

# Development of a Two-Tier Static Electricity to Diagnose High School

## Students' Alternative Conceptions before Teaching

Abdeljalil Métioui - Université du Québec à Montréal

[metioui.abdeljalil@uqam.ca](mailto:metioui.abdeljalil@uqam.ca)



**William Gilbert**



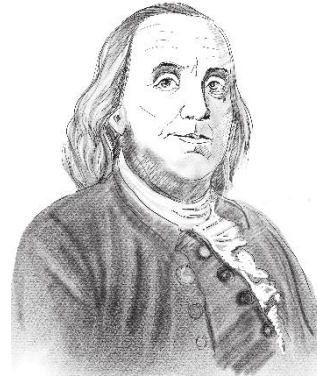
**Charles-Du-Fay**

### PLAN

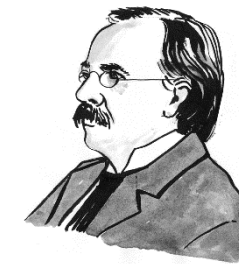
1. Problematic relatively to students' conceptions about sciences
3. Conceptual framework of the two-tier test to diagnose collegiate students' alternative concept about electrostatic
4. Conclusion



**Otto Von-Guericke**



**Benjamin Franklin**



**Thomson**

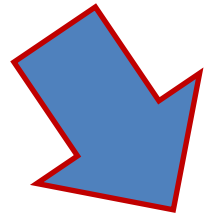


**Rutherford**

# PROBLEMATIC

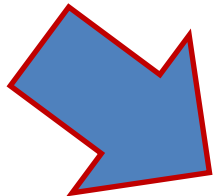
There are several researches about the conceptions of preservice teachers at the primary school with respect to the basic notions in physical, chemical and biological sciences.

## THE PRESENT RESEARCH HAS TWO OBJECTIVES:



**First**

We manage a questionnaire to identify the elementary pre-service teachers alternative concepts regarding the electrostatic phenomena.



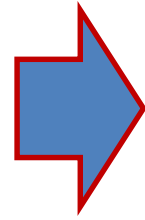
**Secondly**

We develop a two-tier Electrostatic diagnostic test.

# First objective : Pre-Service Teachers Alternative Conception

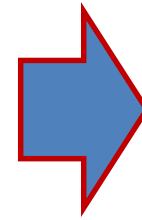
## Description of the Population

94 students (aged 19 to 23) from Quebec (Canada) participated in this study and they are registered in the third year of university in the Baccalaureate Program in Elementary Pre-service Teachers which is of a length of four years.



## Methodology

To identify their alternative concepts, we distributed them a paper-pencil questionnaire (N = 5) of a sixty minutes.



## Questionnaire

The questions associated to events with which they are daily in interaction and whose assimilation requires the understanding of the phenomenon of production of the charges and their displacement, as well as of the laws between opposite charges.

## Paper and pencil questionnaire

**QUESTION 1** - In your opinion, is the following statement true or false: *When rubbing a woolen fabric with another woolen fabric, there is an exchange of charges between the two materials:*

True  False

Explain your choice of the answer:

**QUESTION 2** - In your opinion, is the following statement true or false: *When rubbing a plastic ruler with a woolen fabric, there is an exchange of charges between the two rubbed objects:*

True  False

Explain your choice of the answer:

## Paper-pencil questionnaire

**QUESTION 3** - To load an object, one must always rub it:

True  False

Explain your choice of the answer:

**QUESTION 4** - Nathalie rubbed her feet on a wool carpet and touching the door handle, and she felt an uncomfortable feeling. This sensation is because she received electric charges from the door handle:

True  False

Explain your choice of the answer:

**QUESTION 5** - In your opinion, is the following statement true or false: *Any object can be charge by contact with a charge object:*

True  False

Explain your choice of the answer:

## ANALYZES

**(1)** We compiled the answers, one question at a time, each taken separately.

**(2)** For each of them, we proceeded to the classification in distinct categories, the number of which being variable from one question to the other, according to the different gotten answers.

**(3)** We interpreted the answers classified in categories in order to identify the most widespread explanations.

**(4)** This categorization started by making the distinction between the good and the wrong answers and the incomplete or indecipherable answers.

**(5)** To qualify the answers as advanced of correct or wrong, we compared them to those commonly accepted by scientists.

## *Analysis of the paper-pencil questionnaire: Question 4*

The explanations advanced by the students about the question 4 on the shock that Nathalie receive while touching a metallic handful after having rubbed her feet on a carpet by dry time allowed us to identify four categories of answers:

**Category 1 (33%):** The charges produced by rubbing pass (or are transferred) from our body to the metallic handful (the electrons transfer themselves as shock): **“By rubbing, one can produce the statics. Then, when one touches something that conducts electricity (metal or no one), the static electricity travels to the object and one catches a shock.”** (e<sub>8</sub>)

**Category 2 (9%):** The human body is conductor of electricity: **“Our body is a conductor. Electricity manufactured by rubbing springs of our body by our fingers.”** (e<sub>52</sub>)

**Category 3 (12%):** Affirm implicitly or explicitly that the shock results from the attraction between two opposite objects (the hand and the handful): **“The static electricity contained in the carpet passes to our foot and all our body and while touching metal or another person, one takes a shock because they also have some.”** (e<sub>82</sub>)

**Category 4 (47%):** Use of the scientific terms in a way that is confused, incomplete or indecipherable, or no answer: **“This phenomenon is provoked by static electricity. There are some electrons in the carpet.”** (e<sub>10</sub>)

## Summary of the results of the paper-pencil questionnaire

Despite the formulation that varies according to the presented situation, it seems that the students interpret the various electrostatic phenomena mainly while referring to three explanations.

- The first puts into play opposite charges whose interaction seems to justify the observed phenomenon.
- The second interpretation of the phenomena observed refers to a mechanism of equilibrium that redistributes the charges between the objects.
- The third interpretation leans on an accumulation of charges and its possible out-flow when some conditions are fulfilled.

**Didactic Impact: Constructing a Two-Tier Test to Diagnose Collegiate Students' Conceptual Difficulties**



## TWO-TIER DIAGNOSTIC TEST

**QUESTION 1:** In your opinion, is the following statement true or false: *When rubbing a woolen fabric with another woolen fabric, there is an exchange of charges between the two materials:*  True  False

Which of the following explanations best justifies your answer?

- There will be no exchange of electron because this exchange depends on the chemical composition of the rubber materials. Some give and others more easily receive particles. Thus, two identical elements rubbed together can not exchange electrons because they both have the same chemical properties.
- If we assume that both fabrics are electrically neutral (that is, they contain as many positive as negative charges), there will be no charge transfer. Indeed, a transfer is made from the negatively charged object to the positively charged object, and there will be no transfer since it requires a difference in electrical potential between the two. Besides, the transmission can produce if it is a conductor, but the wool is not one.
- Since the two fabrics are identical, there is not one wool that will be more susceptible than the other to receive or give its charges. Both woven fabrics will remain neutral.
- When there is friction, only the electrons can pass from one material to another. Thus, there is no exchange but a transfer of electrons.
- Other: \_\_\_\_\_

## TWO-TIER DIAGNOSTIC TEST

**QUESTION 2** - In your opinion, is the following statement true or false: *When rubbing a plastic ruler with a woolen fabric, there is an exchange of charges between the two rubbed objects:*  True  False

Which of the following explanations best justifies your answer?

- During the friction between the two objects, there is an exchange of charges. Each object has as many positive electrons as negatives. During friction, both objects lose or gain electrons. The one who suffers becomes positively charged, the one who wins becomes negatively charged, and one has an attraction or a repulsion.
- By rubbing a plastic ruler with a woolen fabric, the frictional movement releases ions that are temporarily transferred from the woolen weave to the plastic ruler.
- Plastic is an insulator so there will be no charge transfer.
- It is not an exchange of charges; it is a transfer because there is an object that will lose some charges and will transfer them to the other.
- When there is a friction between two objects, one object will give positive charges, and the other will provide negative charges, which will make one positively charged and the other negatively charged.
- Other: \_\_\_\_\_

## TWO-TIER DIAGNOSTIC TEST

**QUESTION 3** - To load an object, one must always rub it:  True  False

Which of the following explanations best justifies your answer?

- If we want to charge an object, we must rub it in the same direction to align its loads.
- When a charged object attracts another, there is charge transfer, which makes the second object loaded. It does not apply to all types of materials because some do not load even if we rub them.
- The bodies can be charged by friction, but they can be charged by simple contact with another object positively or negatively charged.
- Whether to charge it positively or negatively, one must rub the body to achieve it. It is by rubbing that it makes it win or lose electrons, which makes it charge. The rubbed object that loses negative electrons becomes positively charged and vice versa.
- If you approach a charged object in front of another unloaded, it can be charged through an electron transfer.
- Other: \_\_\_\_\_

## TWO-TIER DIAGNOSTIC TEST

**QUESTION 4** - Nathalie rubbed her feet on a wool carpet and touching the door handle, and she felt an uncomfortable feeling. This sensation is because she received electric charges from the door handle:

True  False

Which of the following explanations best justifies your answer?

- When Nathalie was rubbing her feet on the woolen carpet, electrical charges were transferred from her to the carpet. Having fewer charges, Nathalie was then able to receive charges from the door handle.
- By rubbing her feet on the carpet, Nathalie loaded the carpet and approaching the handle, and her body served as a conductor in the transfer of charges from the carpet to the handle door. Nathalie was simply the conductor behind a difference in electrical potential between the carpet and the handle.
- When Nathalie rubbed her feet on the carpet, she accumulated a load (positive or negative). Door handles are often metal (conductor). So, when she touched the handle, she transferred some of her charges to the handle.
- When Nathalie touched the handle door, there was repulsion as she was shocked. So, Nathalie's body and the handle door were charged in the same way, positively or negatively.
- Nathalie's body is negative or positive charged as a result of rubbing her feet on the carpet. Her body has a potential difference with the door handle that is loaded, unlike her body. The sensation she has felt comes from the fact that her body has exchanged electrons with the handle to become neutral again.
- Other: \_\_\_\_\_

## **CONCLUSION**

**AWARE OF THE LIMITS INHERENT IN A QUALITATIVE TYPE OF RESEARCH, OUR WORK ALLOWED US, NEVERTHELESS, TO CONCLUDE THAT THE PRE-SERVICE TEACHERS CONSTRUCT ERRONEOUS CONCEPTIONS ABOUT ELECTROSTATIC DESPITE TEACHING.**



**HOW, UNDER, SUCH CONDITIONS, CAN THE TEACHERS HELP THE STUDENTS TO MAKE THE CHANGES TO THEIR CONCEPTUALIZATION NECESSARY FOR THE CORRECT UNDERSTANDING OF THE ELECTROSTATIC PHENOMENA**



**FOR THAT, RESEARCHERS CLAIMED THAT TEACHERS MUST DIAGNOSE THEIR STUDENTS' UNDERSTANDING BEFORE TEACHING TO TAKE THIS INTO ACCOUNT. THE TWO-TIER DIAGNOSTIC TEST DEVELOPED IN THE PRESENT RESEARCH WILL HELP TEACHERS TO IDENTIFY THEIR ALTERNATIVE CONCEPTS ABOUT THE LAW OF CHARGES (ATTRACTION AND REPULSION).**