MARS EXPLORATION THROUGH PROJECT-BASED LEARNING. D. V. Black[1], E. Cortes[1], and Students; [1]American Academy of Innovation (5410 W. Sourth Jordan Parkway, South Jordan, UT 84009 david.black@aaiutah.org).

Introduction: Students at American Academy of Innovation (AAI), a new 6-12 grade public charter school in South Jordan, Utah, have chosen Mars Exploration as the theme for their first school-wide project. AAI uses an innovative Project-Based Learning (PBL) model of instruction where teams of students throughout the school propose and develop STEAM (Science, Technology, Engineering, Arts, and Mathematics) projects on a common theme utilizing the engineering design cycle. This session will report on the structure and progress of our project.

Project-Based Learning: Project-Based Learning (PBL), sometimes also refered to as Problem-Based Learning, is more than small-scale (2-3 day) projects done by students in individual classes. There should be significant learning through deep inquiry over an extended period of time. As described by the Buck Institute for Education and implemented at American Academy of Innovation, gold-standard PBL has eight characteristics [1]:

A Challenging Problem or Question. There should be a compelling question or problem for which students find answers or solutions.

Sustained Inquiry. Students should investigate the question or problem through deep inquiry, both from traditional sources and through first-hand experiments.

Authenticity. The research question should have importance and meaning to students in both large-scale (global) and local settings.

Student Voice and Choice. Students should have a major say in the choice of project and how they will answer the driving question.

Key Knowledge and Design Skills. Students must develop the skills of critical-thinking, collaboration, communication, creativity, and problem solving.

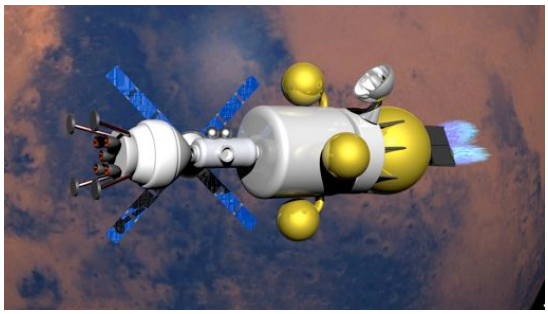
Reflection. Students need to continuously reflect on their experiences, what they are learning, and why.

Critique and Revision. Team projects need formal and informal assessments through formative checkpoints with opportunities for revision and summative critiques based on high-quality rubrics.

Public Product. The teams need to create a finished product that is presented or published to the whole school, the community, and/or online.

Project Development: As a new school implementing Project-Based Learning for the first time, both faculty and students required training. Teachers received professional development during pre-school orientation and brainstormed a list of possible project we could attempt this first year that would be challenging yet reachable. We narrowed the choices down to four, and decided to conduct one school-wide project for our first year.

During the first half of fall semester, students were trained in the necessary skills of collaboration, engineering design, creativity, and communication through a series of smaller scale in-class group projects.



Student-created 3D model of a Mars expedition.

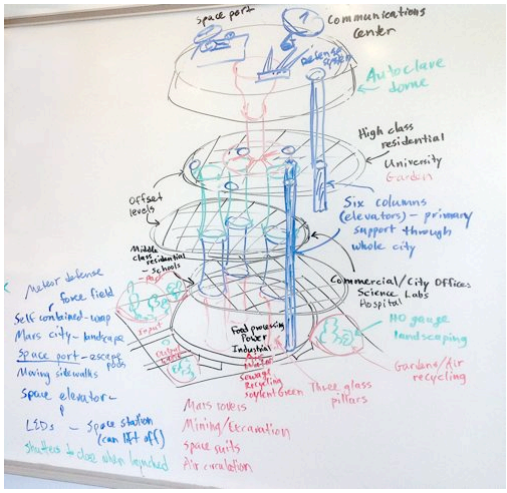
Once the Mars Exploration theme was chosen by our students, the faculty designed a series of hour-long seminars that were given once per week at the end of the semester to bring students up to speed on their knowledge of Mars and to increase their excitement and enthusiasm for the project. Some of the seminar topics included accessing and using 3D altitude data of Mars, building Mars probes from candy, students writing journals as if they lived on Mars, creating paintings of space exploration, researching dumb ways to die on Mars, studying Mars in literature and movies, and creating a 3D animation of a spaceship and habitat to transport astronauts to Mars.

Student Proposals: To maximize the student voice and choice in this project, we asked interested students to write proposals for team projects. The best proposals were selected based on five criteria: (1) A brief project description; (2) a description of their final product which they will present or publish; (3) how they will engage all students in their group; (4) a timeline of what they intend to accomplish by when, broken down into manageable chuncks; and (5) a budget of materials, software, or other items that need to be purchased.

Proposals have included such diverse ideas as building a 3D animation of a Mars lander that incorporates actual Mars altitude data, researching how well plants grow in simulated Mars soil, building and testing a series of model rockets to simulate Mars land-

ings, creating a model of a Mars colony built from junk and upcycled materials, and designing games and sporting events that could be played in the reduced gravity of Mars.

Team Selection: To make this process as realistic as possible, the chosen proposals were advertised and posted throughout the school and students who had not written proposals were asked to choose a team to join. They needed to write resumes describing their qualifications for the team and sign up for interviews with the team leaders. Team leaders were trained in Project-Based Learning and, in consultation with mentoring teachers, chose up to twelve team members. Those students who chose not to submit resumes or join a team were given a list of project topics to pursue individually. By not choosing, the choice was made for them.



Design for a Mars colony sculpture.

Running the Project: We re-organized the school's schedule so that each Friday, the teams would meet during the last hour to carry out their proposals. Each team was assigned a mentor teacher to provide continuous formative assessment and feedback and keep student projects on track according to the timelines they proposed.

Since we wanted to involve all grade levels, each team has a cross-section of age groups ranging from 6th through 11th grades. The team leaders were trained during a series of short after-school and Friday sessions on how to manage Project-Based Learning and how to engage students of all learning levels.

One of our school's goals is to teach students to be leaders. To help the team captains learn leadership skills, the responsibility for engaging and training team members was left to them. As anticipated, not all team leaders were equally good at this, and the team mentors provided guidance and suggestions where needed. Students who have been especially problematical have been "fired" from their teams and asked to work on individual projects.

Preliminary Assessment: We will hold our first Critical Design Review on March 10, 2017 to assess team progress and provide feedback and suggestions. Teams will make formal presentations and fill out self-assessment questionnaires to allow reflection on what they have accomplished and learned so far. The leaders of the teams that are making the best progress will be chosen to travel to the Lunar and Planetary Science Conference in Houston to present where their team projects are at that point, receive professional feedback from scientists at the conference, learn about current Mars research, and return with increased energy to continue leading their teams and revise their projects.

Project Completion and Final Assessment: As the student projects near completion, they will undergo a final checklist and revisions before our public Mars night. All students, their parents, community members, and the press will be invited to attend as the students present their final products and describe how they accomplished their proposals, what challenges they overcame, and what they learned. Individual projects will also be displayed but not presented.

During the entire process, we have been photographing and videotaping our efforts. This evening will also be recorded, and a final 30-minute video will be edited by one of the student teams and posted to YouTube. Blog posts describing our project and its accomplishments and challenges will be written at: http://spacedoutclassroom.com.

As part of our final Mars night, judges will be invited from aerospace companies and other institutions to decide on the best five projects. Representatives of these projects will travel to Washington, D.C. in May to present their work at the Humans To Mars summit sponsored by Explore Mars, Inc.

As a faculty, we will meet to debrief and discuss how the project went, what we did well and what we need to improve and how well we fit into the model of gold-standard PBL. We will apply these lessons to our school-wide projects for next year.

References: [1] Larmer J., Mergandoller J., and Boss S. (2015) Gold Standard PBL: Essential Project Design Elements *Buck Institute for Education*.