**Learning Guide to analyze the Simulations of Lesson 4 and Complete the Respective Worksheet**

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PAFSE Project: Scenario 1: Droplets & the Physics of Viruses Transmission

LEARNING GUIDE FROM CLASS 4

Analyze the Simulations of Lesson 4 and Complete the Respective Worksheet



**Sustainable Development Goals**

**Domains of Citizenship Education**

Sustainable Development

Health

**Competencies when finishing Compulsory Schooling**

Critical and creative thinking, well-being, health and environment

Scientific, technical and technological knowledge

Languages and texts

Information and Communication

# **Guide Objectives**

With this guide, it is intended that the teacher who will teach class 4 be equipped with the necessary knowledge to fulfill this purpose. This document contains the step-by-step explanation of what it is intended to convey to students by watching the videos of the simulations of different breathing regimes prepared by ISEL for class 4 of scenario 1.

# **Video Structure**

The videos in class 4 refer to the same breathing regimes simulated in class 3: situation in which occupant 1 speaks, sneezes and coughs. What varies in relation to the simulations of class 3, are the elements present in the room.

For class 4, these 3 breathing regimes were simulated for 3 different room types, where the complexity of humans is increased in relation to the occupants of the class 3 simulations, that is, they became closer to reality, as shown in Figures 1, 2 and 3, illustrated below.

The set of elements present in the room has also increased, in which each of the three configurations of the room seek to represent a type of office/classroom environment. The three room configurations where the three breathing regimes were simulated for each configuration were as follows:

* **Standard case:** identical to the case of class 3, that is, with the same ventilation system, only the complexity of the occupants and the number of geometries in the room changed;
* **Case with air conditioning in the ceiling:** in this case, the ventilation system was all installed in the ceiling;
* **Case with windows open at 10% and door open at 10%:** here we tried to simulate a situation in which the ventilation system in the room was natural.

## **Standard Case Room Setup**

As mentioned above, the standard case is similar to the case simulated in class 3, having only increased the geometric complexity of the occupants of the room, bringing them closer to reality.

A series of elements (tables, chairs, tower, monitor) were also introduced in order to simulate a typical office/classroom environment. In Figure 1, it is possible to observe the caption of the standard case room.

Uma imagem com texto, captura de ecrã, diagrama, design

Descrição gerada automaticamente

Figure 1. Standard case study room caption

In Table 1 below, it is possible to observe the characteristics of each element present in the room in the standard case.\*

Table 1. Room Present Elements in Standard Case

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Element** | **Quantity** | **Dimensions [m]** | | | **Boundary Condition** | | |
| **X** | **Z** | **Y** | **Power [W]** | **Air Flow** | **Surface Temperature [ºC]** |
| \*North Wall (+X) | 1 | - | - | - | - | - | 24,9 |
| \*South Wall (-X) | 1 | - | - | - | - | - | 25,0 |
| \*East Wall (+Z) | 1 | - | - | - | - | - | 25,5 |
| \*West Wall (-Z) | 1 | - | - | - | - | - | 25,3 |
| \*Ceiling (+Y) | 1 | - | - | - | - | - | 25,7 |
| \*Floor (-Y) | 1 | - | - | - | - | - | 24,0 |
| \*Humanos(sitting) | 4 | 0,6 | 0,6 | 1,45 | 100 | - | - |
| Chair | 1 | 0,5 | 0,5 | 0,95 | - | - | - |
| Table | 1 | 1,65 | 0,75 | 0,75 | - | - | - |
| Monitor | 1 | 0,5 | 0,2 | 0,65 | - | - | - |
| Tower | 1 | 0,2 | 0,45 | 0,4 | - | - | - |
| Keyboard | 1 | 0,6 | 0,2 | 0,05 | - | - | - |
| \*Lamps | 6 | 1,2 | 0,2 | - | 64 | - | - |
| \*Extractor | 1 | 0,3 | 0,3 | - | - | 0,0944 | - |
| \*Diffuser | 2 | 0,3 | 0,3 | - | - | 0,0472 | - |



**\*** This table is also present in the “Characteristics Simulation” sheet, in the “Characteristics of Standard Case Simulations” section.

## **Ceiling Air Conditioned Case Room Setup**

In this situation, the arrangement of the geometries (tables, chairs, occupants) in the room is identical to the standard case, the only difference is that the ventilation system is now installed in the ceiling, in its entirety (diffusers + extractor) as shown in Figure 2 illustrated below.

Uma imagem com texto, captura de ecrã, diagrama, Modelagem 3D

Descrição gerada automaticamente

Figure 2. Ceiling Air Conditioning case room caption

As shown in Figure 2, the air conditioning in the ceiling consists of one extractor (square), surrounded by four diffusers (rectangles).

The characteristics of each element present in the room in the case with air conditioning in the ceiling are as follows:\*

* **Extractor Dimension:** 0.55 X 0.55 [Length X Width] (m)
* **Diffusers Dimension:** 0.55 X 0.01 [Length X Width] (m)
* **Air Flow Emitted by each Diffuser (**There are four diffusers in all**:** 33.5 l/s.)
* **Air Injection Angle:** 45º with Horizontal.

**Note:** The characteristics indicated for the geometries of the standard case also apply in this case.

**\*** This information is also available in the “Characteristics Simulation” sheet, in the “Characteristics of Case Simulations with Ceiling Ventilation System” section.

## **Case Room Setup with windows and door open at 10%**

Also in this case, the arrangement of the different geometries of the room was identical to that found in the standard cases and with a ventilation system on the ceiling. The significant difference is that the ventilation system was natural, that is, one door and two windows were installed, both open at 10% of their capacity, and the air was forced to enter through the windows and exit through the door opening, creating an air current inside the room. The configuration of this room can be seen in Figure 3 below illustrated.

Uma imagem com texto, captura de ecrã, diagrama, Modelagem 3D

Descrição gerada automaticamente

Figure 3. Case Room caption with windows open at 10% and door open at 10%

In Table 2 below, it is possible to observe the characteristics of each element present in the room in this case, with windows open at 10% and door open at 10%.\*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Element** | **Quantity** | **Dimensions [m]** | | | **Boundary Condition** | | |
| **X** | **Z** | **Y** | **Power [W]** | **Air Flow** | **Surface Temperature [ºC]** |
| Door | 1 | - | 0,85 | 1,90 | - | - | 24,9 |
| Door opening (Air Extractor) | 1 | - | 0,085 | 1,90 | - | 0,052 | - |
| Windows opening (Individual Air Diffuser) | 2 | 0,13 | - | 1 | - | 0,026 | - |

**Note:**

**-** The characteristics indicated for the geometries of the standard case also apply in this case.

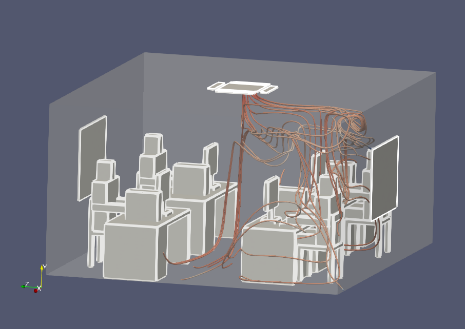
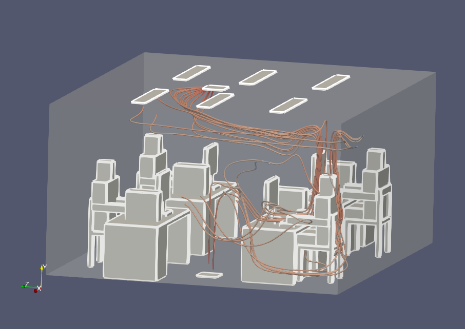
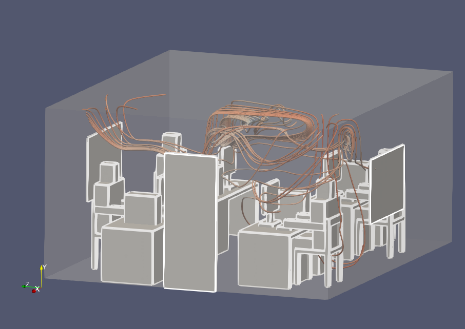
This information is also available in the “Characteristics Simulation” sheet, in the “Characteristics of Case Simulations with Windows Opened at 10%, Door Open at 10%” section.

## **Typology of Videos**

The typologies of the videos available for class 4 are identical to those of the videos from class 3 (videos with 1st minute of the simulation + videos with the total simulation). Again, for the simulations of class 4, only occupant 1 emitted particles, the simulations were conducted for a time of 60 minutes, and the particle size and respective color caption are identical to the simulations of class 3.

Furthermore, as in the simulations of class 3, a set of images are available at the end of each simulation, from different perspectives of the room to assist students in analyzing the phenomena that occurred during the simulations.

As in class 3, students will also have available an image of the draught lines in each configuration of the room, as shown in the images illustrated below.



# **Explanation of phenomena observed in each video**

The explanation of each phenomenon observed in the videos of lesson 4 is present in the PowerPoint “Video analysis guide of lessons 3 and 4” (PowerPoint can be found in the Dropbox link of scenario 1).

# **Videos Analysis Sequence**

In class 3, the focus is on students observing the differences in the propagation of respiratory particles. In class 4, it is intended that students establish, in the first instance, a comparison between having a room with fewer elements (class 3), and a room with the configurations of the standard case, where there are more geometries. Next, it is also intended that students compare the differences observed in the propagation of respiratory particles to rooms with different configurations. As such, it is proposed that in class 4, students only analyze the videos of the simulation of speaking for the standard case, case with ventilation system fully installed in the ceiling, and room with natural ventilation system. As a complementary activity, and to fill out the scientific report, students can later, if they have time, or as homework, analyze the videos corresponding to the sneezing and coughing simulations of these 3 cases.

That said, the sequence of analysis of the videos by the students is similar to what happened in class 3, and should be as follows:

1. Students first analyze the 1st minute videos for the 3 different room configurations (standard, natural ventilation, fully ceiling-mounted ventilation);
2. Subsequently, students analyze the full simulations videos of the three situations.
3. If necessary, students regard the images from different perspectives of the room at the end of each simulation;

**Note:**

**Again, it is** **of utmost importance that students have next to them (either printed, or on their devices), the images of Figures 1, 2 and 3**, so that, when analyzing the videos, they can clearly identify each element inside the room (images present in the learning guide for students “study method class 4”).

In order for this analysis activity to be conducted efficiently, the teacher asks the students in advance (e.g., in the class prior to the analysis of the videos), to analyze the learning script “study method class 4”, so that, when students arrive in class 4, they already have a sense of what will be done during the class and the activities.

To reinforce this last point, it is also suggested that, at the beginning of the class, the teacher tells the students how the sequence of analysis of the videos should be done, also mentioning that video typologies exist, or even the existence of the images.

# **Completing the Lesson 4 Worksheet**

As in the lesson 3 worksheet, this one is available on the Dropbox link for scenario 1 in the “Worksheets” folder. The form is accompanied by a solution that contains the answers to each of the questions. This last one can be obtained in the folder “Solucoes\_Fichas”. The name of the form is “Worksheet\_PT\_Aula\_4” and the solution in the “Solucoes\_Fichas” folder is “Worksheet\_PT\_Aula\_4\_Solucao”. An abbreviated version of the responses to the forms can also be found in the Word document with the description of the educational scenario.

# **Final Note**

In order for the activity to run efficiently, here are some suggestions for the logistics of implementing this specific class:

* It is **fundamental** that students, before entering the classroom, **have read the script "study method class 4"** to already have a little preparation of what they will find in the activities proposed for class 4.
* If possible, before starting the class, the room must already be prepared to carry out the activity, that is, the tables must already be divided so that the groups can work (it is assumed that before this class, the work groups are already known), and the computers (if the school has them) must already be in the room before the students enter, so that these moments of organization do not occupy the precious time of the class;
* If students do not have access to school computers, it is imperative that before class all students have available, at least on their mobile phones, the videos and images related to class 4. This aspect is crucial for the activity to be successfully developed in the stipulated time.