



MARS STUDENT IMAGING PROJECT

ASU MARS EDUCATION PROGRAM



MARS STUDENT IMAGING PROJECT (MSIP) Suggested 3-Week Archived Schedule

This schedule is designed to provide a set of activities to be implemented in your classroom as a three-week MSIP archived format. Each meeting is designed to fit a classroom period of about 45 minutes. This format/schedule can also be used as a 'primer' for your students to put together a formal MSIP proposal and project for use of the THEMIS camera. You can implement this format with students in small groups of three to five students or with an entire class.

Here is an overview of each meeting/session:

Week 1: Meeting 1 - 5

MEETING 1: Earth / Mars Comparisons and an Introduction to MSIP and THEMIS Images

MEETINGS 2 and 3: Mars Uncovered

MEETING 4: Mars Image Analysis Activity

MEETING 5: Mars Image Analysis Activity (continued) and Question Mars Activity

Week 2: Meetings 6 - 10

MEETING 6: Question Mars Activity (continued)

MEETING 7: Question Mars - Question Selection, Experiment Design & Refining Your Experiment

MEETING 8: Refining Your Experiment and Data Collection Methods

MEETING 9: Data Analysis Practice

MEETING 10: Data Analysis Practice (continued) and MSIP Proposal Overview

Week 3: Meetings 11 - 15

MEETING 11: MSIP Proposal Discussion and Data Gathering

MEETING 12: Data Compilation

MEETING 13: Graphing and Data Analysis

MEETING 14: Drawing Conclusions

MEETING 15: Writing up your Final Conclusions

RESOURCES THAT CORRESPOND TO EACH MEETING ARE AVAILABLE AT:

➤ http://marsed.asu.edu/upload/MSIP_Archived

This includes the MSIP ARCHIVED STUDENT MANUAL. (This manual is a compilation of all the materials and activities. If possible, it is recommended that each student have their own manual.)



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MEETING 1: *EARTH / MARS COMPARISONS AND AN INTRODUCTION TO MSIP AND THEMIS IMAGES*

Minimum materials required:

- Internet connected computer with speakers: 1 per class
- Earth/Mars Comparison Outline sheets: 1 per student
- For Homework Reading: *MSIP Resource Manual Chapter 3 (pp 13 - 18)*: 1 per student

Having your students become familiar with similarities and differences between geologic features found on both Earth and Mars can allow them to begin thinking about what may be interesting for them to research.

1. Show the MSIP Intro Video: A video link to this presentation is available at:

- <http://breeze2.is.asu.edu/p93588777/>

2. Have students follow along and take notes using the Earth/Mars Comparison outline. This outline is available at:

- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meeting 1 folder)

HOMEWORK RECOMMENDATION:

1. Read Chapter 3 (pp. 13-18) from the *MSIP Resource Manual*.

Students can read other parts of the *MSIP Resource Manual*, but Chapter 3 is highly recommended. This chapter will continue to increase student's background knowledge about comparisons between geologic features found on both Earth and Mars. This will allow them to potentially narrow down their interests towards a particular topic. The *MSIP Resource Manual* is available at either of the following links:

- <http://msip.asu.edu/pages/pdfs/MSIPResourceManualv200.pdf> OR
- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meeting 1 folder)



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MEETINGS 2 AND 3: *MARS UNCOVERED: Revealing the Geologic History Through Mapping*

Minimum materials required:

- Mars Uncovered Student Guide: At least 1 per pair of students
- Mars Uncovered Mapping Materials: At least 1 set per pair of students
 - THEMIS Image Mosaic (Chryse Planitia recommended)
 - Transparency Sheet
 - Set of red, green, blue and black erasable markers
 - Two paper clips (to secure map and transparency sheet)

This activity guides students through an inquiry-based and critical thinking approach to studying the surface of Mars as planetary scientists do. Students will learn to create a geologic map of Mars and use relative age dating techniques to analyze the information and interpret the geologic history of that region.

You will find the *Mars Uncovered Teacher Guide*, *Student Guide* and three possible images to map at either of the following links:

- <http://marsed.asu.edu/upload/MarsUncovered> OR
- http://marsed.asu.edu/upload/MSIP_Archived (Look for Session 2 and 3 folder)

Students can simply follow the guide with the teacher leading necessary discussions as recommended in the *Mars Uncovered Teacher Guide*. If students are going to map one image, the Chryse Planitia image is recommended.

HOMEWORK RECOMMENDATION:

Whatever students do not finish in class with the *Mars Uncovered* activity, they should finish for homework.



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MEETING 4: *MARS IMAGE ANALYSIS ACTIVITY*

Minimum materials required:

- Mars Image Analysis Activity materials: 1 set per team of 3-5 students
 - One THEMIS visible image
 - The accompanying context image
 - An 11" X 17" MOLA elevation map of Mars
 - Erasable markers
- Set of Feature Identification Charts: 1 per student
- Mars Image Analysis Student Worksheets: 1 per team of students
- Mars Image Analysis video clip
- For Homework Reading: Question Mars Activity page 1 (Objective and Student Introduction background information sheet): 1 per student

This activity allows students to use a hands-on approach to get familiar with geologic features that can be seen in THEMIS visible images. The lesson asks students to identify geologic features seen in images, make measurements and think about the relative ages of geologic features within the image. (Lendable materials are available for this activity.) This activity is available at the following link:

- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meeting 2 folder).
Folder includes Mars Image Analysis Student Worksheets, Mars Image Analysis Lesson Plan (though the formal lesson plan is not followed exactly, the lesson plan can be used to supplement teacher information), Feature Identification Charts and Mars Image Analysis video clip of how to incorporate this lesson into your classroom)

The recommended format to facilitate this activity is as follows:

First give students groups one set of the Mars Image Analysis activity materials and have them do the following:

1. Have students locate the general area of where their THEMIS image is located on the MOLA elevation map of Mars.
2. Have students label and identify geologic features on their THEMIS visible image and the context image. They should use the Feature Identification Charts for assistance in naming the geologic features.
3. Students should think about and label information about the geologic history of the area using the relative age dating techniques they learned in the Mars Uncovered activity.
4. Make measurements.

You may want to play the Mars Image Analysis video clip to explain each part of the activity.





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5. After students have had a chance to label features and make measurements on their initial image, give them the *Mars Image Analysis Student Worksheets*. Have them fill out the information requested for their initial image. The instructions are as follows:

Instructions:

1. Observe the labeled image and materials at your table. Look at the approximate location of where the THEMIS image is located on the MOLA elevation map of Mars. Write down information you think is important about the surrounding area (the context) that may play a role in the formation of the geologic features you are observing in the THEMIS image.
2. Using the *Feature Identification Charts*, look at the labeled features identified on the THEMIS image. List two to three geologic features you find interesting from the image. You can choose to list features that may or may not have been labeled.
3. Sketch and label your favorite geologic feature or combination of features from each THEMIS image.

6. Have student groups rotate from image to image (~5 minutes per rotation). They should continue to fill out their worksheets as they look at the observations other student groups have made of other images. As students rotate from image to image, they should not add additional observations to the images, nor should they cross out any observations they may not agree with. It is normal for scientists to disagree with other scientists work, provided that they have good reasons for their disagreements. If they do not agree with another group's observations, they can include the observations they feel are appropriate on their worksheets.

Note: There may not be enough time for students to make observations of all images during Meeting 4. You can continue this during part of Meeting 5. Even with the additional time provided in Meeting 5, not all students will get to make observations of every image.

HOMEWORK RECOMMENDATION:

1. Read page 1 of the *Question Mars Students Guide*

Even though students will have not completed the *Mars Image Analysis* activity in this meeting and will not officially start the *Question Mars* activity until the end of Meeting 5, assign the background reading (page 1 only) of the *Question Mars* activity as homework. You may decide to give students the entire *Question Mars Student Guide* at this time, but only assign page 1 for reading.

You will find the *Question Mars Teacher Guide*, *Student Guide*, and *Feature Identification Charts* (these are the same ID Charts that were used with the *Mars Image Analysis* activity) that go along with this activity at either of the following links:

- <http://marsed.asu.edu/upload/QuestionMars> OR
- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meetings 5 and 6 folder)



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MEETING 5: *MARS IMAGE ANALYSIS ACTIVITY (Cont'd) AND QUESTION MARS ACTIVITY*

Minimum materials required:

- Mars Image Analysis Activity materials: 1 set per team of 3-5 students
 - One THEMIS visible image
 - The accompanying context image
 - An 11" X 17" MOLA elevation map of Mars
 - Erasable markers
- Feature Identification Charts: 1 per student (students should already have this handout)
- Mars Image Analysis Student Worksheets: 1 per team of students (students should already have this handout)
- Question Mars Student Guide: 1 per student (students should already have this handout)

Mars Image Analysis Activity

Begin this meeting by providing the first 25 minutes for students to continue with the *Mars Image Analysis* activity. Have students continue making observations of images and logging those observations on the *Mars Image Analysis Student Worksheets*.

Bring the activity to a close by reiterating two important points:

- It is important to look at the surrounding area (the context) of where an image was taken in order to better understand what geologic features may be in an image;
- Their research project will need to focus on specific geologic features associated with a general topic.

Question Mars Activity

You will find the *Question Mars Teacher Guide*, *Student Guide*, and *Feature Identification Charts* (these are the same ID Charts that were used with the *Mars Image Analysis* activity) that go along with this activity at either of the following links:

- <http://marsed.asu.edu/upload/QuestionMars> OR
- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meetings 5 and 6 folder)

Once closure has been done for the *Mars Image Analysis* activity, briefly discuss what students read in the background information page of the *Question Mars* activity. Draw students' attention to, as a review of what they read, are the two sets of bulleted information on the page. The first set of bullets state the following:

- Think about what you are curious about related to Mars and create general questions.
- Evaluate your questions making sure you have appropriate tools to answer those questions.
- Realize that science is most often conducted in small bits and pieces. It's understandable to have "big picture" questions, but scientists (and you) need a specific focus/question of study. This will contribute to a greater understanding about Mars through detailed research.



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It is important for students to know that starting with general questions is good, but that those general questions need to be focused on something very specific (like the geologic features related to general topics they were looking at with the *Mars Image Analysis* activity). The goal of this activity is to help them focus their questions.

The other set of bulleted information focuses on the THEMIS instrument. Students should realize that the camera can take both visible and infrared images but that the students should focus on the morphology (specific geologic features or landforms) seen with both of those data sets of images.

Once you have discussed the background information (page 1), have the students group themselves in their research teams. As a class, discuss the *Question Mars Student Worksheet 1*, questions 1 and 2. This should take approximately 3-5 minutes. Students should be identifying general topics rather than specific features at this point. Within their small research groups, have students debate and decide what topic their group wants to study. Research teams must agree upon one topic of study. They do not yet need to focus on what geologic features within that topic they will focus on.

Once the research team has come to a decision, have each member of the group spend approximately 5 minutes individually brainstorming questions they may have about their topic. Some students may not finish creating five complete questions within the time frame provided. They should write down however many complete questions that come to mind in the 5 minutes provided.

HOMEWORK RECOMMENDATION:

1. Have students read pages 3 and 4 (*Student Worksheet 2*) of the *Question Mars Student Guide*. Part 2 of the *Question Mars* activity has students look at THEMIS images related to their topic (available at <http://themis.asu.edu/topic>) and have them start making observations.
2. Along with the reading, students should log at least one observation of an image (*Student Worksheet 2*, page 5 of the *Question Mars Student Guide*) for homework. (Note: If students do not have a computer at home, you can ask them to either try doing this in the library or media center. Students should be able to make at least one observation for homework.)



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MEETING 6: *QUESTION MARS ACTIVITY (continued)*

Minimum materials required:

- *Question Mars Student Guide: 1 per student (students should already have this handout)*
- *Internet connected computer: 1 per pair or per small research group*

Have students get together in their research groups to look at and discuss their first logged observation on the *Question Mars Student Worksheet 2*, page 5. Students should make sure that they:

- Named specific geologic features they observed in THEMIS images. A common error is that students write down the title of the image rather than the features they observed.
- Make sure they wrote down the image ID #. Proper image ID numbers begin with a V (for visible images) or an I (for infrared images). If students logged something that does not begin with a V or an I, they may have written down an image release date number or the title of the image, both of which will be of little use and will be difficult for anyone to relocate that image. (Students can still log those images OR they can choose to only log additional images that have the Image ID # accessible.)
- Sketch: Students should sketch and label a part of the image they observed focusing on the geologic features that interest them. They do not need to sketch the entire image.
- Specific observations: Students should have bulleted information (or at least short sentences) of what they observed.

Once students are sure they understand the procedure for observing and logging images, they should continue logging observations using *Student Worksheets 2* of the *Question Mars* activity. Students should ideally work in pairs on the computer, although if necessary, each small research group can work from one computer. Students should log at least four additional observations of THEMIS images (available at <http://themis.asu.edu/topic>) per pair or per small research group related to their topic.

Students should now have at least five observations (but hopefully more!) of THEMIS images related to their topic of interest.

HOMEWORK RECOMMENDATION:

1. Students should log at least two additional observations of two images for homework. (Note: If students do not have a computer at home, you can ask them to either try doing this in the library or media center. Students should be able to make at least two additional observations for homework.)
2. Have students complete the *Question Mars Student Worksheet 3 – Question Development – Refining Questions* for homework.



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MEETING 7: *QUESTION MARS – QUESTION SELECTION, EXPERIMENT DESIGN and REFINING YOUR EXPERIMENT*

Minimum materials required:

- *Question Mars Student Guide: 1 per student (students should already have this handout)*
- *Internet connected computer: 1 per pair or per small research group (students may not end up using the computer during this meeting)*

Question Selection

Students should come to class having completed the *Question Mars Student Worksheets 3*. They should have identified the one question (out of the three they individually created) as a potential research question for the team to focus on. Students should discuss and decide which one of their individually created potential questions is the most interesting and most answerable using THEMIS images. Encourage students not to feel overly “possessive” of their own created question. Their creation and participation in the team discussions and decisions will help them select the best and most interesting question for the team to focus on.

Experiment Design and Hypothesis Development

The *Question Mars Student Worksheets 4* ask the students to focus on ONLY the one question they feel, as a team, is best answered by using THEMIS visible images. This part of the activity helps students start thinking about how they would go about answering their question - the experiment design.

Question Mars Student Worksheet 4, question 5 is important for students to discuss carefully as it asks them to formulate a hypothesis of what the outcome of their experiment will be. Their hypothesis should be supported by their current observations rather than just an unsupported guess. Students need to discuss their observations together in order to come up with a possible outcome (hypothesis) that is based on the current trends they are observing. Even though they will only have made a few observations (at least 7 per person), basing a hypothesis on those observations is essential. The data they collect throughout the project will allow them to either support or refute their hypothesis and help them come to a conclusion about their question.

Refining Your Experiment

Once they have answered the questions on the *Question Mars Student Worksheets 4*, have them begin the *Question Mars Student Worksheets 5 – Experiment Design – Refining Your Experiment* together as a group. These worksheets give them a pre-made starting list of a step-by-step plan (a more flushed out experiment design) of how they will go about gathering data for their research. This will enable them to think about their experiment design in a more detailed fashion.

HOMework RECOMMENDATION:

1. Have students write down additional information on the *Question Mars Student Worksheet 5*. List what observations they would need to log from every image in order to make their experiment repeatable and be able to come to a conclusion about their question.



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MEETING 8: *REFINING YOUR EXPERIMENT and DATA COLLECTION METHODS*

Minimum materials required:

- *Question Mars Student Guide*: 1 per student (students should already have this handout)
- Internet connected computer: 1 per pair or per small research group (students may not end up using the computer during this meeting)
- *Experiment Design (Data Collection Methods) Handout*: 1 per student
- *THEMIS Image Data Gathering table*: 1 per student

Refining Your Experiment

Students should discuss in their research groups the *Question Mars Student Worksheets 5* that they completed for homework. They should discuss and come to a decision on what data (information) they will collect and log from every image they observe. This will become an important aspect of their step-by-step plan or refined experiment design.

Data Collection Methods

As they discuss and finalize what data they are going to collect as part of their experiment design, they should fill out the *Experiment Design (Data Collection Methods)* sheet available at:

- [http://marsed.asu.edu/upload/MSIP Archived](http://marsed.asu.edu/upload/MSIP_Archived) (Look for Meeting 8 folder)

Filling out this sheet will allow them to see what information they need to collect, where they will find that information and why that information is important for their project. Students should fill out as many pieces of information they feel will help answer their question. There is no minimum or maximum set of data students should collect; that will depend on their research question.

Once students finalize their *Experiment Design (Data Collection Method)* sheets, each student should get a copy of the *THEMIS Image Data Gathering table*. This table is available at:

- [http://marsed.asu.edu/upload/MSIP Archived](http://marsed.asu.edu/upload/MSIP_Archived) (Look for Meeting 8 folder)

Based on what data students decided to collect and log from every image, have them fill in that information as the header of each column of the data table. Students should decide the order in which they should fill in the header information as well as how to divide up column header spaces provided for the data they plan to collect. Students need to make sure their team data tables are consistent.

HOMWORK RECOMMENDATION:

1. Have students log information from images they have already made observations of (from *Question Mars Student Worksheet 2*) on the *THEMIS Image Data Gathering table*.

Students should look at their previous observations and **ONLY** include images that apply to their projects. They may have some observations logged that focus on other aspects of their topic that they decided not to focus on. These observations should **NOT** be included in their data table. Additionally, students probably did not record all the information they now realize they want to



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collect from each and every image, based on decisions they made with their data collection methods. They can relocate any of the previously observed images by going to the <http://themis-data.asu.edu> website. If they type in the image ID # (the V# or I#), they will be able to look at that image again and log the other observations and data they may need to obtain for their project.

Each individual that makes up a research team should create their own data table. The data they record on their *THEMIS Image Data Gathering* tables will be compiled with other team members data at a later time in an Excel spreadsheet. It is again important to stress that their data tables need to be filled out consistently.



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MEETING 9: *DATA ANALYSIS PRACTICE*

Minimum materials required:

- *Graphing Information and Data Analysis Practice Guide: 1 for each pair of students*
- *Computer: 1 for each pair*
 - *Computer needs to have Microsoft Excel*
 - *Provided electronic copy of MOLA elevation map of Mars needs to be on each computer*

Once students know what data they need to collect in order to answer their question and support or refute their hypothesis, they need to think about how they will analyze their data. For this activity, students will need access to a computer that has Microsoft Excel.

Provide students with access to the *Graphing Information and Data Analysis Practice Guide*. This guide and the MOLA elevation map of Mars are available at:

- [http://marsed.asu.edu/upload/MSIP Archived](http://marsed.asu.edu/upload/MSIP_Archived) (Look for Meeting 9 folder)

Note: This activity may take more than one meeting to complete. Allow students time during Meeting 10, if necessary, to complete this activity.

HOMEWORK RECOMMENDATION:

1. Have students continue to log information from images they have already made observations of (from *Question Mars Student Worksheet 2*) on the *THEMIS Image Data Gathering* table.



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MEETING 10: *DATA ANALYSIS (Cont'd) and MSIP PROPOSAL OVERVIEW*

Minimum materials required:

- *Graphing Information and Data Analysis Practice Guide: 1 for each pair of students (students should already have this handout)*
- *Computer: 1 for each pair*
 - *Computer needs to have Microsoft Excel*
 - *Provided electronic copy of MOLA elevation map of Mars needs to be on each computer*
- *MSIP Proposal Outline: 1 per student*

Data Analysis

If students are still working on the *Graphing Information and Data Analysis Practice Guide*, provide them time during the beginning of this meeting to complete the activities.

MSIP Proposal Overview

The proposal outline should be used to have students create an outline of their work to see if they are lacking any information for their project. It can be considered somewhat of a progress report. It is also a guide to assist them with their project. As they progress with their research, some of the initial information they include in this proposal outline will most likely change. This is a natural part of the process of science.

- This outline is available at [http://marsed.asu.edu/upload/MSIP Archived](http://marsed.asu.edu/upload/MSIP_Archived) (Look for Meeting 10 folder)

The Proposal Outline should be self-explanatory, but here is an overview of each of the sections:

I. Introduction: There are three main questions students should address in this section:

- *What is your science question? This is self-explanatory.*
- *Why is this question important and interesting? Students should think about why this topic interests them but ALSO why this question is important in understanding Mars better. For many students this may not be easy for them. Understanding why what they are studying is important can be difficult. It requires students to think more globally and critically about the geologic processes at work on Mars. They need to relate what they are understanding about how a process may work on Mars with what they are studying. Encourage students to think about how their study may help in the understanding of the past or present conditions on Mars and why that would be important. They may also want to consider what effect this better understanding may have for future human or robotic exploration of Mars.*
- *List any hypotheses you may have of what the answer(s) might be to your science question. For this, students should think back to what they did with the Question Mars activity, Student Worksheet 4. Students should base any hypothesis (and they can have more than one hypothesis) on observed trends rather than just an unsupported guess.*



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II. Background:

Gathering background information from books and/or websites and other sources about what is known about the geologic feature(s) they are studying is a very important part of their research. This section should be continually worked on as students go through their research. Student groups may assign different portions of this section to individuals within their research group to be responsible for. This information can include:

- Definitions of the geologic features they are studying
- Specific knowledge and hypotheses other scientists have about these features
- Selected images that illustrate what feature(s) the students are studying. These can be images from the <http://themis.asu.edu> website or a drawing of the feature(s).
- Show and/or describe how the specific features the students are studying form.
- Show geographic regions where feature(s) have been observed on a map of Mars. (Students may or may not have started doing this.)

Students should write down information and keep track of references in order to cite sources appropriately. This includes citing images from the THEMIS website as well.

A few suggested resources students can use as they conduct their research are:

- MSIP Resource Manual: This is included in their Student Manual
- Feature Identification Charts: This is also included in their Student Manual
- THEMIS website: <http://themis.asu.edu>
- Other reliable internet sources or books, magazines or science journals

III. Experiment Design

This section includes a number of questions that are self-explanatory. Students should describe, in as much detail as possible, the information they include as the “answers” to the questions. Students should discuss their answers with each other to be sure they are all on the same page, as a team, with the intentions of their experiment and plan.

The question that asks students to “*list the specific information from archived THEMIS images that they plan to record from each image and why,*” has already been completed by the students. However, asking them to rewrite and include this information as part of their proposal, helps reinforce the importance of what and how they are conducting their research.

- For the specific information they plan to record in a table – this information will come from their *Experiment Design (Data Collection Methods)* handout. They should include a list of the information they will gather from each image and why that information is important.
- If students are going to make measurements as part of their research, they have one of a few options to make their measurements:
 - Use Adobe Photoshop to make measurements
 - Make estimated measurements by using the techniques (determining the scale of the image) they learned with the *Mars Image Analysis* activity. For this technique students would need a print out of images.
 - Make estimated measurements knowing that every THEMIS visible image is 18 km across. By knowing this, they can make estimated measurements without having a print out images.



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IV. Analysis Plan

For the Analysis Plan section, students should focus on two or three main items of how they will list and display their data in order to analyze it. These main items are as follows:

- **THEMIS Image Data Gathering data table:** Students should show the headings of their data table (without the actual data included). At this time they should look at their individual THEMIS Image Data Gathering tables and make sure they all agree on the set-up of their data table. The team should also be thinking about if they are filling out their data table in a consistent fashion. Each member of the research team should have a data table that is consistent in every way, including any abbreviations being used. They should also make sure they include (or do not include) units of measurement in each logged observation. For example, if students have a header for *Longitudes*, it is recommended that they have *Longitudes (E)* in the header section. Therefore, for each logged observation, they will not need to include the *E* after each longitude recorded. This is inferred from the header. They should think about how the headers should be labeled and exactly how they are going to log the information they want to collect from every image. At this point, it is recommended that they review and ensure consistent table header information. Only AFTER they are finished with the proposal outline should they review the consistency of the recorded information. Students should have recorded information in their data tables with previously recorded data (from the *Question Mars* activity) that they completed for homework. Again, it is not recommended that they review their recorded data input until they are finished discussing the entire proposal outline.
- **Graphs:** Students should use the activities they completed with the *Graphing and Data Analysis Practice Guide* to think about what graphs they may want to create to display their data, including their information on a MOLA elevation map of Mars. Students should include which pairs of data they plan to graph.
- **Other:** Students may consider showing annotated images to illustrate some of their data.

V. Conclusion

This section is used to summarize what the team is proposing to do and is almost a reiteration of their Introduction section. This section has three main questions:

- *Restate your science question.* This is self-explanatory.
- *Restate your hypotheses (if you had any).* Students can restate any hypotheses they may have.
- *Restate why it is important to answer your question and why your proposal should be accepted for your team to use the THEMIS visible camera.* For students conducting an archived project, they do not need to address the last part of this regarding why their proposal should be accepted. Their main focus should be on why it is important to answer their question.

VI. References

This section should include a list of all (and ONLY) sources of information used to create their science proposal. Any fact, image or piece of information that they read in a book, website, journal or magazine should be referenced within their proposal. Only those sources referenced should be included in their references section.

HOMEWORK RECOMMENDATION:

Have students fill out each section of the *MSIP Proposal Outline* starting in class. Anything they don't finish in class, they should work on as homework.



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MEETING II: *MSIP PROPOSAL DISCUSSION and DATA GATHERING*

Minimum materials required:

- MSIP Proposal Outline: 1 per student (students should already have this handout)
- THEMIS Image Data Gathering table: 1 per students (students should already have this table)
- Internet connected computer: 1 per pair or per small research group (you may not use the computer during this meeting)

MSIP Proposal Outline Discussion

Students should discuss each section of the *MSIP Proposal Outline* that they finished for homework to ensure that everyone is on the same page with their project. They should share their ideas for each section and come to a consensus on what information is important to include. In the case of the background section, some students may still need time to research or complete their “assigned question/portion”.

Data Gathering

When they finish discussing their *MSIP Proposal Outline*, they should review each others data tables (*THEMIS Image Data Gathering* tables). Students should make sure the data each student has entered on the data table is consistent. Each individual should have their own data table.

Once students finish checking their data tables, they should get back into their groups to continue collecting additional data by going to the appropriate THEMIS website. They should discuss how they should divide up the images available to maximize the number of different data points their team will collect. For example, one group could make observations of the images available on page 1 of the image gallery and another group could look at page 2, and so on. Try to allow students to come up with their own decisions as to how to divide up their efforts.

HOMEWORK RECOMMENDATION:

1. Data gathering can be continued for homework as well as throughout the project. The more data students collect, the more confident they will be when formulating conclusions and answering their question.
2. Students can also work on completing/researching their “assigned question/portion” of the background section of their proposal, which will be needed information for their final reports.



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MEETING 12: *DATA COMPILATION*

Minimum materials required:

- *THEMIS Image Data Gathering table (students should already have this table)*
- *Computer with Microsoft Excel: 1 per research group*
- *Data Analysis Planning handout: 1 per student*

Students should compile their *THEMIS Image Data Gathering* table information into one team master table in an excel spreadsheet. One or two students can be responsible to do this. Students should be sure not to repeat any of the same data and should make sure the data is input consistently. The remaining students can gather additional data or work on some of the background research they may need to work on.

Students should carefully review their final master table as a group to eliminate any inconsistencies. Here are some common errors they should be careful of:

- Repeated data
- Errors in latitude or longitude degree ranges and directions
- Errors in Image Identification numbers
- Errors in values or measurements
- Errors in units

HOMWORK RECOMMENDATION:

Have students take home the *Data Analysis Planning* handout and have them list at least 3 possible graphs they could make of their data. They should think about what they included on the *MSIP Proposal Outline* and also what they did in the *Data Analysis and Practice Guide*.

The *Data Analysis Planning* handout is available at:

- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meeting 12 folder)

Teacher “Homework” Recommendation: If possible, print out a copy of the compiled master data table for each member of each team for use the following day.



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MEETING 13: *GRAPHING AND DATA ANALYSIS*

Minimum materials required:

- Compiled THEMIS Image Data Gathering table (printed from the Excel spreadsheet): 1 per student
- Computer with Microsoft Excel and an electronic copy of students master table: 1 per pair of students
- Data Analysis Planning handout: 1 per student (students should already have this handout)
- Data Analysis handout: 1 per student

Students should discuss their ideas from their homework and *Data Analysis Planning* handout. They should decide what graphs they will want to create for their project. Students should also decide who will be responsible to make what graph. They do not all need to make each graph (unless there is time). Students can make graphs using a computer or “by hand”. The most important aspect of the data analysis will be for them to be able to make observations and interpretations of their data.

Students should use their compiled master data table to create their graphs. They can refer to the *Graphing and Data Analysis Guide* for assistance in making their graphs if necessary. NOTE: To avoid loss or corruption of the master data table, have each person making a graph save the master data table file as a different name.

Once graphs are made, students should use the *Data Analysis* handouts to write down the observations and interpretations of each graph. The *Data Analysis* handouts are available at the following link:

- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meeting 13 folder)

HOMEWORK RECOMMENDATION:

Provide students with a print out of any or all the graphs they have made and have them complete the *Data Analysis* sheets at home.



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MEETING 14: *DRAWING CONCLUSIONS*

Minimum materials required:

- *Data Analysis handout: 1 per student (students should already have this handout)*
- *MSIP Final Report Outline: 1 per student*

As a team, students should discuss the *Data Analysis* handouts they completed for homework. Together, they should discuss their observations and interpretations of each of the graphs. Based on their discussion, they should revise (as necessary) their *Data Analysis* handouts to record the most pertinent information for each graph for their project.

Using the information and data acquired and graphed throughout the project, students should now be able to compile their information, draw some conclusions and put together all of the information into the *MSIP Final Report Outline*.

An outline to use as a guide for the *MSIP Final Report* is available at either of the following links:

- <http://marsed.asu.edu/upload/MSIPArchivedFinalReportOutline1.doc> OR
- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meeting 14 folder)

The Final Report Outline should be self-explanatory and in many cases, extremely similar to the Proposal Outline. Here is an overview of each of the sections:

I. Introduction: There are three main questions students should address in this section:

- *What is your science question?* This is self-explanatory.
- *Why is this question important and interesting?* Students should think about why this topic interests them but ALSO why this question is important in understanding Mars better. For many students this may not be easy for them. Understanding why what they are studying is important can be difficult. It requires students to think more globally and critically about what the processes related to what they are studying about Mars. Encourage students to think about how their study may help in the understanding of the past or present conditions on Mars and why that would be important. They may also want to consider what effect this better understanding may have for future human or robotic exploration of Mars.
- *List any hypotheses you may have of what the answer(s) might be to your science question.* For this, students should think back to what they did with the *Question Mars* activity, *Student Worksheet 4*. Students should base any hypothesis (and they can have more than 1 hypothesis) on observed trends rather than just an unsupported guess.

II. Background:

Students should have researched and compiled all the necessary information for their Background section. A lot of the information was probably obtained and researched when students initially looked at the *MSIP Proposal Outline*, but some of the information they needed to be sure to gather throughout the time they had to work on their project. The suggested information they should include is as follows:

- Definitions of the geologic features they are studying



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- Specific knowledge and hypotheses other scientists have about these features
- Sketches or selected images that illustrate what features the students are studying. These can be images from the <http://themis.asu.edu> website or a drawing of the features.
- Show and/or describe how the specific features the students are studying form.

Students should cite sources appropriately. This includes citing images from the THEMIS website as well.

III. Methods

This section includes a number of questions that are self-explanatory and similar to what the students were asked in the Experiment Design section of the *MSIP Proposal Outline*. For the *MSIP Final Report Outline* they are stating what they actually did rather than what they plan to do. Students should describe in as much detail as possible, the information they include as the “answers” to the questions. Their answers may have changed since they completed their *MSIP Proposal Outline*.

IV. Data

For the Data section, students should again answer the questions in the outline but also they should show each of the following:

- Master Data Table
- Graphs (including the graph of their data on a map of Mars, if they made one of these). For each of the graphs students should include information such as:
 - What the graph is comparing (For example, this graph is showing the channel width versus the channel depth.)
 - General observations and trends they are noticing based on the graph (keep in mind they are only mentioning their observations here – not the interpretations of what those observations may possibly mean.)

V. Discussion

This section asks students to reshow their graphs and discuss the interpretations of the observations they stated in the data section. It may feel as though students are showing the same information, and they are. The only additional information they are including are their interpretations of the data and what it means for their science question. For each graph, students should include the following:

- Their original graph
- A brief overview of the trends, patterns, and observations of that graph
- Explain the interpretations of what those trends, patterns and observations tell them about how the specific process(es) they are studying may work on Mars. They should include significant details that can be specifically linked to and back up those interpretations
- Apply those interpretations to their specific question

These interpretations should reflect the observations they made and should be related to their science question.



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Additionally, within their discussion section, they should also discuss the following regarding potential errors:

- Could there be any inaccuracies regarding measurements made or identification of geologic features they were studying.
- Could there be any misinterpretations among team members, especially in the identification of geologic features they were studying.

V. Conclusion

This section is used to summarize what the team did. This section has four main questions:

- *Restate and answer your science question.* This is self-explanatory.
- *Restate and support or refute your hypotheses (if you had any).* Students can restate any hypotheses they may have and briefly state why they were supported or refuted based on their interpretations of the data.
- *What future work could be done to expand your research project?* Students should think about what other questions they may now have that sparked their curiosity based on the observations they made during their research. Future work can also be how their research could be expanded to gain a better understanding about what they were studying.
- *Who can you acknowledge for helping you complete your science project?* Students should take a moment and acknowledge those who helped them with their research. This may include the teacher, librarian, parents, or anyone else who may have helped them.

VI. References

This section should include a list of all (and ONLY) sources of information used to create their final report (which includes many of the same they included in their *MSIP Proposal Outline*. Any fact, image or piece of information that they read in a book, website, journal or magazine should be referenced within their final report outline. Only those sources referenced should be included in their references section.

HOMEWORK RECOMMENDATION:

Students should complete the *MSIP Final Report Outline* for homework.



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MEETING 15: *WRITING UP YOUR FINAL CONCLUSIONS*

Minimum materials required:

- *MSIP Final Report Outline: 1 per student (students should already have this handout)*
- *MSIP Archived Team Results Outline (optional): 1 per team*

Students should discuss their completed *MSIP Final Report Outlines* in order to ensure they have included all the information that related to the research they have done. It is also important to ensure their information is consistent among each team member.

OPTIONAL: If students wish to potentially publish their results on the MSIP website, they can do so by filling out the *MSIP Archived Team Results Form*.

This outline is available at either of the following links:

- http://marsed.asu.edu/upload/MSIPArchivedTeamResults_web.doc OR
- http://marsed.asu.edu/upload/MSIP_Archived (Look for Meeting 15 folder)