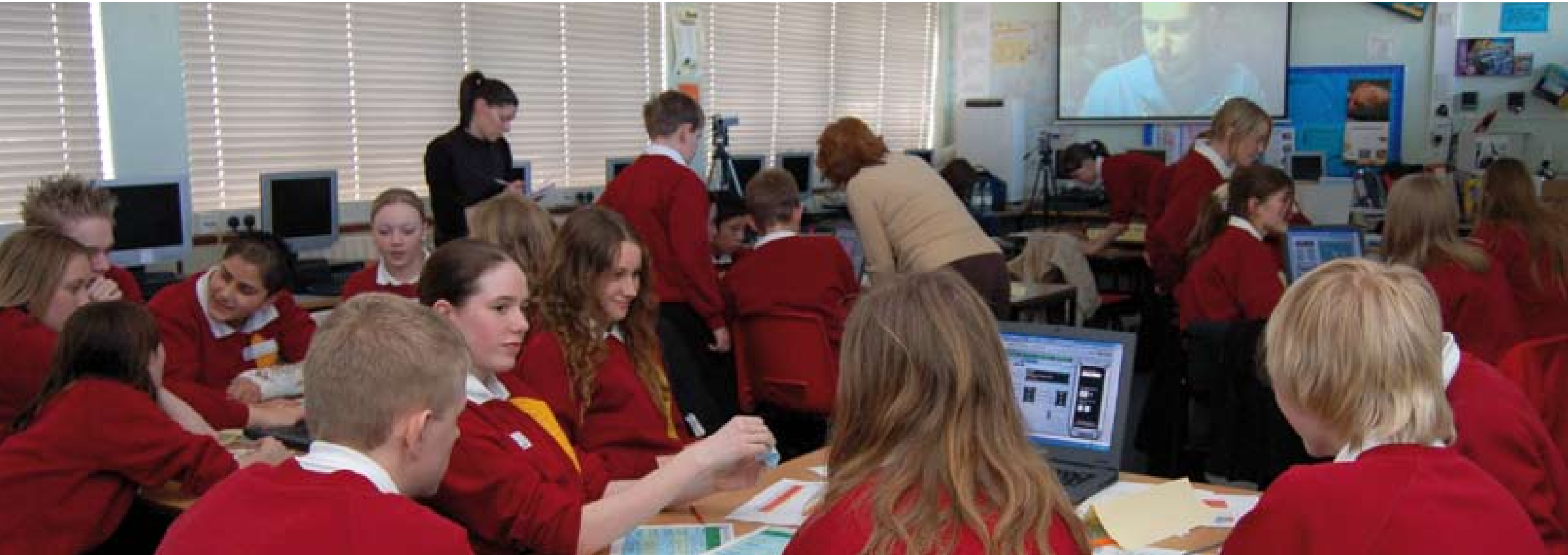
Space Mission: Ice Moon

A unique experience that uses video-conferencing and interactive materials to transform the classroom into an Emergency Response Centre on Earth, encouraging 12-14 year-old students to use their skills as scientists, mathematicians, planetary geographers and communicators to overcome a disaster in space



Your Mission: Four astronauts are trapped beneath the ice on Europa, one of the moons orbiting Jupiter. Oxygen is running out and ice caves are collapsing around them. Can you save them?

Mission Commander

Contents

Overview

Europa, one of Jupiter's moons, is completely encrusted by ice that is up to 100km thick. Experts believe that this dark, frozen moon may be one of the only other places in the solar system where life is possible. Four scientists are on a mission to find out whether microscopic life-forms may be thriving in a liquid ocean beneath the ice, when serious problems force them to reconsider their plans. Oxygen runs low, radiation soars, and ice caves collapse around them...

As members of the Emergency Response Team charged with devising, managing and implementing the rescue plan for the astronauts, groups of up to 30 pupils, aged 12-14, are arranged in teams, each with different areas of expertise. They will have to deal with medical problems, navigational challenges, ice vibration readings, satellite data, and communication problems. Space Mission: Ice Moon offers students an interactive 90-minute experience of 'real time' science, either in a classroom or science centre, which is designed to get them working together to prioritise, solve problems, and make decisions based on sound scientific analysis.

"For 90 minutes the pupils become experts, with the responsibility for saving lives"

Context

Enabling students to work as scientists

"There's lots of movement in the room, but the children are 100% on task - it's very exciting"

Developed by the National Space Centre in Leicester and Futurelab, each mission is led by a Mission Commander (from the Space Centre) who communicates with the students via a live video link. In the role of the only astronaut left at the space station on Europa, he guides them through the formulation of a rescue plan, releasing data to them intermittently.

The students work in teams - Medical, Life Support Suits, Ice, Navigation, Satellite and Communications - with each team needing to prioritise the most important data to download to take their plan forward, as the satellite bandwidth is limited. There is also another optional 'team' which is usually just one student, known as the Data Officer, to coordinate this task. As the information streams onto their screens, the students chart it on graphs in order to generate patterns and make predictions - calculating oxygen consumption and radiation levels, monitoring health profiles, and checking for ice vibrations and cave collapses in order to map safe escape routes. They then communicate their findings to each other and back to Mission Control via video-conference, web chat, and visual presentation tools.

Calling for scientific, geographic, mathematical and communication skills, the mission sets a range of activities which can be varied in difficulty by the Mission Commander, according to the reactions of each individual group. Space Mission: Ice Moon aims to encourage interest in science, and support the learning of scientific processes, via a rich multimedia experience. "The authenticity of the experience is crucial if we are to get the children working as scientists, interpreting raw data and responding with a solution," says the learning researcher responsible for the project from Futurelab, Lyndsay Grant.

Elements of the game

Element 1 - Mission control

Space Mission: Ice Moon brings mission control into the classroom via video-conferencing technology. Wherever the missions are held, mission control is present. Crucial to the project is the presence of the Mission Commander, who runs mission control and controls each simulation from the National Space Centre in Leicester, and his interactive presence plays a major role in making the mission believable. While a computer program manages the data sent to each team's computer, the Mission Commander controls the circumstances, adjusting them to provide further challenges such as an ice cave collapse or a malfunctioning oxygen valve. Each change is then reflected in all subsequent data.

The Mission Commander has a bank of video clips at his disposal, showing the different scenarios, and can make the situation more or less severe depending on the level of challenge the students can cope with. There is also a computer-generated character, AIMEE, who represents the space station computer and, unbeknown to the students, the Mission Commander controls her responses too.

Element 2 - Teamwork

The teams plot the data to ascertain the gravity of the situation, and then need to communicate with each other and mission control to devise a solution to get all four astronauts to safety:

- The **Satellite** team acts as a hub, requesting, downloading and distributing the data needed to help the teams rescue the astronauts. This task is further complicated by the fact that the bandwidth is limited and so they can only download a limited amount of data every three minutes, forcing teams to prioritise the data requested.
- **Communications** work with Satellite to ensure the teams have the information they need and keep the Mission Commander updated, whilst the **Data Officer** (optional) is responsible for ensuring each team updates their processed data.
- The **Medical** and **Life Support Suit** teams monitor each astronaut's data, tracking variables such as oxygen supply and radiation onto a colour-coded graph, where red represents the danger zone.

"The Mission Commander stresses the importance of doing everything to save the astronauts – we want to promote an underlying sense of responsibility and altruism"

"It all happens in real time, which is what forces the pupils to prioritise"

- Meanwhile, the **Ice** team processes ice tremor data, looking for collapses in the escape route. They are given the time and direction of each tremor from sensors on the surface of the ice, and from that must calculate their position.
- Finally, the **Navigation** team plans the astronauts' route back to the space station. This is of course affected by their state of health, remaining oxygen supply and obstacles such as caved-in ice tunnels, so they work on an interactive map and receive updates from the Medical and Life Support Suit teams.

Element 3 - Multimedia technology

At the outset of the project, in-depth research with glaciologists and space scientists was required to plot the various scenarios and ensure that the data logged for all eventualities was correct. To manage all of this, together with the 'real time' element of the game, required a complex multimedia program.

"Once we had the data and the software, we needed to make sure that each of the student's computers could talk to each other," explains Hans Daanen, the project's R&D Technology Manager from Futurelab. "So the data is streamed in off a web server using Flash communication, and connected across the PCs to piece the whole picture together."

A user-friendly interface for the students to receive and respond to that data was also vital, with programs written to control the interfaces for each team. Meanwhile, control software was developed, to allow the Mission Commander to manipulate the variable events, and release the data accordingly. "Everything is relative and constantly changing, and all the programming was designed to reflect this," says Daanen.

The Mission Commander himself appears via a video-link, and it's through this medium that he sends the chosen video clips of the astronauts, as well as any messages from AIMEE, the computer-generated character.

Element 4 - Training

With mission control and the programming ready to go, training for both teachers and students is the last port of call before Space Mission: Ice Moon can be launched.

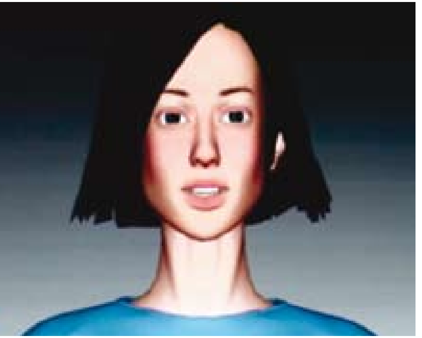
Student training is organised around a two- to three-hour session which can involve:

- research on Europa, using the internet and other sources
- explanation of the role of the Emergency Response Team
- background information on life in space.

They also get an opportunity to practice the skills required to take part so that they are fully prepared to act as experts from the Emergency Response Team when the mission is launched.

"We want to make science meaningful, and for students to engage with it so they can become both critical consumers and producers of science as adults"

Learning objectives



"Science is not just for boffins"

Space Mission: Ice Moon is designed to support the learning of science and scientific processes through a complex multimedia role-playing exercise - in line with the aims and visions of the Twenty First Century Science curriculum, which seeks to foster scientific thinking and to nurture scientific literacy. The learning objectives were to encourage students to:

- interpret and analyse evidence
- solve problems
- work collaboratively
- communicate in a range of ways (multimodal) such as through writing, images, tables, statistics and graphs.

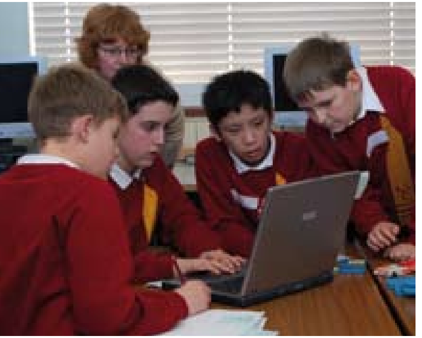
"It's not linked to a particular module within the curriculum," explains Grant, "but focused discussions after the exercise will allow reflection on learning and skills, such as research, problem-solving, analysis and prioritisation." Science lends itself to multimodal learning, she argues, being frequently presented through a combination of text, photographic and video evidence, charts, statistics, graphs and more. So, to become scientifically literate, students would need to learn to juggle all these aspects and translate them into a single cohesive meaning. "We want children to be able to participate actively and form educated opinions on scientific matters, even if they do not become scientists," she says.

Space Mission: Ice Moon is therefore designed to help children learn how scientific facts are discovered and proven from the bottom up, to stimulate thought and analysis, and develop the ability to solve problems logically. It also aims to challenge the misconception that science is remote and unreachable for the majority.

"The simulation should provoke the question, 'how do you know that?', encouraging students to critique the evidence on which explanations are based," says Grant. She continues: "It should be exciting too – we are especially interested in the concept of learning as fun. By role-playing as expert scientists, students actively create their own knowledge rather than passively acquiring received wisdom. Finally, it should support the skills of enquiry being followed in science teaching in the classroom, relating back to elements of the curriculum."

Overall, Space Mission: Ice Moon reflects a holistic approach, aimed at developing young peoples' communication and teamwork skills at the same time as their mathematical and scientific skills and understanding; playing a part in their preparation for the challenges of adult life.

Trials



The prototype version of Space Mission: Ice Moon used in the four trials held in 2005-6 had most of the functionality necessary for a final product. Each trial took place on a single day and consisted of:

- observations taken during the training session and the mission itself
- student questionnaires, before and after the mission
- focus group interviews with students after the mission
- interviews with teachers, before and after the mission.

Researchers were interested in the role of science in school and society

Four schools were involved in the trials. Two of the trials were run on school premises and two at the Frankley City Learning Centre, which has the equipment and expertise for e-missions. One of the schools described itself as 'in challenging circumstances' but had recently been awarded specialist science school status, while the other three described themselves as average for the area.

The students in each trial formed groups of a minimum of 24, drawn from Years 8 and 9 (12-14 year-olds) across a variety of mixed sex science classes. The sampling represented a reasonable social mix.

Researchers were present throughout the day observing students' behaviour to build a picture of the skills and processes demonstrated during the mission. They also interviewed a focus group comprising one member from each team to reflect each function of the exercise. The aim was to discover what the students thought they had learned, what challenges they had faced, and what their overall impression of the experience was. Teacher interviews also took place, to see what teachers thought the students had gained, and what were the critical factors for success. The key questions were:

- Does the project support pupils' interest in science?
- How effectively does it support science enquiry and communication skills?
- How effective is the use of multimedia, broadband-enabled technology to support these activities?

Teachers then carried out a second questionnaire among students, which aimed to find out their views on the overall role of science both in school and in society.

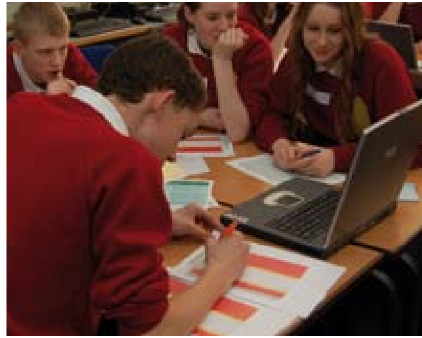
Findings

One boy, getting into the role of a scientist, carried a scientific calculator with him, although it wasn't necessary, explaining "it's a scientific one"

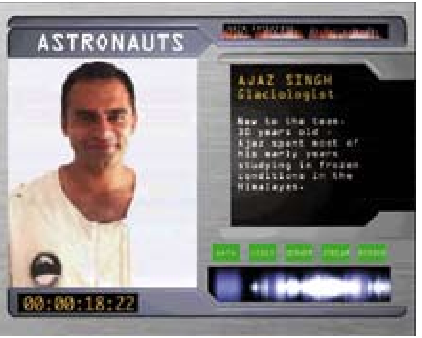
The findings from the research and trials informed further work to improve the prototype and prepare it for general release to schools and science centres. They can best be broken down into answers to core research aims:

- **Authenticity:** Vital to the sense of excitement, most students entered their roles imaginatively, behaving 'as scientists'. Discussions afterwards showed a real sense of achievement, with students imagining they really had saved the astronauts and feeling personally involved – they certainly didn't realise that the positive outcome was fixed. Also the 'live' role of the Mission Commander was deemed central to the experience.
- **Development of scientific literacy:** Students had some difficulty translating data into the various graphs and tables, but across the teams, most developed their own methods and short-hands. The visual representations of the data were helpful for charting progress. Interestingly, many adopted 'scientific language', using phrases like "that would be anomalous". In future, data may be plotted automatically to allow more strategic thinking time.
- **Problem-solving and science as a process of enquiry:** There were many instances of students asking questions and stating goals, identifying tasks to be solved and gaps in knowledge to be addressed. There was also evidence of strategy development and problem-solving as collaborative activities.
- **Generating positive attitudes to science:** Students reported that they found Space Mission: Ice Moon more like they imagined "real science" to be. They felt they had learnt a lot in terms of content – whilst not really identifying specific scientific skills. Therefore it was determined that these and the other, more generic skills being developed by the students could be stressed more specifically in future.
- **Nurturing collaboration and teamwork:** The teams in which students had defined their own roles settled most easily into the routine of processing and analysing the data, so it was determined that work on role definition would feature strongly in future training sessions.
- **Handling, processing and interpreting data:** The results were encouraging, but future training sessions may provide further support in this area:
  - Handling: most teams found some difficulty in getting to grips with the range of data and how to plot it, preventing clear patterns from emerging.
  - Processing: most students saw the importance of processing data swiftly and supported each other in this task.
  - Interpreting: the students' explanations of what was happening was, for the most part, clearly based on an interpretation of the data and evidence they were receiving, which led to the development of a defined course of action.
- **The potential of a broadband-enabled classroom:** The video-conferencing greatly enhanced the authentic role-play experience, with students being highly motivated by the instant feedback.

Most teachers felt that the main strength of Space Mission: Ice Moon was the opportunity for encouraging problem-solving, reasoning and communication skills. There is also no doubt that the students enjoyed the experience, were motivated to save the astronauts, and the levels of cooperation were highly encouraging. Students were comfortable in a multimodal environment, and on the whole, handled and analysed the information well.



Looking to the future



"We hope that one day all science centres and well-equipped schools will be able to run their own Space Missions, with new scenarios evolving and new Mission Commanders being trained"

Space Mission: Ice Moon works very well in environments equipped for e-learning, and there is an added advantage to treating the programme as a memorable field trip, such as to a science centre. Furthermore, it has demonstrated the potential of broadband and video-conferencing technologies to enhance the learning experience, and to help students to develop a wide range of skills.

But where next for Space Mission: Ice Moon? "The quality of the software is excellent, and we have several Mission Commanders here at the Space Centre. Once the teacher training element has been finalised, we can sell it on to schools and science centres," explains Tim Boundy from the National Space Centre who leads the missions, acting as Mission Commander. So, further pre-mission training will be developed, with more information about Europa and the data students are required to analyse. "A scaled-down version of the actual software will be used for the training," says Boundy, "and an interactive website for this is currently underway."

Different endings to the experience are another possibility, to create a more explicit link between students' actions and the consequences for the astronauts – though a wholly negative outcome has currently been rejected as too demoralising.

Finally, there are opportunities to extend students' learning after the mission has been completed. As the experience is a half-day of training followed by an extremely intensive 90 minutes on the mission, much of the learning is likely to happen during reflection on events after the mission. Specific tasks and discussions leading up to and after the mission aimed at capitalising on the themes encountered would be very useful, so full support materials to aid this process are being developed.

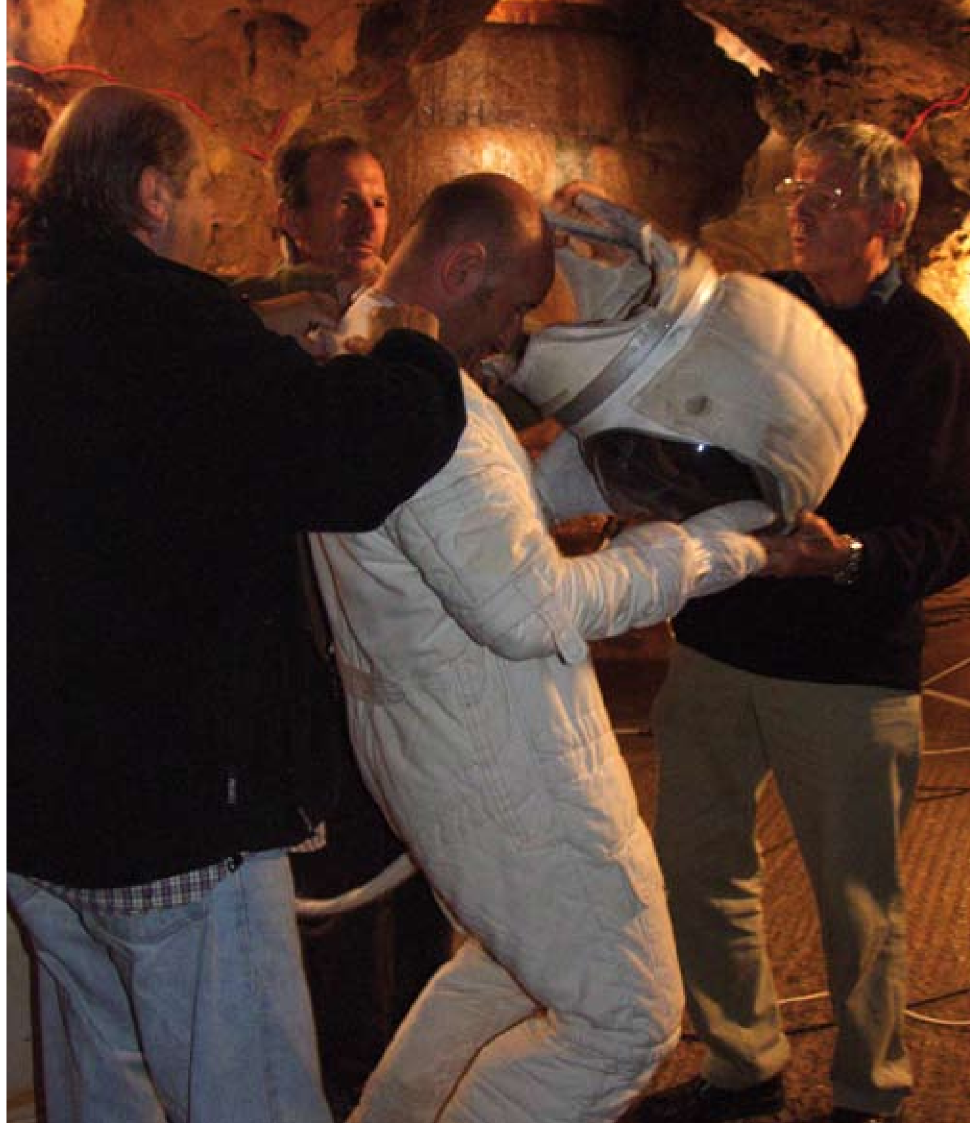
Space Mission
Ice Moon team

The idea for this project came from the National Space Centre in Leicester and was based on an existing activity called Operation Montserrat. Futurelab worked closely with partners at the National Space Centre to develop the scenarios, activities, user experience and user interface for Space Mission: Ice Moon.

Futurelab would especially like to thank:

- Tim Boundy, Education Officer and Project Coordinator from the National Space Centre
- Students and teachers from Four Dwellings High School, Bartley Green Technology College, Colmers School and Sports College and Nicholas Chamberlain Technology College

Thank you also to all the teachers and children who helped to refine our early ideas, the production team who made the outstanding multimedia resources and to everyone else involved in developing Space Mission: Ice Moon.



Futurelab is passionate about transforming the way people learn. Tapping into the huge potential offered by digital and other technologies, we are developing innovative learning resources and practices that support new approaches to education for the 21st century.

Working in partnership with industry, policy and practice, Futurelab:

- incubates new ideas, taking them from the lab to the classroom
- offers hard evidence and practical advice to support the design and use of innovative learning tools
- communicates the latest thinking and practice in educational ICT
- provides the space for experimentation and the exchange of ideas between the creative, technology and education sectors.

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