The application of tutorial based worksheets to enhance student understanding of static electricity and magnetism at lower and upper second level education.

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Background

Misconceptions in student models of static electricity and magnetism have been researched in many countries. In magnetism, students misconceptions include the size of a magnet is proportional to it's strength (Stepans, 1994), the magnetic field only exists external to the magnet (Stepans, 1994), the poles of a magnet are positively or negatively charged (Borges, et al., 1998). In static electricity, student misconceptions include neutral objects have no charge (Caillot, *et al.*, 2003; Thacker *et al*., 1999), objects such as capacitors store a net charge (Thacker, et al., 1999), grounding is unidirectional in nature (Barken & Hitchcock., 2001; Joffe & Locke., 2010).

Materials published that focus on student centred activities to promote conceptual change in student models include Physics by Inquiry (McDermott & the Physics Education Group at the University of Washington, 1996) Tutorials in Introductory Physics *Physics* (McDermott, *et al.,* 2003).

Methodology

The Action Research Project is carried out using a four step cyclical process as outlines in Figure 1.

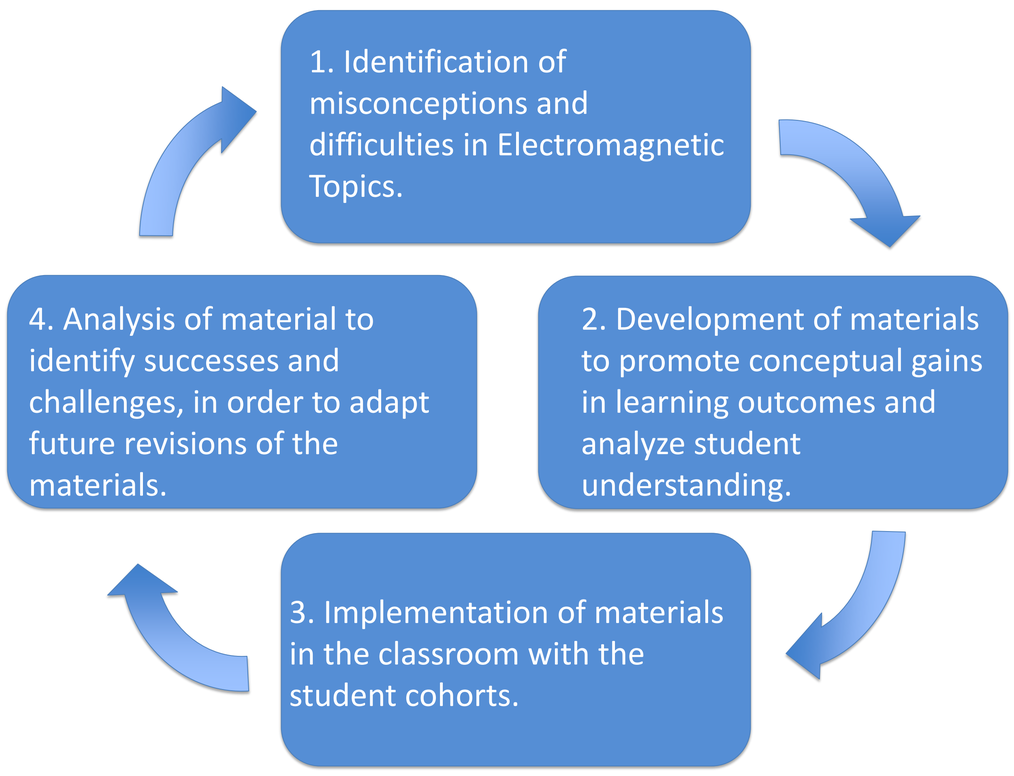


Figure 1. The four sections of the Action Research Project.

Attraction involving a neutral object

Student naïve models can show that students believe a neutral object contains no charge (Caillot, *et al.*, 2003; Thacker *et al*., 1999). From this, students can be unaware of the attraction between a charged object and a neutral object.

Pre – Test results showed that 18/20 students could accurately predict that oppositely charged objects would attract and similarly charged objects would repel. The results also showed 18/20 students stated that there would be no attraction between a positively charged object.

Addressing the misconception

Students were presented with materials to represent neutral objects with charges highlighted. 13/20 students identified the ball as neutral. Intervention was applied to remaining students, highlighting the summation of integers. Students were then given a setup similar to Figure 2. The question highlights to revise sections where the students reason that attraction is seen between charged objects and neutral objects. 2/20 students came to this conclusion without intervention.

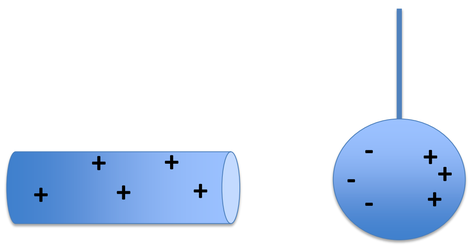


Figure 2. Representation of a neutral object with a separation of charge

Post – Test Analysis

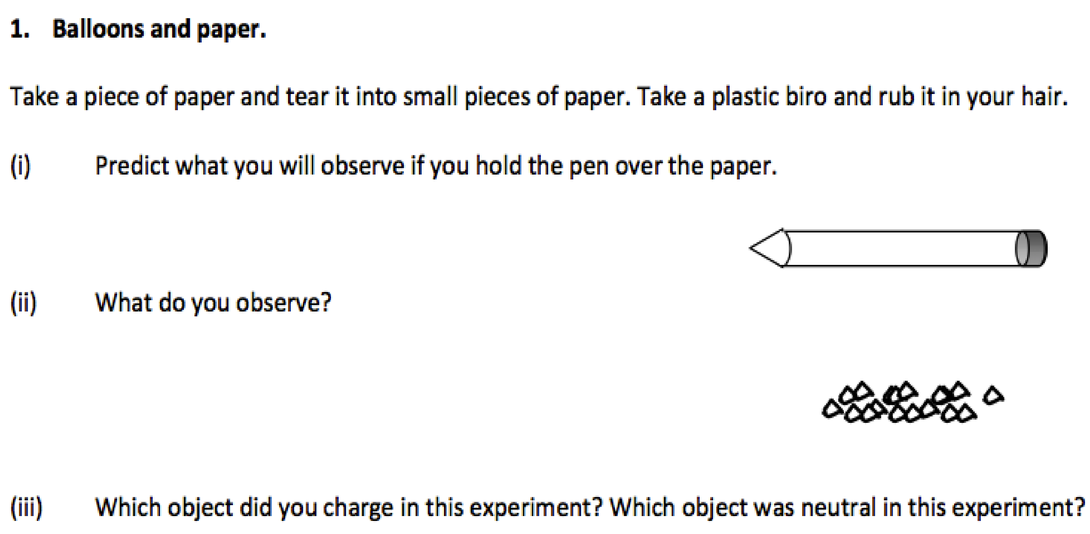
After intervention, 18/20 incorrectly answered that neutral object is not attracted to a charged object. This shows that conceptual change did not occur in this section and revision of the materials must address this.

Notes for revision

Student exposure to the concept was 15 minutes. This was not enough time for student models to be challenged and adapted.

The concept of an induced and displaced charge in a neutral object is abstract. The representation in Figure 2 was used in isolation and too crude to engage students in any meaningful conceptual change.

Students did not explicitly experience practical experiments in which they observed attraction between neutral objects and charged objects.



1. Balloons and paper.

Take a piece of paper and tear it into small pieces of paper. Take a plastic biro and rub it in your hair.

(i) Predict what you will observe if you hold the pen over the paper.

(ii) What do you observe?

(iii) Which object did you charge in this experiment? Which object was neutral in this experiment?

Figure 3. Current revision taken into account some of the findings of the first implementation of the materials

Conclusions

Pre - test data from the group shows that student models contain the same misconceptions as seen in literature, which are not addressed by traditional instructional methods.

A qualitative comparison of pre – test and post – test data is a useful tool to test the efficacy of the worksheets to measure gains in student understanding.

Post – test data from the group shows the pilot materials were not successful in addressing the particular misconception. In order to promote conceptual change, the concept will be addressed through various contexts, such as experimental investigation, micro – scale interactions based on gains and losses of electrons and macro – scale representations involving induced charge separation.

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