A Trail Between Two Cities: A Virtual Exchange, Problem-Based Learning Physics Activity

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Abstract

Science is a collaborative process and electronic means of communication enhance collaborative possibilities. It is an important ability to be able to effectively work with people from different cultures. Our program uses physics activities to bring secondary school girls from different cultures together. Students from a school in the United States and a school in Egypt worked over various media and completed activities designed by their teachers. The program goals are to develop cultural awareness, abilities to work with people who are different, distributed leadership skills, physics skills, and knowledge. This article will explain the overall approach of the program, describe one physics activity, and present evaluation data.

Keywords: Physics, virtual exchange, problem-based learning, students exchange, leadership, classroom activity.

INTRODUCTION

Problem Based Learning

Problem based learning (PBL) is an approach where students work in small groups to study a problem from various angles. In PBL, exploration comes before explanations (Loyens, Magda, and Rikers, 2008; Neville and Norman, 2007). Students are challenged as a group and work together to achieve results. This increases their communication and teamwork skills (Koh et al., 2008). The PBL approach increases cognitive engagement (Rotgans and Schmidt, 2011), creativity (Ozdemir and Dikici, 2017), critical thinking (Iwaoka, Li, and Rhee, 2010), and problem-solving skills (Hmelo-Silver, 2004).

Student Exchanges

Participation in physical student exchanges can have many positive benefits including participants learning about themselves, about other cultures, and how to tolerate ambiguity (Dwyer, 2004). The benefits led universities to classify them as a high-impact practice (Brown, Garnjost, and Heilmann, 2011). The logistics and cost of physical student exchanges, however, make them rare at the high school level. Virtual exchanges are educational programs that use technology to bring diverse students together for collaborative problem-solving.

Leadership and Problem Based Learning

Leadership research and distributed cognition theory led to a distributed-leadership model, with emphasis on shared leadership (Spillane, Halverson, and Diamond, 2004). Leadership roles require skills in problem solving, critical and creative thinking, working with diverse others, and communication. A virtual exchange with PBL may be effective to foster distributed leadership abilities (Yeo, 2007).

METHODOLOGY

Program Description

The physics portion of the Leadership through Problem-Based Learning program had 22 students from Al Farouk Islamic School in Egypt and 27 from Xavier College Preparatory in the USA participate. The students were all high school girls. Each formed group had two students from Egypt and two or three students from the USA. During the 12-week program, five activities were conducted, with students working on them for about two hours per week. The first activity, “A Trail Between Two Cities”, illustrates the approach.

Description of First Physics Activity

Students are challenged to create one combined video of an object moving with the same velocity between similar scenes in Egypt and in Arizona. The activity requires communication and decision making: which object is easy to find in both Egypt and Arizona, where should the object roll, and how can the velocity seem uniform between the two scenes? Students learn various "invisible cut" video combining strategies and choose a method for their film.

Prior to the launch, students were emailed with their groups, and it was suggested that they reach out and introduce themselves to their partners. The schools launched the activity on the same day, with Egypt launching earlier due to time zone differences. Students were also given access to the Google Doc activity sheet before the launch meeting. The activity sheet can be accessed through the following link: https://tinyurl.com/Phy1-Trail

At the launch (shown in Figure 1), students were challenged to plan and produce an international video about an object moving at constant velocity. They were instructed to open the activity sheet and enter their names and follow the instructions. Students were invited to communicate through their preferred method (email and WhatsApp were most popular), make decisions, and then write information into the activity sheet. They were reminded that they might ask a question or suggest but not hear back from their international partners until the next day.

Figure 1. A Classroom Scene from The Launch in Cairo

The activity sheet guided their work. Different students are prompted to write their plan according to the following prompts: (1) Describe your object, (2) Describe your location, (3) Describe how you are planning to do the invisible transition, and (4) At what velocity will the object move at? How will you measure the velocity? In the Video section, students provide a link for their video. Finally, students write up what they did and describe any problems they experienced.

After two weeks, there was a debrief session where students shared videos they produced with the rest of the class. Students also explained their object and location selections, discussed their experience working with their international partners, and shared interesting information they learned about their partners' culture.

Evaluation Data for the Activity

In analyzing the activity sheets, multiple groups selected oranges as the common object. Tennis balls and toy cars were also used. One group used students walking at a steady pace. For location, all groups selected locations near the school, such as roads, sidewalks, school halls and benches. Sample videos can be accessed from the following links:

https://youtu.be/hltHr2lCalY

https://youtu.be/9mfB_IRGS00

For the prompt that asks the groups about the challenges they faced, the most common answer was breaks in communication. Motivation and work were affected when there were several days before students would get a response. Getting rolling objects to move at constant velocity was another challenge. Here are some sample responses.

> *"Some problems we experienced include the time difference and the different locations. It was a challenge to communicate, especially in the beginning because as we (XCP) were released from school, they (AF) were about to go to bed. It was also a challenge*

to obtain an orange that was about the same size. It was a lot of fun and a good learning experience once we started the project and were communicating a lot better."

"Problems experienced during this lab included issues with rolling the orange. It was difficult to obtain the exact measurement of where the orange stopped. An exact measurement was very important to have so that he (sic) calculation of the velocity was also accurate. Once this was solved, we then needed to figure out how to have the orange roll in a straight direction. This problem was solved by finding a flat surface and adding more force to the roll. Other than these few minor problems, we found that the lab ran smoothly with few errors."

The post-activity survey and the assessment questions were completed by 24 students. There were four Likert-items on the survey; with response ranges from Strongly Agree (5) to Strongly Disagree (1). The following table shows the items, the percentage of agreement, the mean, and the standard deviation.

Table 1. Likert-Item Responses on The Survey

Question	Percentage of Agreement	Mean	Standard Deviation
I enjoyed the activity.	83%	4.08	0.88
The activity was a good opportunity to practice working with others.	83%	4.38	0.88
I learned from the activity.	79%	4.00	1.10

Another Likert-item was used to evaluate the difficulty of the activity. "Far too easy" response was coded with 1, "About right" with 3 and "Far too difficult" with 5. The mean for this item was 2.46 and the standard deviation was 0.93. The distribution of student responses is shown in Figure 2.

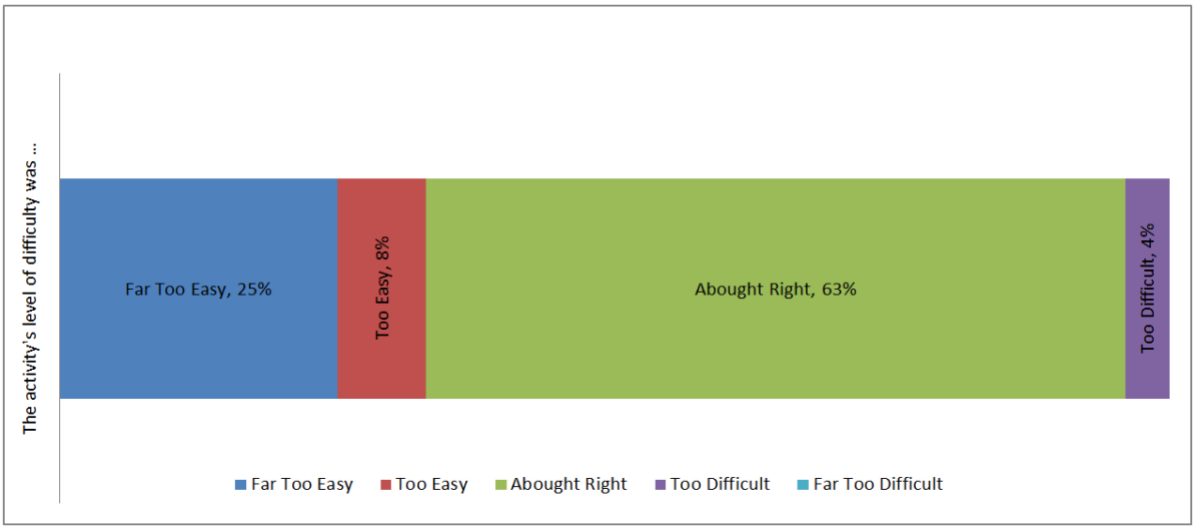

Figure 2. Student Responses for Level-Of-Difficulty Item, With the Legend Below the Graph

On a multiple-choice pretest, 11.8% of the students selected the correct response for defining velocity, with most (49%) selecting the distractor "The rate of change of speed, with a specific direction."

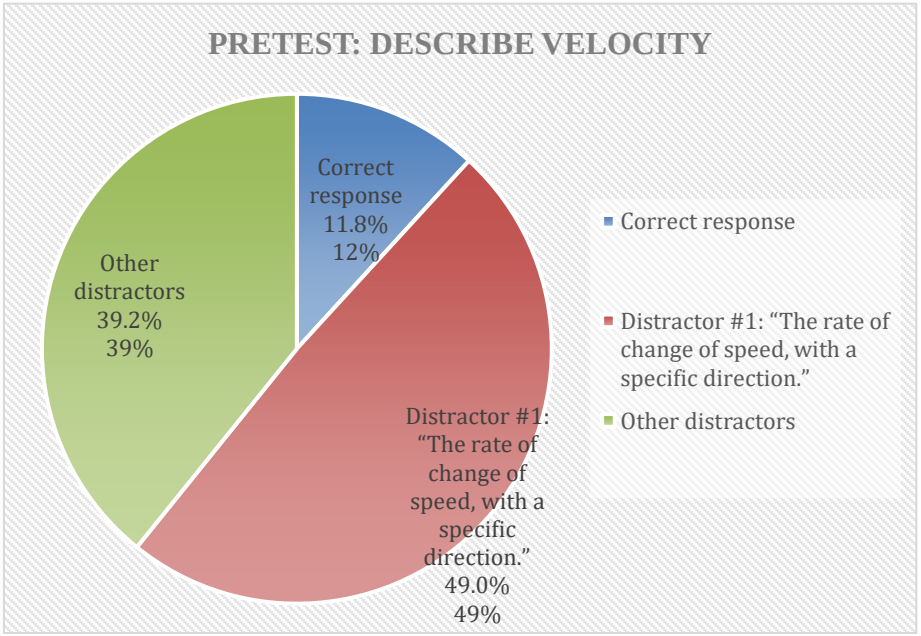

Figure 3. Distribution Of Student Responses for The Pretest Item Asking to Describe Velocity.

After the activity, 23 students answered two open-ended velocity questions. On question 1, 10 students (43%) answered correctly by either relating velocity with rate of change of displacement or relating it with speed and a direction. 4students got confused and wrote the magnitude of the velocity they used in the activity, and 3 students mentioned speed without a specific direction.

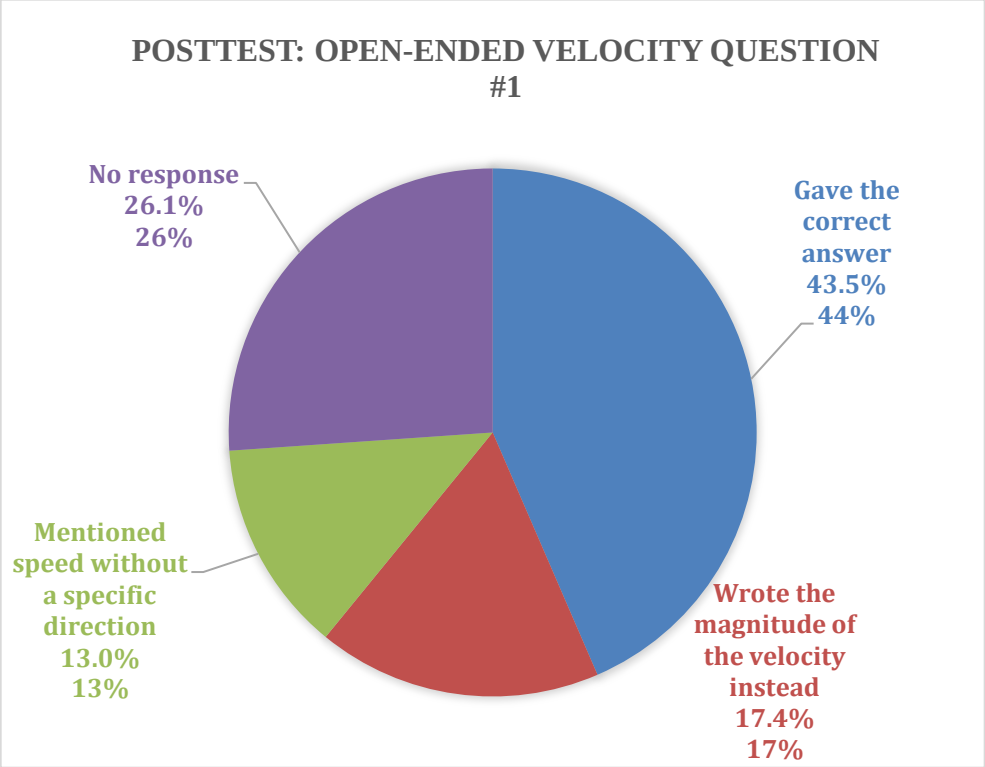

Figure 4. Distribution Of Student Responses for The Posttest Open-Ended Item #1 About Velocity

Question 2 asked students how to measure the velocity of a sliding box. Out of the 22 students who responded, 13 (59%) suggested workable methods. 4 students mentioned how to find acceleration and 1 student described how to measure displacement.

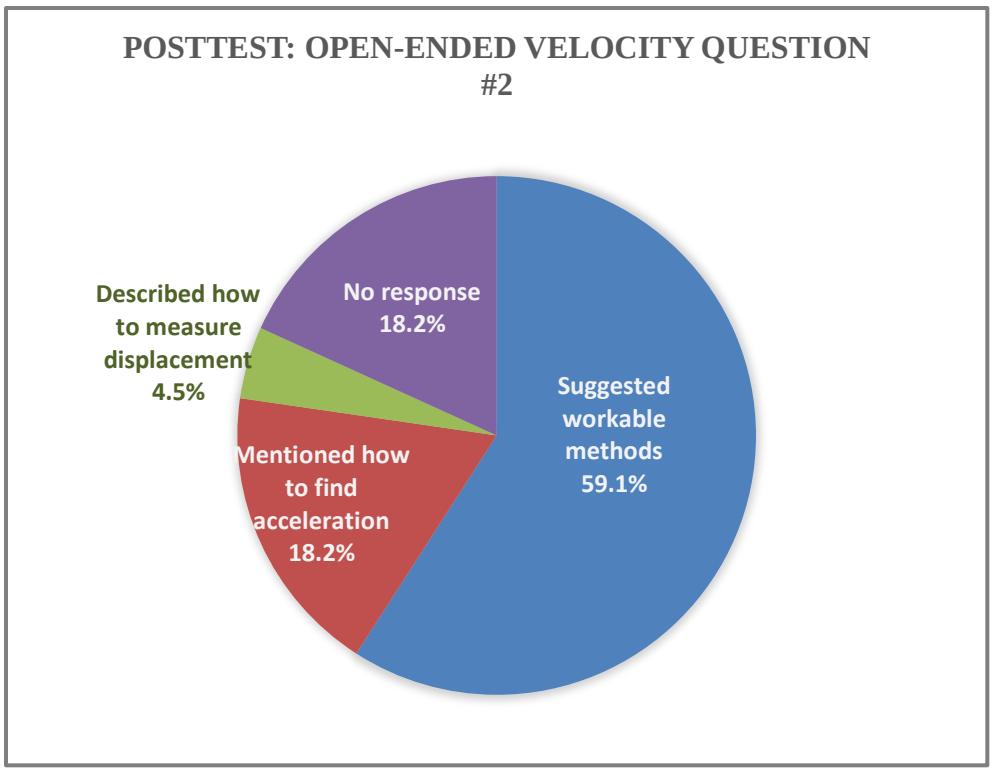

Figure 5. Distribution Of Student Responses for The Posttest Open-Ended Item #2 Asking Them About Velocity

Interview Data

In the interviews, students were positive about the program. The following are responses to a prompt about their overall feeling of the program:

> *"I liked interacting with the girls in Egypt because I really haven't done any collaboration like this before, so it was just interesting to see the way they react to things and the way they process things and then it's different from the way we do. And it's just the environment that they are in and the environment we are in – it's just interesting to see how we communicate." (US Student)*

> *"I think it's an amazing program. It's a great chance. You just learn new things. It's improving yourself, having a new self. I had new things in my life. It's just made an enormous impact in my life. I learned new things. It's a new me after the project." (EG Student)*

In the collaborative activity discussed in this paper, students had to find common objects and shoot videos of them in similar locations in their school. Other activities required the students to discuss their home environment. While searching for common points, the students were exposed to each other's culture and thought processes, which prompted these interview responses.

Students generally found the level of activities not too simple, and not too complex.

> *"I thought they were just right. They weren't too hard, but they were challenging in some ways." (US Student)*

Several students said that communication was the most challenging part of the program:

> *"It was just hard to communicate with them sometimes, mostly because of the time difference. We just weren't on our phones at the same time, so, sometimes we would be waiting a few days for a response." (US Student)*

The majority of US students were Christian, and the majority of the Egyptian students were Muslim. Despite this, religion was not mentioned in any of the reviews. Most students said language was not a problem.

> *"Their English was really good! I was actually surprised – I was afraid there was going to be a little bit of a language barrier, I wasn't really sure at all, but there wasn't at all. It was easy to understand them"* (US Student)

One factor that helped the virtual exchange is the attitude of modern youth towards communications technology. Students from both the USA and Egypt were adept in using collaboration and communication tools. An interesting observation is that the program generally increased the skill of the involved educators with collaboration tools.

DISCUSSION AND CONCLUSIONS

In "Trail Between Two Cities," students communicated with their international partners, discussed their school environment, and what kinds of objects were common in the US and Egypt. The process of collaborative decision making in the video production is what is important; the goal is not to produce professional videos (Abbott et al., 2019).

Communication, decision making, problem solving, and creativity were evident as the students worked to produce their videos. The participants generally reported that they enjoyed the activity, it was a good opportunity in working with diverse others, and they learned from the experience. During the interviews, students reported learning time management and communication skills.

The activity used PBL in a virtual environment. It had almost no material costs and utilized technologies the students were already familiar with. Physics activities, PBL, and virtual exchange can effectively be combined to enhance learning, abilities, and connections between different cultures.

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