**O3.2\_Framework of the lesson plan**

**Age group/class: 15 years old and above**

**Lesson title: Friction drag.** Car and airplane simulation.

**School Discipline: Physics**

**Key concepts:** Friction. Friction drag. Computer simulation.

**Aims:**

* How to understand concepts such as friction, friction drag etc.
* How computer simulation reduces costs, materials and time compared to reduced and full scale experiments.

**Skills developed**: observation, description, analysis

**Materials/Equipment needed**:

* VR headset
* VR video/link <https://eloquent-ramanujan-887aa5.netlify.app/aerodynamics.html>

**Lesson plan:**

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| **Stages** | **Description of activity** | **Time** |
| **Preparation before the lesson** | This lesson focuses on friction drag.  If this is a first VR experience for students – go through the safety rules: -  Learners are to sit down whilst using the VR glasses and not hold anything in their hands, unless the experience is of such a nature that it requires you standing, in which case, ensure enough space is allowed around all students.  -  Learners will be told to expect a feeling of vertigo. If it gets worse, students must remove VR glasses.  -  Learners need to know how to adjust the viewing focus before using the headsets.  -  Learners must not use the headset when they are: tired, need sleep, under emotional stress or anxiety, when suffering from cold, flu, headaches, migraines as this can worsen their susceptibility to adverse reactions.  -  Learners should be given the choice to opt out of using VR. |  |
| **Introduction** | Share Learning Intentions with students.  Ask learners to think and write any questions they have regarding the learning objectives, as for example: *What is friction? What causes friction? What is friction drag? How does the shape of the object influence friction drag? If the object is a vehicle, how does friction drag influence fuel consumption?* | 5 min. |
| **Initial Immersive Experience** | Learners put on the VR headsets and explore the video at their own pace.  Turn the headsets off and bring students back into the classroom. | 3 min. |
| **Guided Immersive Experience** | Learners begin to explore the VR material on friction drag.  Students put on the VR headsets and start the immersive experience focusing on finding more information on how vehicles are affected by friction drag.    Allow time for this guided exploration or on and off for as long as it is needed for learners to familiarise with the tools. | 5 min. |
| **Follow up** | When the VR moment is over, learners gather in groups of 2 or 3and share their ideas.  Learners compare notes and discuss to complete their knowledge and understanding. The teacher facilitates the discussion and ensures there are no misunderstandings.  Learners use their research stations (laptops/tablets/phones) to add to the knowledge gained through the VR experience by completing their notes.  The task is:   * analyze how friction drag can be visualized by computer simulation * analyze how shapes can be more or less aerodynamic * analyze how computer simulation affects factors such as cost, time, materials when it comes to experiments and design. | 5 min.  10 min. |
| **Formative Assessment** | Teacher shows materials that explain how friction drag influences the speed and fuel consumption of a vehicle. | 5 min. |