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DA VINCI SATELLITE – ROLL OF THE DICE

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Abstract

The Da Vinci Satellite project is a non-profit initiative started at the Delft University of Technology to inspire and enthuse the youth to learn more about technology and space travel. The team does this by focussing on demystifying space and making it a fun and engaging subject. The non-profit student team is divided into different sub teams, two of which are the technical team and the educational team. The technical team has been building a 2U CubeSat with two payloads that have been designed to support educational packages for children from primary schools and high schools. The educational team works to make these educational modules available for schools all around the world such that children have the opportunity to interact directly with space via The Da Vinci Satellite.
Keywords: Primary School Education, Educational Satellite

Acronyms/Abbreviations

Da Vinci Satallite (DVS)
International Space Station (ISS)
Vliegtuigbouwkundige Studie Vereniging (VSV)

1. Introduction

Space has been a topic that has captivated human imagination for generations and that has inspired many. However, often the topic of space can appear distant and complex to children when they first start to learn about it. The Da Vinci Satellite Project aims to demystify space and make it an engaging and accessible subject for young minds. The team has done this through working together with primary- and high schools in the Netherlands to bring specially designed educational modules to the students. These educational modules have been developed by the team in a simultaneous fashion with a cube satellite. The cube satellite will be the fourth satellite that has been developed at the TU Delft after being kickstarted by the Aerospace Engineering study society.

On board of the satellite there will be two specially designed experiments, the Dice Payload and the Bitflip Payload. The first one consists of a mechanism that is able to 'throw dice in space', such that children can play a game with the satellite. The second payload has been developed for high school students and will be a personalised computer science experiment on board of the satellite. For both primary schools and high schools there are special educational modules that are currently being designed to make use of these payloads and teach children and students more about space. The team does this in various ways, including the development of an international website and by combining efforts with other educational organizations.

2. Dutch School System

The team is based is based in Delft, the Netherlands, which is why Dutch (International) schools have been a testbed for the educational modules that are being developed together with the input of local teachers. The first level of the school system in the Netherlands is for children until the age of 5. Young children in the Netherlands can attend a variety of non-compulsory daycare options. Children from the age of 4 can be enrolled in a primary school or elementary school, called 'Basis School' in Dutch. Students attend primary school for 8 years until they are usually around the age of 12, after which they can start at a secondary school, called 'Middelbare School'. The educational modules are designed for both age groups [1].

3. TU Delft and Space

Delft University of Technology, TU Delft, is the oldest and largest technical university in the Netherlands. With eight faculties and several research institutes the university offers over 16 bachelor's and more than 30 master's degrees. Within the Aerospace Engineering Master, students can choose to specialise

with the Space MSc track the prepares them for a career in the international space sector [2]. The track focuses on space engineering, spaceflight dynamics and planetary exploration. Students from the Aerospace Engineering Master, Bachelor and other faculties at the TU Delft have been working on several space related projects and teams that the TU Delft hosts. The Da Vinci Satellite team is preceded by three other satellites that have been developed, designed, and tested by the TU Delft. The first satellite that the TU Delft launched was Delfi C3 in 2008. Delfi N3XT was launched in 2013 and Delfi PQ in 2021. The Da Vinci Satellite will, together with its educational modules, be launched in 2024 [3].

4. Birth of the Da Vinci Satellite Project

The VSV Leonardo Da Vinci is the study association of the Aerospace Engineering faculty at the Delft University of Technology. Established in 1945, the association with its approximately 2300 members aims to serve the interests of Aerospace Students in different study and career phases [4].
In honour of the 75th anniversary of the study association, the VSV Leonardo Da Vinci initiated the Da Vinci Satellite project to contribute to the educational needs of children and students all around the world. The mission of the project is to inspire and enthuse children and students through the development of an educational satellite with special educational packages that are being developed in parallel with the satellite. The educational packages are aimed at primary school and high school students and are free of charge. By bringing the satellite data directly into the classroom the students of different ages will be able to learn about space and everything related to space in an interactive and fun way.

5. Vision of the Da Vinci Satellite Project

In current society, space travel has become an integral aspect of people's daily lives, carrying significant societal implications. By becoming acquainted with the vast and all-encompassing space around us from an early age onwards, children can become inspired and motivated to discover the world in general, including technology, societal challenges, global climate challenges and sustainability.

All education modules of the Da Vinci Satellite project will be available free of charge, online and offline and in multiple languages. Furthermore, the educational modules will be subject to a sensitivity assessment and have been tested thoroughly. Next to this, once the official Da Vinci Satellite website is launched, the education team is readily available to provide support when needed.

The Da Vinci Satellite project is an innovative initiative aiming to let schoolchildren interactively engage with educational and the world, and its place in the cosmos, around them. The team aims to demystify space and provide insights into its multidisciplinary aspects. Furthermore, space is often seen as a very difficult to grasp subject. The Da Vinci Satellite project aims to show the children that space is not a difficult subject if it is explained well. Subsequently, the children will feel more comfortable tackling 'difficult' subjects in their academic and personal lives. Acknowledging the role of the youth as the future leaders, the project aims to cultivate awareness and knowledge among this group. By doing so, it aspires to enhance the quality of education, thereby contributing to a more enlightened and promising future under the motto "*Elevating Education*".

6. Technical Team

A big part of the Da Vinci Satellite project revolves around the design, construction, and eventual launch of the satellite. The satellite is a 2U CubeSat that thus has the following dimensions: 10x20x20 cm. To tackle this ambitious engineering challenge, the technical team is entirely dedicated to the various aspect of designing, developing, integrating and testing the satellite. This team collaborates closely with several experts found at TU Delft and the aerospace industry located in Delft and around the world, ensuring the success of the mission.

The technical team is structured into several key sub teams: Systems Engineering, Software Engineering, Electronics, Payload, Testing and Integration and Ground Station, each headed by a respective chief engineer responsible for organizing the engineering processes. The ultimate accountability rests with the two technical managers, who are core team members.

The initial preliminary satellite design was completed by a group of ten aerospace engineering students from TU Delft as part of their final Bachelor project the 'Design Synthesis Exercise'. Throughout this phase, they received guidance from both TU Delft engineers and experts from "Innovative Solutions in Space" and "Hyperion", two Delft-based space companies specializing in CubeSats.

Following the initial design phase, the current technical team, in collaboration with numerous experts, is advancing the design to a more comprehensive level. As of the current writing, the team is engaged in the testing of the two payloads and integration of the subsystems of the satellite bus. The integration of the satellite bus primarily involves assembly, as individual modules

have been sourced from the industry partners. This integration will be a collaborative effort, undertaken by the Da Vinci Satellite team with guidance from industry experts and TU Delft. It will take place within the clean room facilities at TU Delft and the industry partners' facilities.

6.1 Dice Payload

For the primary school education module, a contest amongst primary school students was held in order to determine what would be the most interesting educational payload to them. What would spark their interest in space flight the most? What did they want to learn about space? For they themselves are eventually the best at determining what they want to learn about space and what intrigues them most about space. The answer that the team got back from the primary school children was clear: "Play Games!". As a result of this contest it was decided that the payload should let the children play game directly in space, and thus the 'Dice Payload' concept was born. This payload will be the main instrument the primary school educational modules will be centred around.

Together with LIS (Leidse Instrumentmakers School) this special payload was designed, fabricated, and tested. The 'Dice Payload' includes five differently coloured dice in colours that have been chosen such that colourblind children are also able to differentiate them, this is in line with the inclusive vision of the Da Vinci Satellite project. These dice are situated in a special mechanism that is able to 'roll' the dice in microgravity and also clamp them such that a picture of the numbers can be taken with the Earth as a backdrop. All the pictures will be added to a special database accessible to all people interested.

6.2 Bitflip Payload

The second payload, tailored for high school students, is currently in the testing phase and will comprise of an interactive memory module. This module will demonstrate how radiation can impact spacecraft hardware, serving as an example of the challenging conditions encountered in orbit, in addition to microgravity and vacuum conditions. Students will have the opportunity to interact with the stored memory within this payload, gaining a personalised insight into the effects of radiation and the necessity of radiation protection.

7. Educational Team

The educational part of the team is also divided into two parts, the primary school sub-team and the high school sub-team. Each time works on their corresponding educational modules. The educational modules are designed to fit into a more conventional classroom setting and curriculum, and are also suitable for a more non-conventional classroom setting and curriculum.

Next to these two teams, a third and overlapping team has been set up that oversees the development of the online platform (it should be noted that this is a different platform than the current and out-dated Da Vinci Satellite website [6]) that will contain all educational modules and will provide a direct interface between Earth and the satellite.

7.1 High School Team

The high school team works on three different and stand-alone educational modules: The computer science module, mentor classes and masterclasses. Each module has its own unique features. Some are more plug-and-play and some challenge the students to develop their own space missions.

The team has been developing a special educational module for the computer science track that focusses on interactive coding and mission design. This is an in-class book based teaching method where the students will start with a general introduction about space and then can choose to work on orbit determination or error correction. Both of these work with data from the Da Vinci Satellite and this module focuses specifically on the use of the bit-flip payload. High school students can upload their picture via the Da Vinci Satellite online platform on to the satellite. These pictures are then subject to the space environment and bit-flips will occur. These bit-flips will yield visual errors and thus the effect of the space environment can directly be seen on the picture the students uploaded. In this module, students have the opportunity to learn how to write a code to find and correct the bit-flips incurred to restore their picture back to normal – this is exactly what is done with, for example, scientific data obtained by large space missions!

7.2 Primary School Team

For children in primary school, the team has developed an eight week lesson package that uses conventional teaching methods for children to train to become an astronaut. After finalising the lesson package the children are ready to launch in the Space-bus. Spacebuzz is an initiative that was started by Dutch astronaut André Kuipers to give children the chance to experience the 'overview effect'. Through a VR-based education and outreach program children are able to see what the earth would look like from space.[5]

Next to the collaboration with Spacebuzz, the team has also developed another way for children to either

independently or in a classroom learn more about space. Through 'Space Around You', space will be brought closer to Earth in a figurative way. This educational module has been co-developed with kids, where everything is made to be a see-able sight or a tangible thing. Through this inquiry based way of teaching, the children will not only learn within the classroom, but also go explore the outdoors. Both the Bitflip Payload and the Dice Payload are used in this educational module such that the children can interact with something that is in space.

These interactive lessons will be completed with a special certificate from the 'Da Vinci Academy'. The first sequence of these lessons has been given in collaboration with the International School in Delft. Here during one of the lessons, the children were able to express the completer lifecycle of stars through a special theatrical play with movements and sounds. The children synthesized information from pas classroom lessons and converted this into a play in their own unique way. Through being creative, all the children are encouraged to learn in a fun and playful way about space.

'Da Vinci Academy' also has a way for children all around the world to independently learn more about space and the Da Vinci Satellite. Currently, a website is being developed where lessons will be made available about space, the history of the Da Vinci Satellite, what satellites look like, and a live location of the Da Vinci Satellite. Next to this, children will be able to 'go on an adventure in space' though the website. By making a personal profile children will be shown a solar system that has been deprived of its colours. By going through the different lesson storylines and by going to the multiple interactive pages the different sections of the solar system will regain their colour.

9. Conclusions

In conclusion, the Da Vinci Satellite project combines the development of educational modules for primary school and high school students with the creation of a cube satellite. The project began with a vision to demystify the complexities of space, and it has since evolved into a multifaceted initiative with potentially in the future a global impact.

The project's roots in the Netherlands, at the Delft University of Technology, where in collaboration with local schools and educators the educational modules are being developed. By actively engaging with primary and high schools in the region, the Da Vinci Satellite team has tailored educational modules to suit the needs of young learners, making space education an integral and fun part of their academic journey.

The satellite itself, a 2U CubeSat houses two specially designed payloads, the Dice Payload and the Bitflip Payload. The Dice Payload offers primary school students the opportunity to play games in space, while the Bitflip Payload presents high school students with a unique insight into the challenges of radiation in orbit.

The educational part of the team is currently developing an online platform that will bring space education to children worldwide. These modules will be freely accessible and available in multiple languages. The project's commitment to inclusivity and accessibility is evident in its efforts to engage with diverse learners, including those with colorblindness.

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