic components to build a circuit which is assigned to their group on a breadboard and add to it the switches that they have identified in the previous stage. During this phase, students will be able to check their own reasoning based on the knowledge that they have acquired from the first phase. After finishing the circuit assigned to their group, students may attempt to build more circuits if there is any time left.

The fourth stage, serves as a conclusion, where each group is assigned to present to the rest of the class the reasoning and the way of how they arrived to solve a particular task. Finally, the teacher presents some notes and examples of daily use to the students related to switches.

Phase 1 **Introduction** **Group work** **(20 mins)**	Students are presented with 8 different switches, a multimeter, a tablet and a worksheet. The teacher divides the students in four groups. Students with different abilities and strengths are present in each group. This is done to enhance communication and collaboration amongst group members. The teacher says: ***"Today we are going to investigate certain switches. You are being presented with eight switches on your desk. You will work in groups, investigate these switches, by finding out how they function. The tablet and the multimeter should serve as helping aids in your investigations. Record your findings in the provided space on the worksheet statements.***

	Some suggested questions that the teacher can use while the students are working are: ***"Have you set the multimeter in a proper way for continuity testing?"*** ***"Have you identified all the connections of the switch?"*** ***"Are you capable of drawing the switch symbol and identifying its connections?"*** ***"Have you tried to operate the switch to check how it functions?"***
Phase 2 **Individual work** **Discussion** **(10 mins)**	This is followed by a task where the students individually have to read the given scenarios and analyse the given information related to them. The teacher says: ***"Go through the second task by reading and analysing the given information in relation to each scenario and decide which switch or switches you will use for each scenario. You have 10 mins"*** Afterwards the students have to discuss within their group which type of switch or switches should be used. The teacher says: ***"Now, you need to discuss and agree as a group upon which switches you are going to use. Write down the name of the agreed switch on your worksheet."*** Some suggested questions that the teacher can use to elicit discussion amongst the group members: ***"Can you recognise all the component symbols represented in the schematic diagram?"*** ***"Have you fully understood how the given circuit functions?"*** ***"Apart from this switch, have you tried any other which may allow the circuit to function as described?"*** ***"What led you to make such a choice?"***
Phase 3 **Group work** **Building Circuits** **(30 mins)**	While the students remain seated within their group, the teacher will distribute all the necessary electronic components so that the students will physically build one circuit presented in a scenario while incorporating the switches that they have decided to use in the previous phase. Then, the students will build the remaining circuits if they still have enough time to do so. The teacher says:

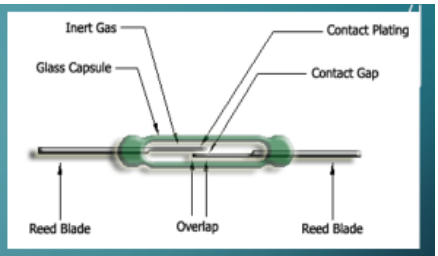
	"Now, you need to build the circuit which was assigned to you which also corresponds with the scenario. In your circuits you have to include the switch or switches that you have decided on earlier. This will make the circuit function as per its description. Once the components are connected properly, connect the appropriate battery to test it. You have to take a photo and paste it on your worksheet as evidence. You have 30 mins." Some suggested questions that the teacher can use to elicit discussion amongst the group members: ***"Can you remember how the connections are set on the breadboard?"*** ***"Have you identified the pins of a [particular component e.g. 555timer]?"*** ***"Have you secured all the connections on the breadboard?"***
Phase 4 **Plenary** **Teacher summary** **(20 mins)**	The fourth stage serves as a conclusion, each group is assigned to present on the four given scenarios, and therefore, all the four given scenarios will be presented one from each different group. The teacher says: ***"Now I will ask each group to come out and explain how you managed to operate that particular circuit assigned to you and why you have chosen that particular switch?"*** The same procedure is repeated for the three remaining groups. The teacher concludes the lesson by presenting a PowerPoint presentation related to switches, their symbols and typical usage.

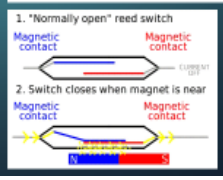
INVESTIGATING SWITCHES

ENGINEERING TECHNOLOGY – YEAR 11

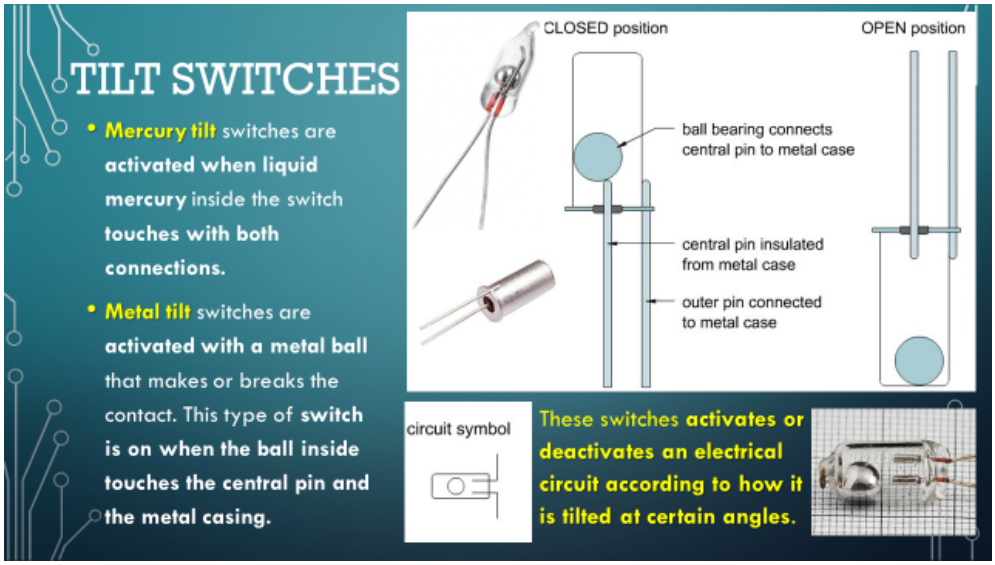
REED SWITCHES

- Activated by a magnet
  - When a magnet is placed next to the switch, it will attract both **ferrous** metals which are **good conductors.** This will result in having both metals touching each other, therefore electrical current can pass from one end to another.
- Other information
  - Reeds switches **cases are made of glass** therefore, one needs to be **careful when bending its leads** since the **cases are very fragile and can easily break.**

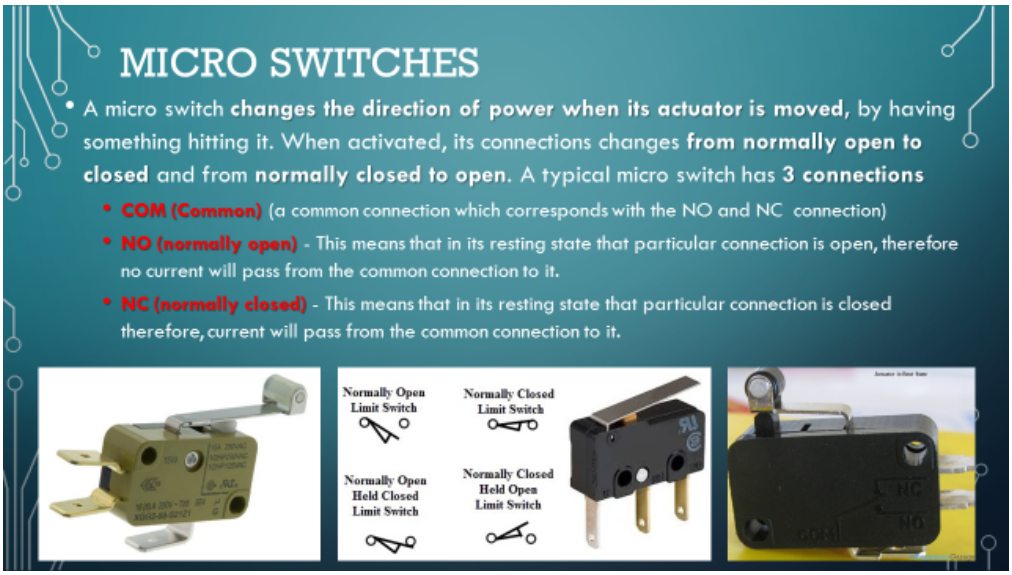




APPLICATION OF REED SWITCHES

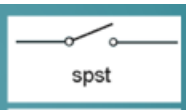

TILT SWITCHES
• Mercury tilt switches are activated when liquid mercury inside the switch touches with both connections.
• Metal tilt switches are activated with a metal ball that makes or breaks the contact. This type of switch is on when the ball inside touches the central pin and the metal casing.
CLOSED position
OPEN position
ball bearing connects central pin to metal case
central pin insulated from metal case
outer pin connected to metal case
circuit symbol
These switches activates or deactivates an electrical circuit according to how it is tilted at certain angles.

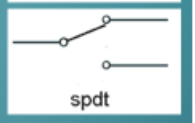

APPLICATION OF TILT SWITCHES
Garage door closed: Ball connects center pin to tube
Garage door open: Ball doesn't touch center pin

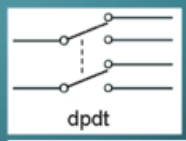

MICRO SWITCHES
• A micro switch changes the direction of power when its actuator is moved, by having something hitting it. When activated, its connections changes from normally open to closed and from normally closed to open. A typical micro switch has 3 connections
• COM (Common) (a common connection which corresponds with the NO and NC connection)
• NO (normally open) - This means that in its resting state that particular connection is open, therefore no current will pass from the common connection to it.
• NC (normally closed) - This means that in its resting state that particular connection is closed therefore, current will pass from the common connection to it.
Normally Open Limit Switch
Normally Closed Limit Switch
Normally Open Held Closed Limit Switch
Normally Closed Held Open Limit Switch

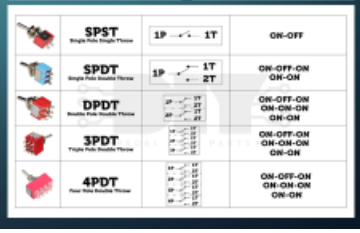
TOGGLE SWITCHES

- A toggle switch is **activated by hands** by moving a lever to one side or to the other to **make the current flow in one or multiple directions, or not toflow at all.**
- Other information
  - There are **various types of toggle** switches. These are **characterized by the number of poles** and **throws** they have.
  - Some toggle switches do not have a centre off position while others do.
  - One can get **latching** (remain on) and **non-latching** (do not remain on) toggle switches.
  - It is important to refer to the **manufacturer catalogues datasheets** to check the connections.

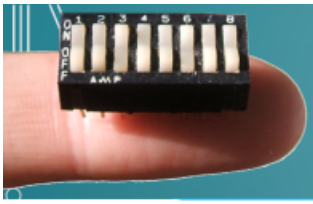


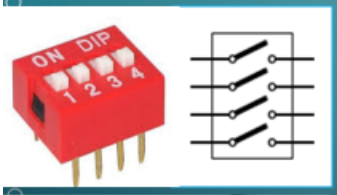






DUAL INLINE PACKAGE (DIP) SWITCHES

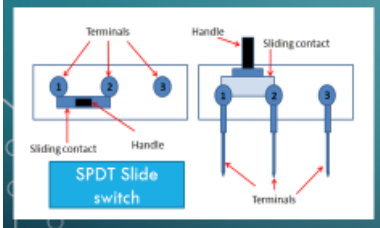


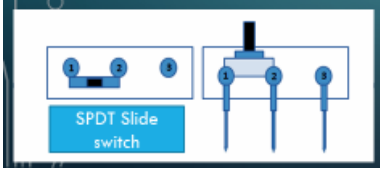


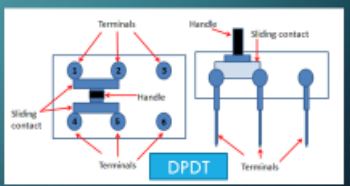
- A **DIP switch** is a manual switch which **needs to be activated either by hands or by a pointed edged object** such as a screw driver since it is very small. **Different packages of individual operated switches are available.**
- These types of switches are designed to be used on a **printed circuit board** (PCB)
- DIP switches are **commonly used to customize the behaviour of an electronic device for specific situations by setting a combination of either on or off switches.**
- Generally they are set for a long period of time

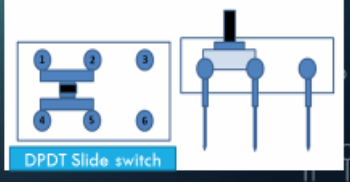
SLIDE SWITCH

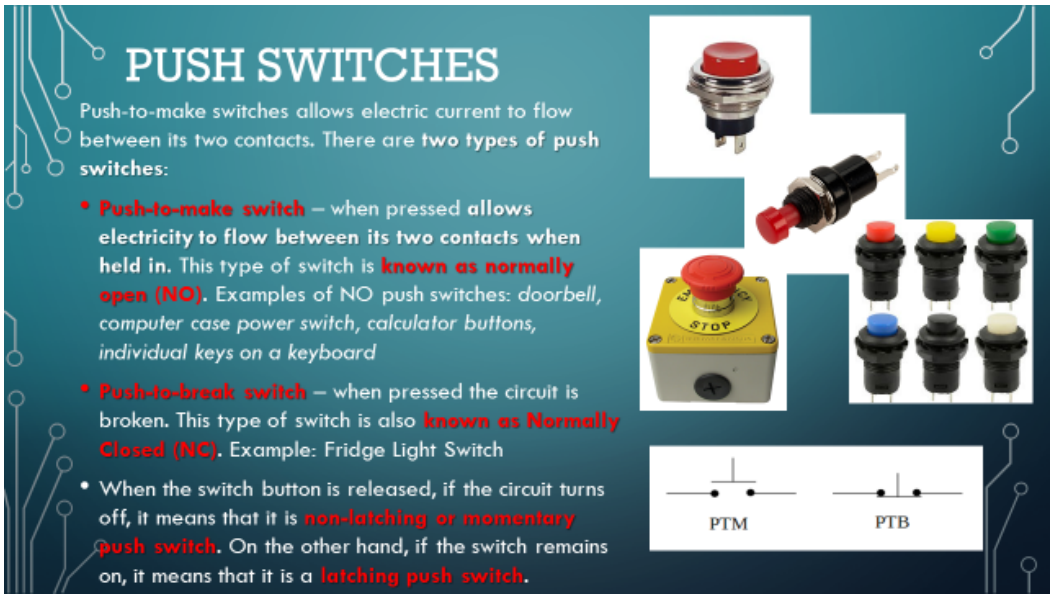
- Slide switches are **mechanical** switches which need to be **activated by hands** by moving a handle called a slider that **moves (slides) from one position to another** causing the switch to an **open** (off) position or to a closed (on) position. There are **various types of slide** switches. These are **characterized by the number of poles** and **throws** they have.











Finally, the teacher assigns homework to reinforce and consolidate the students' learning.

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