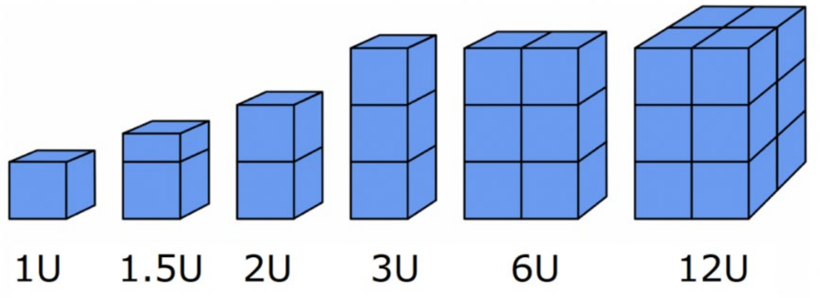
EIRSAT-1

Primary Classroom Resource Booklet

EIRSAT-1 Background

About CubeSats:

CubeSats are tiny satellites, based on a cube that is 10 cm by 10 cm by 10 cm, and this size is called a 1U form. CubeSats are less expensive to make than conventional large satellites and can be launched from rockets or from the International Space Station.



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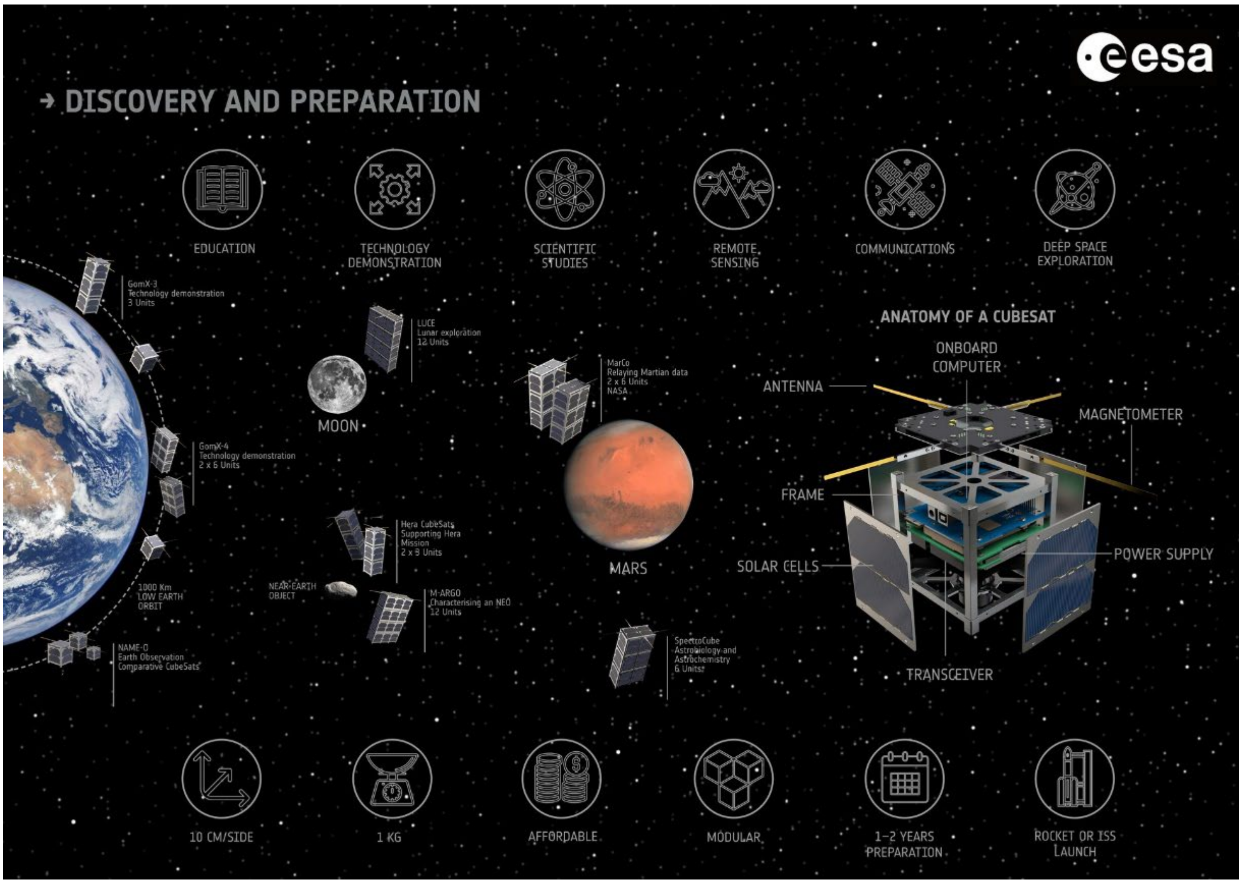


About EIRSAT-1: This is an Irish CubeSat, developed by a team of students at University College Dublin as part of ESA's "Fly Your Satellite!" Over the last few years more than 50 people have worked on the mission! It is now complete and is waiting for a launch date. It has three science experiments on board, each of which is described below.

About **GMOD**: The **G**amma ray **Mod**ule will detect gamma rays from both cosmic and atmospheric phenomena (linked to lightning strikes). Gamma rays are a high energy type of light, and they have been detected from energetic events all over the Universe. Bursts of gamma rays can come from the mergers of neutron stars or from the formation of black holes. GMOD has been developed in the UCD School of Physics.

About **EMOD**: The **E**NBIO **Mod**ule was developed with Irish company, ENBIO Ltd., to see how two protective coatings SolarWhite and SolarBlack perform in space. These coatings have been used on spacecraft already, but this is the first time they will be tested in Low Earth Orbit*.

About **WBC**: **W**ave **B**ased **C**ontrol is a new way of tracking the position of the spacecraft by using the Earth's magnetic field. It has been developed in the UCD School of Mechanical and Materials Engineering.

All parts of EIRSAT-1 have been carefully assembled in a clean room, tested and certified as ready for launch.

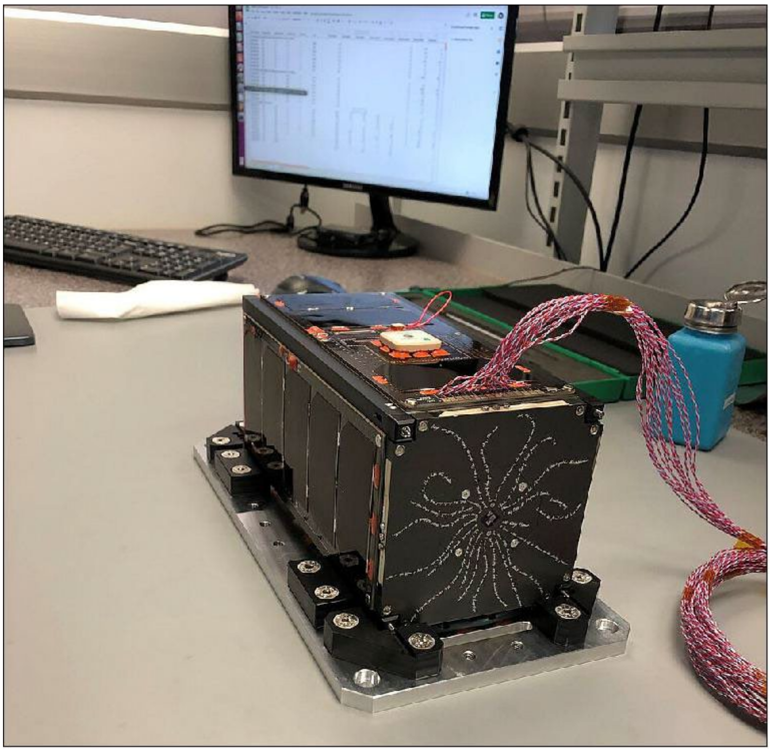
Read more about EIRSAT-1 in this comic book and this Space Week resource.

Find out more about EIRSAT-1 at https://www.eirsat1.ie/.

Watch this video for information about the people who have made EIRSAT-1: STEM careers in SPACE: EIRSAT-1

And see this article about some of the students: https://www.eirsat1.ie/about

*Low Earth Orbit? Review Satellites with this Space Week Resource.



EIRSAT-1 satellite assembled (image credit: EIRSAT-1)

SFI Curious Minds/ESERO Framework for Inquiry

Theme	EIRSAT-1
Curriculum	**Strand>Strand Unit>Curriculum Objectives:** Materials>Materials and change> --investigate the effects of light, air and water on materials Materials>Properties and characteristics of materials> --describe and compare materials, noting the differences in colour, shape and texture Energy & Forces>Heat> -- measure changes in temperature using a thermometer --experiment with a range of materials to establish that heat may be transferred in different ways -- measure and compare temperatures in different places in the classroom, school and environment and explore reasons for variations Energy & Forces>Magnetism and electricity> --examine and classify objects and materials as magnetic and non-magnetic -- explore the relationship between magnets and compasses **Skills Development:** Working Scientifically: Questioning; Investigating & Experimenting; Analysing. Designing and Making: Exploring; Planning; Making; Evaluating.

Engage

The Trigger	Wondering	Exploring	Considerations for inclusion
Could you design and make a satellite? Watch this video about CubeSats and EIRSAT-1.	What will your satellite do? Watch this TED video from Planet Labs about small satellites that view the Earth. Do you have an answer to the question he asks: "If you had access to imagery of the whole planet every single day, what would you do with that data? What problems would you solve? What exploration would you do?"? What will EIRSAT-1 do? Read about GMOD, EMOD and WAC.	How big is a CubeSat? Can you make a scale model, or even a full size one? What systems or parts does a CubeSat need? Explore the parts with this game from NASA.	

Investigate: GMOD

Starter Question	Predicting	Conducting the Investigation	Sharing: Interpreting the data / results
How likely are we to spot a Gamma Ray Burst? Model GRBs with a 'dice-GRB.' How likely are we to see a 'die-burst?' Extension: what would happen if we used a different sided die? This is equivalent to the GRBs having a different "beam-width."	The bursts can be thought of as coming from opposite sides of the die, say 1 and 6. Roll a large number of dice - how many 1s and 6s would you expect to see? Children might predict that this depends on where you view the dice from and is not just 2/6 of the total number of dice.	Children could work in small groups to roll the dice and each child could tally how many 1s or 6s they view from their position. Children should be evenly space around the dice, viewing along the table as well as from above. If you do not have a lot of dice, use a computer die roller and tally the number of 1s only. This is like viewing the dice from above only.	Each group should share their results with the class – if groups have carried out their modelling differently, they can explain what they changed and how it has affected their results. How well does this model show the distribution of GRBs? One limitation is that the dice always end up sitting flat on the table!

Investigate: EMOD (heating)

Starter Question	Predicting	Conducting the Investigation	Sharing: Interpreting the data / results
How does the colour of a container (SolarBlack or SolarWhite) affect the temperature of what is inside?	Children should refer to their knowledge of heating and colour to predict how different coloured containers will behave when heated and/or allowed to cool. (N.B. generally something that is good at absorbing heat is also good at giving out heat, so the darker container should heat up faster and cool down faster).	Try the two different colours as covers for thermometers or containers of water and place them in sunlight. How does the temperature of the thermometer/water vary? Fill the containers with the same temperature hot water, which cools down faster? Children should think how to make this test fair, and if they can compare their results with others in the class.	Each group should share their results with the class and can show their results as a line graph over time. If there are any unexpected results, can the children suggest reasons for them? (One container might have been in a draft…)

SFI Curious Minds/ESERO Framework for Inquiry

Investigate: EMOD (change over time)			
Starter Question	Predicting	Conducting the Investigation	Sharing: Interpreting the data / results
How will SolarBlack and SolarWhite change over time? (This is a very open-ended inquiry, with no set answer. Children should be encouraged to find places in their classroom that are different in terms of lighting, temperature etc)	Children should identify a property of their coloured cards that they want to investigate and predict how it will change. For example: they might think the card will curl up if it gets warm, so might think the black card will curl more because it absorbs heat better. They might look at colour stability and think the black card will fade faster in sunlight or think that the white card will get dirtier faster.	Place sections of black and white coloured card in different locations around the classroom. Children might place cards in places that are sunny, hot, cold, or on the floor, on the ceiling, under a table, where people walk etc. Inspect them every few days and record any changes with photographs and / or descriptions. Keep one set of the cards in a controlled place to act as a comparison. Children should be able to explain how they have made their comparisons "fair."	This is a long duration activity, so children should be encouraged to record their results with images which can be displayed on a poster or electronically.

Design and Make: WAC – magnetic sensor			
Explore	Plan	Make	Evaluate
Make a magnetic sensor with a micro:bit.	Review the makecode blocks to plan how you will make a magnetic sensor.	Create your code using the makecode editor.	Does your code work as you intended? Review and change as needed. Can you detect different strength magnets with your micro:bit?

Take The Next Step

Applying Learning	Making Connections	Thoughtful Actions

GRBs can be produced in the same events that form gravitational waves. Explore this resource from Space Week Ireland about Gravitational Waves.
Children can create nets for different U CubeSat forms, or model the forms with blocks. How many ways can a 4U CubeSat be formed?
Explore Satellites with this Space Week resource.
Compare GRBs to lighthouses, using Curious Minds Make a Lighthouse.
Older children can find out more about Gamma Ray Bursts with this resource from the US.
Older children can explore the Engineering of CubeSats with this resource from the US.

Reflection	Did I meet my learning objectives? What went well, what would I change? Are the children moving on with their science skills? What questions worked very well? What questions didn't work well? Ask the children would they change anything or do anything differently. Are there cross curriculum opportunities here? What further questions did students have?

Gamma Ray Module

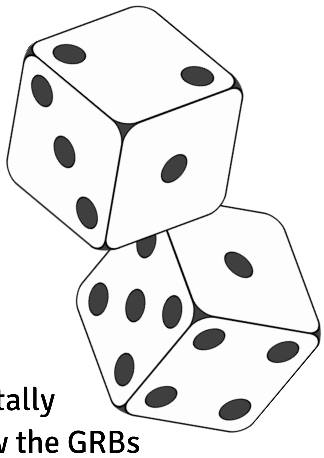
GMOD is the **G**amma ray **Mod**ule, developed in the UCD School of Physics, and it will detect gamma rays from both cosmic and atmospheric phenomena (linked to lightning strikes). Gamma rays are a high energy type of light, and gamma ray bursts (GRBs) were discovered in the late 1960s as short (from milliseconds to a few minutes) bursts of gamma rays. They are generally divided into two types: short bursts are less than 2 seconds and long bursts are longer than 2 seconds. Both types of bursts have been detected all across the sky. Long bursts are thought to be caused by the collapse of stars and are the most common type of GRB detected. Short bursts are thought to be created in a 'kilonova,' when neutron stars merge. GRBs release enormous amounts of energy, and it is thought that the bursts must be in narrow beams, like the beams of a lighthouse. Satellites orbiting the Earth usually detect 1 GRB a day, but only those that are "pointed towards us" can be detected. Satellites are needed since gamma rays are absorbed by the Earth's atmosphere.

View this 2min video about a recent GRB discovery https://youtu.be/FQLZPm34Chg and read this student article from Space Scoop.

The European Space Agency has several satellites that can detect gamma rays (including Integral, which has operated for more than 20 years!) and explains why in this article.

Modelling Gamma Ray Bursts:

Start with Make a Lighthouse from Curious Minds. How is your lighthouse like a GRB? Does it have two beams? Use mirrors or light shields to modify your design and then consider how your model is like and unlike a real GRB.



Use a class set of GRB models around the room – how many are pointing towards you?

This can be modelled with a set of dice.

Collect lots of 6-sided dice (the more the merrier!). Select 2 numbers that are on opposite sides of a 6-sided die, to be where the GRBs "come from." This models how GRBs are given out as beams.

Shake all the dice and allow them to fall onto a table. Each child should tally how many of the correct faces are directly facing them – this models how the GRBs can only be detected if they are pointing towards the Earth. For younger children, give just one number and ask them to tally how many of 'their number' they can see on the dice.

How many "die-GRB" were detected as a proportion of the dice? What would you expect if you used a different sided die, that had a 'smaller beam'? Try this with 20-sided die!

Enbio Module

EMOD is the **E**NBIO **Mod**ule, developed by the UCD Schools of Mechanical & Materials Engineering and Physics with ENBIO, who make SolarBlack and SolarWhite, two special coatings that can be (and have been!) used on spacecraft. EMOD is going to see how these two coatings work in low Earth orbit.

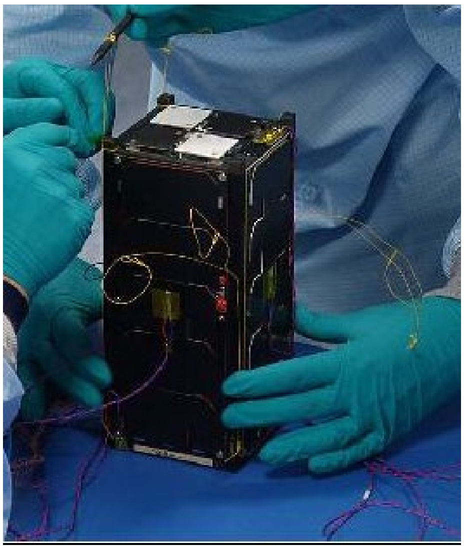
The European Space Agency used SolarBlack on the Solar Orbiter Mission which launched in 2020. See this video about Solar Orbiter.

Engage: If you were sending a spacecraft somewhere hot, would you use a black or white coating? Think about the clothing you wear on a hot sunny day, what colour do you prefer to wear? It can get very hot in sunshine, even in space, so do you think different parts of a spacecraft need a 'coat' that reflects heat and light *or* absorbs heat and then gives that heat back out?

Investigate: How would you expect the temperature of a black container vs a white container to vary when it is heated and then allowed to cool? Does a black container heat up faster than a white container? Which colour container will cool down faster?

Design a fair test to explore how different colour coatings affect what is inside those coats. You could place thermometers under different colour papers and leave them in sunlight, or cover metal cans with black and white paper, fill them with hot water and measure the temperature of the water over time. If the water cools down faster, that tells us that the can is giving off more heat.

Take the Next Step: What might happen to different colour coatings over time? Will they 'show the dirt?' – and will that affect how they behave? Predict what you think will happen, explain why and then test out your ideas.



WBC Module

WBC is the **W**ave **B**ased **C**ontrol Module, which is a software-based attitude control test-bed, developed at University College Dublin. It will test a new way of using the Earth's magnetic field variations to help the spacecraft work out where it is pointing in space and orient itself correctly.

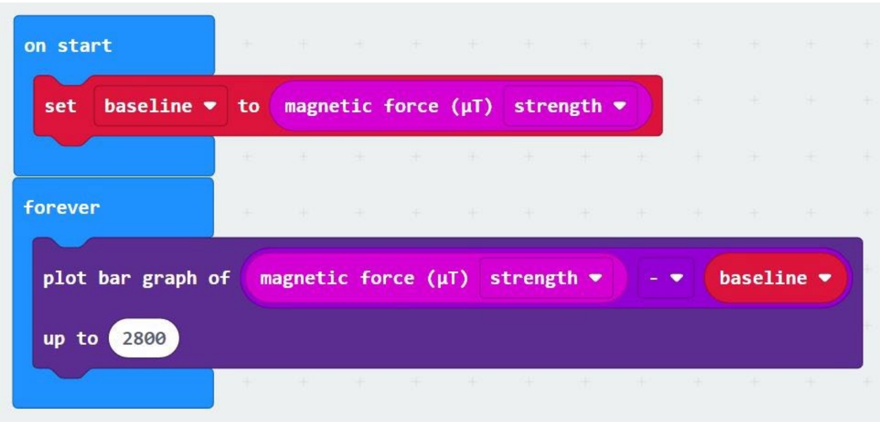
Engage: Explore how a compass behaves. How does it respond to different magnets? What happens if you bring a strong magnet near a compass needle?

Investigate: [Make a compass](#) with a micro:bit, using the [makecode.org](#) site to write the code. This site can simulate a micro:bit if you don't have an actual micro:bit. [This video](#) from makecode can help.

OR Children can write code that will display how the magnetic field changes as the micro:bit is moved around.

Sample code:

1. Create a 'baseline' variable.
2. On start, set the 'baseline' to the 'magnetic force (µT) strength'
3. Plot a bar graph of the value of ('magnetic force (µT) strength' – 'baseline')
4. When you use 'plot bar graph' – you must give an 'up to' value. If you leave 'up to' as 0, the plot bar graph will display the maximum number of LEDs based on the most recent large value. Over time this means that the display will vary depending if the micro:bit was recently near a strong magnet or not.



Take the Next Step: How well does this magnetometer work in detecting magnets or magnetic objects?

What background magnetism does it measure? What values does it detect near a computer? Near a battery? Near a pair of scissors? Change the 'up to' value and see how the magnetometer works.

Use a real magnet: can you find areas near the magnet where the magnetic field strength stays nearly the same as you move the micro:bit around the magnet?

Curious Minds ESERO

Framework for Inquiry - Promoting Inclusion

SPECIAL EDUCATION SUPPORT SERVICE
building on ability

When planning science activities for students with Special Educational Needs (SEN), a number of issues need to be considered. Careful planning for inclusion using the framework for inquiry should aim to engage students in science with real purpose. Potential areas of difficulty are identified below along with suggested strategies. This list is not exhaustive, further strategies are available in the Guidelines for Teachers of Students with General Learning Disabilities (NCCA, 2007).

ENGAGE

POTENTIAL AREA OF DIFFICULTY	STRATEGIES
Delayed language development/poor vocabulary/concepts	• Teach the language of science demonstrating meaning and/or using visual aids (material, property, strong, weak, textured, dimpled, absorbent, force, gravity). • Have the student demonstrate scientific phenomena, for example gravity —using 'give me, show me, make me,' as much as possible. • Assist the student in expressing ideas through scaffolding, verbalising a demonstration, modelling. • Use outdoor play to develop concepts.

INVESTIGATE

POTENTIAL AREA OF DIFFICULTY	STRATEGIES
Fear of failure/poor self-esteem/fear of taking risks	• Model the speculation of a range of answers/ideas. • Repeat and record suggestions from the students and refer back to them.
Understanding Time and Chronology	• Practice recording the passing of time, establish classroom routines that draw the students' attention to the measurement of time. • Teach and practice the language of time.
Fine/Gross Motor Difficulties	• Allow time to practice handling new equipment. • Allow additional time for drawing diagrams, making models etc. • Give students the option to explain work orally or in another format.
Short Term Memory	• Provide the student with visual clues/symbols which can be used to remind him/her of various stages of the investigation.

TAKE THE NEXT STEP

POTENTIAL AREA OF DIFFICULTY	STRATEGIES
Developing Ideas	• Keep ideas as simple as possible, use visuals as a reminder of earlier ideas. • Discuss ideas with the whole group. • Repeat and record suggestions from students and refer back to them. • Encourage work in small group and in pairs.
Communicating Ideas	• Ask students to describe observations verbally or nonverbally using an increasing vocabulary. • Display findings from investigations; sing, do drawings or take pictures. • Use ICT: simple written or word-processed accounts taking photographs, making video recordings of an investigation.

REFLECTION

- Did I take into account the individual learning needs of my students with SEN? What differentiation strategies worked well?
- Did I ensure that the lesson content was clear and that the materials used were appropriate?
- Was I aware of the pace at which students worked and the physical effort required?
- Are there cross curriculum opportunities here?
- Are the students moving on with their skills? Did the students enjoy the activity?

More strategies, resources and support available at **www.ncse.ie**

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