The Mars Society's Artic and Desert Research Stations as a Science Education Opportunity…An Educator's guide

Introduction to the MDRS and FMARS

Human beings possess the capability to travel to Mars. This trip will be very expensive, in terms of money, resources, and time. It is therefore very important to think about why we would go; Is it worth the effort? What would we do when we got there? It is also important to spend our time on Mars wisely, doing the things that are most important, as efficiently as we can, to make the most out of the expensive opportunity. We have to actually be able to do the things we hope to do there. Planning, testing, and practicing Mars activities must be done ahead of time, not after we arrive. The MDRS (Mars Desert Research Station, established by the Mars Society) and the FMARS (Flashline Mars Artic Research Station) were designed to be a "testbed" for planning, testing, and practicing the kind or work and science that we can do on Mars. It is a tool to help us learn as much as we can about working on Mars, so we can do good work and good science once we are there. In being used this way, MDRS/FMARS also become a wonderful vehicle for teaching science and stimulating the imaginations of students.

For simplicity, we will use "MDRS" throughout the document, please take that to mean "MDRS and FMARS"

In order for the MDRS to be a useful simulation of working and living on Mars, we need to look at the most likely activities we can imagine being necessary on Mars. Science is really the main reason to visit Mars, but if we cannot stay alive, return home, communicate with each other, and safely make our way around Mars, we will have a very small opportunity to do science. We can look at several different types of Activities necessary on Mars, and find Science education opportunities in all of them. Since the MDRS does not simulate actually traveling to Mars, we will not look at tht in this document, but that that too offers rich science education possibilities.

1.The first group of activities pertain to staying alive. Mars is

cold, and has a thin and unbreathable atmosphere. First on the list are air, warmth, food, water, shelter, sanitation, and electrical power, and maintaining all these systems as long as we are there. The MDRS does not exist in a cold CO2 atmosphere, but many of the activities that would be required on Mars can be simulated there. Simulation is a specific kind of make believe. A simulation is make believe constrained by what we know about what we are simulating, and constrained by what we know of how the universe actually behaves. You say, "let's pretend that if we walk out of the classroom door, we will no longer be able to breathe, and will freeze within minutes." What kinds of things would we have to do to be able to safely go out in the hall and do our homework?

Breathing, eating, sleeping, staying warm, and going to the bathroom are all real activities that will happen here or on Mars. How much food do we have to bring? How much water? How do we stay clean, rested, healthy? The MDRS is a place where these questions can be explored and tested. Biology, environments, physics, nutrition, and systems are study areas touched by “Staying Alive” simulation.

2. The second group of activities pertain to insuring our ability to return to Earth. On Mars, we will most likely be using resources there (CO2 from the atmosphere, water from the ground or ice deposits) to produce fuel for the return trip, and water and oxygen for living on. There will certainly be a lot of engineering activity setting up these systems, and insuring that they are working properly. While the MDRS may not actually set up a plant to produce methane for a return trip to Earth, the activities associated with this can be simulated. The chemistry and math involved in ISRU (In Situ Resource Utilization, using material present on Mars to create fuel for the return flight, water to drink, and oxygen to breathe) is a science education opportunity all by itself.

3. The third group of activities relate to communicating, and "getting around" on Mars. We will be in touch with Earth, to report findings, and to be supported by many expert engineers and scientists on earth as we perform our various activities. We will also need to communicate with each other as various groups of

crew leave our shelter to work on the surface of Mars. We will need to have some form of ground (and perhaps air) transport, and navigating and avoiding getting lost will be a life or death matter on Mars. The word navigate comes from the Latin word for sea, and means making ones way about the sea; we will be "navigating" our way through the vacuum of space, and "navigating" at a place with no bodies of liquid water. The history of exploration and navigation is called up by the discussion of these topics as pertain to Mars. Communicating and navigating in the Utah desert has its own difficulties, right here on Earth. Compass, Radio navigation systems (Loran, and radio direction finding, triangulation)GPS, Maps and grid systems, Latitude and Longitude, dead reckoning, radio, portable radio use and communications protocols are some topic areas. Mars has no magnetic field, so compasses will not work. How will people navigate on Mars? Is an excellent topic for classroom discussion

4. The fourth group of activities pertain to science. The most important scientific reason to visit Mars is looking for life, either ancient, fossil life, or perhaps even presently existing life of some sort. The guiding idea for the search for life is "follow the water". Life as we know it on earth is all dependent on water, in one way or the other. We now know there is water on Mars, a lot of it, and that in the past, liquid water was plentiful on the surface. Very recent discoveries suggest liquid water may even now appear on the surface , for at least brief periods. It makes sense to start our search for life by looking at where water now is, or where water once was.

In order to know where water is or was, we need to study the geology of the area we will be in. Geology includes the physical structure of the rocks and soil, their chemical compositions, and the forces and processes that acted upon them over the years. The robot Mars rovers and orbiting satellites have provided much data about the history and present state of Mars geology, but eventually, there is no substitute for a human pair of eyes scanning the ground, climbing up a cliff, and hitting rocks with a hammer to find out what stories they can tell. It has been said that you could survey the Colorado Rockies from the air, or with rovers, for many years, and never find a dinosaur bone, but geologists can hike the mountains,

follow the visible clues, and go right to where dinosaur remains can be found. That is what human scientists on Mars will be doing. Can we read maps through a space helmet? Can we swing a rock hammer, collect samples, and drive motorized vehicles while wearing clumsy pressure suit gloves and boots? These are the kinds of questions that can be explored at the MDRS, in simulation, even though we are not actually on Mars.

With some understanding of the geology of Mars, the work of examining samples and choosing hopeful locations to study requires the work of Biologists and Paleontologists, experts in the study of life. The ability to recognize possible Martian biomes, which if they exist may be unlike any on earth, requires knowledge of earthly biomes to at least give a strating place. Both Biology and Geology are key areas of Science education with many specifc topics that can be richly illustrated and explored with the MDRS.

5. Crew Behavior and Dynamics could be considered a fifth activity group. Close teamwork will be required among the geologists, biologists, engineers, pilots, and systems specialists that make up the crew, if the mission objectives are to be accomplished. No matter how eager they are, people cannot keep working for days on end without some rest and recreation. A pace of activity that can be sustained for two weeks may have people collapsing if kept up for six months. We know that tired and overworked people make mistakes and have accidents. What is the optimum balance between productive work and "human maintenance"? The MDRS is a way to observe crew behavior and dynamics while simulating the conditions of working we will find on Mars. In addition, scientists on Mars will be working with guidance from teams of scientists on Earth. The distance from Earth to mars makes radio communication subject to extensive delay times, depending on Mars' actual distance from the earth (8-20 minutes at radio speeds). Therefore Remote science teams and Crew on Mars will have to develop efficient, sustainable means of working together to do an effective job. Remote team and local team dynamics are an area of study that can be well observed using the MDRS.

6.A sixth group of activities pertains to robotic assistants. The

time spent on Mars will be very precious; to the extent that (reliable) automated assistants can help collect data, record sample numbers and positions, report crew locations and status, monitor life support systems, an maybe even do automated maintenance chores, the crew will be more able to devote their talents and training to the work they have come there to do. An emphasis on reliable is key here; if the assistant that is helping you wash the dishes takes more time to keep working that it takes to do the dishes, it is no of much help! The MDRS is an ideal setting to develop and explore automated systems and robots to assist scientists in getting the most work done, efficiently. NASA has utilized the MDRS for development of robotic assistants for astronaut data and sample data logging. The designing of simple systems to do this is a fertile topic for classroom thought (what would a robotic assistant have to do to be a useful adjunct to a Mars geologist in the field.)

In conclusion, it can be seen that MDRS provides a platform for planning, testing, and practicing activities which will be necessary on Mars. It also provides a practical arena for learning science.

Summary of Science Study Areas demonstrable at the MDRS and FMARS.
Some areas of learning that have immediate practical application, and illustration, at the MDRS include:

Biology
Biomes
Chemistry
Communications
Computers
Cooking
Geology
Group Dynamics
Math
Micro- and Cell Biology
Navigation
Nutrition

Planning
Power Generation, Distribution and Management
Reasoning
Resource Management
Robotics
Sanitation (and plumbing)
Stratigraphy
Systems Engineering

Other activities with scientific content:
Airlocks
ATV use
Computer networking
GPS
Radios
Satellite Communications
Simulated Space (or Mars Surface) Suits

Biology, Biomes, Chemistry, Communications, Computers, Cooking, Geology, Group Dynamics, Math , Micro- and Cell Biology, Navigation, Nutrition, Planning, Power Generation, Distribution and Management, Reasoning, Resource Management, Robotics, Sanitation (and plumbing), Stratigraphy, Systems Engineering

Other activities with scientific content: Airlocks, ATV use, Computer Networking, GPS, Radios
Satellite Communications, Simulated Space (or Mars Surface) Suits