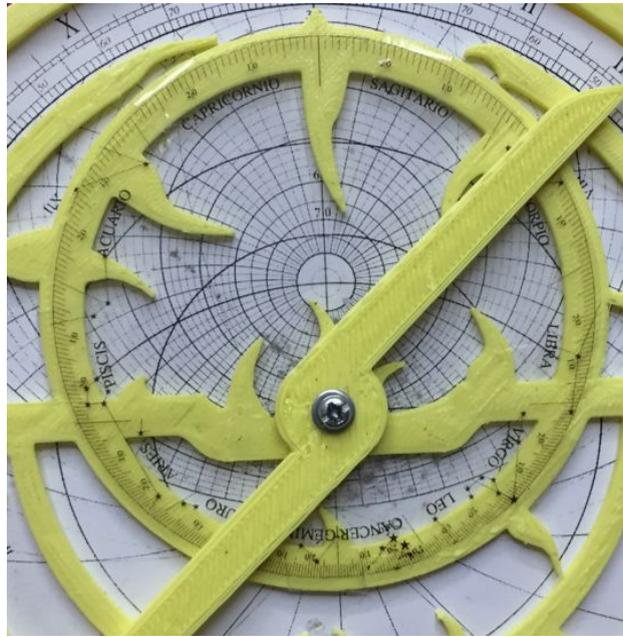


## Science in 3D – Summary



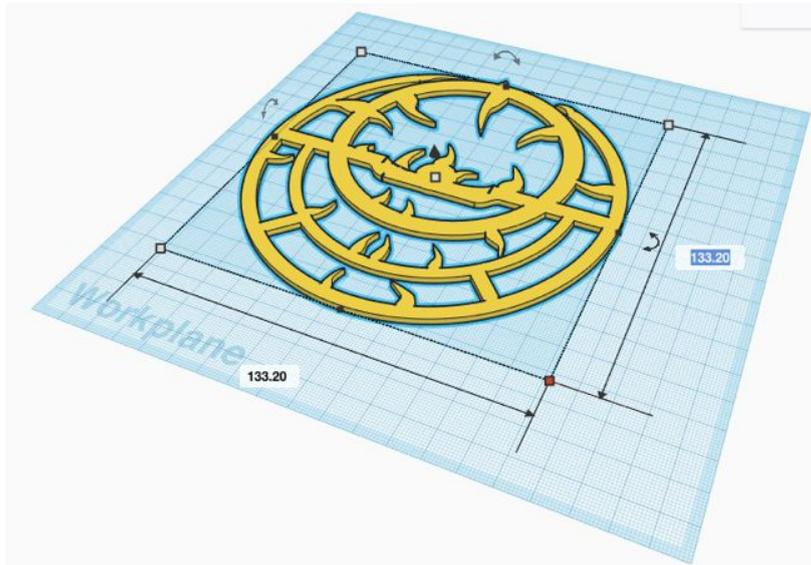
3D Astrolabe.

The universe is a source of astonishment and research. The astrolabe is a model of the universe which fits in the palm of your hand. Satellites and GPS's could be hacked and these devices are experimenting a renaissance.



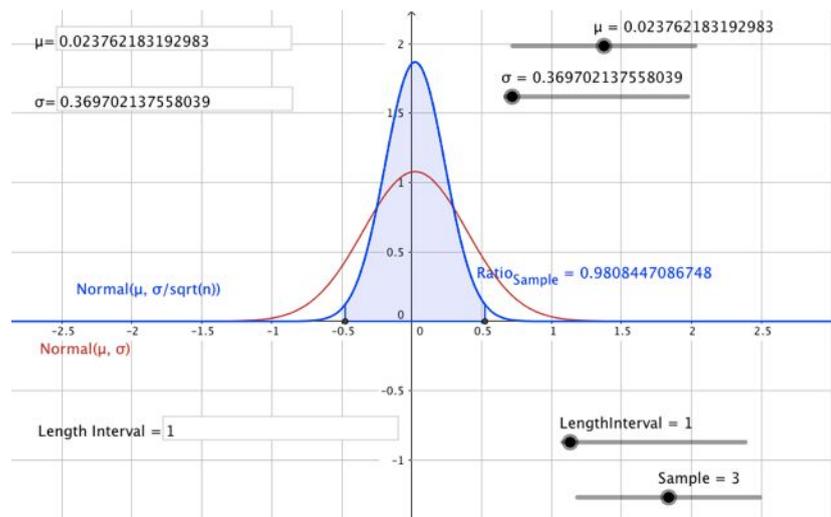
Celestial navigation for officials (Armada Española).

Making an astrolabe needs some [principles of stars' motion](#). 3D pieces were quite complex to make, since their precision should be high and our 3D printers were not professional. At first, the work was split into: astronomy's basics, astrolabe's principles and 3D design. Everybody learnt from each other. Software was widely used: [Stellarium for time calculations](#), spreadsheets... Interdisciplinary skills played a significant role.



Astrolabe's rete (Tinkercad).

Designing, [putting all together](#) and make [astronomical observations](#) were challenging. Once finished, questions arose about exactness. Was it possible to measure the precision of the instrument? If it was possible, how could it be done? This led to the statistical analysis of time calculations errors. So that, in a second stage, tasks were divided into: study of the accuracy and design improvements.



Errors and normal distribution.

Sampling design, analysis of data and conclusions were carried out using statistics. Moreover, it was proved that the distribution of the errors was normal. It revealed a method that raises the precision using mean values. Meanwhile, significant improvements of 3D pieces were done. It was even designed a new piece to join pieces, avoiding problems with usual precision of 3D printers.

We enjoyed the trip, though sometimes we were exhausted and lost, we have new ideas to extend our project. We don't want to end the adventure of the universe in a real STEM journey.

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