Evaluating Student Learning in the Challenger Space Flight Simulator Informal Learning Environment

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Born out of tragedy, Challenger Center for Space Science Education is the living tribute to the astronauts who perished in the explosion of the Space Shuttle Challenger 51-L. Founded by the families of the crew in 1986, Challenger Center is an educational organization that allows students to learn about space, explore their critical thinking powers and decision-making skills, and be inspired to become knowledgeable in the evolving scientific fields of the 21st century. There are currently thirty-one Challenger Learning Centers throughout the United States.

The Challenger Learning Center on the campus of Wheeling Jesuit University (WJU) was established in 1995. The Challenger Center at WJU services over 10,000 students per year. The centerpiece of the Challenger Center is a space flight simulator, which allows students to experience many of the tasks that face shuttle astronauts. Students communicate between mission control and the space shuttle. They monitor the atmosphere inside the space shuttle to ensure the health of the crew. They engage in mission-specific studies of plant life and rock composition.

During the school year, middle-school students participate in flights through school-based missions. Teachers spend approximately four weeks preparing students for their mission. On the day of the mission, students travel to the Challenger Center to participate in a two-hour flight. On weekends and holidays, students can participate in day-long camps that provide hands-on activities as well as the simulated space flight. During the summer, the Challenger Center hosts week-long summer camps.

METHOD

Designing assessment instruments for informal learning environments poses unique problems that are not faced by designers of classroom-based assessments. (1) Given the limited amount of time that students spend in an informal learning environment, assessment tasks should be brief. (2) Given the informal nature of the environment and lack of accountability, the assessment tasks should be interesting for students. (3) Given the limited budgets for most informal learning environments, the assessment tasks should be affordable to administer and score.

In partnership with the Challenger Learning Center at WJU, researchers and undergraduate students at the Center for Educational Technologies at WJU have been designing an assessment framework for evaluating various missions at the Challenger Learning Center. Assessment tasks based on the framework can be administered in less than 15 minutes, students enjoy participating, and the tasks can be scored in an efficient manner.

The tasks center around posing a basic question that students investigated as part of their mission. In the Encounter Earth mission, students are asked how a volcanic eruption will affect plant growth. In the Dare to Fly summer camp, students are asked how airplanes fly. In each case, students respond by writing a brief paragraph that answers the questions and also by drawing a diagram that answers the question. Within a class, the order of responding is counterbalanced. Half the class writes a paragraph first and then draws a diagram, while the other half draws a diagram first and then writes a paragraph.

Working with Challenger Learning Center staff, researchers developed a list of concepts and relationships that are covered in each mission. Then researchers coded the paragraphs and diagrams for the presence of these concepts and relationships. Each student received four scores: the number of concepts and relationships represented textually and graphically.

RESULTS

In spring 1998, researchers piloted the assessment framework using the Encounter Earth school mission. Two schools participated in the pilot study (n=59 middle school and n=33 high school). The assessment task was administered to students after they completed the two-hour Encounter Earth mission. The results indicate that middle-school students represented more concepts in diagram form (5.5 concepts) than in text form (4.1 concepts). These differences were statistically significant ($F(1, 58) = 6.27$, $p<.05$). There were no statistically significant differences in the number of relationships represented textually versus graphically. The high-school students, on the other hand, represented both concepts and relationships at a higher rate in text form (6.5 concepts, 0.8 relationships) than in graphic form (4.9 concepts, 0.3 relationships). These differences were statistically significant ($F(1, 65)=5.69$, $p<.05$ for concepts and $F(1, 65) = 8.88$, $p < .01$ for relationships).

Based on these data, it appears that there is an interaction between students' age and the form of the response. Students in the middle school seem to be more adept with graphical representation, while high school students are more adept with textual representation. In order to test this relationship more directly, researchers administered the assessment tasks at the Dare to Fly summer camps. In the Explorers I camp, students entering grades 2-4 participated in age appropriate Dare to Fly activities. In the Explorers II camp, students entering grades 5-8 participated in more advanced Dare to Fly activities. In one study, students in both Explorers I and Explorers II received the assessment task as a post-test only to explore more directly the relationship between students' ability to express themselves textually and graphically as a function of age. In another study, students in the Explorers II camp received the assessment task as a pre-and post-test to explore the impact that the Dare to Fly camp has on student learning.

There were 98 students from whom data was collected for this part of the study. The results indicate that the number of concepts represented increases with age ($F(1, 97) = 29.19$, $p < .001$) and that there is a main effect indicating that students represented more concepts textually (4.1 concepts) than graphically (3.1 concepts) ($F(1, 97) = 7.90$, $p < .01$). However, there was no interaction between age and the format of the response. The number of relationships represented also increases with age ($F(1, 97) = 11.83$, $p < .001$). There was no main effect on the number of relationships represented due to format. These results do not replicate the findings of the earlier study of Encounter Earth, which indicated there was an interaction between age and format.

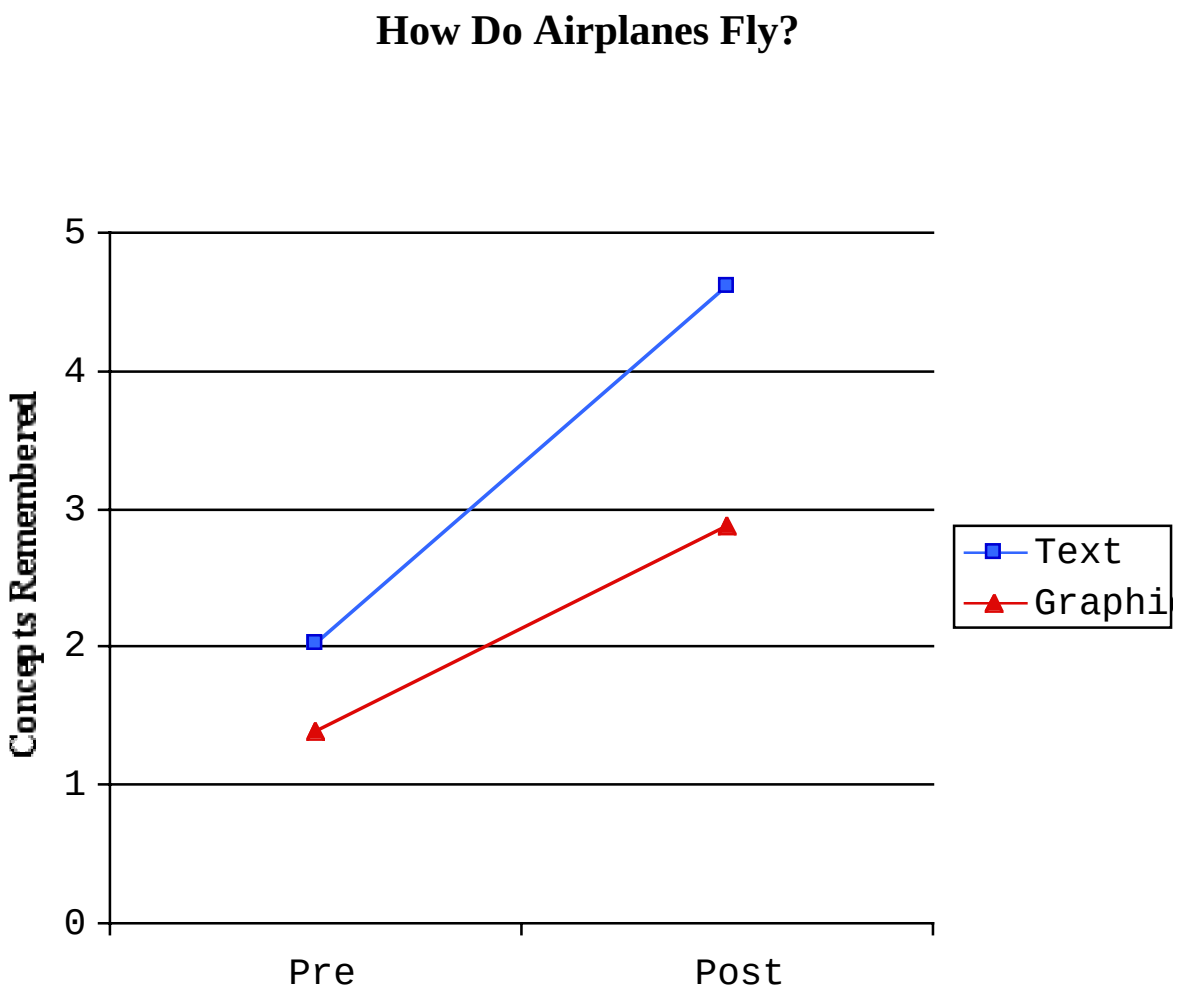
There were 222 Explorers II students for whom data was collected as pre- and post-test during this section of the study. The results indicate that the number of concepts and relationships represented in either format at the post-test (3.8 concepts, 1.9 relationships) more than doubled the number of concepts and relationships represented in either format at the pre-test (1.8 concepts, 0.9 relationships) ($F(1, 221) = 69.37$, $p < .001$ for concepts and $F(1, 221) = 16.19$, $p < .001$ for relationships). There was also a main effect due to format for concepts ($F(1, 221) = 18.50$, $p < .001$) but not for relationships. Students represented more concepts textually (3.3 concepts) than graphically (2.3 concepts). There was also an interaction effect between pre/post difference and format. There was a greater increase in the number of concepts reported textually than the increase in concepts reported graphically (see Figure 1).

CONCLUSION

The Challenger Center assessment framework proved to be a useful tool for conducting research and evaluation projects with Challenger Center programs. The assessment tasks that resulted from the framework were efficient to administer, enjoyable, and affordable. The assessment task for the Dare to Fly mission was used to determine that the summer camp was effective at helping students understand the principles of flight. In the future, the Challenger Learning Center staff can now experiment with alternative sets of activities and have a means to evaluate the effectiveness of these activities.

The assessment tasks have also revealed that there are interesting differences between students' abilities to represent concepts and relationships through text and graphics. Based on the results of the research it appears that age may be factor and that the nature of the task may be factor. The Dare to Fly activities were easier overall than the Encounter Earth activities. This might explain the differences in results. In addition, it will be important in future studies to understand students' general verbal and graphical abilities to help validate the results of the assessment tasks.

Figure 1


How Do Airplanes Fly?
Concepts Remembered
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