2. Teaching Guide

2.1. Suggested Teaching Strategy

1. Give the problem to students.
2. Allow the students to think about the problem and draw a reconstruction diagram using the available data.
3. Expect students to be able to determine the time taken for the student to reach the point of the accident after setting off across the road (consolidation of the ability to apply understanding to a new situation). Also expect the students to indicate what assumptions they have made in arriving at this determination.
4. Guide students to suggest what further information they need to determine about the car (this being the velocity before skidding and the time for which the skidding took place).
5. Based on a consideration of kinetic energy and the work done against friction (see teacher notes), and side-tracking from the investigation into a consideration of friction with the aid of friction experiments, guide students to derive $v=(2\mu gs)^{1/2}$. The goal is to introduce the concept of the coefficient of friction as F/N.
6. Return to the accident problem and use the new found information to determine the velocity change on skidding, and from this, the velocity of the vehicle prior to braking.
7. Students are now in a position to determine the time needed for the car to skid and hit the student. This time, plus reaction time by the car driver, should be the same as the time taken by the student to cross to the scene of the accident.
8. Students can also determine the position of the car when the yellow light first appeared and hence determine whether the car could have stopped before hitting the student had the brakes been applied at this point.
9. The students are now in a position to discuss whether any blame should be attached to anyone by undertaking a group discussion and put forward justified decisions.

SEVENTH FRAMEWORK PROGRAMME
5.2.2.1 – SiS-2010-2.2.1, Grant Agreement No. 266589
Supporting and coordinating actions on innovative methods in Science education:
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2.2. Description of the suggested teaching-learning outline stage

Stage	Teaching/Learning Approach	Teaching/Learning Outline
1. Setting the scene	Material presented through a real life title and scenario (1 lesson)	Becoming familiar with the scenario. Putting forward ideas on how to tackle the issue Realisation that the scientific question to answer is 'how can the speed of the car be determined before the accident ?'
2. Inquiry-based Problem Solving	Teacher guided, Student-centred material includes Problem Solving, Nature of Science and Conceptual Science Learning (and consolidation of the conceptual learning through adequate feedback - assessment). (2 lessons plus homework)	Tackling the problem. Teacher guidance so that students realise that the tyre marks can indicate speed if the relationship between change of kinetic energy and work done against friction is examined. Teacher guidance so that students realise that frictional force depends on the surfaces and this can be indicated by a coefficient of friction. Knowing the coefficient of friction leads to a value of the frictional force and thus to the velocity of the car. Students realise that the scientific question can be simplified to 'How can the coefficient of friction be determined' Teacher guidance to enable students to determine the coefficient of friction experimentally, using the ration N/F where F is the weight of the car and N the fictional force.

Stage	Teaching/Learning Approach	Teaching/Learning Outline
		Knowing the coefficient of friction (and assuming, in the simplest case, the car was moving a zero speed at the time of the collision and assuming a reasonable reaction time for the car driver), students are expected to be able to determine the velocity of the car before skidding.
3. Socio-Scientific Decision Making	Teacher guided, Student centred material includes reasoned socio-scientific decision making (and consolidation of the conceptual learning through adequate feedback – assessment). (1 lesson)	Knowing the speed of the car before skidding, the distance of the car from the pedestrian crossing and the time taken for the student to reach the point of the accident, the students are in a position to discuss, making reasonable assumptions, a possible reconstruction of the accident scene and hence to suggest, with clearly outlined justification, whether, if they were called upon to make a judgement, would anyone be to blame.

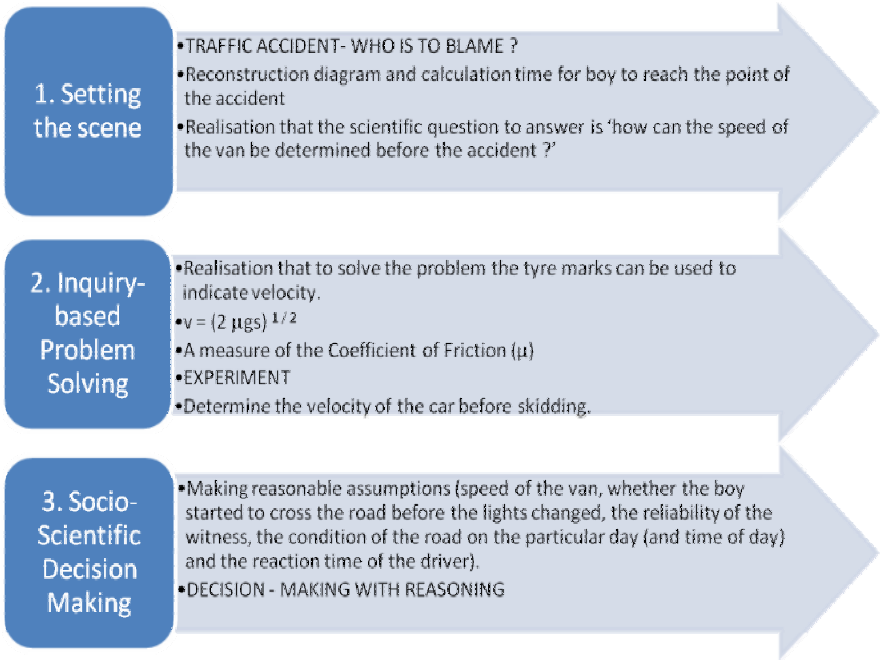

Fig. 1 *Suggested Teaching Flowchart*

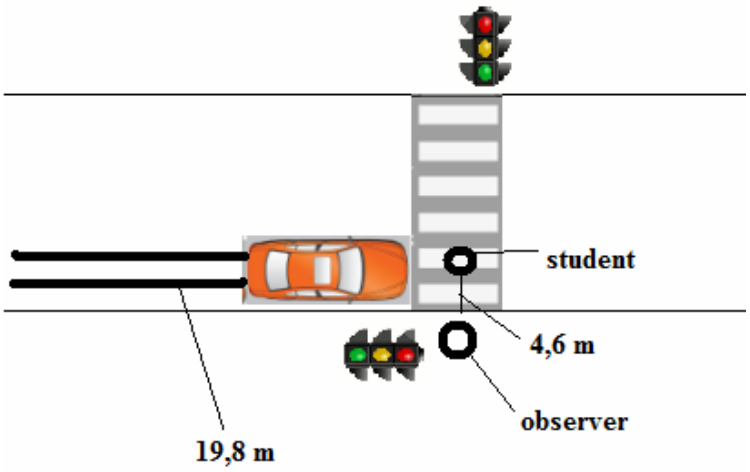

Fig. 2 *Example of a reconstruction diagram*

2.3. Achieving the Objectives

1. To understand the problem:
This is achieved by the students drawing a reconstruction diagram.

2. To draw a reconstruction diagram of the situation:
Each student draws the diagram and includes all relevant information.

3. To solve the traffic problem using laws of motion and coefficient of friction:
This is achieved by the students undertaking the necessary calculations, being guided by the teacher to appreciate new areas of physics such as the relationship between change of kinetic energy and work done against friction, plus the coefficient of friction and how this can be determined experimentally.

4. To show cooperative learning:
Each student cooperate by participating as a member of a group in a discussion on the outcomes of the calculations to determine whether to apportion blame.

2.4. Suggested Lesson Breakdown

Lesson 1 (associated with stage 1):
At the end of the lesson, students are expected to be able to:
- draw a reconstruction diagram of the accident scene;
- determine the time taken for the student to reach the point of the accident indicating assumptions made in arriving at this determination (consolidation of previous learning).

Lesson 2 (associated with stage 2):
At the end of the lesson, students are expected to be able to:
- suggest information needed to determine whether the car driver is to blame of the accident (this being the velocity before skidding and the time the skidding took);
- appreciate that the change in kinetic energy pf the car is the same as the work done against friction when the car skidded;
- derive $v = (2\mu gs)^{1/2}$.

Lesson 3 (associated with stage 2):
At the end of the lesson, students are expected to be able to:

- show that the coefficient of friction is F/N;
- determine values for the coefficient of friction experimentally;
- determine how long it took the car to stop by making use of the skid marks;
- assuming a given reaction time for the car driver, determine the position of the car when the lights went red and the student started to cross the road.

Lesson 4 (associated with stage 3):
At the end of the lesson, students are expected to be able to:

- shown justified reasoning for arriving at a decision whether anyone is to blame for the accident;
- arrive at a consensus decision agreed by all students.