DRAWING CONCLUSIONS

Minimum materials required:

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

The recommended strategy for filling out and finalizing the *Data Analysis* handouts is as follows:

- Small Research Teams: Working as a team, students should discuss and debate the information they completed for homework. Together, they should discuss their observations and interpretations of each of the graphs. Students should show the graph(s) they analyzed and discuss their observations and interpretations. Based on input from other team members during their discussion, students should revise (as necessary) their*Data Analysis* handouts to record the most pertinent information for each graph for their project. All members of the team should write down the appropriate and consistent final information for each graph.

Using the information researched and the 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.

Download the ***MSIP Final Report***.

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

I. Introduction

Here are three main questions students should address in this section:

1. *What is your science question?* This is self-explanatory.

2. *Why is this question important and interesting?* Students should think about why this topic interested them but also why this question is important in understanding Mars better. For many students this many not be easy. Understanding why what they are studying is important can be difficult. It requires students to think more globally and critically about 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.

3. *List any hypotheses you had of what the answer(s) might be to your science question.* For this, students should think back to what they originally wrote for their Introduction section of the *MSIP Proposal*. Students should have based any hypothesis (and they can have more than one hypothesis) on observed trends rather than just an unsupported guess. Students will indicate if these hypotheses were supported or refuted in the Conclusion section of their final report.

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. Students should be sure to change and update the information as necessary. Students should also be sure to cite sources appropriately. This includes citing images from the THEMIS website as well.

The suggested information they should include in this section is as follows:

1. *List definitions of the geologic feature(s) on Mars you are studying as part of your science question.* Some of this information can be found in the Feature Identification Charts.

2. *Show how the geologic feature(s) you are studying are thought to form (the geologic process) on Mars in a sketch.* This can be done in a student drawn sketch or diagrams they have found in a resource.

3. *Describe how the geologic feature(s) you are studying are thought to form?* If you created a sketch describe the process you sketch is illustrating. This can be a written explanation of their sketch or diagram.

4. *Show what the geologic feature(s) you are studying look like on Mars.*
   - *Draw sketches.* Students can draw or sketch the feature(s) they are studying.
   - *Show THEMIS images that show good examples of your geologic feature(s).* These can be images from thehttp://themis.asu.edu website.
   - *Describe the defining characteristics or criteria for identifying the geologic feature(s) you are studying. (For example: Let's say you are studying the relationship between sand dunes in different types of craters. If this is the case, you should describe what the criteria or defining characteristics are for the different types of craters (preserved, modified or destroyed) as well as what criteria or defining characteristics you look for to identify sand dunes.)* Students should describe defining characteristics or criteria for identifying the geologic feature(s) they are studying.

5. *List any hypotheses or information about the formation of the geologic features(s) you are studying from other scientists:* Different sources may provide different information about the geologic feature(s) students are studying or thoughts on how those features may form.

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 (or at least should be updated) since they completed their *MSIP Proposal Outline*.

Anything students can show in an example to illustrate any part of their methods would be useful. For example, if students were studying the relationship between different types of craters and sand dunes, they should have already mentioned the different types of craters and sand dunes in their background section. As part of their methods, they should discuss the criteria they specifically used for their research as they gathered their data. If they used a "control", that should be discussed as well. Another example would be if the students made measurements as part of their research. They could include a labeled image to indicate what they measured and a step-by-step description of the process they used to make their measurements.

IV. Data

For the Data section, there is one main question students should address. The total focus is on **listing and displaying** the data and **observations** of that data:

1. *Display your data (attach any and all information you put together for this section):*

- *Show your data table and explain what it is showing.* Students should show and discuss some of the details of their compiled master data table. This should include the headers of each column of data they collected, the number of images/data points that are on the table. If the table is organized in some way (by image ID # or by latitude or by individual who collected the data) that can also be mentioned. Students can also mention that the data in this compiled master table is what they used to display their data in different ways. By displaying the data in graphs, they are able view it in a way that allows them to more easily understand what the data is showing.

- *Show each of your graphs and explain what each graph is comparing and what observations, including patterns or trends you can observe with the data displayed on each graph.* Students should include each individual graph and either under the graph or by the side of the graph they should list the following information:
    - What the graph is comparing (For example, this graph is showing the channel width versus the channel depth.)
    - Observations, patterns, 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.)

- *Show your data on a map of Mars and explain what it is showing and what observations, including patterns or trends you can observe with the data displayed on the map.* Again, students should include their data on a map of Mars (elevation map, dust index map, etc. There are many different maps available of Mars.) Students should again include:
    - What the graph is comparing (For example, this graph is comparing latitude versus longitude and is showing channel locations on Mars.)
    - Observations, patterns, and trends they are noticing based on the map (keep in mind they are only mentioning their observations here – not the interpretations of what those observations may possibly mean.)

- *Show and discuss any qualitative information (sketches and overall general observations) that are important for better understanding the feature(s) you are studying or how the surrounding areas (the context) that may play a role in the process or formation of the feature(s) you are studying.* Students should include any qualitative observations that are important for their project. These qualitative observations can be a part of the data table. Sometimes students do not think they need to include this qualitative information. This information is extremely important as it allows students to think about what different aspects of their feature may be telling them about the formation of the feature or how the surrounding area (the context) may be affecting the process or formation of the feature(s) they are studying. Again, they should only discuss their observations of this qualitative data and save their interpretations for the discussion section of the final report.

V. Discussion

This section asks students to show their data 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 those interpretations may mean as it related to their science question.

1. Show each graph individually (including your data on the map of Mars) and include the following:
    - A brief overview of what the graph is comparing and the trends, patterns, and observations of that graph. This overview should be brief and used just to reorient the reader to the graph students will discuss.
    - 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. Students should include information about how things may be working on Mars according to their data. If the data is not giving them enough information

to support a consistent idea of how the specific process may be working on Mars, students should discuss this as well.
- Apply those interpretations to their specific question. Students should always apply what the data is showing them to their specific question and/or hypothesis(es). Student interpretations should reflect the observations they made and should be related to their science question.

2. Discuss the potential errors with the data you collected.
- Could there be any inaccuracies? If so, please explain. Students should explain if they could have any inaccuracies with their data. For example, students may have had some potential errors in some of the measurements they made. Students should discuss any of these type of potential errors or inaccuracies.
- Could there be any misinterpretations? If so, please explain. Among team members, especially in the identification of geologic features, different students may have identified or classified incorrectly or differently than others. Depending on the student project, this could affect their results. Students should discuss this.

VI. Conclusion

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

1. *Re-state and answer your science question based on your interpretations from the discussion section.* This is self-explanatory. In some cases, students will find that they can not come to a conclusion about the answer to their question. If this is the case, the students can explain why and what they could do in order to be able to answer their question in the future.

2. *Re-state and support or refute your hypotheses (if you had any) based on your interpretations from the discussion section.* Students can restate any hypotheses they may have and briefly state why they were supported or refuted based on their interpretations of the data (the discussion section). Again, if they feel they do not have enough data to support or refute their hypotheses they should discuss why.

3. *What future work could be done to expand your research project?* Students should think about how their research could be expanded to gain a better understanding about what they were studying. Future work can also include what other questions that have sparked their interest and curiosity because of the research they just conducted.

4. *Who can you acknowledge for helping you complete your science project?* Students should acknowledge those who helped them with their research. This may include the teacher, librarian, parents, or anyone else who may have helped them.

VII. 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 within the final report should be included in their references section. Students should reference carefully.

HOMEWORK RECOMMENDATION:

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