



Rethinking Education... on Mars

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Pros and Cons of Present Education System on Earth

OFFLINE MODE

- ▶ Large distances between schools and homes
- ▶ Monotonous classes
- ▶ Non-exposure to innovative technology
- ▶ Wastage of time and resources

ONLINE MODE

- ▶ Active participation by all students is not guaranteed
- ▶ Student-teacher and student-student interaction is limited; hence discussion of other topics not on the agenda does not take place. ~Social theory plays a smaller role
- ▶ Learning will be more passive; distraction and procrastination may happen more

ANALYSING VARIOUS THEORIES

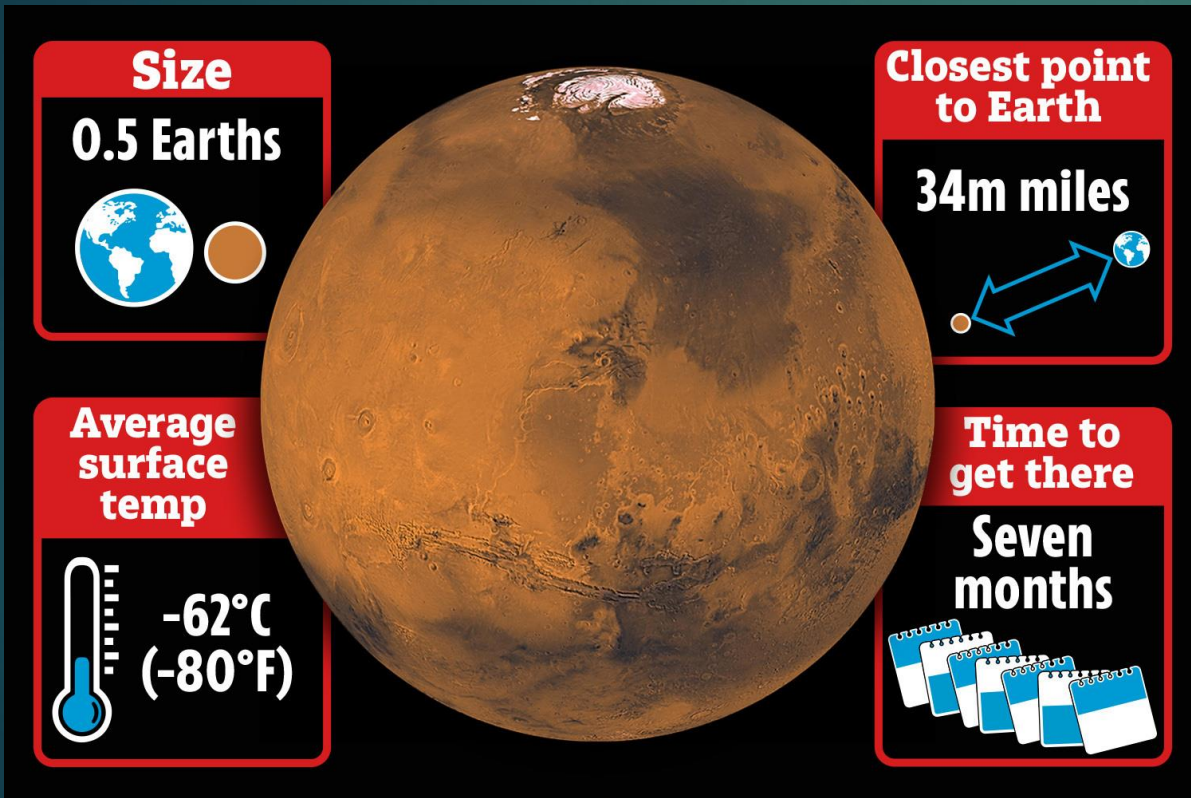
Theory of Learning	Pros	Cons
<i>Constructivism</i>	<ul style="list-style-type: none">• Active construction of knowledge	<ul style="list-style-type: none">• Harder concepts are difficult to construct without collaboration
<i>Constructionism</i>	<ul style="list-style-type: none">• Advancement of Technology• More accessible to students	<ul style="list-style-type: none">• Artefacts can not be constructed in all contexts
<i>Cognitive Apprenticeship</i>	<ul style="list-style-type: none">• Learner learns from observation of masters in the domain	<ul style="list-style-type: none">• Learner may find it hard to learn without mentorship
<i>Connectivism, Behaviourism</i>	<ul style="list-style-type: none">• Learners connect better	<ul style="list-style-type: none">• Highly learner-specific
<i>Social Theories</i>	<ul style="list-style-type: none">• Multidimensional learning• Community influences learning• Experiences play a major role	<ul style="list-style-type: none">• Situations may be complex to comprehend• Legitimate Peripheral Participation is mandatory for successful learning
<i>Embodied Cognition</i>	<ul style="list-style-type: none">• Action, Observation and Imagination	<ul style="list-style-type: none">• Metacognition is harder• Not all experiences can be embodied

ON MARS...

- ▶ Motto: Students will apply scientific concepts, math skills, critical thinking, research, and engineering design to plan a long term habitat on Mars.
- ▶ Designing a Mars Colony is real multidisciplinary project. Students will need to consider questions like:
 - How will colonists get food?
 - What is the Martian environment like?
 - Will our colony have a government?
 - How do we prevent boredom?



Planetary Conditions



Characteristic	Earth	Mars	Notes <i>Answers will vary</i>
Distance from Sun (km)	149,597,891 km	227,936,637 km	Mars is 7,833,874 km farther away from the Sun; light will be dimmer.
Diameter (km)	12,756 km	6,787 km	Mars is much smaller than Earth.
Atmospheric composition	N ₂ 77% O ₂ 21% Ar 1% CO ₂ 0.4%	CO ₂ 95% N ₂ 3% Ar 1.6% O ₂ 0.1% Water vapor 0.03%	There is very little oxygen on Mars.
Atmospheric pressure(Pascals –Pa or atmospheres— atm_	101,325 Pa 1 atm	600 Pa 0.006 atm	Pressure is much greater on Earth.
Average temperature (°C)	14 °C (57°F)	-63°C (-81°F)	Mars is much colder.
Length of day (hours)	24 hours	24 hours, 7 minutes	similar
How long to revolve around sun (length of year)	365 Earth days	687 Earth days	Year takes much longer on Mars.
Available water	Liquid; abundant	Ice; small amounts on surface	There is water on Mars, but not in liquid form.
Gravity	2.66 times greater than Mars	0.375 times that of Earth	Gravity is much stronger on Earth.

Brainstorming Chart

LIFE SUPPORT (ie Water)	SAFETY NEEDS (ie Security)
ENERGY (ie Electricity)	COMMUNITY (ie Government)

Latest Trends in Educational Technology





TECHNOLOGIES AVAILABLE

- ▶ **Knowledge Net** ~ can upload gained knowledge into a virtual cloud and hence knowledge and experiences can be downloaded, each person's experience is unique so each person's data will be unique and incorporated into the K/E-database ~ *Unifies Constructivism and Constructionism*
- ▶ **Continuous cognitive feedback machine** – Thought processes can be shared and visualized real time
- ▶ **Neuronics** ~A machine which converts cognitive structures into artificial memory (links constructionism and constructivism)

TECHNOLOGIES AVAILABLE

- ▶ Open book exams replaced by **real time data access** - students can access the knowledge net while giving assessments
- ▶ Knowledge database will have attributes and these attributes will be modelled by empirical (random) variables, and will be open to analysis by cognitive scientists
- ▶ All the existing technologies on Earth ~ AI, Augmented reality, Virtual reality, 3D printing, simulation...
- ▶ **Scaffolding machine**: Using artificial intelligence to identify weaker cognitive structures and to suggest plausible scaffolding solutions to the teacher

DIVERSITY OF SAMPLE SPACE

- ▶ Student population is selected to be as diverse as possible; **uniform** distribution over all genetic codes ~ advancements in bioinformatics and big data
- ▶ IQ to be **normally** distributed in each classroom
- ▶ 50-50 distribution of male and female subjects
- ▶ Students shall be **physically strong**; need to pass certain physical fitness tests tailored for their age and gender, but this criteria shall not be applicable to humans born on Mars

IMPORTANCE OF PHYSICAL EDUCATION

- ▶ Resonates with **social theories** of learning and **embodied cognition** theories
- ▶ Since the gravity on Mars is ~40% of Earth's, physical education will be of prime importance to protect the bone density and physique of Martian humans.

https://science.nasa.gov/science-news/science-at-nasa/2001/ast01oct_1

- ▶ Challenges will be given to the learners as a team and they will be required to relay and collaborate; This is because community is inextricable from learning according to a social theory
- ▶ The challenges will be related to **acclimatizing**, **disaster/crisis management**, **novel situations**, and so on.

Scenario 1: Oxygen

In order to stay in shape, the members of your community have been exercising extensively. They have more than doubled their oxygen intake.

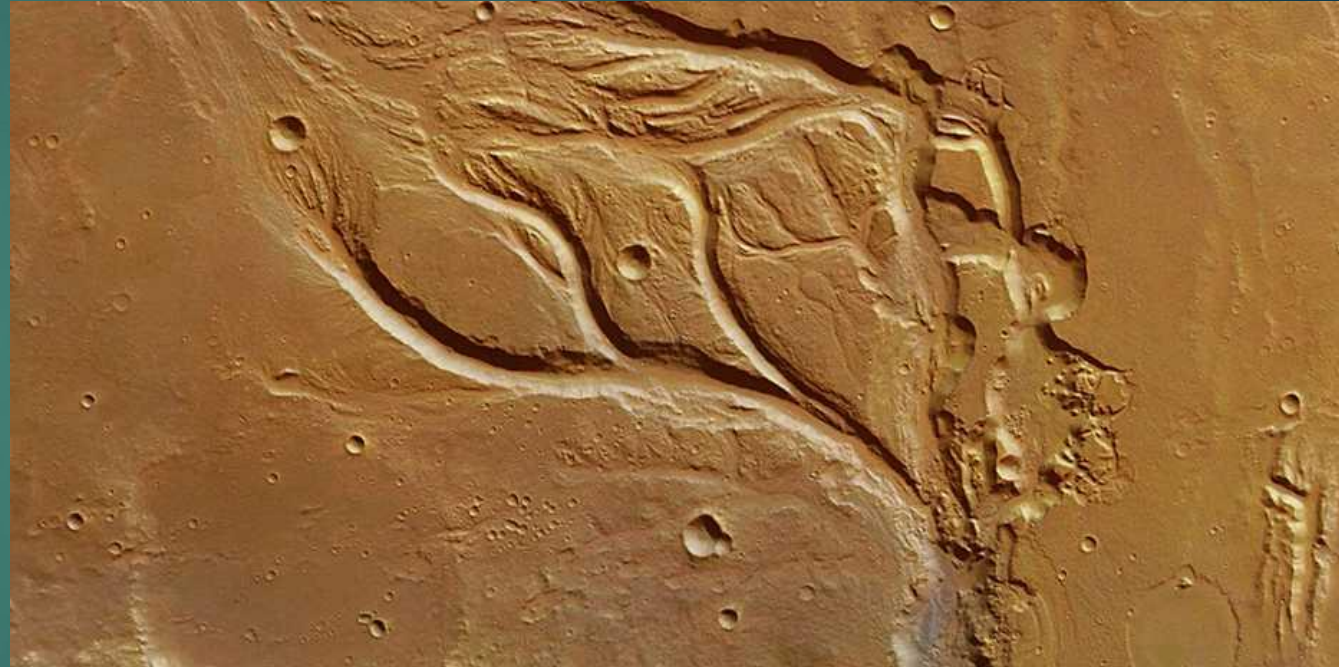
Do you have a way to provide enough oxygen for every person for at least one academic year?



Scenario 2: Water

On Earth, Calculate the amount of water needed to grow food and for hydration of one person per day. The people in your community need to hydrate, and the plants need water to grow to provide enough food. So-

How will you increase water production for every person and for food growth?



Scenario 3: Gravity

The strongest person in your community, Captain Crusty is losing muscle mass due to the $\frac{1}{3}$ gravity. You need the Captain and every other community member in top physical shape.

What is your plan to overcome the $\frac{1}{3}$ gravity effect on the human body?

MARS FACTS / WEIGHT

If you weighed 100 lbs on Earth,
you would weigh only 38 lbs on Mars!



#JOURNEYTOMARS
mars.nasa.gov

IMPORTANCE OF CRISIS MANAGEMENT

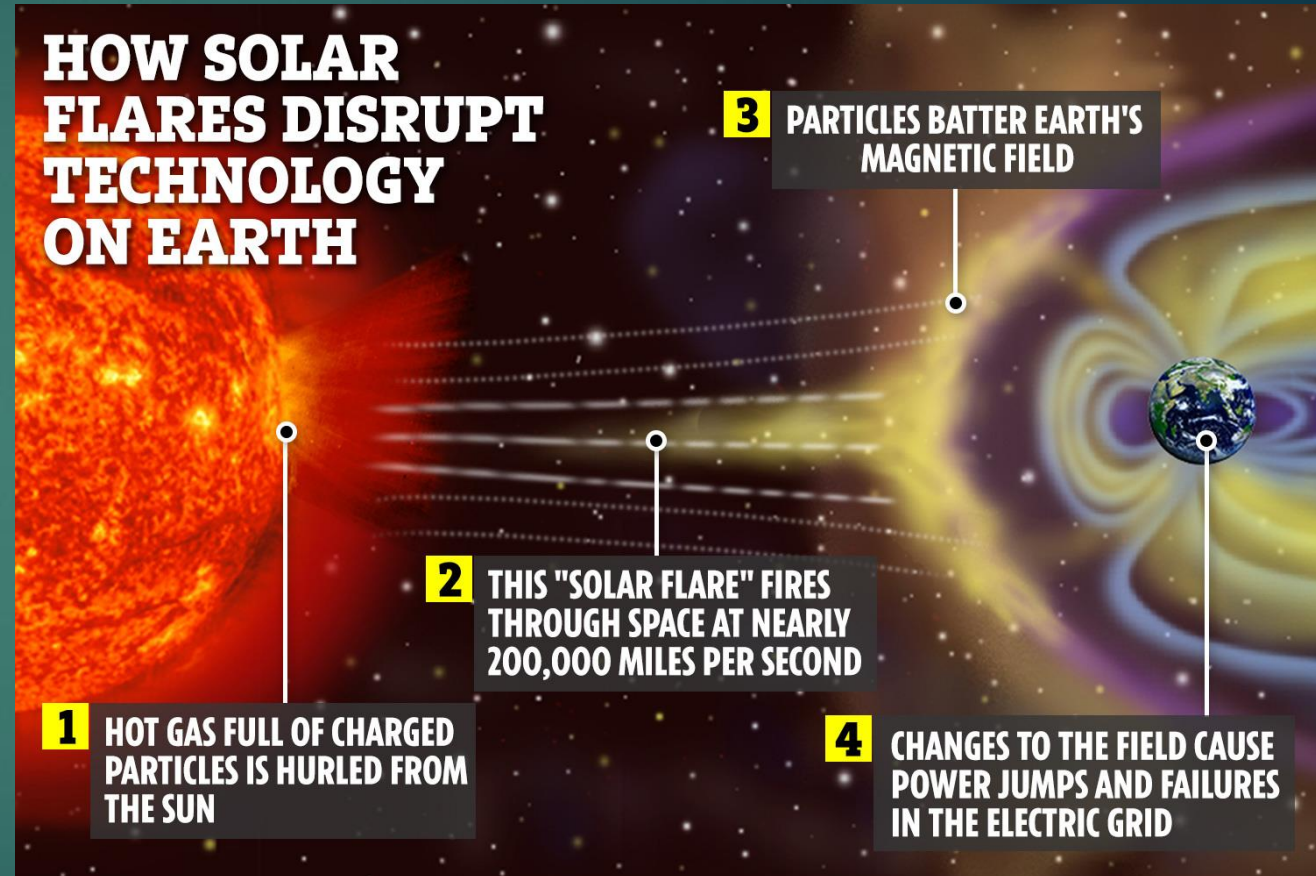
- ▶ Mars will still be an alien planet with hostile conditions until it is successfully terraformed
- ▶ Artificial environments will be prone to extreme sandstorms, instrument malfunctions, depressurisations, temperature fluctuations and so on...
- ▶ Management of disasters will be of prime importance in such conditions; Every citizen on Mars must be equipped with basic crisis management skills
- ▶ Novel situations may arise on Mars ~Shortage of food, water, oxygen... So, learners are encouraged to solve these problems using novel methods

Scenario 1: Solar Flare

During a very strong flare, solar ultraviolet and x-ray emissions can increase by as much as 100 times. Flares heat the solar gas to tens of millions of degrees. The heated gas then radiates strongly across the whole electromagnetic spectrum from radio to gamma rays. This radiation can cause risks to human health and can take out communications systems.

Can your community withstand a solar flare?

1. Scientists believe hydrogen may block radiation.
2. Mars has a few small magnetic field “umbrellas,” which can block some radiation from space.



Scenario 2: Dust Storms

At times, the entire planet of Mars can be covered in dust storms. Wind speed can increase to 50-100 meters per second during dust storms, and everything gets covered.

Can your community withstand a dust storm?



Scenario 3: Winter

Winter has arrived. Your community faces severe cold with temperatures potentially dropping to -190 degrees Fahrenheit (-123 degrees Celsius).

Can your community withstand an entire season of cold?



Must have skills



Leadership



Digital literacy



Communication



Emotional intelligence



Entrepreneurship



Global citizenship



Problem solving



Team-working

CALENDAR YEAR ON MARS

- ▶ One **SOL** on Mars is equal to 24 *h*, 39 *m*, 35 *s* on Earth
- ▶ One year is ~ 668 **SOLS** with the seasonal variations happening for a much longer duration
- ▶ The plan will be to facilitate learning throughout the year and to not have specific summer/winter vacations
- ▶ The content per lecture will be significantly lightened so that students get more time to relate to the topics and to parse them; Lectures will not feel like lectures on Earth, rather will be very interactive so that participation is guaranteed by every student
- ▶ 1 **WEEK** = 4 **SOLS**
- ▶ **SOL #4** will be an off-sol (like a Sunday on Earth)
- ▶ Public off-sols may be declared due to certain unavoidable circumstances

ASSESSMENTS

- ▶ Hybrid mode of lecture delivery and assessment is **Offline + Online** , minimizing drawbacks of each mode
- ▶ **SOL #1** and **SOL #3** in a given WEEK will be dedicated to Online lectures and assessments
- ▶ **SOL #2** will be Offline and the subjects are required to assemble at a common enclosure (artificial habitat)
- ▶ **Skill set based assessments**; The skills will be acquired through apprenticeship, constructionism and situated learning
- ▶ **Approach based assessment**; More weight will be given to the approach than the correctness of final answer
- ▶ Creativity and novel ideas are encouraged through **Projects**
- ▶ Disaster management skills will also be assessed



LOAD ON ONLINE SOL

- ▶ (complete certain material within certain time limit)
- ▶ Example: X will have to complete a certain content in a course per week. However, X can complete more
- ▶ X 's cognitive structures will be compared to the existing databases by **Neuronics**
- ▶ X 's understanding of the topic will be assessed by the **Scaffolding machine** and appropriate suggestions will be given as scaffolds
- ▶ On evaluation weeks, students will be posed novel problems to which they must brainstorm solutions to by themselves, on online sols and then exchange ideas on the offline sol. For example, *construction of a remote rover to explore the Mars moon Demos, problems associated with health, food, water, technology...*
- ▶ Interaction hours with the teacher will be provisional; Students can present their doubts, if any to the teacher on a certain time of the sol

LOAD ON OFFLINE SOLS

- ▶ 9:00-10:00 -Assembly at common enclosure (school)
- ▶ Evaluation week, regular week, project week, seminar week ~ different types of weeks
- ▶ Regular weeks will have regular interaction hours with the instructor, 1 hour for each course X takes. In this case, the instructor would fix the timing to be, say, *Course 1*~11:00- 12:00 ; *Course 2*~ 14:00-15:00 ; *Course 3*~ 16:00-17:00
- ▶ The instructor would also use a CCFM in order to amplify the experiences or the knowledge he shares
- ▶ X can take up to 6 courses
- ▶ Crisis management and physical education happen in the evenings (after 17:00)
- ▶ The remaining hours are left free; students may benefit from social learning

Sol 1 (Remote/Online)

Topic for exploration - Understanding the gravity on Martian moons

Resources -

- Access to relevant resources on the knowledge net and K/E database
- Access to the handbook of the SpaceX lab in school (where advanced experiments can be performed)

Deliverables -

- To develop a lab experiment to measure the acceleration due to gravity on different Martian moons

Sol 2 (Physical/Offline)

Activities:

- Students present their experiments
- Reflect on the methods of peers
- Form groups to perform experiments in SpaceX lab
- The scaffolding machine suggest best group formation based on the presentation and student skills (available with the machine)
- Students perform experiments, note observations and conclusions as a group
- Submit a group memory (using neuronics)

Sol 3 (Remote online)

Agenda - To give closure

Teacher -

- Goes through the K/E submissions
- Provides activities/relevant resources addressing the misconceptions (if identified)
- Scaffolding machine is used to decide optimum scaffold/activity

Deliverables -

- Submit an individual memory (using neuronics)

TAILORING EDUCATION POLICY

- ▶ Continuous feedback and reformation of education policy every 2 Mars years - Feedback between the stakeholders of two systems ~ Earthly and Martian
- ▶ Judicious sharing of resources owing to the lack thereof
- ▶ Learning takes place more in conjunction to social theories (community, practice...)
- ▶ Education should be such that it is complementary to survival on Mars
- ▶ Three levels of education: Basic ~ Primary school level, Intermediate ~ High school level, Advanced ~College level (no age restriction on any group); The students can choose what they want to learn

Meanwhile on Earth... Starbucks is missing you!

