

2010



When Things Go Wrong...  
A Space Mission Simulation

## Final Evaluation Report

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Prepared for:  
The Martha Holden Jennings Foundation

Prepared by:  
Jacob Burgoon, M.S.  
Northwest Ohio Center for Excellence in STEM Education

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## EXECUTIVE SUMMARY

Tiger Team 2010 was a professional development and outreach project designed and conducted by the Challenger Learning Center of Lucas County and funded by the Martha Holden Jennings Foundation. The project aimed to improve 21<sup>st</sup> Century Skills and content knowledge in science and mathematics for grades 6-12 students and their teachers, as well as develop and test new methods of distance program delivery to potentially increase the number of schools that can benefit from Challenger Distance Learning.

The main goals of Tiger Team 2010 were to (1) provide effective professional development for middle and high school teachers, (2) provide an engaging curriculum and real-world Challenger programming for grades 6-12 students, (3) improve teacher and student content knowledge in inquiry science, mathematics and technology, (4) improve teacher attitudes toward and aptitude for distance learning, (5) effectively reach rural and urban teachers with new STEM content and technologies for distance learning.

Eighteen teachers and their students (mostly from middle and junior high schools) from the northwest Ohio area participated in Tiger Team 2010. Ten teachers and their students participated in the distance learning component of the project, and eight teachers and their students visited the Challenger Center in person.

The evaluation of the project was conducted by the Northwest Ohio Center for Excellence in STEM Education. The purpose of the project evaluation was to assess the extent to which Tiger Team 2010 achieved its goals, and to provide recommendations for how the Tiger Team activities can be improved. The evaluation was guided by the following questions:

1. What is the quality of the professional development experience provided for teachers?
2. How successful is the distance learning component of the project?

3. What is the impact of the project on teachers' attitudes toward and aptitude for distance learning?
4. What is the impact of the project on teachers' and students' knowledge of space history, science, and mathematics?

Several data collection methods were used to answer the evaluation questions, including teacher surveys, professional development and classroom observations, and a student content knowledge test.

The findings from the teacher professional development survey and professional development observation demonstrate that the professional development workshop was high in quality. The teachers perceived the workshop to be valuable, specifically in that it allowed them to experience the distance learning program from the perspective of their students. The workshop was engaging for the teachers, and gave the teachers opportunities to ask questions and make suggestions regarding the distance learning program.

The findings from the teacher reflections and classroom observation demonstrate that the distance learning program was successful, based on the technological components of the distance connection, the facilitation of the classroom activities, and the extent to which students enjoyed and were engaged in the distance learning activities. The only technological issue faced during the distance connection was poor audio quality. Although all of the teachers successfully facilitated the distance connection activities, the findings indicated that the success of the program was dependent upon the extent to which teachers implemented relevant activities before the distance connection. The students enjoyed the distance learning experience overall, and were highly engaged in the distance connection activity. The teachers reported that the distance learning program was a valuable experience that offered their students something different from their everyday activities.

The findings from the teacher survey demonstrated that the project was successful in improving teachers' attitudes toward and aptitude for distance learning. Teachers significantly increased their frequency of using distance learning in the classroom and their preparedness to use distance learning in the classroom. Teachers also significantly increased their self-efficacy to integrate technology in their classroom.

The findings from the student content knowledge tests demonstrate that the distance learning program was successful in improving students' knowledge about space history, science, and mathematics. All student groups – middle, junior high, and high school – significantly improved their content knowledge as a result of participating in the distance learning program.

The following recommendations are based on the evaluation findings and are intended to assist the project staff in making improvements to the project:

- Continue to include the teacher-as-student aspect of the professional development workshop
- Clearly describe the sequence of events that should unfold in the teachers' classroom before and during the distance connection
- Increase the number of activities that teachers are required to facilitate before the distance connection
- Increase the amount of time that students have to complete the distance connection activity

## INTRODUCTION

The purpose of this report is to describe the evaluation activities and findings regarding Tiger Team 2010. The Northwest Ohio Center of Excellence in STEM Education conducted the evaluation of Tiger Team 2010. The report will begin with a brief description of the project and continue with a description of the project evaluation methods. The report will then describe the findings of the project evaluation before concluding with a list of recommendations for future Tiger Team projects.

## AN OVERVIEW OF TIGER TEAM 2010

Tiger Team 2010 was a professional development and outreach project designed and conducted by the Challenger Learning Center of Lucas County and funded by the Martha Holden Jennings Foundation. The project aimed to improve 21<sup>st</sup> Century Skills and content knowledge in science and mathematics for grades 6-12 students and their teachers, as well as develop and test new methods of distance program delivery to potentially increase the number of schools that can benefit from Challenger Distance Learning. The distance learning program used for this project (i.e., Apollo 13) focuses on 21<sup>st</sup> century skills through inquiry-based problem solving and builds student content knowledge in mathematics, technology and science.

The main goals of Tiger Team 2010 were to (1) provide effective professional development for middle and high school teachers, (2) provide an engaging curriculum and real-world Challenger programming for grades 6-12 students, (3) improve teacher and student content knowledge in inquiry science, mathematics and technology, (4) improve teacher attitudes toward and aptitude for distance learning, (5) effectively reach rural and urban teachers with new STEM content and technologies for distance learning. Tiger Team 2010 began in November of 2010 and concluded in May 2011. The project included a one-day professional development workshop for teachers, distance learning programs, and field trips to the Challenger Learning Center of Lucas County.

Teachers who participated in the distance learning component of the project attended a one-day professional development workshop in January of 2011 and received two distance learning programs in their classroom from the Challenger Learning Center (CLC). Most of the teachers received the distance learning programs during March of 2011. Teachers who participated in the Challenger programming component of the project received a field trip to the Challenger Learning Center for one of their classes. Many of the distance learning connections were made between the students of a teacher participating in the distance learning component and the students of a teacher participating in the Challenger programming component. Reed Steele, the director of the CLC, and Bob Hower co-facilitated the distance learning connections.

## **PARTICIPANTS**

Eighteen teachers and their students from the northwest Ohio area participated in Tiger Team 2010. Ten teachers and their students participated in the distance learning component of the project, and eight teachers and their students visited the Challenger Center in person. Most of the participating teachers were middle and junior high school teachers. The distance learning group was comprised of four middle school (grades 5 to 6), four junior high (grades 7 to 8), and two high school (grades 9 to 12) teachers. The field trip group was comprised of four middle school and four junior high teachers. All of the teachers but one (who taught social studies) taught science, science and math, or all subjects (self-contained classroom).

## **EVALUATION METHODS**

The evaluation of Tiger Team 2010 was originally based on the following questions:

1. What is the quality of the professional development experience provided for teachers?
2. What is the quality of the Challenger programming provided for students and teachers?



3. What is the level and quality of teachers' participation in the Challenger programming?
4. How successful is the distance learning component of the project?
5. What is the impact of the project on teachers' attitudes toward and aptitude for distance learning?
6. What is the impact of the project on teachers' and students' knowledge of space history, science, and mathematics?

Two changes were made to the evaluation plan during the implementation of Tiger Team 2010. First, the quality of the Challenger programming<sup>1</sup> and the level and quality of the teachers' participation in the Challenger programming (evaluation questions 2 and 3) was not evaluated. The project staff decided that the distance learning component was the main focus of the project, and therefore the evaluation activities focused on the distance learning programming. Furthermore, the Challenger Learning Center of Lucas County has collected an abundance of data over the past several years that demonstrate the high quality of the Challenger programming. Collecting more data for this particular project, therefore, would not have been productive. The second change was that content knowledge was measured for students only, instead of for students *and* teachers. After reviewing the project activities, the project staff decided that while teachers would likely learn some content during the project, improving teacher content knowledge was not a main goal of the project. The project sought to determine the impact of the distance learning programming on *student* content knowledge. Thus, improving teachers' abilities to facilitate the distance learning programming was considered to be more important than improving teachers' content knowledge. The evaluation activities therefore focused on the quality of the professional development, the success of the distance learning activities, teachers' attitudes toward distance learning, and students' content knowledge.

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<sup>1</sup> Challenger programming refers to the "Return to the Moon" simulation that students participate in at the Challenger Learning Center. The Challenger programming can be viewed in contrast to the distance learning programming that students participate in at their school.

## DATA COLLECTION METHODS

Several data collection methods were used in order to evaluate the quality of the professional development, the success of the distance learning activities, teachers' attitudes toward distance learning, and students' content knowledge. From this point forward, "teachers" will refer only to the teachers who received the distance learning programs, as the field trip teachers were not asked to participate in any evaluation activities. The data collection methods will be described below along with a description of the data collection procedures.

### ***Professional Development Surveys and Observations***

A paper survey was administered at the conclusion of the one-day professional development workshop in order to measure teachers' perceptions regarding the quality of the professional development experience. Seven surveys were completed, as three teachers were unable to attend. (Those teachers not in attendance participated in a modified distance professional development session in January.) The survey included three sections regarding the quality of the workshop, the value of the workshop, and the teachers' reasons for participating. This evaluation focused only on teachers' responses to the seven items regarding the quality of the professional development. These seven items represented different aspects of the workshop: content, organization, presenter(s), ideas and activities, integration and use of technology, opportunities for audience participation, and overall value. Teachers rated each item on four point scale, with 1=Poor, 2=Fair, 3=Good, and 4=Excellent. The survey also included three open-ended items to which teachers could write about the most and least valuable aspects of the workshop and provide additional comments about the workshop.

In addition to collecting paper surveys regarding the quality of the professional development, the evaluator also observed and took field notes about the professional development workshop.

## ***Teachers' Attitudes Toward Distance Learning and Project Content Survey***

The project staff developed a survey to measure teachers' attitudes toward distance learning and project content (physical science and social studies). The teachers completed a paper version of the survey at the beginning of the professional development workshop, and completed an online version of the survey in May of 2011.

The survey consisted of 14 items that could be grouped into three different sections. The first section contained ten items, and measured teachers' self-efficacy (confidence in their ability) regarding the integration of instructional technology in their classroom. The items in this section were measured on a five-point scale, with 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4= Agree, and 5=Strongly Agree. Examples of items in this section include, "I know the steps that are necessary to effectively integrate technology into my classroom lessons," and "I know how to use technology to get my students more excited to learn".

The second section of the survey consisted of three items that measured teachers' perceived use of and attitudes toward distance learning. The items were measured on a four-point scale (the values differed for each item), with 1=Never/Not Useful/Not Prepared, 2=Rarely/Slightly Useful/Slightly Prepared, 3=Sometimes/Moderately Useful/Moderately Prepared, and 4=Frequently/Very Useful/Very Prepared.

The third section consisted of two items that measured teachers' attitudes toward physical science and social studies. One item asked teachers to rate their level of comfort for teaching physical science, and the other item asked teachers to rate their level of comfort for teaching the history of the space race (e.g., the Cold War, NASA, the Apollo missions). These items were measured on a four-point scale, with 1=Not Comfortable, 2=Slightly Comfortable, 3=Moderately Comfortable, and 4=Very Comfortable.

The survey can be found in Appendix A.

## ***Teacher Reflections and Classroom Observations***

Teacher reflections were collected to evaluate the success of the distance learning programs. After both distance learning programs were delivered in their classroom, teachers were asked to write a reflection in response to the following prompt:

Please write a reflection that includes you and your students' reactions of the distance learning experiences provided during Tiger Team 2010. You may want to comment about things that were really successful or things that didn't go as well you had hoped. Comment about your overall reaction to the distance learning experience. Were you surprised by anything? How did the technology work? What could have been done to make the experiences better? Also, ask your students what they thought of the experience, and include their reactions in your reflection as well. You can write whatever you want, but make sure that your reflection is detailed enough so that I can clearly understand your experience.

The reflections were collected online and via e-mail. First, teachers were asked to submit their reflection on a discussion board on the Tiger Team 2010 wiki (see <http://tigerteam2010.wetpaint.com>). However, many teachers did not complete the reflection using this venue. Therefore, the reflection prompt was directly e-mailed to the teachers in order to increase the response rate. All but two of the remaining teachers completed the reflections via e-mail.

The reflections provided a measure of teachers' and students' perceptions regarding the success of the distance learning programs. In addition to the reflections, the evaluator visited one of teachers' classrooms and observed his/her students participating in the distance learning program.

## ***Student Content Knowledge Test***

The project staff developed a content knowledge test that measured students' knowledge of space history, science, and mathematics topics that were addressed

during the distance learning program. Since each teacher had a different timeline regarding the delivery of the distance learning programs, the teachers were asked to administer the test to their students before and after the delivery of the distance learning program. The tests were mailed to the teachers before any of the distance learning programs were delivered. Pre-paid envelopes were included for teachers to mail back the completed tests. The content test was comprised of ten items, of which eight were multiple-choice and two were open-ended. Students were prompted to provide a unique code, which would be used to match the students' pre- and post-test responses. The students' test responses were graded and entered by student assistants.

The student content knowledge test can be found in Appendix B.

## EVALUATION FINDINGS

The evaluation findings in this section will be organized according to the evaluation question they answer. The findings will be preceded by a description of the analytical methods that were used to determine them.

### **WHAT IS THE QUALITY OF THE PROFESSIONAL DEVELOPMENT EXPERIENCE PROVIDED FOR TEACHERS?**

The quality of the professional development was evaluated using teachers' responses to the professional development survey and the field notes from the professional development observation.

The teachers' responses to the professional development survey were entered into a spreadsheet, and a frequency analysis was conducted in order to determine the number and percentage of responses in each category for each statement. Teachers' open-ended responses were thematically analyzed to identify common themes among the responses. The observation field notes were analyzed to identify the extent to which the professional development consisted of best practice methods and effectively engaged the participating teachers.

The results of the professional development survey demonstrate that teachers perceived the professional development workshop to be valuable overall. All of the aspects of the workshop were rated as “Excellent” by at least five of the seven teachers who participated in the professional development. Three aspects – namely, the presenters, the integration and use of technology, and the overall value of the workshop – were rated as “Excellent” by all seven of the participating teachers.

Regarding the most valuable aspect of the workshop, a majority (four) of the teachers wrote that it was valuable to participate in the same activities that their students will experience during the distance learning program. Only two of the teachers wrote about aspects of the workshop that they deemed to be least valuable. One teacher wrote that learning how to use Skype was not valuable (s/he already knew how to use it), and the other teacher wrote that any content more complex than his/her grade’s science standards was not valuable (s/he did note, however, that s/he could tailor the information to meet his/her students’ needs).

The observation field notes included descriptions of the professional development activities as well as the actions of the facilitators (Reed Steele and Bob Hower) and the teachers. The professional development workshop took place at the Challenger Learning Center. The workshop started with a brief introduction of the Challenger Learning Center before moving on to an explanation of the distance learning program and how it would be implemented in the teachers’ classroom. Then, Reed and Bob guided teachers through the distance learning program. Reed left the room in which the professional development workshop was being held, and went to one of the rooms in which the Challenger programs are implemented<sup>2</sup>. Reed made a distance connection (via Skype) to the teachers in the professional development room, and proceeded to give them a tour of the inside of the spacecraft. After Reed explained the

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<sup>2</sup> This room simulates a spacecraft, and contains several different “stations” that students work at during a Challenger mission. During the distance learning program, students in the classroom are asked to solve an emergency that comes up at the Life Support station involving the concentration of carbon dioxide in the spacecraft.

emergency to be solved during the distance learning program, the teachers were given the opportunity to solve the problem, using the same rules and materials that their students would use. The following selection from the observation field notes demonstrates the teachers' level of engagement in the distance learning program:

The teachers worked in teams of 4 to solve the problem. They were all engaged, talking to each other. The teachers reiterated the problem – talked about how the air filtration system worked, and what they needed to do in order to solve the problem, saying things like, “OK, dirty air goes in here, and clean air comes out here”. The teachers asked Bob and Reed for assistance and clarification about the problem and the solution.

After the distance learning program, Reed and Bob had a question and answer session to help teachers better understand what had happened during the distance learning program and what will happen when the program is implemented in their classroom. The question and answer session resulted in several suggestions from the teachers about how to make the distance learning program better for their students. The following field note selections illustrate these suggestions:

The teachers noticed that the mock up board [in the distance learning kit] wasn't exactly the same as what was in the spacecraft. One teacher suggested the kit include pictures of the boards as they appear on the spacecraft. Reed said that they can take pictures and label them and put them on the Challenger website.

Teachers asked if before hand they should practice with their students how to give clear directions. Reed said that it would be a good lesson to do ahead of time and gave examples of what they could do, including writing and communicating the directions to a particular task.

The workshop facilitators went on to explain and demonstrate the technology that would be used during the distance learning program, and also explained the activities that would need to be done in the classroom before and after the distance learning program. The field notes demonstrate that the professional development workshop included best practices teaching methods in the form of inquiry-based hands-on instruction and technology integration. The teachers were highly engaged during the workshop, not just during the distance learning program, but also throughout the

demonstrations. Teachers asked many questions and offered several suggestions for the implementation of the project.

### **HOW SUCCESSFUL IS THE DISTANCE LEARNING COMPONENT OF THE PROJECT?**

The success of the distance learning program was determined by examining the following aspects: the technological components of the distance connection, the facilitation of the classroom activities, and the extent to which students enjoyed and were engaged in the distance learning activities. These components were analyzed using the teachers' reflections of their (and their students') distance learning experience as well as the field notes from the classroom observation. The reflections and field notes were thematically analyzed using ATLAS.ti qualitative analysis software. Eight reflections (varying in length from one paragraph to several paragraphs) and one classroom observation were analyzed in order to answer this evaluation question.

#### **Technological Components of the Distance Connection**

The success of the technological aspects of the distance learning component is one criterion for the overall success of the distance learning component. The Challenger Learning Center used Skype and WebEx computer software to connect to teachers' classrooms and implement the distance learning programs. The biggest technological issue associated with the distance connection seemed to be poor audio quality. A few teachers mentioned that the audio was too quiet or would "come and go" during the connection. This was certainly the case during the classroom observation. The Challenger Learning Center connected to the classroom via Skype, but because of poor audio quality, had to disconnect and connect again in an attempt to improve audio quality. Although the second connection was better, the students in the classroom had difficulties in understanding Reed. In order to ensure that the students understood the emergency, the classroom teacher repeated much of what Reed said to the students. Another teacher also reported having to repeat words and phrases to his/her students.



Despite the audio problems that were experienced by some teachers, there seemed to be no other technological issues. All of the programs were implemented during their scheduled time, and no teachers needed to reschedule or cancel a program due to an inability to connect with the Challenger Learning Center.

### **Facilitation of Classroom Activities**

Another component that contributed to the overall success of the distance learning program was the facilitation of the classroom activities – before, during, and after the distance connection – by the classroom teachers. Since the extent and quality of the classroom facilitation depending on the individual efforts of the classroom teachers, the success of this component varied from teacher to teacher. The written reflections indicate that all the teachers successfully facilitated the classroom activities during the distance connection, but there was a range of success regarding the facilitation of pre-connection activities. During the distance learning connection, the teachers were required to manage the materials that were sent from the Challenger Learning Center before the distance connection, and guide students through the distance learning program activities. Before the distance connection, the teachers were sent a box of materials for the distance learning activity and a box of materials for a pre-connection activity. The teachers were required to implement and facilitate the pre-connection activity sometime before the distance connection, and were encouraged to implement other relevant activities beforehand that were made available by the Challenger Learning Center on their website. Post-connection activities were also made available, and teachers were encouraged to implement and facilitate these activities after the distance connection.

There seemed to be some confusion among a few of the teachers regarding what activities were supposed to be done ahead of time and when those activities were supposed to be done. In the words of two teachers:

*As a teacher, a timeline would have been nice. We were given many materials/resources, but I did not know when to do them. Nor, did I really know if I was "supposed" to give task cards before or explain the life support board before. Had there been a timeline of things to do before the connection day, I would have felt better.*

*I myself was confused as to when to give [the students] the boxes and the clipboards.*

The data suggest that the success of the distance learning program depended in part on the extent to which the teachers prepared their students before the distance connection. While some teachers only implemented the required pre-connection activity, other teachers implemented multiple activities before the distance connection. One teacher spent an entire week before the distance connection doing activities that prepared his/her students for the distance connection. Many teachers perceived the pre-connection activities to be an important part of the program, and attributed the success of the distance learning activities to the preparation provided by the pre-connection activities. Three of the teachers wrote:

*I can honestly say that the 4 previous days of "training" were the perfect recipe for success when it came down to mission day. The students performed amazingly.*

*I am glad I did the pre-connection activity with my students. We called it "astronaut support training." My goal was to get my students to work together as small groups and large groups, a procedure that would be similar to connection day .... By the end of the four [training] days the groups were more comfortable making decisions together. On connection day the groups were effective in their communication and decision making skills.*

*I felt the pre-activities and extra activities on the CLC website really helped the students be prepared and understand what to do.*

Without adequate preparation, the students could not experience the distance learning program at its full potential. Some of the teachers mentioned that their

students felt overwhelmed during the distance connection, which was likely due to their lack of preparation. For example, some students experienced difficulty in solving the emergency because of their unfamiliarity with the air filtration panel<sup>3</sup>. In the words of one teacher:

*During the connection many groups needed questions answered about the panel and some initial design errors were made due to students not understanding the how the parts of the panel worked. If my students were familiar with the panel ahead of time they would have been more efficient solving the LiOH problem during the connection. The unfamiliarity with the panel made it hard for my students to give directions to the students in the Challenger Learning Center. The student who was the communications officer struggled finding the proper vocabulary words needed to give good directions. He used words like tube and holes. If he had been more familiar with the materials he would have used the words like cabin intake and suit hose.*

The classroom observation provides a good example of how unpreparedness might have resulted in students becoming overwhelmed. Before the distance connection, the classroom teacher expressed some concern that the students didn't understand how the board worked in terms of input and output. (The students saw the board for the first time at the beginning of the distance connection.) During the distance connection, the students' proposed solutions indicated a lack of understanding regarding the panel. One group had connected a tube on the back of the panel, which would not be possible in the spacecraft because the panel is permanently attached to the wall. Perhaps if the students had been more familiar with the panel, their solutions would have been more creative and appropriate.

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<sup>3</sup> The emergency required students to use the provided materials to come up with a way for a square lithium hydroxide (LiOH) filter to work in a round filter compartment. The distance connection kits included all of the needed materials, including a model of the panel on the spacecraft where the LiOH compartment is located. The panel was comprised of several components, including input and output valves for the air in the main cabin as well as for two spacesuits.

## **Students' Enjoyment of and Engagement in the Distance Learning Activities**

Since the distance learning program is meant to improve student learning, the extent to which students enjoy and engage in the distance learning activities is a major factor in the overall success of the distance learning program. Overall, the teachers reported that their students were eager to participate in and enjoyed the distance learning activities.

Two teachers wrote:

*The [distance learning program] gave the students a new experience that they enjoyed. I asked the students if they would like to do something similar again (perhaps a little more organized), and they said "absolutely".*

*The distance learning was a wonderful experience .... One student said, "I did not know this was going to be so cool!"*

Teachers also reported that their students were highly engaged in the distance learning activities. The observed classroom again stands as an example of this conclusion. During the distance learning connection, the students actively worked in their groups to come up with a solution to the problem. Every student in every group was participating in some way during the distance connection. Three of the teachers wrote:

*The technological and "theatrical" aspects of this lesson fascinated my students, held their attention, and enriched the learning. Skype, the web camera, the students in the space station and Reed in his NASA uniform made for a great experience.*

*The students were very on task and serious!!*

*Most students were very serious about their responsibilities for the team.*

Some of the teachers commented on the short duration of the distance connection, and suggested that more time would have made for a better experience for their students. Two teachers wrote:

*The last suggestion I have is to watch the time carefully. My first class took too much time deciding which design was best. This left precious little time to communicate the solution to the students in the Challenger Center before the end of the connection.*

*I would have liked to give the students more time to work on their solutions. The short time frame did simulate a real emergency, but students are not used to working with hands-on materials so quickly. I think that some of the solutions would have been more creative, effective, and well-built if they had more time to work.*

Overall, the teachers perceived the distance learning program to be valuable experience for their students. The teachers mentioned that the distance learning program offered their students something different from their everyday activities. Teachers also perceived the program to be valuable because it allowed students to experience the Challenger Learning Center even when there were no funds for field trips. Some of the teachers wrote:

*I felt this was a fun activity, and it got [the students] thinking outside of the textbook and the normal day-to-day activities I perform in the classroom.*

*The Tiger Team distance learning program was an excellent learning opportunity for my students. It offered them a chance to work cooperatively with hands on materials, technology, and experience a different type of learning activity.*

*This was a wonderful cross-curricular learning activity, especially at a time when our department had no funds available for field trips.*

*Overall, it was a great experience, and I am very thankful I had the opportunity to do this with my class since we can not go to the [Challenger Learning Center] this year.*

## WHAT IS THE IMPACT OF THE PROJECT ON TEACHERS' ATTITUDE TOWARD AND APTITUDE FOR DISTANCE LEARNING?

The impact of the project on teachers' attitude toward and aptitude for distance learning was evaluated using the teacher survey. Of course, there are many limitations to these data, especially in determining the "impact" of the project. Ideally, the impact of a project would be determined using a randomized experimental design, with teachers being randomly assigned to either an experimental or control group. This procedure allows one to confidently attribute changes in a particular variable to the project in question. We did not have the resources to conduct such an experiment, and instead used a one group pre-post design. Furthermore, the small sample size (n=10 teachers) used for this evaluation decreases the power of the statistical tests, and makes it more difficult to obtain statistically significant results<sup>4</sup>. The findings for this evaluation question should be interpreted with these points in mind.

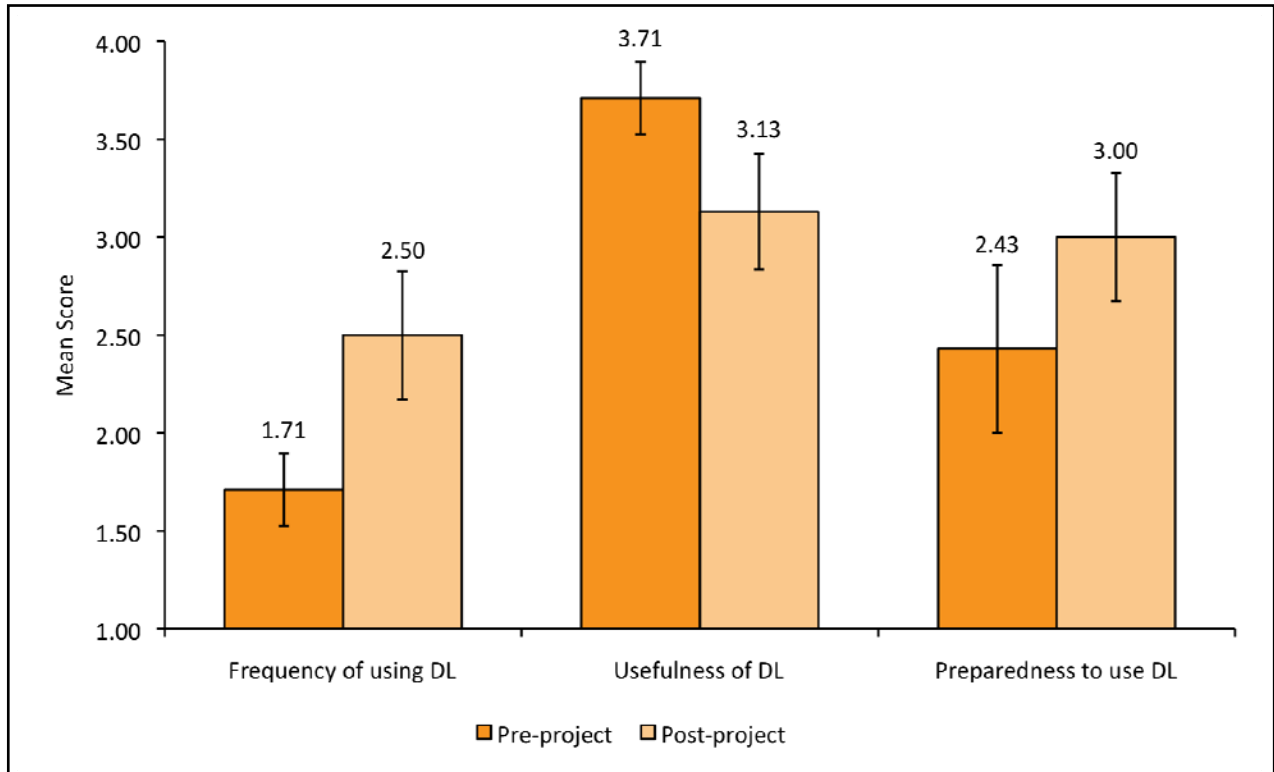
The teachers' survey responses were analyzed using a series of Wilcoxon signed ranks tests in order to determine the extent to which teachers' attitudes changed over the course of the project. Seven teachers completed the pre-survey and eight teachers completed the post-survey. However, there were only six matching pairs, and only the matching responses were used in the analyses. Each of the three items in the distance learning section were analyzed separately in order to determine how each aspect of teachers' attitude/aptitude toward distance learning (i.e., frequency of use, beliefs regarding its usefulness, beliefs regarding their preparedness) changed during the project. The results of the Wilcoxon tests demonstrate the teachers significantly improved their frequency of using distance learning ( $Z = 1.86, p < 0.1$ ) and beliefs regarding their preparedness to use distance learning ( $Z = 1.89, p < 0.1$ ). However, the

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<sup>4</sup> For this reason, a more conservative criterion ( $\alpha=0.1$  instead of  $\alpha=0.05$ ) was used to determine the statistical significance of the test results. This means that instead of accepting that our test results could have occurred by chance 5 in 100 times (as is implied by  $\alpha=0.05$ ), we are accepting that our results could have occurred by chance 10 in 100 times (which is implied by  $\alpha=0.1$ ). Although this lowers our confidence in the significance of the results, it helps us to avoid obtaining a false negative, which often occurs with small sample sizes.

teachers did not significantly improve their beliefs regarding the importance of distance learning ( $Z = 1.00$ , n.s.<sup>5</sup>). Figure 1 illustrates the changes in teachers' survey scores over the course of the project.

**Figure 1. Changes in teacher survey scores during Tiger Team 2010**



More broadly, the results of the teacher survey also demonstrate a significant improvement in teachers' self-efficacy regarding the integration of instructional technology in their classroom (pre-mean = 3.96, post-mean = 4.07,  $Z = 2.21$ ,  $p < .05$ ). Distance learning technology was the only instructional technology used during this project, so the improvement in teachers' self-efficacy to integrate technology likely reflects teachers' increased confidence/preparedness to use distance learning technology in their classroom.

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<sup>5</sup> Not significant

## WHAT IS THE IMPACT OF THE PROJECT ON STUDENTS' KNOWLEDGE OF SPACE HISTORY, SCIENCE, AND MATHEMATICS?

The impact of the project on students' knowledge of space history, science, and mathematics was evaluated using the student content knowledge test. Again, the lack of a control group makes it difficult to attribute changes in content knowledge to the project activities. However, the fact that the distance learning program occurred over a short period of time makes it unlikely that the changes in student content knowledge would have resulted from anything else. It's unlikely that the teachers would have provided additional instruction (not associated with the Tiger Team 2010 project) regarding the topics assessed by the content tests in the short time between the administration of the pre- and post-tests. Therefore, even though a control group was not used for this evaluation, we can be fairly confident that the changes in student content knowledge were due to the distance learning programs.

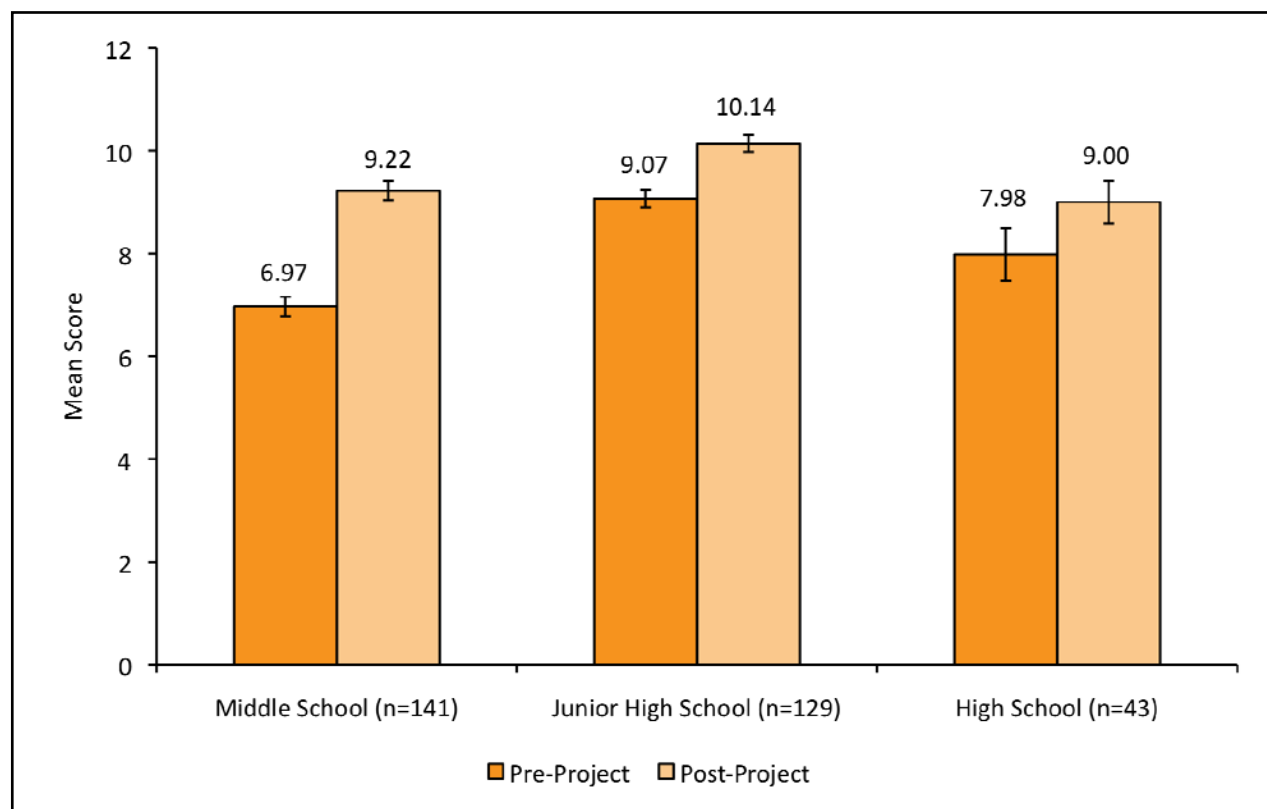
All but one of the teachers returned their students' pre- and post-tests, resulting in a total of 342 student responses to the pre-test and 347 students responses to the post-test. Of all the student responses, 313 matching pairs were identified and used for analysis. A series of Wilcoxon signed ranks tests were conducted to test the differences between the students' pre- and post-test scores.<sup>6</sup> Since the student sample contained such a wide range of grades (and therefore previous knowledge), the total sample was grouped into grade levels (middle, junior high, and high school) for analysis. The results of the Wilcoxon tests demonstrate significant increases in content test scores for students in middle school ( $Z = 8.89$ ,  $p < .0001$ ), junior high school ( $Z = 6.30$ ,  $p < .0001$ ), and high school ( $Z = 3.59$ ,  $p < .0001$ ). Figure 2 illustrates the changes the student content test scores that occurred over the course of the project.

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<sup>6</sup> The distribution of student responses was not normal (i.e., bell-shaped), and since normality is a requirement for parametric tests like the t-test, we chose to conduct a non-parametric test, which does not require a normal distribution.



**Figure 2. Changes in student content test scores during Tiger Team 2010**



## RECOMMENDATIONS

The evaluation findings indicate that Tiger Team 2010 was successful in providing valuable professional development and distance learning opportunities that 1) improved teachers' attitudes toward and aptitude for distance learning, 2) successfully engaged students in inquiry-based problem solving activities, and 3) improved students' knowledge of space history, science, and mathematics.

One of the primary purposes of this project's evaluation was to identify the strengths and weaknesses of the project in order to foster discussions among the project staff regarding ways to improve the project activities. In general, the evaluation findings demonstrate that Tiger Team 2010 was successful in achieving its goals. We can also use the findings to identify the aspects of the project that were the most successful as well as the aspects of the project that could be improved. This section will

outline a few recommendations based on the evaluation findings that can assist the project staff in making improvements to the project.

**1 Continue to include the teacher-as-student aspect of the professional development workshop.**

The teachers reported that the most valuable aspect of the professional development workshop was the opportunity to participate in the distance learning program as their students would participate. This aspect of the workshop should be continued. Based on the teachers' responses about this issue, we can predict that teachers would also value opportunities to participate (as students) in pre-connection activities, which is something that was not included in Tiger Team 2010. Allowing teachers to participate in pre-connection activities is especially important if teachers are required to facilitate (more of) these activities before the distance connection (see recommendation three).

**2 Clearly describe the sequence of events that should unfold in the teachers' classroom before and during the distance connection.**

A few of the teachers were confused as to what they were supposed to do in the classroom before the distance learning connection. One teacher suggested that a timeline be provided regarding the activities that should be done before the distance connection.

**3 Increase the number of activities that teachers are required to facilitate before the distance connection.**

The findings from the teachers' reflections and classroom observation indicate that the success of the distance learning program depends in part on the extent to which teachers implemented pre-connection activities. The teachers were required to implement one pre-connection activity, but several more were provided for the teachers to facilitate at their discretion. The teachers who facilitated several of these pre-connection activities commented on the importance of the activities in making the distance learning program a success. Several teachers reported that students

were unfamiliar with some of the distance learning materials (i.e., task cards, air filtration panel), and suggested that exposing the students to these materials before the distance learning connection might improve the success of the program. Therefore, teachers should be required (or at least strongly encouraged) to facilitate more pre-connection activities to prepare their students for the distance connection. These pre-connection activities could include the existing activities that were provided to teachers during Tiger Team 2010 as well as additional activities that would familiarize students with some of the distance learning materials.

#### **4 Increase the amount of time that students have to complete the distance connection activity**

The teachers' comments indicated that students would have a better experience with the distance learning program if they were given more time to complete the distance learning activity. A few of the teachers mentioned that their students felt overwhelmed during the distance connection, and two teachers directly suggested that the time for the distance connection be increased. The distance learning program during Tiger Team 2010 gave students 20 minutes to solve the crisis before they needed to vote on the best solution and present the solution to the students at the Challenger Learning Center. The time constraints existed mostly because the project staff attempted to connect (via distance) the students in the classroom to students at the Challenger Learning Center. (The students at Challenger Learning Center only have a certain amount of time to complete their tasks on the spacecraft, so the distance learning program could only be implemented at particular times during the day.) And while connecting with other students may be more exciting/motivating, removing the student-student connection would allow the distance learning program to be run over a longer period of time, which would give students more time to think about and understand the concepts involved in the distance learning program.

Appendix A:

Teachers' Attitudes Toward Distance Learning and  
Project Content Survey

## Tiger Team 2010 Teacher Survey

Unique Code	First 2 Letters of Mother's Maiden Name		Your Birth Month (2 digits)		Your Birth Day (2 digits)	
EXAMPLE	D	E	0	7	1	8
<b>YOUR ID</b>						

**Directions:** Please carefully read the statements in this survey, and use the given rating scale to communicate your beliefs/opinions about the statement. Circle your response.

<b>1.</b>	<b>I am continually finding better ways to use technology in my classroom.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>2.</b>	<b>I know the steps that are necessary to effectively integrate technology into my classroom lessons.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>3.</b>	<b>I am not very effective at monitoring my students' use of technology in the classroom.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>4.</b>	<b>I understand instructional technology well enough to be able to effectively use technology in my classroom.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>5.</b>	<b>I find it difficult to help students who have trouble using technology in my classroom.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>6.</b>	<b>I do not know what to do to get students excited about using technology.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>7.</b>	<b>I know how to use technology to enhance my classroom lessons.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>8.</b>	<b>I wonder if I have the necessary skills to integrate technology into my classroom lessons.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>9.</b>	<b>I am typically able to answer my students' questions about using technology in the classroom.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
<b>10.</b>	<b>I know how to use technology to get my students more excited to learn.</b>	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree

PLEASE CONTINUE ON THE BACK.

<b>11.</b>	<b>How often do you use distance learning in your classroom?</b>	Never	Rarely	Sometimes	Frequently
<b>12.</b>	<b>How useful do you think distance learning is for promoting student learning?</b>	Not Useful	Slightly Useful	Moderately Useful	Very Useful
<b>13.</b>	<b>How prepared do you feel to use distance learning in your classroom?</b>	Not Prepared	Slightly Prepared	Moderately Prepared	Very Prepared
<b>13.</b>	<b>How comfortable are you teaching about physical science?</b>	Not Comfortable	Slightly Comfortable	Moderately Comfortable	Very Comfortable
<b>14.</b>	<b>How comfortable are you teaching about the history of the space race (e.g., the Cold War, NASA, the Apollo missions)</b>	Not Comfortable	Slightly Comfortable	Moderately Comfortable	Very Comfortable

THANK YOU FOR COMPLETING THIS SURVEY!

Appendix B:

Student Content Knowledge Test

**CHALLENGER LEARNING CENTER  
OF LUCAS COUNTY**

**“Tiger Team Distance Learning Connection”  
Pre/Post Test**

**Please answer the questions in the table below to give us your unique code. We will use your code instead of your name so that your answers will be kept confidential. This way, no one will know what your answers are.**

<b>What is the FIRST letter of your last name?</b>	<b>What is the LAST letter of your last name?</b>	<b>What month (1-12) were you born?</b>	<b>What day (1-31) were you born?</b>

**For example, if a student named Emily Owens was born on April 13<sup>th</sup>, her unique code would be: OS413. Make sure you’ve accurately answered the questions.**

**Directions: For each question, circle the correct answer or provide the correct explanation. If you do not know an answer, make your best guess.**

1. The United States and the Soviet Union obtained advanced rocket technology from what country?  
  
A. Japan  
B. Germany  
C. China  
D. England
2. The Space Race effectively began with the launch of the Soviet artificial satellite called:  
  
A. Sputnik 1  
B. Soyuz 1  
C. Skylab 1  
D. USSR 1
3. During the Apollo 13 mission, damage to the Command Module forced the astronauts into the Lunar Module. This created a problem because there were not enough air filter cartridges in the Lunar Module, and the air filter cartridges from the Command Module did not fit in the Lunar Module. How did NASA solve this problem?  
  
A. NASA sent more Lunar Module air filter cartridges to the crew on Apollo 13.  
B. The crew on Apollo 13 were told to recycle the old air filter cartridges.  
C. The crew on Apollo 13 were told to sleep as much as possible so they would use less air.  
D. The crew on Apollo 13 built an adaptor so the air filter cartridges from the Command Module fit in the Lunar Module.



4. What gas is removed from the air in the spacecraft by the lithium hydroxide in the air filter cartridges?

- A. carbon dioxide
- B. oxygen
- C. nitrogen
- D. hydrogen

5. NASA has determined that a space mission will require 240 kg of water to support the crew. If the water comes in 25 kg containers, how many containers of water would be needed for the mission?

- A. 1
- B. 10
- C. 25
- D. 240

NASA is planning a space mission with a crew of 4 astronauts. The spacecraft must carry enough supplies for a 10-day mission. The table below shows how much of each item each astronaut needs for every day of the mission. Use the table to answer questions 6 & 7.

Supply Item	Amount needed for each person per day
Oxygen	1 kg
Water	3 kg
Dried Food	2 kg
LiOH Canisters	0.25 canisters

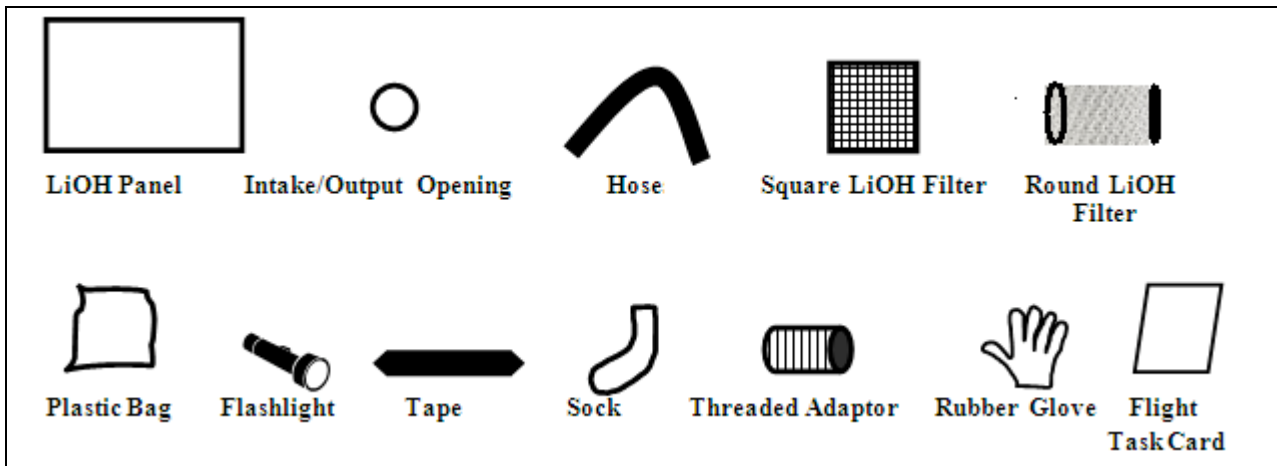
6. How many kg of dried food will be needed for the mission?

- A. 2 kg
- B. 8 kg
- C. 80 kg
- D. 160 kg

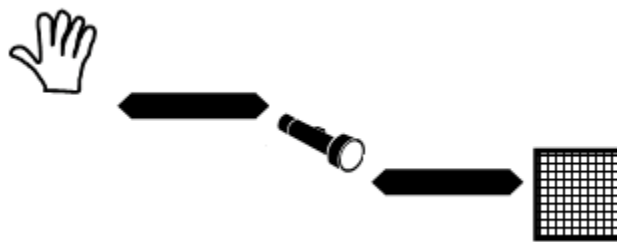
7. How many LiOH canisters will be needed for the mission?

- A. 0.25
- B. 4
- C. 10
- D. 25

Use the following symbols to answer question 8.



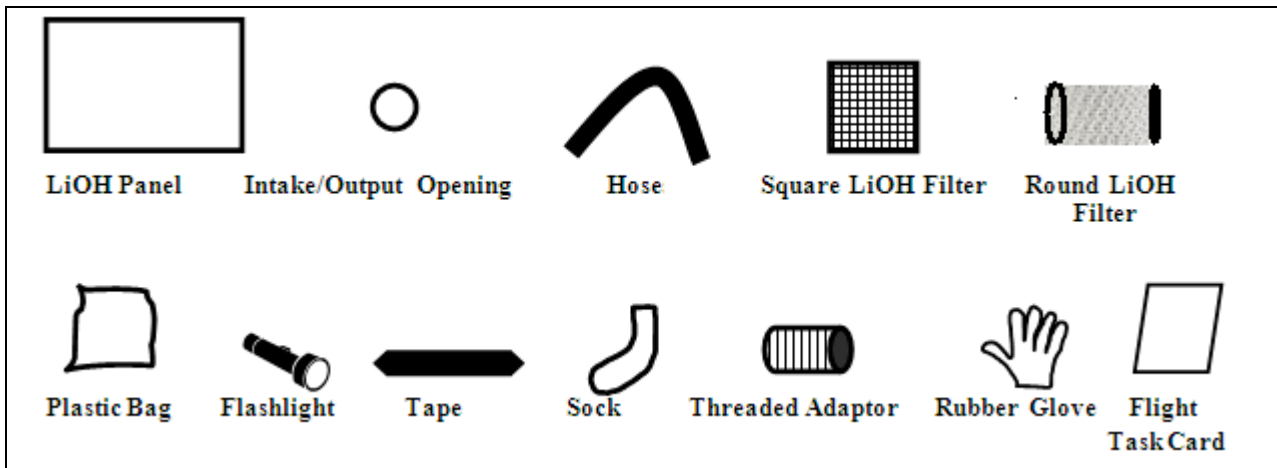
8. Imagine you are a Communication Officer for a team of NASA engineers. The Engineering Specialist has given you the following diagram.



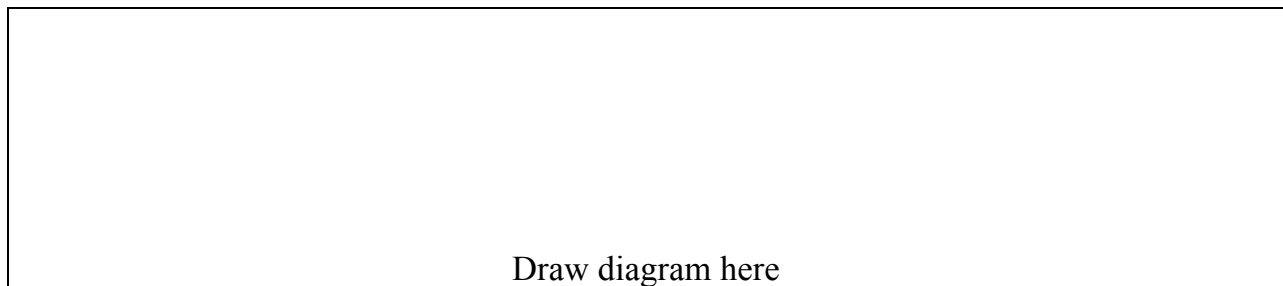
Which of the follow would be the best description of the diagram?

- A. A hand is waving at a flashlight that is shining on a window screen.
- B. A rubber glove is connected to a hose that is connected to a flashlight. The flashlight is connected to another hose that is connected to a square LiOH filter.
- C. A rubber glove is pointing at a flashlight that is pointing at a square LiOH filter.
- D. A rubber glove is taped to the handle end of a flashlight, and a square LiOH filter is taped to the light end of the flashlight.

Use the following symbols to answer questions 9 & 10.



9. Imagine you are the Engineering Specialist for a team of NASA engineers. Your team was given the problem of cleaning an air duct that has become blocked. The solution that your team has decided upon is to tape a sock to the end of a hose to clean the air duct. Using the symbols in the chart above, draw a diagram of the solution your team has developed.



10. Imagine you are the Communication Officer for a team of NASA engineers. The Engineering Specialist has given you the following diagram.



Write a word description explaining the diagram.

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