We are the makers – IoT: Learning Scenario – Rack and Pinion System (by Edumotiva Team)

1. Title of the Scenario	***Rack and Pinion 3D printing***
2. Target group	Secondary school and vocational school students between 14-17 years old
3. Duration	This scenario can be divided in 2 different sessions each lasting 3 teaching hours.
4. Learning needs	Interlocked parts, rack and pinion application, 3D designing, try and error projects
5. Expected learning outcomes	• Understanding the concept of Interlocked parts and the use in 3D printing projects. • Learn the different forms of interlocked parts. • Identify the several applications of a rack and pinion system in everyday life. • Learn the basic parameters that have to be considered in order to design a rack and pinion system. • Execute calculations in order to produce a successful 3d design. • Create unique 3D designs. • Understand the limitations of the materials used for the final 3D print • Learn to identify the errors after the first print and understand the changes that have to be made to lead to a successful print.
6. Methodologies	Lesson 1: Presentation of rack and pinion (given) from the teacher. Learning by doing, Exercises Learning by doing, Calculations Lesson 2: Learning by doing, 3D designing and printing
7. Place / Environment	3D printing Laboratory
8. Tools / Materials / Resources	Projector, Audio system, Copies of the students exercise and calculation documents. Digital Material: presentation "Rack and Pinion"

9. Step by step description of the activity / content	Lesson 1: Presentation of rack and pinion (given). i. The teacher have to explain the concept of interlocked parts in 3D Printing and their use in designing specific 3D printed projects. ii. Afterwards , the system rack and pinion can be explained as it is made from interlocked parts. iii. At the point that different rack and pinions systems are presented (right after slide 15), the students will do a matching exercise in order to identify the right rack that matches several pinions that are given to them. ("match pinions and racks.docx") iv. Finally a detailed designing of a rack and pinion system will be presented and explained in order to make sure that all of our students have understand the basics calculations that have to be made, so their design will be successful. v. A calculation sheet ("make your calculations.docx") will be given to them to make their own unique design and then they can start their 3D designs. Lesson 2: 3D designing and printing i. The students will finalize their designs and then they will print their rack and pinion. ii. Tests will be made to determine if the system is functional and robust. iii. The teacher will help the students to identify the errors of their designs (if any) and point out the parameters that have to be changed for a better final print. iv. The students will print again (if needed)
10. Feedback	Lesson 1: the first exercise is a feedback exercise to determine if our students have understand the concept of rack and pinion. The calculations document is also a feedback exercise, that help us determine if our students have understand the basic parameters that need to be considered, in order to build a functional rack and pinion system. Lesson 2: after the test of the first printed system of each student – group, we can discuss with them, about what went wrong and how they can fix it. This is a way to figure out if our students have acknowledge of their projects.
11. Assessment & Evaluation	Lesson 1: observation in the classroom. We can assess our students understanding about complex 3D projects. We can evaluate their ability to understand a design and perform calculations based on specific formulas. Lesson 2: Assessment of the final printed project. We can evaluate how our students can improve their designs based on their ability to identify errors. Are they willing to try again?