**03.2 Lesson plan**

**Age group/grade: 11-12th grades**

**Lesson title: Leonardo da Vinci inventions. Self-supporting bridge.**

**Key concepts:**

**A beam** is a connecting element of walls and supports.

**Engineering** is a discipline and profession that practically applies knowledge of physics, chemistry, mathematics, materials science, mathematical modeling (and bioengineering biology), economics and practical activities in various technical fields - static and linear (roads, shipping and irrigation channels, communication lines, etc.), in the design, development, adjustment, repair and the like of equipment, machinery and other devices, technological systems and processes.

**A bridge** is a structure that connects a road above a river, canal, gorge, etc.

**Objectives:**

* To analyse theoretical material on Leonardo da Vinci inventions.
* To design the structural parts of a bridge, to get them produced with 3D printer, to process the parts manually and assemble the structure of a bridge.
* To perform bridge load testing experiments.

**Skills developed:** engineering thinking. Application of knowledge of mathematics and physics in civil engineering. Interest in innovative technologies and engineering solutions. During the production of prototypes, we will check the results of the design and construction and, after detailed testing, we will find out whether the component and the construction meet our expectations.

**Materials/Equipment needed: computer class, VR headsets, 3D printer, digital drawing tools** (Fusion 360 3d modeling software), cutting blade, sandpaper.

**Assumptions:** (Programs for students with special needs, other important information)

**Lesson plan**

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| **Stages** | **Description of activity** | **Time** |
| **Preparation before the lesson** | If this is the first VR experience for students – go through the safety rules:  -Students 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.  -Students will be told to expect a feeling of vertigo. If it gets worse, students must remove VR glasses.  -Students need to know how to adjust the viewing focus before using the headsets.  -Students 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. | 2 min |
| **Introduction** | Short presentation on Leonardo da Vinci’s bridge design history.  Leonardo da Vinci – one of the most famous historical figures, was an Italian Renaissance painter, sculptor, architect, inventor, military engineer and draftsman. His thinking was based on visions of the future, and how his inventions could change the world in the distant future.  Leonardo da Vinci’s ingenious design for a self-supporting bridge is one of such inventions.    **Features of the bridge**  A self-supporting bridge is constructed of the simplest hemispherical beams that do not even require fasteners or other components integral to traditional bridges. Once the bridge is assembled, its weight must be enough to create the necessary pressure so that the longitudinal beams press against the crossbars and prevent them from moving. This fastening method can be compared to scissors. The stability of the bridge also depends on the weight on it - the higher the mass that presses the bridge at the top, the more stable it is. This ingenious design demonstrates Leonardo da Vinci’s genius and talent to turn nothing into something wonderful, simply by considering the basic laws of physics that were, at the time, incomprehensible to many ordinary people.  **3D printing the bridge**  Nowadays, technology is more advanced, so da Vinci’s self-supporting bridge can be designed using a 3D modeling program and printed with a 3D printer. Using Leonardo da Vinci’s original drawings and a 3D printer, we can construct one of the oldest self-supporting bridge designs. With such technologies, in the future the construction of bridges can be greatly simplified, as their parts can be printed on printers.  When creating his drawings, Leonardo da Vinci did not focus on the ignorance of his time but looked at a brighter tomorrow and how he could bring a deeper understanding of physics to the people of this world. And since today we are still talking about his genius and keep developing projects based on Leonardo da Vinci’s inventions, we can confidently say that he succeeded. | 10 min |
| **Initial Immersive Experience** | Using VR headsets, we invite students to visit the Leonardo da Vinci museum in Florence, The Da Vinci Machines Exposition  <https://eloquent-ramanujan-887aa5.netlify.app/da-vinci.html> | 5 min |
| **Guided Immersive Experience** | After VR experience, move forward with the task.  Stages of bridge construction   1. Drawing        1. Design using Fusion 360 software      1. Printing  * Printer ANET a6 * 3D plastic Fiberlogy PET-G 1.75mm 0.85kg – Black * Thanks to the properties of PET-G, you can produce even more functional prototypes and end-use parts. This is possible due to its strength, which is better than ABS. Due to the Glycol compound, the material is more durable and less prone to shrinkage. Chemical resistance to acids, salts and alkalis also expands its applicability            1. Construction          1. Testing   <https://www.dropbox.com/s/5ouvjx3hg8dda4z/Fizika.mp4?dl=0&fbclid=IwAR3qUhWwm9LFdxVcokSxvX3acFu8IpBTGYSLARS7CXRUPwWvatV8kV2FpkU> | 18 min  5 min |
| **Follow up** | Drawing, design and construction skills of students can be assessed. | 5 min |
| **Formative Assessment** |  |  |