Activity 6

Exploration of Europa

By **Éric Lavigne**

Activity developed
at Collège André-Grasset

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The appendices in PDF format are contained on the CD-ROM accompanying this guide.

They are also available in Word format in the "Trésors pédagogiques" (Teaching treasures) section of the Saut quantique Web site (http://www.apsq.org/sautquantique). Instructional analyses of these activities are also available on this site.

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Activity 6

Exploration of Europa

Introduction

In teams of three to five, the students develop a project to explore the solar system. Each team oversees a particular aspect of the project and must communicate with the other teams in order to provide and obtain the information needed for the mission.

The students are divided into nine teams, each responsible for a particular aspect of the mission:

- management
- launch
- trajectory
- energy
- characteristics of the celestial body and landing
- communication with the Earth
- imagery
- science I[1]
- science II

The students must find a solution to their aspect of the problem. They must be creative and use the knowledge acquired in their science courses.

This project is designed for a group of approximately 36 students in the second year of the DEC^{Plus} Natural Science program[2] offered at Collège André-Grasset.

[1]Given the numerous science topics that can be covered in an exploration mission, there can be more than one science team.

[2]This program is intended for students wishing to do more in-depth studies than what the Natural Science program ordinarily offers. They attend conferences, carry out a mini research project and take additional modular courses. Other activities are also added to the program.

The project is part of the astrophysics module. It requires two hours of class time per week over a period of 15 weeks.

The activity objectives, as they appear in the course outline of the astrophysics module, are as follows:

- *To better understand the nature of science.*
- *To develop a more in-depth knowledge of celestial phenomena and objects.*
- *To use discoveries in physics to explain celestial phenomena.*
- *To solve problems involving celestial bodies and phenomena.*
- *To use their knowledge of mathematics, chemistry, physics and biology to solve complex problems.*
- *To work effectively in a team.*
- *To solve original problems with no direct solution.*
- *To develop creative problem-solving solutions.*
- *To develop metacognitive skills.*

This activity makes students responsible for their own learning. It also provides an overall objective to be achieved: to explore Europa, a satellite of Jupiter. In addition, since the students are each responsible for different aspects of the project, they must report to their teammates and to other teams, who cannot make progress without them.

The Energy team, for example, cannot know the required quantity or flow of energy without the necessary information from the other teams and instruments that they plan to use. This energy must be transported or harnessed, which implies an enormous weight difference, which, in turn, will affect the Launch team's work.

The project is characterized mainly by the synergy that develops among teams, which is an additional motivating factor for students.

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We believe that the results obtained, the extremely positive comments from students and the clear attainment of objectives that are often difficult to achieve in a regular course, such as the development of original solutions to complex problems or the development of teamwork skills, ensure the relevance of this activity.

Relationship between the activity and the program

Links to the general aims of the program

The activity facilitates the achievement of the following general aims of the Natural Science program (200.B0):[3]

- ***To solve problems systematically.***

  The students must find clear solutions to complex problems.

- ***To use appropriate information processing technologies.***

  The preliminary and final reports must be written using word-processing software. Several teams used software to make their presentations more dynamic. They also used e-mail to share information and schedule meetings. Finally, they found a lot of information on various Web sites.

- ***To reason scientifically.***

  Given the scope of the problem, scientific rigour is a necessity.

- ***To communicate clearly and precisely.***

  The teams must submit written reports and give presentations to their peers.

- ***To learn autonomously.***

  Students learn autonomously, within teams and with the help of other teams.

- ***To work in a team.***

  The overall activity requires teamwork. Teams must also share information with each other.

- ***To establish links between science, technology and a changing society.***

  This activity enables students to recognize the scientific and technological complexity of an exploration mission.

- ***To identify the emergence and development of scientific concepts.***

  With the help of this activity, the students identify the conditions needed to carry out large-scale scientific projects.

- ***To adopt attitudes conducive to scientific discovery.***

  The students must share their discoveries and proposed solutions with others. They must also criticize the solutions proposed by their peers and be open to similar criticism.

- ***To handle new situations on the basis of acquired knowledge.***

  In order to find solutions, students must use and apply the knowledge acquired in other courses.

This activity facilitates the attainment of the general aims of the DEC^{Plus} program by:

- ***Dealing with all aspects of modern-day scientific activity.***

  This module focuses on a modern-day scientific activity: the exploration of our solar system.

- ***Presenting concepts that cannot be dealt with in the Natural Science program.***

  The students must solve a variety of problems. The proposed solutions often result in

[3] Quebec Department of Education, description of the Natural Science program 200.B0 (1998), (page consulted January 26, 2002) on line at the following URL address: http://www.meq.gouv.qc.ca/ens-sup/ens-coll/Cahiers/program/200b098.htm.

more in-depth studies than those covered by the Natural Science program.

- ***Establishing links with other disciplines and presenting concepts that are the result of an overlap of several scientific disciplines.***

  The astrophysics content, especially the aspects regarding an exploration mission, encompasses knowledge from a variety of scientific disciplines.

- ***Incorporating fundamental concepts dealt with in courses and enrichment activities.***

  Students use their knowledge of physics, mathematics, chemistry and biology to deal with a variety of problems related to an exploration mission.

- ***Improving research skills and autonomy in the laboratory.***

  Students must find and manage the information needed to plan an exploration mission.

- ***Developing written communication skills.***

  Students must submit a written report.

- ***Developing oral communication skills.***

  Students must present their results to the entire class.

Links to other courses

Depending on the aspect of the mission that they are responsible for, the students refer to different concepts seen previously in other courses. One team, for example, is responsible for penetrating Europa's icy surface. It must therefore calculate the amount of energy needed to penetrate the ice and the current to be sent through a heating resistor, and estimate the rate of progress in terms **of the quantity of ice melted per hour.**

Elements of entry/exit profile

The module is offered in the third semester, by which time the students have acquired a basic knowledge of various scientific disciplines.

At the end of the module, the students will have learned a lot about a specific field. They will also have learned to use their knowledge creatively and to work effectively within a group.

Educational support

Teacher's role

The teacher serves as a guide and facilitator and, through the Management team, an organizer.

The teacher also provides teams with important feedback. Once the students have submitted their preliminary reports, for example, he or she suggests elements that must be included in the final report. This ensures that the students study the problems in sufficient depth to the students' learning.

Organization of the activity

The teacher meets with the Management team occasionally to share information, to ensure that deadlines are being met and to motivate the group. Meetings between teams are organized by the Management team as needed.

Presentation of the activity

Required preparation time

Preparation time is difficult to evaluate. If the teacher wants to have enough time to answer students' questions and properly evaluate their work, he or she must have a clear understanding of the different areas related to this activity, such as orbital paths, the characteristics of planets and satellites in the solar system, image sensing, etc.

It is, however, possible to carry out the activity with a minimum of knowledge, and to allow some time to fill in the missing information according to the students' needs and the proposed solutions. Since it is difficult to accurately predict the theoretical content of such an activity, the teacher needs to be flexible.

Procedure

The schedule of activities, as contained in the course outline, is provided on the following page.

Required material

The students must have a place where they can meet and have access to computers in order to look for and share information, and work together.

Suggested evaluation

This module is credited as a complementary course. The activity, which represents the entire module, is therefore worth 100 marks.

Since it is a complementary module for students in the DEC^{Plus} program, the final mark on the transcript will be 90 if the student obtains a mark between 80 and 90. This measure is taken in order not to penalize students registering for university programs with limited enrolment.

Evaluated assignments

General and specific objectives, and decision matrix (20%)

Each aspect of the mission must satisfy certain objectives. These objectives must be defined globally for the overall mission, and specifically for each aspect of the mission. This is the case for each team.

Preliminary report and presentation (30%)

The preliminary report and presentation enable teams to provide initial results, and take stock of their progress and that of other teams. They also give the teacher the opportunity to provide important feedback before students produce their final reports.

Final report and presentation (50%)

The final report and presentation describe what was accomplished during the activity. They also allow students to realize what they and their peers have accomplished. Students are left with a tremendous feeling of pride at the end of the activity.

Schedule of activities

Week	Content
1	Presentation of module Choice of project Formation of teams
2	First definition of overall objectives of the project and specific objectives of each aspect of the project Preliminary search for information
3	Definition of overall objectives of the project and specific objectives of each aspect of the project Production of the decision matrix Preliminary search for information
4	Brainstorming
5	Handing in of general and specific objectives Handing in of decision matrix Evaluation and development of solutions
6	Evaluation and development of solutions
7	Evaluation and development of solutions
8	Handing in of preliminary report (everyone) and presentation of preliminary results (management, launch, trajectory, energy) Group discussion
9	Presentation of preliminary results (characteristics of the celestial body and landing, communication with the Earth, imagery, science I, science II) Group discussion Review of techniques used
10	Teamwork
11	Teamwork
12	Teamwork
13	Handing in of report (everyone) and final presentation (management, launch, trajectory)
14	Final presentation (energy, characteristics of the celestial body and landing, communication with the Earth)
15	Final presentation (imagery, science I, science II)