Impact of Using NewPath's Multimedia
Elementary Science Lessons on
Student Learning

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800-507-0966
www.newpathlearning.com

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Study Research Team

- **George Nassis, M.S.Ed** – Principal Investigator
- **Kurt Gelke, M.B.A.** – Co-Investigator
- **Dina Markowitz, Ph.D.** – Focus Group & Pilot Testing Coordinator
- **Susan Holt, M.S.Ed** – Research Assessment Consultant
- **Guillermo Montes, Ph.D.** – Statistical Analysis

Impact of Using NewPath's Multimedia Lessons on Student Learning

EXECUTIVE SUMMARY

NewPath Learning worked in conjunction with Dr. Guillermo Montes, an expert in student outcomes measurements, to develop, implement and analyze data from validated pre- and post-assessments to determine the impact that NewPath's Online Multimedia Elementary Science Lessons have upon student learning. **Field testing provided research-based evidence which demonstrated that the use of the Online Multimedia Elementary Science Lessons by students generates substantial and significant increase in the comprehension of the science concepts presented.** Therefore, for administrators and teachers interested in ensuring the science readiness of their students, NewPath's multimedia lessons offer a proven method for success.

To make comparability to the literature and to other multimedia lessons easier, scale change scores for each lesson were transformed into a Cohen's d effect size, a widely used metric of effect size.

What are Ecosystems? Multimedia Lesson had an effect size **d=0.67**, meaning that on average students improved **0.67** standard deviations from pre- to post-testing.

What is Weather? Multimedia Lesson had an effect size **d=1.36**, meaning that on average students improved **1.36** standard deviations from pre- to post-testing.

Cohen's d effect sizes greater than or equal to **0.80** are considered to be large intervention effects.

INTRODUCTION

Schools are placing increased emphasis on evaluating the impact of instructional materials on student learning, but few, if any, publishers provide evidence that use of their products results in increased learning of science concepts and processes. The purpose of this study was to develop and use reliable and valid pre- and post-assessments to determine whether the use of the Multimedia Elementary Science Lessons promotes students' science knowledge acquisition and application of that knowledge.

DESCRIPTION OF NEWPATH'S ELEMENTARY MULTIMEDIA LESSONS

NewPath Learning's Multimedia Elementary Science Lessons are complete, ready-to-use, interactive lessons for students in grades 3-5 covering key life, earth and physical science topics. Each Elementary Multimedia Science Lesson follows the *5E Science Learning Cycle* – **Engage**, **Explore**, **Explain**, **Elaborate** and **Evaluate**. The lessons provide engaging tutorial presentations, inquiry-based interactive activities, vocabulary review activities, and virtual investigations and assessments that are critical to the mastery of the often complex concepts pertaining to current, standards-based science requirements.

The Multimedia Elementary Science Lessons tested in this study were developed under the Phase II SBIR project and focused on key science topics for grades 3-5. While initially planned specifically for whole-class use on the Interactive Whiteboard (IWB), the elementary Multimedia Lessons are also highly effective for use by individual students for self-paced instruction, one-to-one computing initiatives and flipping the classroom.

The elementary Multimedia Lessons are delivered entirely online and accessible by teachers and students wherever Internet access is available via a standard browser on any computing device, including tablets. The online platform is completely hosted by NewPath Learning, thereby eliminating the need for schools or end-users to install and run any special hardware or software other than the typical plugins which are already available on most standard computers. In addition to the elementary Multimedia Lessons, the online platform also includes a comprehensive learning management system to make assignments and track and analyze student performance.

Each Elementary Multimedia Lesson field tested included the following sections in the order outlined:

- **Pre-Test – "Check What You Know"**
  Consists of lesson-specific multiple choice questions based upon Bloom's taxonomy (knowledge, comprehension, application, analysis, synthesis and evaluation) to determine students' existing understanding of the lesson content prior to its use.

- **Lesson Presentation**
  Consists of a series of narrated, visual presentations, each featuring detailed graphics and animations to build student comprehension of the concept presented.

- **Interactive Activities**
  Includes a variety of activities, such as drag-and-drop, matching, etc. that allow students to practice and apply the knowledge presented in the Lesson Presentation section.

- **Virtual Lab Investigation**
  Includes a fully interactive virtual lab investigation, along with a study guide. The investigation allows students to practically apply the knowledge gained in the other sections of the lesson.

- **Post-Test – "Check What You Learned"**
  Consists of lesson-specific multiple choice questions based upon Bloom's taxonomy (knowledge, comprehension, application, analysis, synthesis and evaluation) and directly related to the learning objectives of that module to determine students' comprehension after completing the lesson.

DEVELOPMENT OF OUTCOME MEASURE

For each of the two elementary Multimedia Lessons tested, we created a reliable, valid, and unidimensional pre/post-test for its respective learning objectives. The pre- and post-assessments for the *Ecosystems* consisted of 14 lesson-specific multiple choice questions, while the *Weather Multimedia Lesson* included 15 questions. The assessment was again based upon Bloom's taxonomy (knowledge, comprehension, application, analysis, synthesis and evaluation) and directly related to the learning objectives of that lesson.

The pre- and post-assessments were developed using an iterative refinement process based on modern item response theory (IRT). The assessments for each of the two Multimedia Elementary Science Lessons were piloted in classrooms of 4 different teachers – from schools comprised of urban, rural and suburban demographics. This testing was conducted in March 2015.

Pilot test teachers were provided with a unique username and password for each student to login online. Teachers instructed their students to login to their individual online accounts to complete the pre- and post-assessments immediately before and after using the lesson.

After the pilot testing, the pre- and post-assessments were rigorously analyzed using the Rasch model. Items (test questions) with low overall reliability that were (a) redundant based on item difficulty, (b) had negative or low item-test correlation (<.15), (c) had distractors no one chooses, or (d) were not unidimensional were either discarded or modified as necessary before we proceeded with the field testing.

MEASURE DEVELOPMENT RESULTS - Pilot Testing

Analysis of pilot test data of the 2 elementary multimedia lessons occurred in March 2015.

Based upon the analysis of the tests completed by **167 students**, the overall test reliability of the 14 item test for *Ecosystems Multimedia Lesson* was **0.74**. The reliability of the questions (whether one can expect that the questions will retain their position by ability of student) was high at **0.88**. Infit and outfit values, item-test correlations, item difficulty, unidimensionality, behavior of the distractors and fit with the Rasch model were analyzed.

The research team decided that the test for the *Ecosystem Lesson* was unidimensional, had adequate fit with the Rasch model, had demonstrated sensitivity to pre-post change, and was reliable enough for group assessment. Post norms were constructed. These are scaled normally distributed scores from **102** to **676**, with a mean roughly at **500**.

Based upon the analysis of the tests completed by **200** students, the overall test reliability of the 15 item test for the *Weather Multimedia Lesson* was **0.70**. The reliability of the questions (whether one can expect that the questions will retain their position by ability of student) was very high at **0.96**. Infit and outfit values, item-test correlations, item difficulty, unidimensionality, behavior of the distractors and fit with the Rasch model were analyzed.

The research team decided that the test for the *Weather Lesson* was unidimensional, had adequate fit with the Rasch model, had demonstrated sensitivity to pre-post change, and was reliable enough for group assessment. Post norms were constructed. These are scaled normally distributed scores from **51** to **700** with a mean roughly at **500**.

After pilot testing, and achieving high reliability with the assessment questions for the two Multimedia Elementary Science Lessons, field testing was scheduled for May 2015.

FIELD TESTING PROCEDURE

Field Test teachers were recruited through a database of approximately **100,000** teachers collected and maintained by NewPath Learning. Teachers applied by completing an online application via SurveyMonkey. More than **300** teachers applied to be involved in the NewPath Learning field testing of the two Multimedia Elementary Science Lessons. In the survey application, teachers indicated which lesson they were interested in field testing. They also provided information on their school and the type of classes they would involve in that testing.

A total of **23** field test teachers and **810** students participated in the study as detailed in the data table below. Field test teachers were selected if they indicated that they would use the Multimedia Lessons with their science classes with a mix of below average, average, or mixed ability students. No data was collected regarding gender, race, or ethnic background of students.

Teachers were given adequate time to assign the lesson to their students when appropriate in relationship to their curriculum. Field test teachers were provided with unique username and password codes to distribute to each of the students. The lessons were assigned and completed online. Students were forced to complete the lesson in the order of the sections provided and could not jump to the next section until the section prior was fully completed. Individual student data was captured in NewPath's learning management system and downloaded after students had completed the lesson in its entirety. Teachers allowed students with up to 90 minutes of time to complete the lesson. No prior instruction on the lesson topic was required. The investigators did not participate in the observation of the students. A stipend of $200 was paid to each teacher whose students fully completed the lesson.

Participating Teachers & Students

LESSON	TEACHER	LOCATION	SCHOOL TYPE	# of STUDENTS
What are Ecosystems?	Brown	China Elementary	Rural	49
What are Ecosystems?	D'Angelo	Riverhead Charter School	Rural	38
What are Ecosystems?	DePalo	Gator Run Elementary	Suburban	29
What are Ecosystems?	Fratus	Manatee Cove Elementary	Suburban	38
What are Ecosystems?	Gooden	Chestnut ES for Science & Engineering	Suburban	38
What are Ecosystems?	Gurt	Miller Intermediate	Urban	37
What are Ecosystems?	Jones	Arcadia Park ES	Urban	38
What are Ecosystems?	Miramontes	Bella Vista Elementary	Suburban	30
What are Ecosystems?	Pena	J.B. Kennedy	Suburban	30
What are Ecosystems?	Peralta	Gator Run Elementary	Urban	20
What are Ecosystems?	Raubenstrauch	Francis S. Grandinetti Elementary School	Rural	54
What are Ecosystems?	Rodriguez	Klentzman Intermediate	Urban	30
What are Ecosystems?	Smith	Bell Vista Elementary	Rural	27
ECOSYSTEMS LESSON TOTAL				450
What is Weather?	Borquez	Golden Hills Elementary	Rural	22
What is Weather?	Griffiths	Aspen Creek Elementary	Suburban	29
What is Weather?	Gutierrez	Miller Intermediate	Urban	30
What is Weather?	Miller	Surgoinsville Elementary	Rural	30
What is Weather?	Nissen	Pilot Elementary	Suburban	43
What is Weather?	Phillips	East Ward Elementary	Suburban	53
What is Weather?	Pitman	Bowman Middle School	Rural	50
What is Weather?	Robinson	Golden Hills	Rural	29
What is Weather?	Styles	Sorrento Elementary	Rural	37
What is Weather?	Syed	TAG Young Scholars	Urban	29
WEATHER LESSON TOTAL				352

FIELD TEST STATISTICAL ANALYSIS

Field test data was downloaded from NewPath's learning management system for each student in an Excel spreadsheet format. Students who had not completed the lesson in its entirety, had not answered all of the questions or for which any of the answers were not properly captured by the learning management system were omitted and not analyzed. A total of **756** records with complete pre- and post-test data were analyzed.

Student's overall results at both pre and post-test were calculated, resulting in scale scores for each student at pre- and post-test, as well as an individual change scale score. Dependent samples' t-test was estimated to determine if pre- to post-test change was statistically significant at the conventional **p<.05** level.

What are Ecosystems? Elementary Multimedia Lesson

Students improved 62.43 points in the scale score. The pre- to post-test improvement was statistically significant **(t=14.47, p<0.001)**. To make comparability to the literature and to other lessons easier, these scale change scores *were transformed into a Cohen's d effect size, a widely used metric of effect size*. *What are Ecosystems? Multimedia Lesson* had an effect size **d=0.67**, meaning that on average students improved **0.67 standard deviations** from pre to post. Cohen's d effect sizes greater than or equal to **0.50** are considered medium intervention effects.

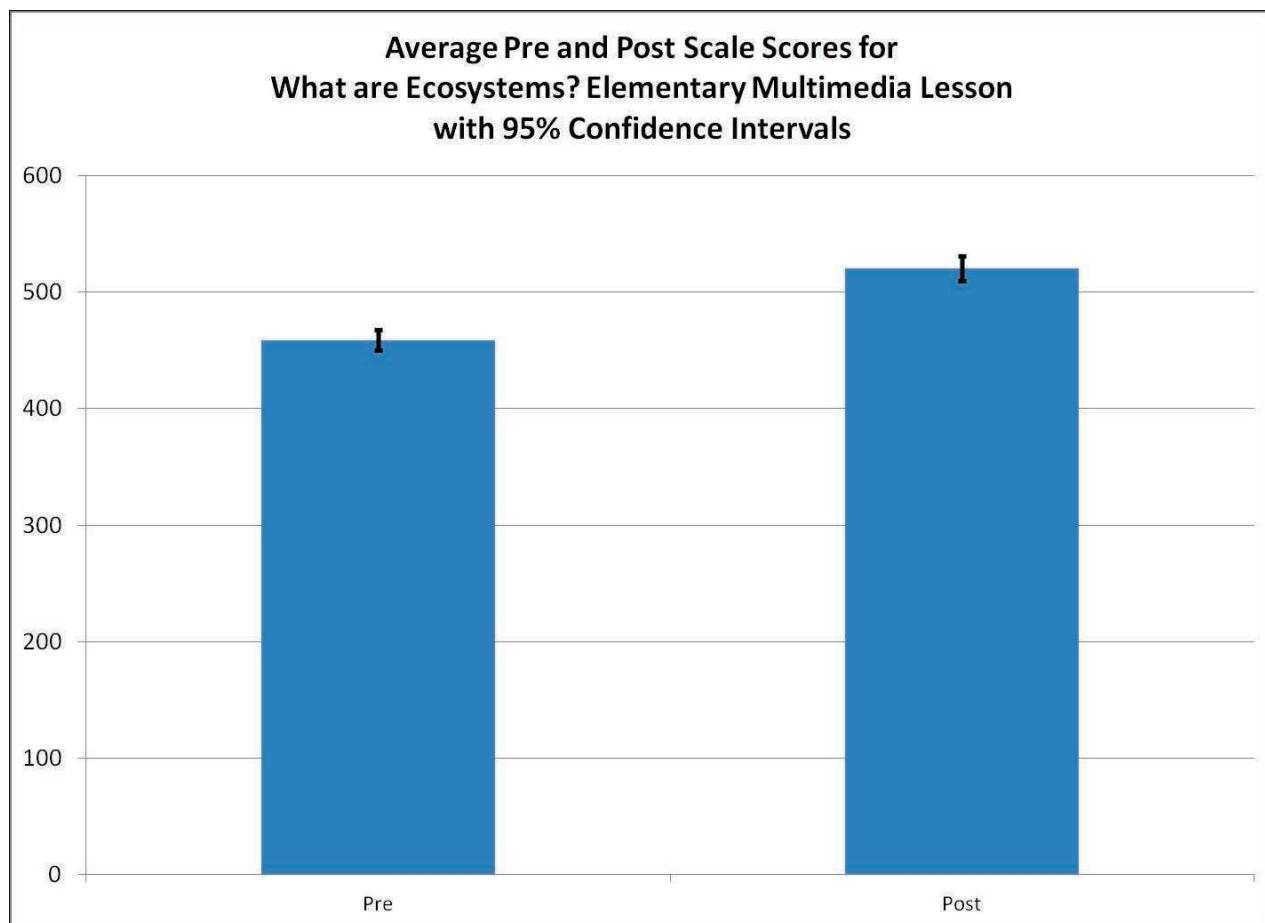**Figure 1** shows the average pre and post scores and their associated **95%** confidence intervals.

Figure 1. *Pre-Post Scale Score Field Testing Results for Ecosystems Lesson.*

What is Weather? Elementary Multimedia Lesson

Students improved 102.33 points in the scale score. The pre- to post-test improvement was statistically significant **(t=19.52, p<.001)**. To make comparability to the literature and to other lessons easier these scale change scores *were transformed into a Cohen's d effect size, a widely used metric of effect size. What is Weather? Multimedia Lesson* had an effect size **d=1.36**, meaning that on average students improved **1.36 standard deviations** from pre to post. Cohen's d effect sizes greater than or equal to **0.80** are considered large intervention effects.

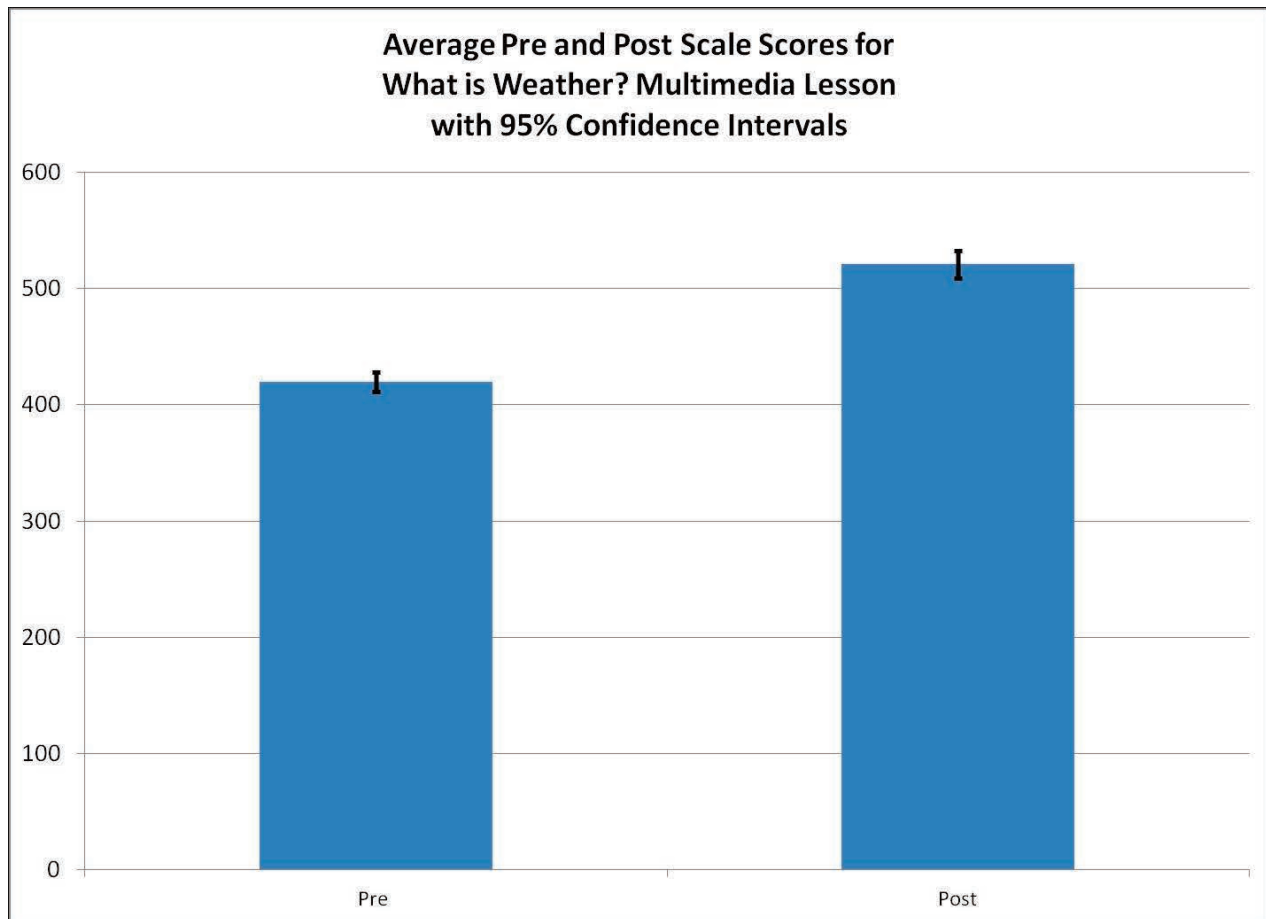**Figure 2** shows the average pre- and post-test scores and their associated **95%** confidence intervals.

Figure 2. *Pre-Post Scale Score Field Testing Results for Weather Lesson.*

COMPARISON OF RESULTS WITH ESTABLISHED BENCHMARKS IN GRANT PROPOSAL

Based upon previous experience and published academic literature, our grant proposal established expected pre- to post-test Cohen's d effect sizes of "**d=0.3** or above" (i.e. we expected improvements around 1/3 one standard deviation). The *Ecosystems Multimedia Lesson* clearly exceeds this benchmark with an effect size of **d=0.67**. The *Weather Multimedia Lesson* also exceeded the established benchmark with an effect size of **d=1.36**.

Field testing demonstrated that the Multimedia Elementary Science Lessons substantially and significantly increases students' understanding of the concepts presented in these lessons.

Dr. Guillermo Montes

Guillermo Montes, Ph.D., is an Associate Professor in the Ed.D. Program in Executive Leadership at Saint John Fisher College in Rochester, NY. Dr. Montes teaches doctoral-level courses in the program, conducts research, supervises doctoral students in field-based experiences, provides dissertation advisement for doctoral students, and chairs dissertation committees. Dr. Montes has an extensive background in quantitative research methods. Prior to joining Fisher, Dr. Montes was a Senior Research Associate and Co-Director of Research at the Children's Institute.

Dr. Montes received his Ph.D., M.A., and B.A. in Economics from the University of Rochester. His research interests include studying services for children with autism spectrum disorders in school and community settings using large scale nationally representative datasets. He has published the results of his research in a number of prestigious peer-reviewed journals and had support for his research from national and state grants.

APPENDIX A

NEWPATH'S ELEMENTARY SCIENCE MULTIMEDIA LESSONS

The perfect complement to any ELEMENTARY SCIENCE curriculum!

NewPath Learning's Multimedia Elementary Science Lessons are complete, ready-to-use, interactive lessons for students in grades 3-5 covering key life, earth and physical science topics. Each Elementary Multimedia Science Lesson follows the 5E Science Learning Cycle – Engage, Explore, Explain, Elaborate and Evaluate. Designed for multisensory learning and extensively piloted in the classroom, they are perfect for individual student instruction, one-to-one computing initiatives, flipping the classroom model, or for instructing the entire class on interactive whiteboards.

The multimedia lessons are also available online for use on any device, including tablets, via a subscription by visiting **www.newpathlearning.com**

LIFE SCIENCE ELEMENTARY MULTIMEDIA LESSONS		
Title	**Single Computer License**	**Site/Single Building License**
What are Ecosystems?	54-3210	54-3410
Life Cycles of Plants and Animals	54-3211	54-3411
EARTH SCIENCE ELEMENTARY MULTIMEDIA LESSONS		
Title	**Single Computer License**	**Site/Single Building License**
What is Weather?	54-3307	54-3507
How Does Earth's Surface Change?	54-3306	54-3506
PHYSICAL SCIENCE ELEMENTARY MULTIMEDIA LESSONS		
Title	**Single Computer License**	**Site/Single Building License**
All About Matter	54-3601	54-3801
All About Energy	54-3606	54-3806

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