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Effective lesson planning: field trips in the science curriculum

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EFFECTIVE LESSON PLANNING:
FIELD TRIPS IN THE SCIENCE CURRICULUM

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ABSTRACT

Science field trips can positively impact students and motivate them into future studies in various science fields. However, if a field trip is not executed properly, it can result in a loss of valuable educational time and could promote misconceptions in the students. This study was undertaken to determine if a classroom lesson before an out-of-the-classroom activity would affect learner gain more or less than a lesson after the activity. The students were divided into two different groups. The groups differed based on the sequence of activities that they received. The activities involved in this study included visiting an immersive theater to view the movie *Earth's Wild Ride* and participating in a teacher-led lesson using guided notes with a Power Point for visual aid. The participants in this study, students in a sixth grade physical science class, were given a pretest to determine prior knowledge of topics covered in the classroom lesson and the movie. The same assessment was also administered after each activity to measure learning gain.

The order of lessons showed no detectable effect on learner outcomes. There were no significant differences between the mean learning gain of the two groups after participating in both activities. Even though the teacher-led lesson produced significant gains independent of the movie, the visit to the immersive theater had a positive effect on the students and increased their interest in learning the material. If executed properly, implementing field trips into the science curriculum will increase learning gain and/or improve attitudes towards the study of science

INTRODUCTION

Every year, millions of children participate in organized school field trips with their classes. These field trips have been widely held to be educationally beneficial to school children and can increase a student's aspiration for science-related careers (Gibson & Chase, 2002; Nazier, 1993; Rudmann, 1994;). A trip could be a safari at the zoo or a trip back in time at a local museum. Many of the experiences these venues provide are related to science learning and provide students with experiences that are not possible in a normal day classroom setting. Research has shown that school field trips can be important for enhancing school children's science learning by giving them genuine experiences, direct contact with real objects, and simulating their curiosity and interest in the topic (Davidson *et al,* 2010 ; DeWitt & Hohenstein 2010; Knapp, 2000; Falk *et al*., 2005). A number of empirical studies have confirmed the benefits of field trips both on a cognitive level and on an emotional level confirming the general agreement on the usefulness of field trips as a part of the curriculum (Bitgood, 1989; Orion, 1994; Zoldosova, 2006).

In spite of this, many students do not experience the educational impact of a field trip due to the requirements placed on teachers from the school board, local government, and insurance companies. Taking students off campus, with the recent increase in gasoline, can also put a financial strain on the school and/or the parent. If a student were injured during a field trip, it could cause a liability problem for the school district. The time required to travel to and from the school takes away from the instructional time. Critics also argue that time away from classroom learning will have a negative impact on the student (Bergin, 2007). This brings a negative view of field trips.

If it were not for the stimulation and enthusiasm generated by field trips, we might not have as many scientists and engineers working in technical fields as we do today. The most natural way of learning is to experience the world around us and acquire new information from the environment (Falk *et al*., 2005; Zoldosova, 2006). If we only teach students from books and show them images from videos or the internet, they may never truly reach their potential in life. Nazier (1993) interviewed 300 full-time science and engineering professors to find out what led them to choosing science as a career. He found that one of the top factors leading to their choice was a field trip they experienced while in school. In addition, Bitgood (1989) found that students who participated in a marine ecology field trip showed a positive attitude toward the subject matter following the field experience. Zoldosova et al. (2006) studied 153 students who experienced 5-day field trips and experiments in the Field Centre in Slovakia and compared their interest towards science to a control group (n = 365) that did not experience the education at the Field Centre. They found significant difference between the two groups and based their findings on the experiences at the Field Centre. Although Zoldosova et al. (2006) did not know the long term effects on the students; they do know the field trip increased their interest in the study of science during the time period following the experience.

There is great deal of time and effort expended by a teacher when planning an effective out-of-the-classroom activity. Not only does the educator have to pick an appropriate venue, he or she has to plan transportation, provide lunches, find chaperones, collect permission slips and money, and then plan effective classroom activities that will prepare the students for the trip. Gennaro (1981) argued the need for pre-visit instructional material for museum trips by introducing students to new material to familiarize them with the purpose of the activity. His study emphasized key concepts, principles, and technical terms as well as preparing students for the general structure of the material to be learned. His study is distinctly similar to the study in this thesis because the students were attending the *Genesis* experience, a video about the Big Bang shown in a theater in the round.

Just as quality pre-planning is essential to the success of a field trip, planning for appropriate follow-up activities will facilitate student learning and multiply the value of hands-on experiences outside the classroom. However, relatively little of this literature has shown quantitative data on the importance of follow-up lessons after the excitement of the field trip has passed. Failure to follow up can give rise to and sometimes reinforce unexpected and potentially undesirable alternative concepts in some students. In reality, teachers rarely execute effective post-visit activities that are designed to assess what the students learned during the field trip (Bitgood, 1989). The importance of planning and follow-up is not only to support the development of scientific concepts, but also to detect and respond to alternative concepts that may be produced or strengthened during an out-of-the-classroom activity.

A post lesson is essential to reinforcing the importance of a field trip; otherwise, this can sometimes be lost due to the distraction of learning caused by the novelty of the environment. It has been shown that students' perceptions of the novelty of the trip affect what they learn, and that fundamental learning can be inhibited in settings where novelty is either extremely great or small (Anderson *et al*., 2000). A child may remember the train that was passed on the way to the museum or the stuffed lion he/she bought in the gift shop but may not recall the point of the trip. Research has shown that extremely novel settings can place preemptive demands on the learner and can negatively influence the concept being learned (Falk *et al*., 2001). This suggests that teachers should choose learning experiences for students that minimize novelty, and that post lessons should emphasize the fundamental concepts in order to maximize their impact.

A field trip (especially if it is preceded by proper preparation and followed by proper post lessons) can be an experience to build a student's prior knowledge. In British Columbia, a study by Nielsen *et al.* (2009) was done on a high school teacher, Jim Wiese, who took 11th and 12th grade students to an amusement park to participate in "amusement park physics". The out-of-school experience provided an environment for experimental learning and developed background knowledge. This opportunity allowed students to develop a meaningful understanding and highly motivated learning. They could then use metacognitive reflection during follow up activities. Metacognition is a learner's awareness of how he/she learns. "An important goal for teachers is to create a learning environment that enables students to become more self-aware of their own learning process, including the ability to identify these processes and subsequently master (control) them in the service of learning" (Nielsen et *al.* 2009). While on the trip, Mr. Wiese had the students work in small groups to complete basic problems. Once the field trip was concluded and the students returned to the normal class environment, the teacher began asking the students deeper probing questions that made the students reflect on the field trip and develop a more profound understanding of the physics at the amusement park.

In recent years with the advancement of technology, outside experiences have also entered the classroom with teleconferencing, guest presenters, and portable theaters. These experiences, which are not normal to the everyday classroom routine, can result in cognitive and effective gains for the student without robbing valuable classroom time. Nevertheless if an informal classroom experience is not executed properly with appropriate pre and/or post lessons, learning gains may be lost and students might develop misconceptions the about concepts that should have been learned. Understanding how to present material in ways that help students learn is an essential part of being a teacher. The students in today's classrooms are being raised in the era of technology. To relate to the students, a teacher must integrate multimedia instruction lessons containing words (e.g., printed words or spoken words) and pictures (e.g., illustrations, photos, animation, or video that are chosen to foster the learning) into his/her lesson planning. The use of illustrative tools such as animation, graphs, sound and video clips makes it possible to show the student many phenomena which cannot be demonstrated using conventional teaching methods (Mayer, 2008). This is one reason why field trips that use multimedia instruction, such as the one used in this study, are potentially an effective teaching tool that the students can relate to and understand. "Learning is a change in the learner's knowledge that is attributable to experience" (Mayer, 2008).

Purpose of this Study

This study is based on a study done by the Houston Museum of Natural Science, in partnership with Rice University and funded by NASA, that suggests that significant student content gain is achieved after viewing the video *Earth's Wild Ride* projected on a digital dome theater (Sumners *et al.*, 2008). Some of the students who were assessed by Sumners *et al.* (2008) viewed *Earth's Wild Ride* in a Discovery Dome. The Discovery Dome is similar in size and shape to the Elumenati Open-Dome used in this study. A portable dome is a cost effective experience that does not require transportation. It is a "field trip without the bus." The experience happens during the classroom period so the students are not missing other classes or lunch; in addition, the teacher is not required to get a substitute or insurance for the trip. In fact, a dome can reach populations far from urban areas where IMAX theaters and major planetariums are not available.

There are other desirable aspects of the immersive digital dome besides its ability to travel. Large formatted digital theater productions can be shown because the small portable dome is scalable. The immersive experience created by full-dome video enhances the learning of difficult concepts by requiring the students to change reference frames. In addition, the dome can be successful in teaching non-astronomy concepts and can expand its role as a tool for learning at all grade levels and other fields of study.   Furthermore, the immersive quality and high activity level of the full-dome experience makes it appropriate for many different student populations.

Sumners *et al*. (2008) conducted three different studies using the same assessment instrument. All individuals that participated in the study were administered a 17-question pretest within three days of visiting the dome and a posttest within a day of the visit. Seventh graders from an inner city school traveled to the Burke Baker Planetarium to view *Earth's Wild Ride* and were assessed immediately upon returning to campus. While collecting data for the study, the researchers looked at each individual question's result and not the students' overall test scores. As a result all items showed gains between pretest and posttest. A second study was performed on a different group of seventh graders at a majority Hispanic school.   This school had two different science teachers, labeled Teacher B and Teacher C. Teacher B was a veteran teacher while Teacher C was new to the field. The 221 students viewed the movie in a Discovery Dome that was transported to the campus. Sumners et *al.* (2008) found that the students of Teacher B had more prior knowledge than the students of Teacher C. Even though both groups showed high significant gains, Teacher B's better prepared students showed greater learning gains than the students of Teacher C.   A third study was conducted with students at an elementary, middle, and high school of Tohatchi, New Mexico. The Discovery Dome traveled to this rural location as part of the Astronomy Road Show. Students in grades 3-12 were pretested and post tested before and after watching *Earth's Wild Ride*. The product was successful in all grades; however, in high school the significance dropped because the students had a higher prior knowledge making the testing instrument less sensitive to content gains.

The students in the study described in this thesis participated in an “in school” field trip that took place inside an immersive full-dome digital theater. This is similar to the second and third study done by the Houston Museum of Natural Science but unlike the students who traveled to the Burke Baker Planetarium. Based on the findings that the students of Teacher B performed better on the pre and post assessment due to the higher level of prior knowledge, this study tested the idea to see if prior knowledge would increase content gain. This study was performed by providing a group of students a teacher-led lesson before viewing *Earth’s Wild Ride*. A second group of students was tested by viewing the movie before participating in a teacher-led instruction.

MATERIALS AND METHODS

This study was designed to test whether the order of the lessons that accompanied the field trip affected learning gains. The students were divided into two different groups. The groups differed based on the sequence of activities that they received. The activities involved in this study included visiting an immersive theater to view the movie *Earth's Wild Ride* and participating in a teacher-led lesson using guided notes with a Power Point for visual aid. All participants were given the same assessment three different times to measure learning gains. This assessment consisted of twenty multiple choice questions with each question having three distracters and one correct response. The questions were created from the example multiple-choice questions at http://earth.rice.edu/shows/EWR/ (Appendix A). The assessment was administered to all participants as a pretest within two days of the start of the project and as a posttest administered at the completion of each activity. Any students who were not present for the pretest, lesson, dome experience, and/or either posttest were eliminated from the study.

The field trip experience used in this study involved viewing a twenty minute movie, *Earth's Wild Ride* (Handron, 2005), in an immersive digital theater. The dome has an internal screen diameter of 6.5 meters and a maximum height of 4.1 meters and can accommodeate approximately 25-30 students at one time. A Discovery Dome Mirror Projection System was used to project the movie. The LCD projector has a 1920 x 1080 pixel resolution and uses a spherical Newtonian One mirror to reflect the images unto the dome (Appendix E). The dome was brought to the students' school by the staff of the LSU Department of Physics and Astronomy. The dome was set up on the stage of the school's gymnasium and special accommodations were arranged by the school's administration and science department to ensure all sixth grade science students were available to participate.

The *Earth's Wild Ride* (Handron, 2005) centers on children of the future that are born on the Moon learning about Earth as an alien planet during an evening watching an Earth transit (solar eclipse from the Earth) with their grandfather. The child characters ask the questions that students in the audience would ask and the grandfather becomes the patient and enthusiastic teacher, parent, and tour guide. In this experience, students see the Earth in stark contrast to the Moon and compare the conditions on both worlds. *Earth's Wild Ride* teaches the children about what it would be like living on a lunar colony. In addition, there are lessons about what happens during a solar eclipse, life during the Ice Ages, Volcanoes, Dinosaurs and the theory of how they were destroyed by an asteroid impact, canyons, and the water cycle. During the immersive experience, the video is projected on the walls of the dome around the students causing them to change frames of reference resulting in active learning.

In addition to viewing the movie, all students in the research participated in a teacher-led lesson that was accompanied by a Power Point presentation (Appendix C) used as the visual aid. During the lesson the students took notes using a note taking method called "guided notes." Guided notes are teacher-prepared hand-outs that outline or map lectures, but leave "blank" space for key concepts, facts, definitions, etc (Appendix B). As the lecture progresses, the student fills in the spaces with content. To insure credibility of this study, all information covered in *Earth's Wild Ride* was also covered in the Power Point presentation. Whereas the movie began with children on the moon, the presentation began with the Ice Age where Woolly Mammoths walked the Earth and man communicated by drawing images on cave walls. The students then transitioned back in time to the lush and tropical climate of the era of the dinosaurs. At this point, the teacher instigated a discussion about theories of what happened to the dinosaurs. There was then a transition to a discussion of the effects that an asteroid has on the

Earth and what happens to the surroundings when a volcano erupts. The teacher then directs the instruction to the horizons by discussing the moon and comparing the surface of the Earth to that of the moon. In addition to this content, the teacher-led instruction included information about fields of study and careers in science.

The first group in the research received a pretest and then teacher-led instruction that introduced concepts mentioned in the video *Earth's Wild Ride*. The students were post tested using the same twenty question assessment immediately after the lesson. The next class period (two days later), the same group of students viewed *Earth's Wild Ride* in the immersive digital theater. Once returning to the classroom, the students received the same post assessment.

The second group of students took the same pretest. They then viewed the movie without previously receiving the pre-lesson, and took the posttest after viewing the film. The next class period (two days later) the students took part in the same teacher led-lesson and note taking that was administered to the first group of participants. After participating in this lesson, the second group received another posttest assessment. In summary, all students received a pretest and then received the same post evaluation after each activity. The only difference between the activities was the order in which they were administered.

Definition of the Study Population

A total of 89 students participated in the pre and posttest. The participants in this study were all sixth grade physical science students, ages 10-14, in an urban public middle school, Woodlawn Middle School in Baton Rouge, Louisiana during the 2009-2010 school year. The ethnicity of the students in this study is similar to that of the school, as shown in Table 1. Of the school's students, 63.5% are classified as eligible for free/reduced lunch. This school is classified as a Title 1 school and in a high needs district.

Table 1. The 2009-2010 ethnicity of Woodlawn Middle School in Baton Rouge, Louisiana compared to participants in the study from the same school. (eSchoolPlus+, 2010).

Ethnicity for Woodlawn Middle School in Baton Rouge, La		
	School Population (n≈892)	Participating Students (n=89)
African American	62.1%	71.9%
Caucasian	30.3%	20.2%
Asian	2.9%	1.1%
Hispanic	3.6%	4.5%
Other	1.1%	2.2%

All students in this study were required to a have a parent or guardian sign a letter of consent (Appendix D). The parental consent form and this research project were approved by the Institutional Review Board at Louisiana State University.

Normalized Gains

Learning gain in the study is used to analyze success of the teacher-led activity and viewing *Earth's Wild Ride* in the immersive theater. The difference in students' scores on the pretest and posttest were used to determine learning gain. These data do not properly reflect individual students who score high on the pretest allowing only minimal gain on the posttests. This is why normalized gain was also analyzed to determine learning gain. The normalized gain measures the fraction of the available improvement that is obtained.

$$g = \frac{posttest - pretest}{20 - pretest}$$

RESULTS

The outcome of the students' scores on the pretest, posttest of the lesson, and posttest of *Earth's Wild Ride* in the immersive theater (the "Dome"), varied extensively with results ranging from 3 to 20 of a possible 20 points. There were some negative learning gains in this study as a result of some students scoring higher on the pretest than on one or both of the posttests. In addition, there were negative learning gains for some students when they scored higher on the first posttest (either teacher-led lesson or *Earth's Wild Ride*) assessment than they did on the last posttest assessed. In a case, for example, where a student scored an 11 on the pretest and a 4 on both posttests, this brought the student's learning gain to a -7 on both posttests. This was significant enough to cause positive learning gains to be cancelled out.

Learning Gains

The learning gains of the two groups were compared by the order in which they received the presentation technique. All students received the initial pretest. The students in group 1 of the study then received a teacher-led lesson accompanied by a Power Point presentation the class period before viewing *Earth's Wild Ride* in the immersive theater. Their learning gains are shown in Table 2 and distribution of scores are shown in Figure 1. For group 2, with the order of the test and movie reversed, the results are shown in Table 3 and distribution of scores shown in Figure 2. These gains and the normalized gains for both groups are shown in Table 4.

Table 2. Pretest and posttest results for the first group of students showing range, mean, standard deviation, and standard error. (Number of students n = 46)

Pretest and Posttests Results for Group 1			
	Pretest	Posttest Lesson	Posttest Dome
Range	5-15	5-20	5-20
Mean	9.83	14.52	14.52
Standard Deviation	2.6	3.32	3.36
Standard Error	0.39	0.49	0.50

Table 3. Pretest and posttest results for group 2 of students showing range, mean, standard deviation, and standard error. (Number of students n=45)

Pretest and Posttest Results For Group 2			
	Pretest	Posttest Dome	Posttest Lesson
Range	3-14	4-19	8-20
Mean	9.78	11.64	14.40
Standard Deviation	2.46	3.16	2.94
Standard Error	0.36	0.47	0.44

Table 4. Mean learning gains and normalized learning gains for both groups of the study.

Learning Gains						
	Group 1 (Lesson First)			Group 2 (Dome First)		
	Pretest/ Lesson	Pretest/ Dome	Lesson/ Dome	Pretest/ Dome	Pretest/ Lesson	Dome/ Lesson
Regular Gains	4.70 (±0.46)	4.70 (±0.50)	0.00 (±0.32)	1.87 (±0.51)	4.62 (±0.48)	2.76 (±0.42)
Normalized Gains	0.46 (±0.04)	0.46 (±0.05)	-0.06 (±0.09)	0.17 (±0.05)	0.44 (±0.05)	0.32 (±0.06)

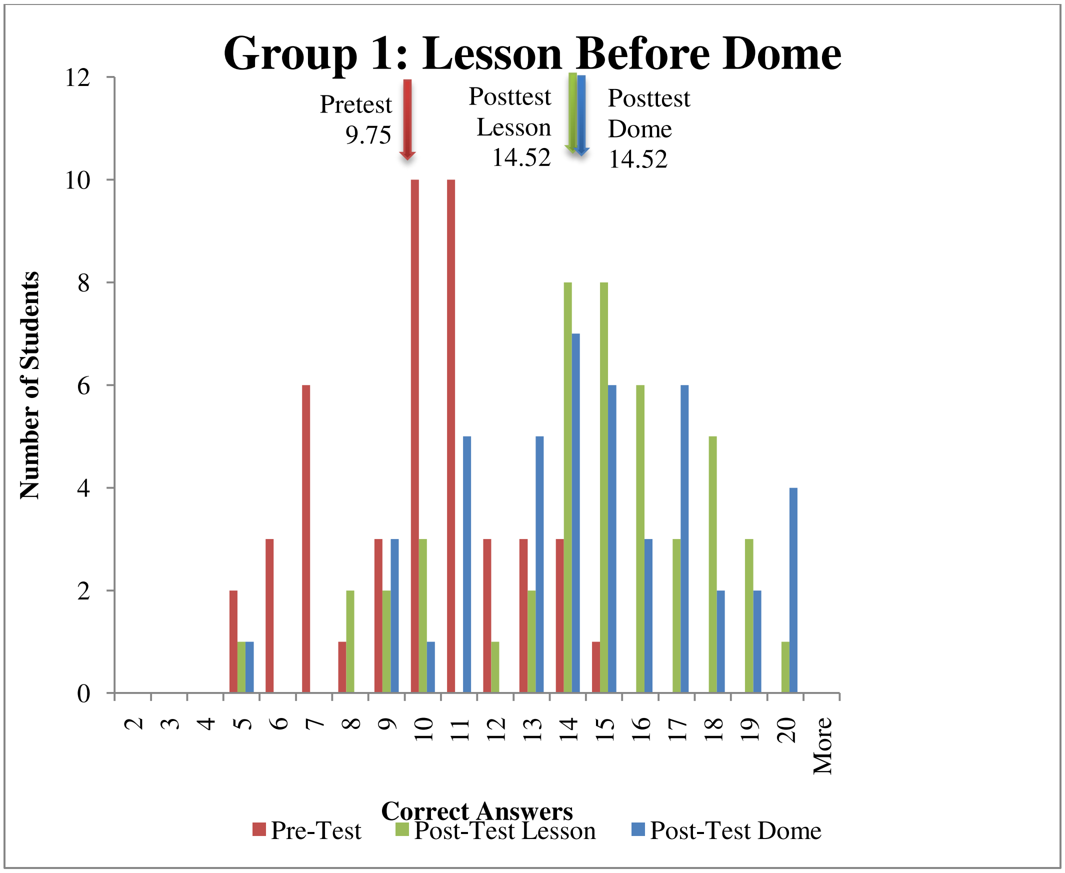

Figure 1. A histogram displaying the pretest, posttest lesson, and posttest dome scores for students in group 1 (n=46).

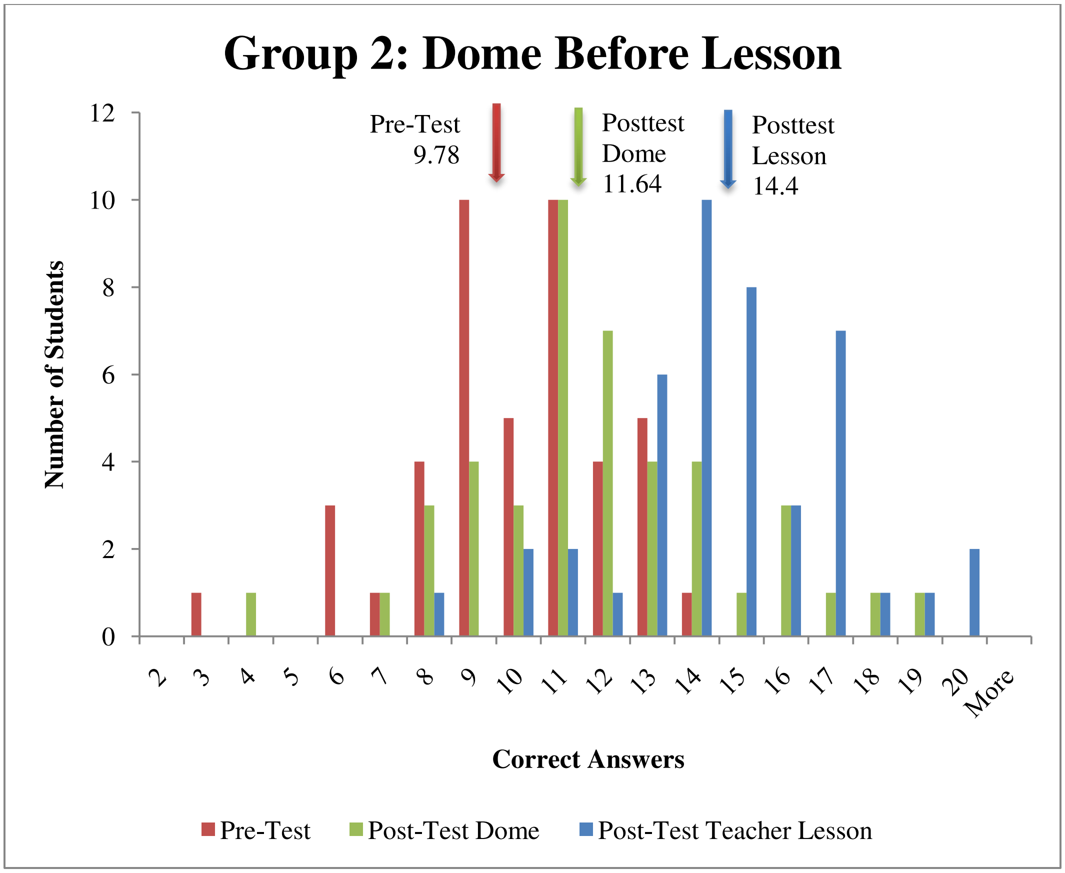

Figure 2. A histogram displaying the pretest, posttest lesson, and posttest dome scores for students in group 2 (n=45).

Comparing Final Posttest

The final mean learning gain from pretest to second posttest for group 1 (0.46 ± 0.04) was not significantly different from the mean learning gain for group 2 (0.44 ± 0.05). The results are shown in Table 5 and the distributions of scores are shown in Figure 3. The mean learning gains for each group is displayed in Figure 4. After just one activity (either the lesson or the movie) the lesson produced significantly better test results (0.46 ± 0.05) than the movie (0.17 ± 0.05). Therefore, the order of the activities did not affect overall gains. As measured by the test results for this small sample, the lesson appears to produce the gains independent of the movie.

Table 5. Learning gains comparing final posttests for the two groups of the study.

	Group 1	Group 2
	Teacher-led Lesson given first	*Earth's Wild Ride* in the Dome shown first
Score	14.52 (± 3.36)	14.40 (± 2.96)
Mean Difference	4.70 (± 3.15)	4.62 (± 3.21)
Normalized Gain	0.46 (± 0.04)	0.44 (± 0.05)

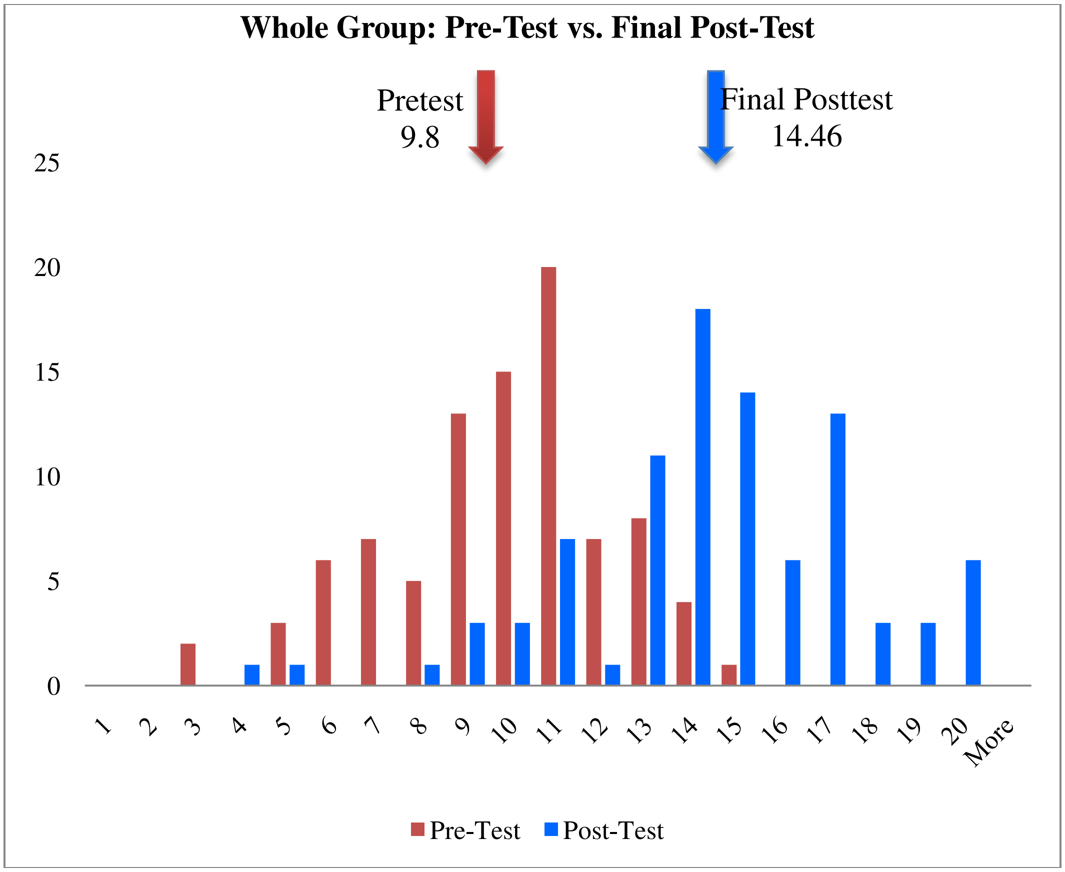

Figure 3. A histogram displaying the pretest and final posttest scores for whole group of students. (n = 91)

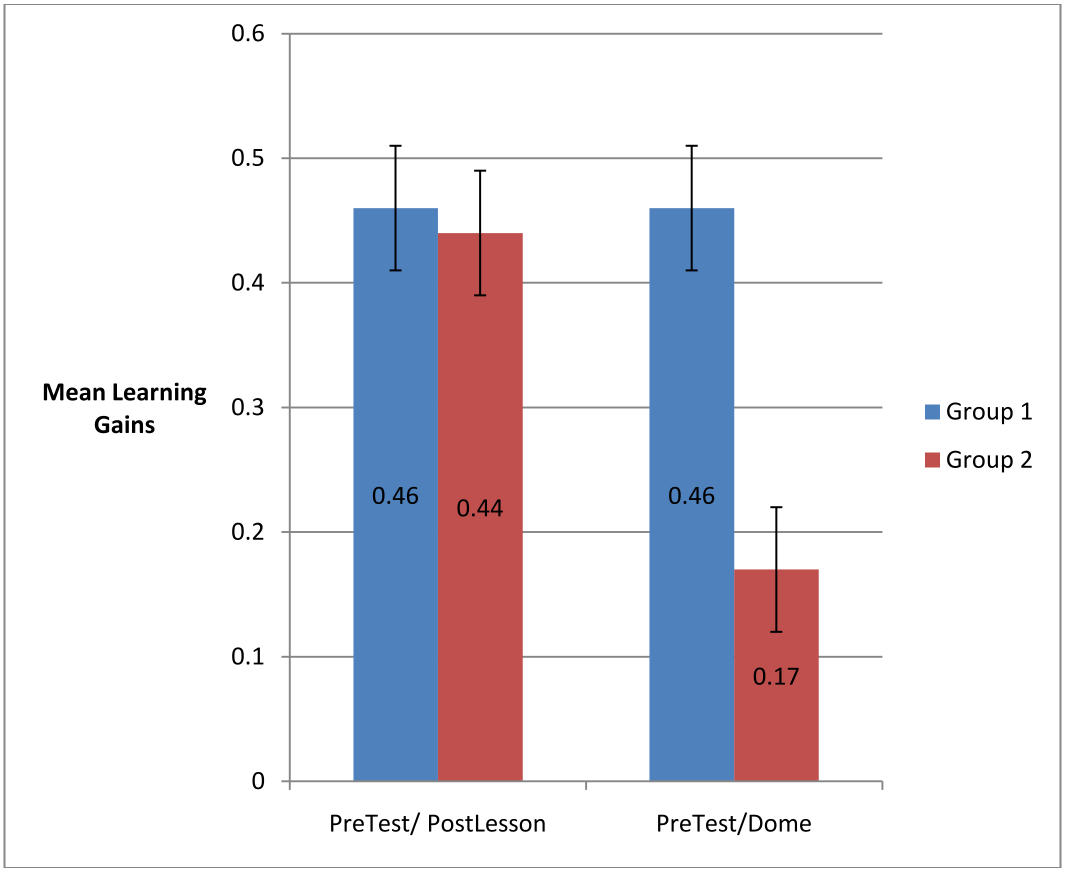

Figure 4. Mean learning gains comparing growth between the pretest and both posttest. For the pretest and the posttest lesson, there was minimal difference between mean learning gains in group 1 vs. group 2 (P=0.388). For the pretest and the posttest dome, there was a difference between mean learning gains in group 1 vs. group 2 (P < 0.001), and a difference in gains for the average posttest (P=0.006). Standard errors are shown.

DISCUSSION

The purpose of this study is to investigate the need for planning a pre-lesson or a post-lesson when setting up a field trip or out-of-the-classroom activity. Other studies have researched the value of field trips in a school's curriculum (Knapp, 2000), the need for proper planning of lessons to employ during outside-the-classroom activities (Davidson et al., 2009; Falk et al. 1982), and the need for field trips to build prior knowledge before teaching key concepts in the class (Nielsen et al., 2009). However, there has not been a study to see if a lesson before the activity will build a student's understanding of the purpose of the field trip more or less than a lesson following the trip.

The teacher-led lesson following the visit to the digital immersive dome (the out-of-the-classroom activity used in this study) showed the greatest learning gain (i.e., the difference in the mean between the dome activity and the teacher-led lesson). Group 1, which received the classroom lesson before visiting the dome to view *Earth's Wild Ride,* had a mean difference of -0.06 ± 0.09 while the Group 2, which received the teacher-led lesson after viewing the movie, had a mean difference of 0.32 ±0.06. In other words, the classroom lesson led to greater gains than did the movie.

Although there was not a significant difference for Group 1 in the gains between the teacher-led lesson and the visit to the immersive theater, the students in Group 1 showed a slightly greater overall learning gain than did the students in Group 2. Group 1 achieved a mean posttest score of 14.52 ±0.49 out of a possible 20 points after completing the classroom lesson, resulting in a learning gain of 0.46 ±0.04 compared to the pretest. The mean test score (14.52 ±0.50) after viewing *Earth's Wild Ride* was not significantly different from the first posttest resulting in a learning gain of 0.46 ±0.05 compared to the pretest and a negative gain between the two activities. Group 2, on the other hand, achieved a final overall learning gain of 14.40 ± 0.44 and a normalized gain of 0.44 ± 0.05. One should not assume from this statistic that the visit to the immersive theater was an ineffective teaching method. This may only suggest that the classroom activity is more directly related to the posttest assessment used in this study and leads to an increase in learning gain; whereas, the movie has no effect on that gain.

Based on the statistical results, order of the lessons does not make a difference. There was not a significant difference of the overall learning gain (calculated from the final posttests) between the mean of group 1 (0.46 ± 0.05) and group 2 (0.44 ± 0.05). These data strongly suggest the importance of a classroom lesson to accompany a planned field trip.

There are several factors that might have contributed to the lack of learning gain after visiting the immersive digital theater. Most notable is the novelty of the experience; this was the first time most of the students experienced viewing a movie in such a structure. "Research has shown that extremely novel settings placed preemptive demands on the learner and thereby negatively influenced concept learning" (Faulk et al. 2000). Some of the students were so excited about what they saw in the dome that it was difficult for these students to refrain from conversation during the video. When this occurred, the disruptive student and those around him/her had a difficult time engaging on what was being taught during the video. One way to avoid this problem would be to pause the video during the transition of topics and discuss the concepts being taught. This teaching method would reinforce what was covered and "catch up" the students that may have missed or misunderstood the information. This teaching technique should show greater learning gains in both groups.

In addition to the novelty of the experience there were also some technical and structural issues that could have affected learning gains. On a few occasions the video "froze" in the middle and had to be restarted. All students were able to watch the video in its entirety but the distraction could have caused some students to lose focus. Furthermore, there were a few cases when the top of the dome began deflating before the start of the video and one time during the video. This was caused by a small flap that was open and allowing air out. To avoid this situation in the future it is strongly recommended to check all parts of the dome before introducing it to the students. Any delay in instruction can cause a student to get too excited and divert him/her from learning.

Based on the statistics, it appears that the teacher-led lesson is more effective than the visit to the immersive theater. However, the students greatly appreciated the experience. Rudmann (1994) suggested, "Field trips can create relevancy to science classroom learning when connected to the outside world encouraging science interest and possibly increasing student aspirations for science-related careers."   After visiting the immersive dome, Savannah, a participant in group 1, wrote in her journal "I loved how everything in the dome just popped out at you and at the same time you are learning! It is like you were there to experience it! I just really enjoyed that I got the opportunity to go!" Before the experience several students were unaware that an asteroid may have caused the extinction of the dinosaurs. After viewing *Earth's Wild Ride* in the immersive dome, a few students conducted independent research on dinosaurs and shared what they learned with the class. The experience ignited an interest in science for several students. This was a highly significant result not measured in this study.   Gibson and Chase (2002) conducted a longitudinal study on a group of middle school students that completed a 2-week inquiry-based science camp at Hampshire College Amherst, MA. They found the students maintained a more positive attitude towards science and a higher interest in science careers compared to the control group (students that applied for the program but were not accepted).

Future studies may be interested in researching the long term effects field trips have on learning gain compared to a classroom experience. Months after the experience the students would talk about what they learned during this study. When discussing the dinosaurs, volcanoes, or living on the moon, the students always referred to the visit to the dome and not the classroom lesson. This suggests that the classroom lesson served as a reinforcement of the concepts being taught, but the visit to the immersive theater left the lasting impression.

SUMMARY AND CONCLUSION

This study tested the teaching strategies for implementing an effective classroom activity to accompany a field trip or an out-of-the-classroom activity into the science curriculum. There were no significant differences between the order of the lessons taught (Figure 3) because both groups resulted in very similar learning gains at the end of the study. These data do show the need for a classroom lesson to accompany the field trip; otherwise participating in a field trip without a lesson before the trip or a follow-up lesson may not produce significant learning gain. Although there was not a significant learning gain after viewing *Earth's Wild Ride* in the dome compared to the teacher-led lesson, the experience did not detract from learning. The students were excited about the experience and demonstrated long term effects of the visit. The results of this study should encourage teachers to integrate field trips or out-of-the-classroom activities into their science curriculum because it could excite and encourage students into future studies of science.

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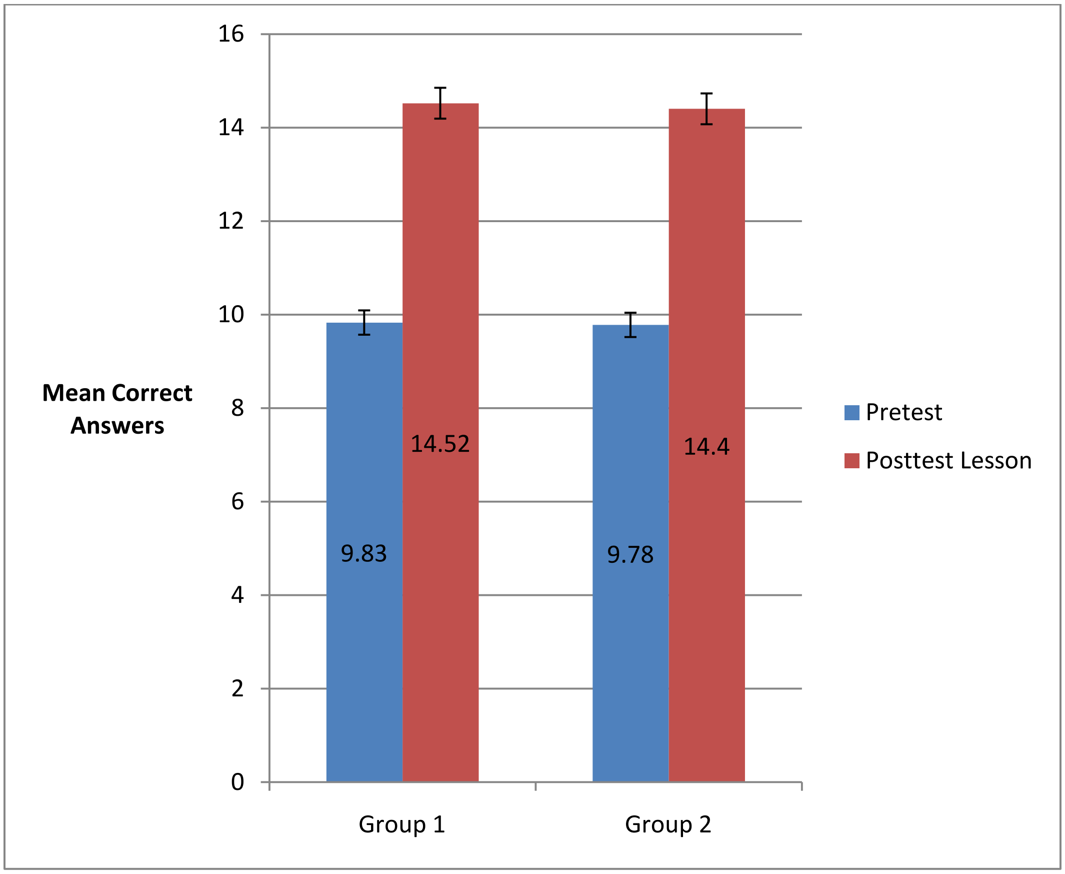
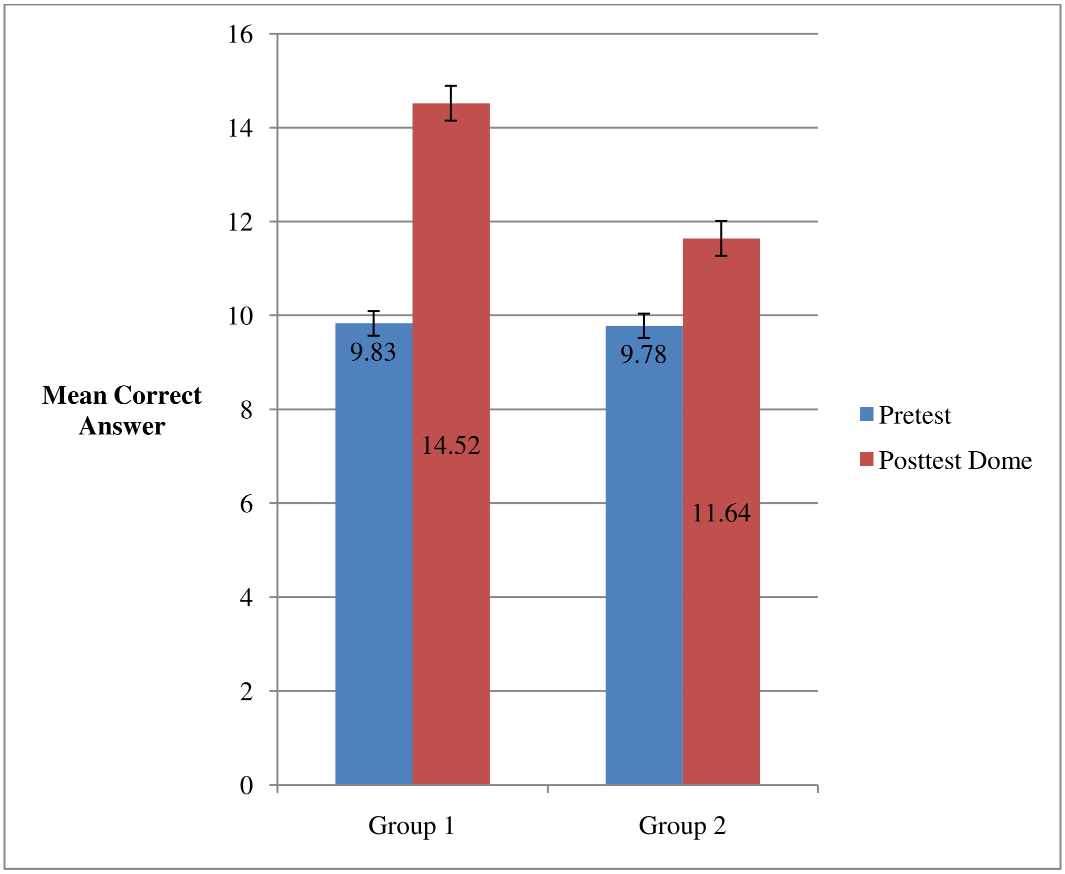
APPENDIX A
MEAN SCORES FOR CLASSROOM LESSON



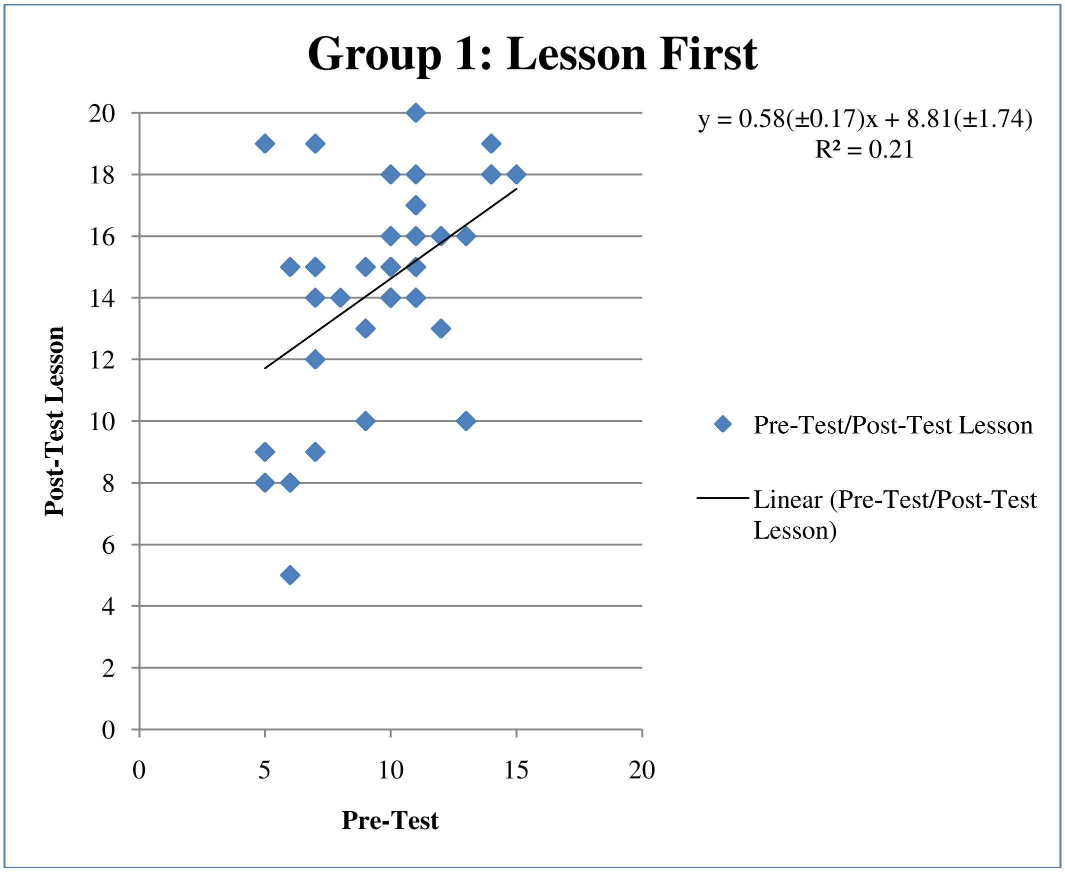
Pretest and posttest after classroom lesson student achievement means by group. Group 1 is the control without a pretreatment (P <0.001, r= 0.46, n=46). Group 2 receive a pretreatment of viewing *Earth's Wild Ride* in the immersive dome (P< 0.001, r= 0.31, n=45). The total students show a raw mean gain of 4.66 ±3.16 (P<0.001, r=0.39, n=91) Standard errors are shown

APPENDIX B
MEAN SCORES FOR *EARTH'S WILD RIDE* IN THE DOME

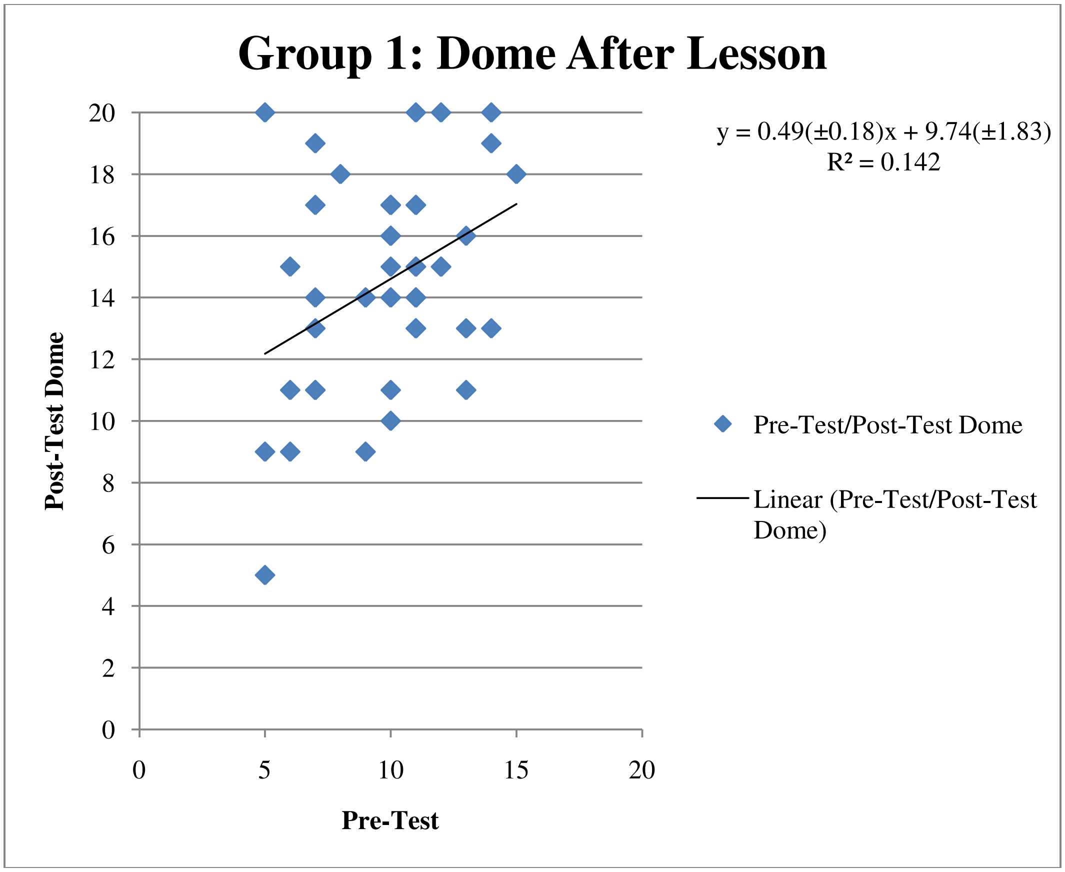


Pretest and posttest after viewing *Earth's Wild Ride* in the immersive dome. Group 1 received the pretreatment of classroom lesson before viewing the movie (P<0.001, r=0.38, n=46). Group 2 is the control without a pretreatment (P<0.001, r=0.28, n=45). Standard errors are shown

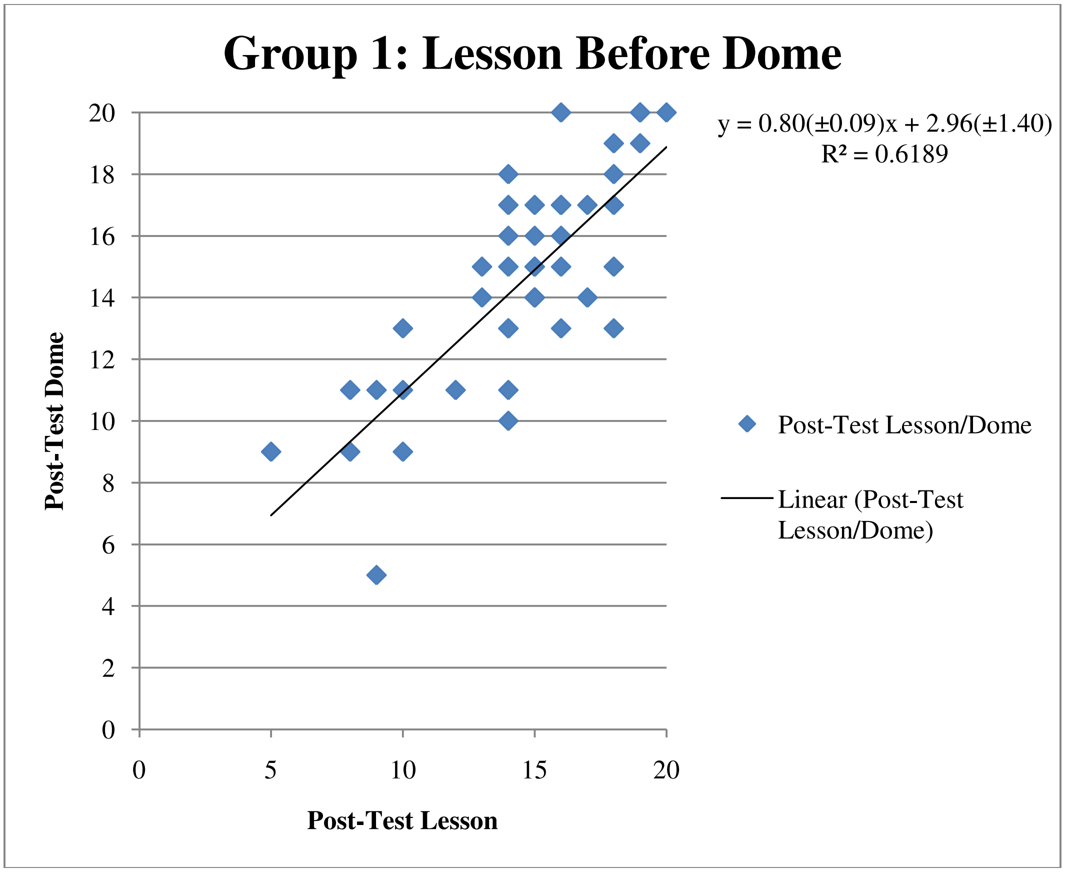
APPENDIX C
SCATTER PLOTS FOR GROUP 1



Scatter plot comparing students' scores on the pretest to the scores obtained on the posttest following just the classroom lesson for group 1. Pearson Correlation r = 0.46

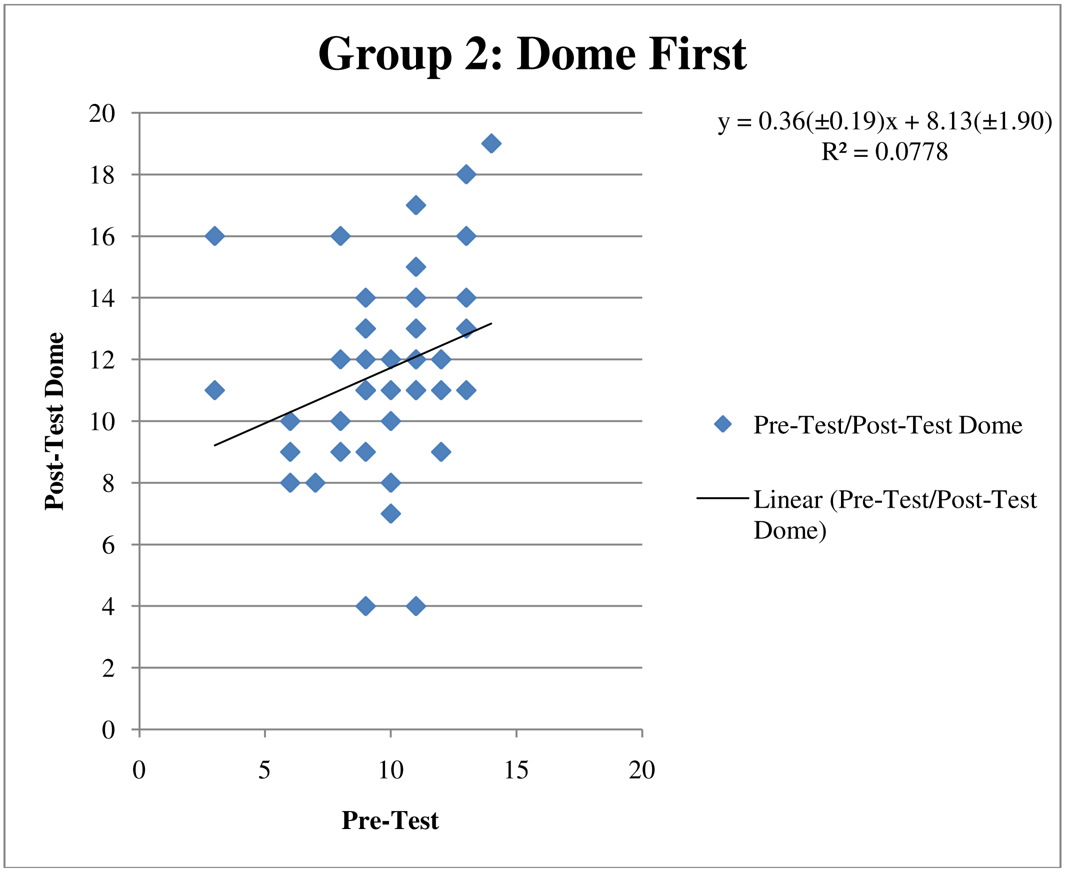


Scatter plot comparing students' scores in group 1 on the pretest to the scores obtained on the posttest after both the classroom lesson and viewing *Earth's Wild Ride* in the immersive dome. Pearson Correlation r = 0.38

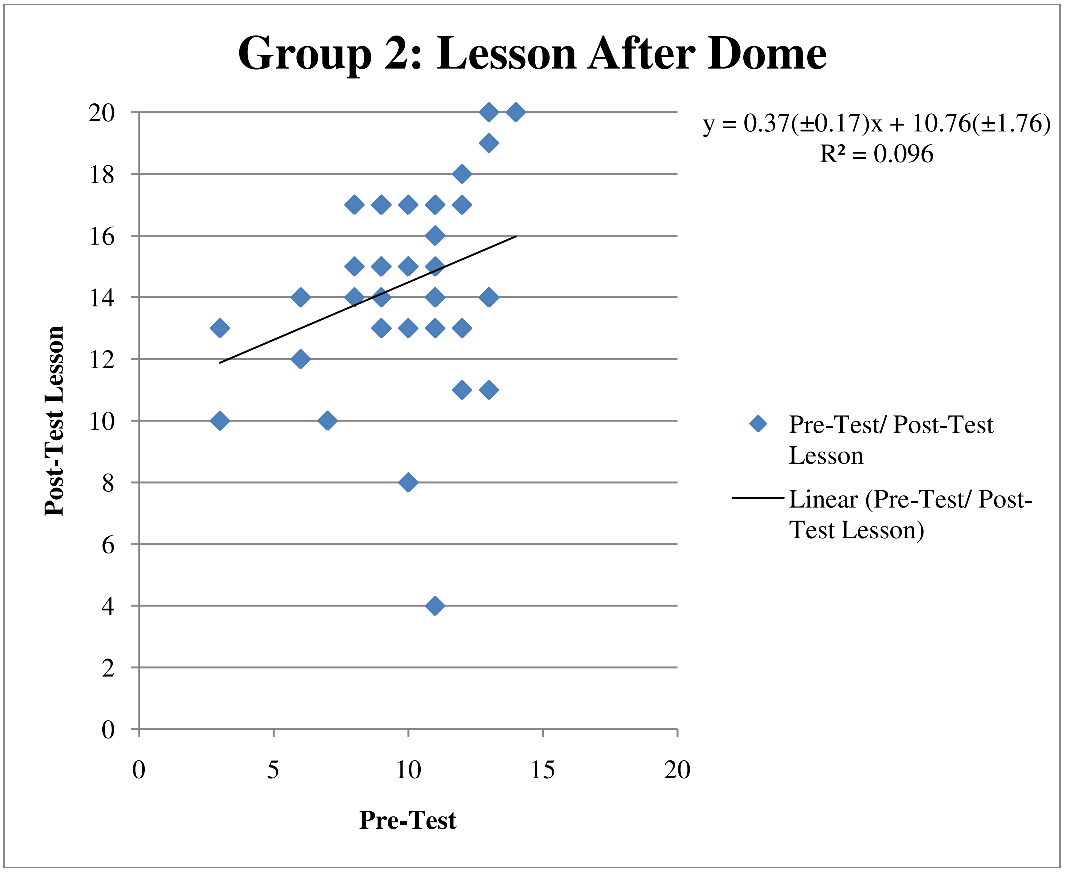


Scatter plot comparing students' scores in group 1 on the first posttest after the classroom lesson and the posttest after viewing *Earth's Wild Ride*. Pearson Correlation r = 0.79. The strong correlation shows that the event between the first test and the second (the dome experience) did not change the results. The students already had the knowledge from the lesson and the dome experience made no change.

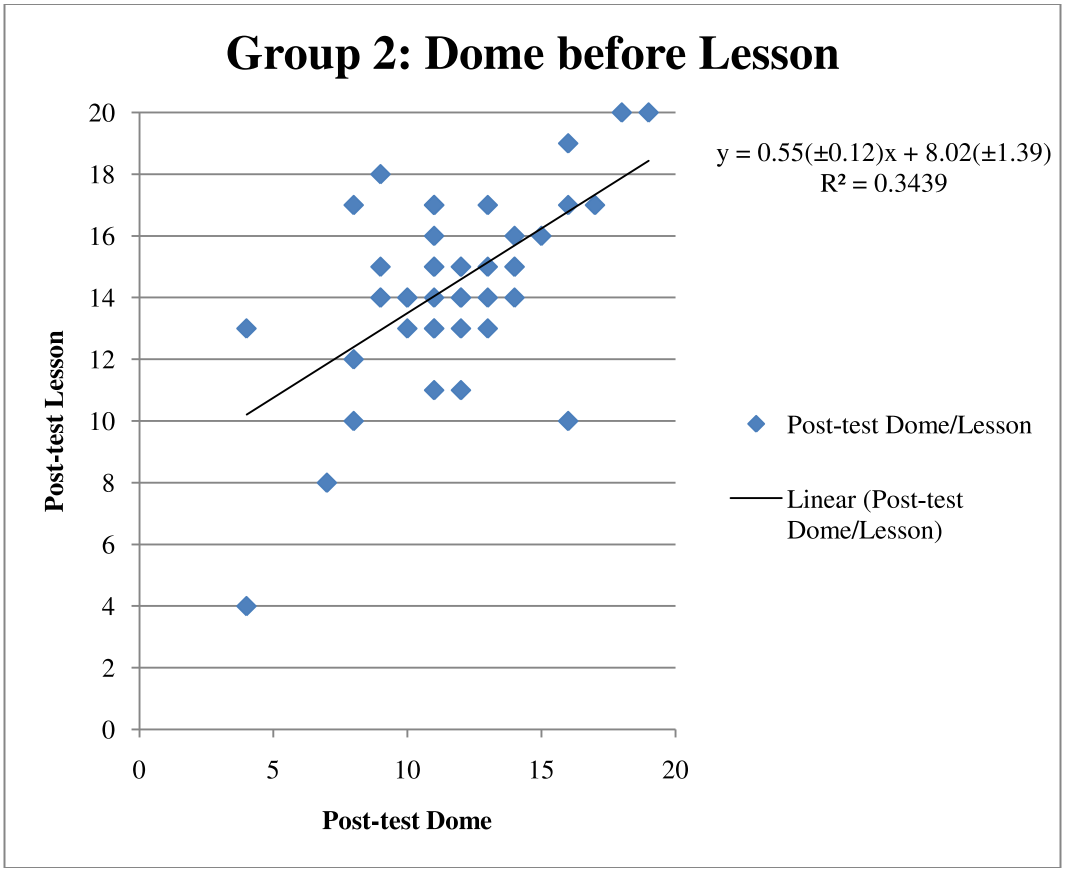
APPENDIX D
SCATTER PLOTS FOR GROUP 2



Scatter plot comparing students' scores in group 2 on the pretest to the scores obtained on the posttest after viewing *Earth's Wild Ride* in the immersive dome without the lesson. Pearson Correlation r = 0.28

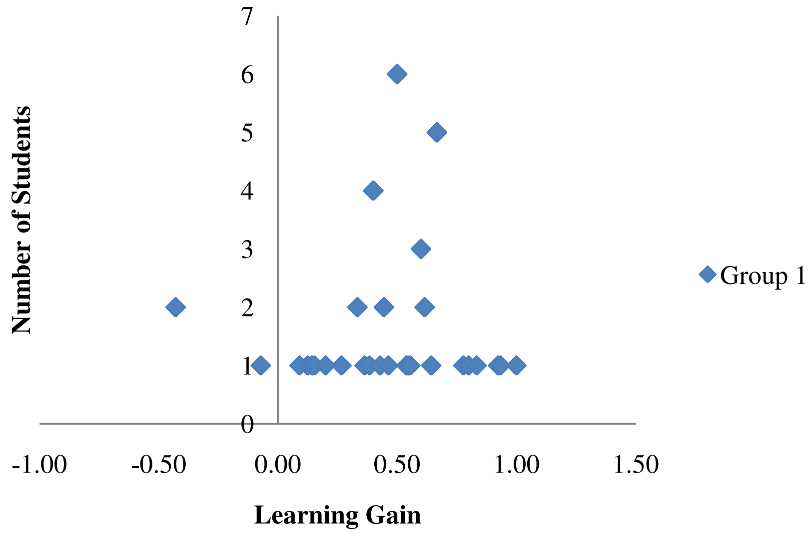


Scatter plot comparing students' scores on the pretest to the scores obtained on the posttest following both the movie and the classroom lesson for group 2. Pearson Correlation $r = 0.31$

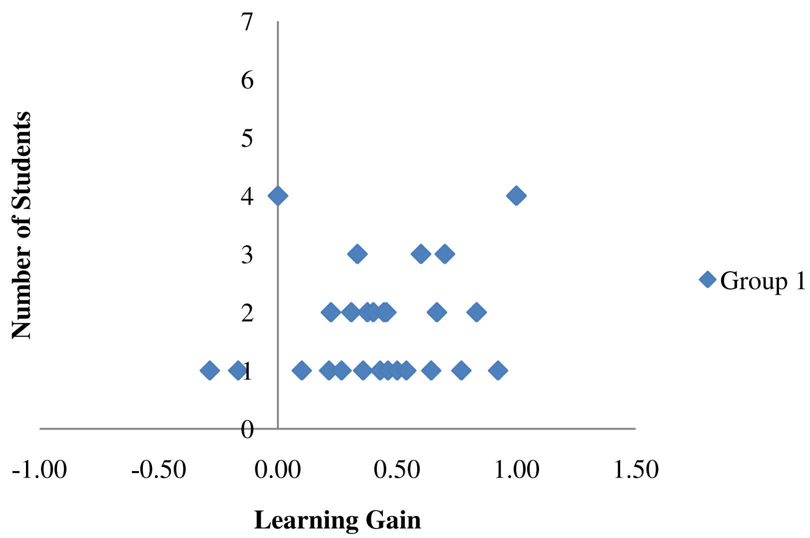


Scatter plot comparing students' scores in group 2 on the first posttest after the classroom lesson and the posttest after viewing *Earth's Wild Ride*. Pearson Correlation r = 0.59. The higher r value for Figure 11 compared to Figures 9 and 10 (and the lower value compared to Figure 8) suggests that the event between the first test and the second for Group 2 (the classroom lesson) has modest impact on the students' test results when it comes after the movie, but more impact than the movie following the lesson for Group 1.

APPENDIX E
DISTRIBUTION OF LEARNING GAINS GROUP 1

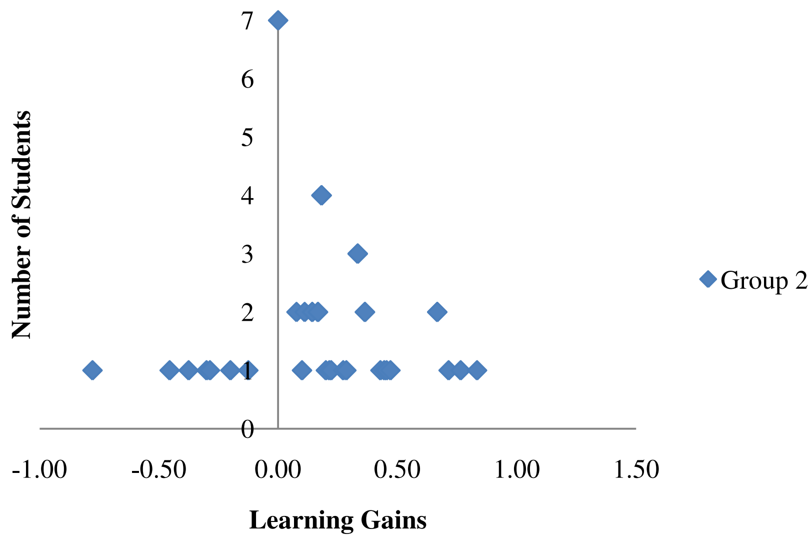


Distribution of learning gains for all students in group 1 completing the posttest for the teacher-led lesson.

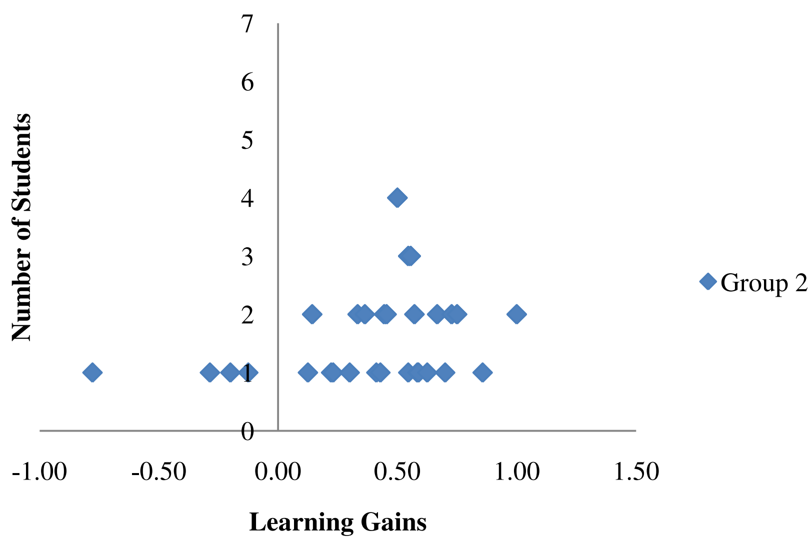


Distribution of learning gains for all students in group 1 completing the posttest after viewing *Earth's Wild Ride*

APPENDIX F
DISTRIBUTION OF LEARNING GAINS GROUP 2



Distribution of learning gains for all students in group 2 completing the posttest after viewing *Earth's Wild Ride*



Distribution of learning gains for all students in group 2 completing the posttest for the teacher-led lesson.

APPENDIX G
PRETEST AND POSTTEST

1. What is easier to do outside on the Moon than on the Earth?
    a. bounce up and down
    b. go swimming
    c. grow flowers
    d. fly a kite

2. When people on Earth see a solar eclipse, the Earth, Sun, and Moon are all in a straight line. What is the order of the Earth, Sun, and Moon?
    a. Sun, Earth, Moon
    b. Earth, Sun, Moon
    c. Moon, Earth, Sun
    d. Sun, Moon, Earth

3. When people on Earth see a total solar eclipse, what are people on the Moon seeing?
    a. the Sun disappearing behind the Earth
    b. the Earth disappearing behind the Sun
    c. the Moon casting a shadow on the Earth
    d. the Earth casting a shadow on the Moon

4. During an ice age, ice
    a. is found only at the North and South poles.
    b. covers most of Europe.
    c. covers the whole Earth.
    d. covers all the land areas of Earth.

5. During the last ice age, people drew pictures on
    a. cave walls.
    b. rice paper.
    c. clay tablets.
    d. pulp wood.

6. Which of these is an adaptation of mammoths to their environment?
    a. thick fur.
    b. meat diets.
    c. small feet.
    d. long necks.

7. The mammoth is most like
    a. a leopard.
    b. a tiger.
    c. a gorilla.
    d. an elephant.

8. During the last ice age, people used caves for
   a. killing mammoths.
   b. growing food.
   c. shelter.
   d. protecting their sheep.

9. Name the country that looks like a boot.
   a. Texas
   b. China
   c. Italy
   d. Mexico

10. Why don't the stars twinkle on the Moon?
   a. because the moon doesn't have any air.
   b. because there are no clouds on the Moon.
   c. because stars are closer from the Moon.
   d. They do, the astronauts just can't see it.

11. Which of these causes craters on Earth, but NOT on the Moon?
   a. comets.
   b. asteroids.
   c. volcanoes.
   d. meteoroids.

12. Why does the moon have more craters than the Earth?
   a. It has been hit more often.
   b. Asteroids reach the moon first.
   c. Earth doesn't crater as easily.
   d. Earth craters are wiped away by wind and water.

13. What was the climate like at the time of the dinosaurs?
   a. an ice age
   b. warm and wet like the tropics
   c. dry like a desert
   d. we don't know.

14. A large asteroid impact can kill animals around the world because it
   a. produces clouds covering the entire planet.
   b. floods the entire earth.
   c. causes fires that burn for days.
   d. produces earthquakes around the world.

15. Are there rivers on the Moon?
    a. only in the mountains.
    b. only at the poles.
    c. only at night.
    d. no.

16. Clouds in the Earth's sky are made of
    a. water droplets.
    b. carbon dioxide.
    c. oxygen.
    d. water vapor.

17. Melted rock is called
    a. obsidian
    b. sedimentary
    c. lava when it's underground and magma when it's flowing on the surface
    d. magma when it's underground and lava when it's flowing on the surface

18. A river flows through a canyon. It is probably true that
    a. the canyon made the river.
    b. the river made the canyon.
    c. an earthquake made the canyon.
    d. wind produced the canyon and the river.

19. Which of these features do you expect to see on the Moon?
    a. canyons cut by ancient rivers.
    b. craters from a recent volcano.
    c. geysers.
    d. craters caused by asteroids.

20. Why would living on the Moon good for an old person?
    a. The rocks are safer.
    b. Lunar spring water is very healthy.
    c. Lower gravity is easier on the heart.
    d. The sunlight is less bright.

APPENDIX H
GUIDED NOTES

Name
Date Class Period

Scientific Investigations
Imagine yourself in a time machine, going back in time about 20,000 years. You get out of the machine and all you can see is ice. All around you are miles and miles of ice. You'd think you must have landed on a glacier or frozen lake. Actually, you are in the _____________
The Ice Age

- For a span of about a million years, about _________________________
- Do you ever wonder how we know that ice ages really exist?
- Well one reason is that it left clues.

During this time, most of Europe was covered by ice
The Cave

- The people during this time period found shelter in __________
- In these caves, people _____________________ what life was like at the time on the sides of their caves
- They painted pictures a different animals that were around at this time such as the __________________
- They are related to the modern day _____________
- They had a thick layer of fur and 4” of fat beneath its skin _____________________________ from the cold. This allowed them to adapt to the environment
- No one really knows why they become extent. Could be due to the ______________________________

Now we are going to travel further back in time to a period in history that paleontologist love to study

- During this time the planet was a lot different - more ______________________________
- About 65 million years ago when dinosaurs walked the Earth

How do we know the dinosaurs existed?

- Because they left behind ____________________ and bones
- We know a lot about their ____________and their ______________________ but there are still a lot of things we do not know about dinosaurs

What happened to the dinosaurs?

- One popular theory (guess) is that an _________________ crashed through Earth’s atmosphere and hit the ocean
- Shock waves from the ______________________________ the air and generated searing winds that scorched the planet.
- Dark clouds now covered the Earth
- These clouds are was unlike the clouds in our sky today. Our clouds are made of __________________________________ which allow light to pass through. These clouds were composed of dust, water, and soot and blocked the Sun for months
- causing plants to die and the _____________________________________ to drop. Soon the dinosaurs died, as well.

- Asteroids are not the only thing that scientist study and investigate that can cause clouds of dust and soot, ______________________ can do this as well.
- Volcanologists are scientists who study how ______________________________ inside the earth cause volcanoes to erupt
- Imagine if you could look inside a volcano as it erupts and see the _______________________ pouring out of the crater.
- These scientist study the melted rock, which is called magma when it's underground, can reach the surface, ____________________________.
- Did you know that there are other kinds of volcanoes that can build up pressure until they explode? When that happens, the entire __________________________________, leaving a huge hole

How do we know so much about outer space????

- ________________________ love to study our moon and they are currently researching ways in which life could sustain on the moon.
- What do you think it would be like if you could live on the moon??????
- The moon is ____________________________, so the moon's gravity is much less than the earth's gravity, 83.3% (or 5/6) less to be exact. Finally, "weight" is a measure of the ____________________________ between two objects. So of course you would weigh much less on the moon. Imagine how far you could jump on the moon! The Apollo astronauts apparently had fun :-)
- Also if you lived on the moon, you would live much longer because less ________________ is easier on your organs including your ____________________.
- Because there ___________________, the stars at night do not twinkle the way we see them from Earth
- There are no rivers on the moon. Therefore there are no ________________ which are created by rivers.
- This is also why the moon has more craters than the Earth. The craters on the Earth are wiped away by ____________________.

Imagine what it would be like to live on the moon during a __________________!
A solar eclipse is when the ____ are in a line.
When this happens on Earth, we cannot see the sun. However, if you were on the moon, the moon would be casting large shadow on the Earth.
This is something that would be amazing to see!
Maybe one of you will get the opportunity in your life time!!!!

APPENDIX I
POWER POINT FOR TEACHER-LED LESSON

Slide 1

Scientific Investigations

Past, Present, and Future

Slide 2

Imagine yourself in a time machine, going back in time about 20,000 years. You get out of the machine and all you can see is ice. All around you are miles and miles of ice. You'd think you must have landed on a glacier or frozen lake. Actually, you are in the ice age.

Slide 3

THE ICE AGE

- For a span of about a million years, about 1/3 of the earth was ice
- Do you ever wonder how we know that ice ages really exist?
- Well one reason is that it left clues.

Slide 4

During this time, most of Europe was covered by ice

Italy

Slide 5

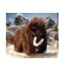
The Caves

- The people during this time period found shelter in caves
- In these caves, people painted pictures what life was like at the time on the sides of their caves
- They painted pictures a different animals that were around at this time such as the woolly mammoth

Slide 6

The Woolly Mammoth

- They are related to the modern day elephant
- They had a thick layer of fur and 4" of fat beneath its skin to insulate it from the cold. This allowed them to adapt to the environment
- No one really knows why they become extent. Could be due to the warming climate.



Slide 7

Now we are going to travel further back in time to an period in history that paleontologist love to study

- During this time the planet was a lot different - more lush and tropical
- About 65 million years ago when dinosaurs walked the Earth

Slide 8

How do we know that dinosaurs existed?

- Because they left behind fossils and bones
- We know a lot about their size and their shape but there are still a lot of things we do not know about dinosaurs

Slide 9

What happened to the dinosaurs?

- One popular theory (guess) is that an asteroid crashed through Earth's atmosphere and hit the ocean
- Shock waves from the explosion heated the air and generated searing winds that scorched the planet.
- Dark clouds now covered the Earth

Slide 10

- These clouds are was unlike the clouds in our sky today. Our clouds are made of tiny water droplets which allow light to pass through. These clouds were composed of dust, water, and soot and blocked the Sun for months
- causing plants to die and the temperatures to drop. Soon the dinosaurs died, as well.

Slide 11

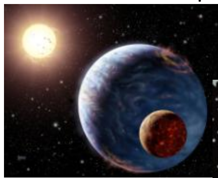
- Asteroids are not the only thing that scientist study and investigate that can cause clouds of dust and soot, volcanoes can do this as well.
- Volcanologists are scientists who study how forces and materials inside the earth cause volcanoes to erupt

Slide 12

- Imagine if you could look inside a volcano as it erupts and see the molten rock pouring out of the crater.
- These scientist study the melted rock, which is called magma when it's under ground, can reach the surface, flowing down as lava.
- Did you know that there are other kinds of volcanoes that can build up pressure until they explode. When that happens, the entire mountain can disappear, leaving a huge hole.

Slide 13

How do we know so much about outer space????



Slide 14

- Astronomers love to study our moon and they are currently researching ways in which life could sustain on the moon.
- What do you think if would be like if you could live on the moon??????

Slide 15

Facts about the moon

- The moon is 1/4 the size of Earth, so the moon's gravity is much less than the earth's gravity, 83.3% (or 5/6) less to be exact. Finally, "weight" is a measure of the gravitational pull between two objects. So of course you would weigh much less on the moon. Imagine how far you could jump on the moon! The Apollo astronauts apparently had fun :-)
- Also if you lived on the moon, you would live much longer because less gravity is easier on your organs including your heart.

Slide 16

On the moon, there is no wind or water.

- Because there is no air, the stars at night do not twinkle the way we see them from Earth
- There are no rivers on the moon. Therefore there are no canyons which are created by rivers.
- This is also why the moon has more craters than the Earth. The craters on the Earth are wiped away by wind and water.

Slide 17

Imagine what it would be like to live on the moon during a solar eclipse!

A solar eclipse is when the Sun, Moon, and Earth are in a line.

When this happens on Earth, we cannot see the sun. However, if you were on the moon, the moon would be casting large shadow on the Earth.

This is something that would be amazing to see!

Slide 18

- Maybe one of you will get the opportunity in your life time!!!!

APPENDIX J
PARENTAL PERMISSION FORM

Project Title: Evaluation of an immersive theater on learner outcomes
Performance Site: Woodlawn Middle School
Investigators: The following investigator is available for questions,
Mrs. Cynthia Rau Rieger (225)751-0436
Woodlawn Middle School

Purpose of Study: The purpose of this project is to determine if an immersive theater affects learner outcomes.

Description of the Study: Students will experience a lesson taught through the technology of an immersive theater and through lecture with power point. I will be using pre-test and post-test scores from the students in order to determine learning gain among students who experienced the immersive theater compared to those taught with a lecture with power point. Both groups of students will get the opportunity to learn through both teaching styles. The scores will be used to determine if the immersive theater affects the learner's outcomes.

Benefits: All students will have the opportunity to experience learning with the immersive theater.

Risks: The research is not expected to cause any harm or discomfort.

Right to Refuse: Participation is voluntary, and a child will become part of the study only if both child and parent agree to the child's participation. At any time, either the subject may withdraw from the study or the subject's parent may withdraw the subject from the study without penalty or loss of any benefit to which they might otherwise be entitled.

Privacy: The school records of participants in this study may be reviewed by investigators. Results of the study may be published, but no names or identifying information will be included for publication. Subject identity will remain confidential unless disclosure is required by law.

Signatures: I will allow my child to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Parent's Signature: ________________________________

Date: ____________________

Additional questions or problems regarding your child's rights as a research participant should be addressed to Dr. Robert Mathews, Chair, Institutional Review Board, Louisiana State University, 203 B-1 David Boyd Hall, Baton Rouge, LA 70803; Telephone (225)578-8692 ; E-Mail Address irb@lsu.edu

APPENDIX K
DOME SPECIFICATIONS

OPF-6.5 Specifications

OPENDOME ADVANTAGES

- Fully open doorway with no airlock
- No rigid supports
- No complex assembly

DIMENSIONS

- 7.62m (25') Outside Diameter
- 6.5m (21.3') Internal Screen Diameter
- 4.1m (13.5') Maximum Height

CAPACITY

- Maximum capacity depends on age/size of audience and seating arrangement.
- Adult Capacity: 20
- Typical Student Capacity: 25-30

Minimum Setup Area

- 25' x 25' clear floor space
- 13' minimum ceiling height

MINIMUM SETUP CREW

- 1 adult – 2 are recommended

MINIMUM SETUP TIME

- Approximately 20 minutes

WEIGHT

- 140 lbs

PACKED SIZE

- 1.07m x 0.86m x 1.07m (42" x 34" x 42")

FLOORING

- No special flooring is provided. The floor of the setup area is usually sufficient.

MATERIALS

- 200 Denier Nylon Oxford

CUSTOM COLORS & BRANDS

- Available in a wide range of colors
- Custom graphics can be printed directly on the dome
- Custom removable wraps available

POWER REQUIREMENTS

- Blower fan requires (1) 110V AC outlet during inflation period
- Screen fan requires (1) 110V AC outlet while in use

STANDARD ACCESSORIES

- Shipping case
- Blower fan
- Screen fan
- Installation manual
- Patch kit

OPTIONAL ACCESSORIES

- Hard-shell shipping case

OPERATING ENVIRONMENT

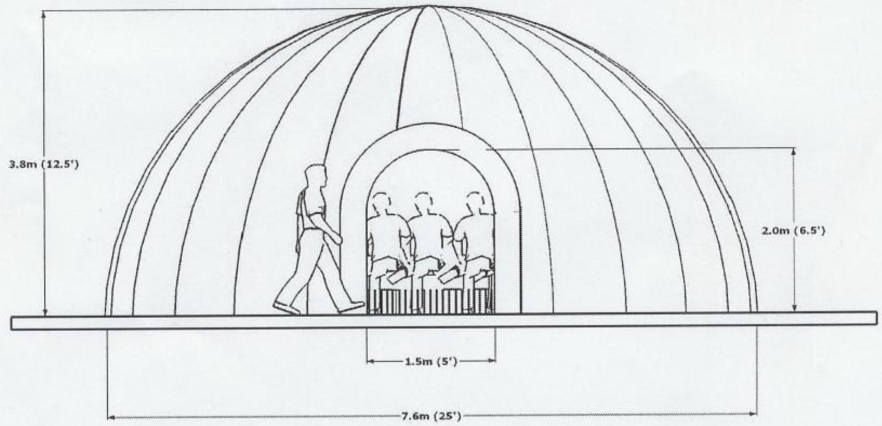
- Indoors or under cover
- Less than 5 mph wind untethered

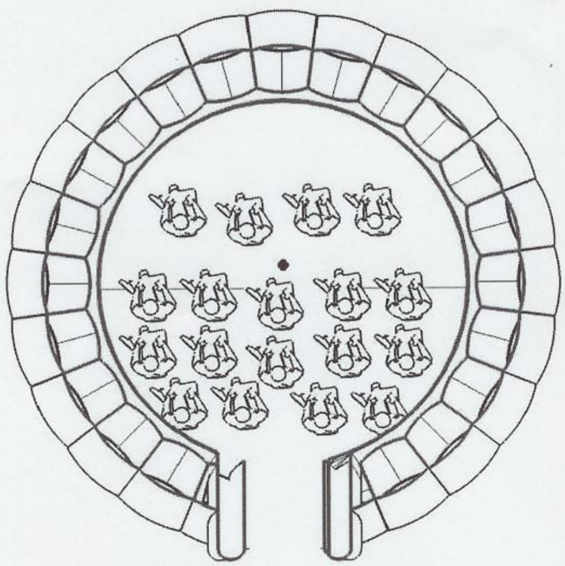
LIMITED WARRANTY

- 1 years part and labor

CARE

- Spot clean with water and cloth
- Screen is machine washable and replaceable


3.8m (12.5')
2.0m (6.5')
1.5m (5')
7.6m (25')



APPENDIX L
PICTURES OF PARTICIPANTS AT WOODLAWN MIDDLE

APPENDIX M
RAW DATA

Group	Student	pretest	ppt	dome	lesson 1st
1	1	9	15	14	ppt
1	2	14	18	13	ppt
1	3	9	13	14	ppt
1	4	13	10	13	ppt
1	5	5	8	9	ppt
1	6	7	15	17	ppt
1	7	11	20	20	ppt
1	8	11	18	17	ppt
1	9	11	17	17	ppt
1	10	6	8	11	ppt
1	11	10	14	10	ppt
1	12	12	16	15	ppt
1	13	6	15	15	ppt
1	14	10	18	15	ppt
1	15	11	14	13	ppt
1	16	7	19	19	ppt
1	17	15	18	18	ppt
1	18	7	9	11	ppt
1	19	14	19	20	ppt
1	20	5	19	20	ppt
1	21	11	15	15	ppt
1	22	7	14	13	ppt
1	23	5	9	5	ppt
1	24	8	14	18	ppt
1	25	6	5	9	ppt
1	26	13	10	11	ppt
1	27	7	12	11	ppt
1	28	10	16	17	ppt
1	29	12	16	20	ppt
1	30	9	10	9	ppt
1	31	10	16	17	ppt
1	32	14	18	19	ppt
1	33	10	15	16	ppt
1	34	10	15	14	ppt
1	35	11	14	15	ppt
1	36	10	14	11	ppt
1	37	7	15	14	ppt

1	38	11	17	14	ppt
1	39	10	14	17	ppt
1	40	10	14	16	ppt
1	41	11	16	13	ppt
1	42	11	17	14	ppt
1	43	12	13	15	ppt
1	44	11	15	14	ppt
1	45	13	16	16	ppt
1	46	10	15	14	ppt
2	1	9	15	13	dome
2	2	3	10	16	dome
2	3	10	15	11	dome
2	4	9	14	11	dome
2	5	6	14	9	dome
2	6	13	14	13	dome
2	7	12	11	12	dome
2	8	10	13	10	dome
2	9	12	17	11	dome
2	10	11	14	12	dome
2	11	11	16	14	dome
2	12	8	14	10	dome
2	13	7	10	8	dome
2	14	9	17	11	dome
2	15	9	17	11	dome
2	16	10	8	7	dome
2	17	11	4	4	dome
2	18	14	20	19	dome
2	19	6	12	8	dome
2	20	9	15	9	dome
2	21	13	11	11	dome
2	22	12	18	9	dome
2	23	13	19	16	dome
2	24	13	20	18	dome
2	25	11	16	11	dome
2	26	8	15	12	dome
2	27	9	13	4	dome
2	28	13	14	14	dome
2	29	11	15	14	dome
2	30	9	15	14	dome
2	31	11	14	12	dome
2	32	12	13	12	dome

2	33	11	16	15	dome
2	34	11	17	17	dome
2	35	11	17	13	dome
2	36	11	13	11	dome
2	37	10	15	12	dome
2	38	10	17	8	dome
2	39	3	13	11	dome
2	40	9	15	11	dome
2	41	8	17	16	dome
2	42	8	14	9	dome
2	43	9	14	12	dome
2	44	6	14	10	dome
2	45	9	13	13	dome

VITA

Cynthia R. Rieger was born in Little Rock, Arkansas, in July 1979. She attended elementary, middle, and high school in Baton Rouge, Louisiana. She graduated from Baton Rouge Magnet High School in May 1997. The following August she entered Louisiana State University Agricultural and Mechanical College and in December 2002 earned her degree in elementary education. She entered the Graduate School at Louisiana State University Agricultural and Mechanical College in June 2008 and is a candidate for a Master of Natural Sciences. She has been a middle school science teacher in East Baton Rouge Parish for the past 7 years and is currently teaching at Woodlawn Middle School.