Testing Geospatial Technology Learning Tools in the Classroom for Inspiring the Learning of Environmental Science

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Figure A: Winnacunnet High School Students engaged in the use of Handheld Spectrometers for understanding the electromagnetic spectrum and measuring vegetation health.

Figure B: Winnacunnet High School Students engaged in the use of GSS Technology First-Person View (FPV) Goggles and UAVs for understanding how to map coastal ecosystems via aerial remote sensing.

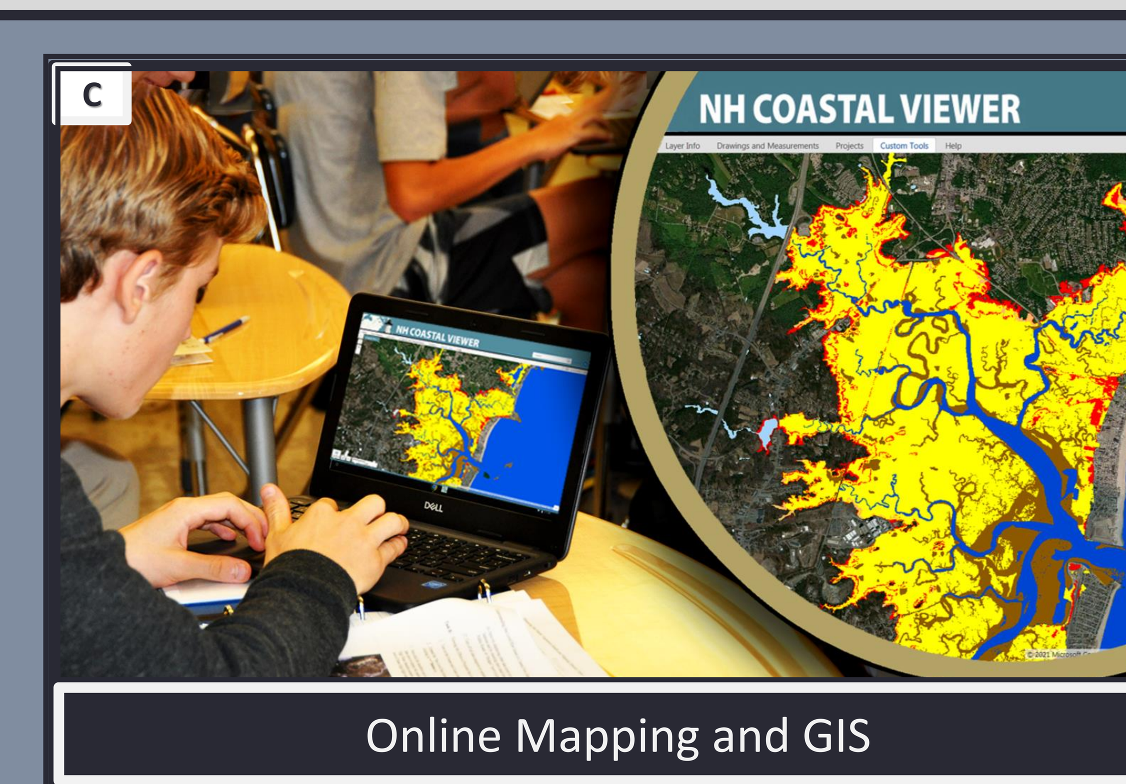


Figure C: Winnacunnet High School Students engaged in the use of the On-Line Mapping and GIS tool, NH Coastal Viewer, for visualizing environmental impacts such as the effects of future sea level rise on the Hampton, NH Salt Marsh.

BACKGROUND

Research shows that a majority of students who complete a major in STEM related fields at the undergraduate college level make their choice to do so while still in high school[1,2]. Since Geospatial Science (GSS) technologies have been shown to enhance interest towards STEM learning at the high school level[3], researchers at the University of New Hampshire have completed a new educational study to evaluate the research question: "How do **GSS Technology learning tools** compare to **Traditional learning tools** to promote knowledge and inspiration in STEM learning?"

Eighty freshman and sophomore high school students from Winnacunnet High School in Hampton, NH participated in the study during a two-week period in October of 2019. Because of the proximity of the high school to the state's largest salt marsh, this research included the instruction of **Salt Marsh and Sea Level Rise** Environmental Science topics.

CLASSROOM LESSON PLANS

Lesson plan learning tasks were completed over nine school days. Each task was completed with tools classified as either Traditional vs. GSS Technology learning tools and either Passive or Interactive learning tools. Traditional learning tools included **Lectures**, **Discussions**, **Videos**, **Drawing Boards**, and **Dichotomous Keys**, and GSS Technology learning tools included **Handheld Spectrometers** *(Figure A)*, **First-Person View (FPV) Goggles and UAVs** *(Figure B)*, and **Online Mapping and GIS** learning tools *(Figure C)*. Groups of tools are called methods within this research.

Day	Task Learning Topic	Learning Tools	Traditional or GSS Tech	Passive or Interactive
1-9	General Salt Marsh Science	Lectures	Traditional	Passive
1	Importance of Salt Marshes	Video	Traditional	Passive
2	Marsh Vegetation Species ID	Dichotomous Keys	Traditional	Interactive
3	Marsh Vegetation Zonation	Drawing Boards	Traditional	Interactive
4	The Electro-Magnetic Spectrum	Spectrometers	GSS Technology	Interactive
5	Marsh Vegetation Health	Spectrometers	GSS Technology	Interactive
6	Marsh Vegetation Mapping	FPV Goggles & UAVs	GSS Technology	Passive
7	Sea Level Rise	On-Line Mapping / GIS	GSS Technology	Interactive
8	Storm Surge, and Marsh Migration	On-Line Mapping / GIS	GSS Technology	Interactive
9	Conservation / Salt Marsh Protection	Discussion	Traditional	Interactive

PROJECT RESEARCH QUESTIONS

The following research questions were assessed within this project:

Research Questions:

- Do students' **performances on Science Topic assessments** vary in relation to Traditional versus GSS learning tools and Passive versus Interactive learning tools?
- Do students' **pre-instruction knowledge of learning tools** vary in relation to Traditional versus GSS learning tools and Passive versus Interactive learning tools?
- Do students' **perceptions related to ease of use, fun, interest, and inspiration** vary in relation to Traditional versus GSS learning tools and Passive versus Interactive learning tools?

PROJECT ASSESSMENT TOOLS

Research questions were assessed through the design and administering of:

Knowledge Tests:

- A **Pre-Instruction Knowledge Test** assessed student's science knowledge prior to instruction.
- A **Post-Instruction Knowledge Test** assessed tested science knowledge post instruction.

  These tests contained multiple choice questions and were administered on day #1 and #10 of the project.

Perception Surveys:

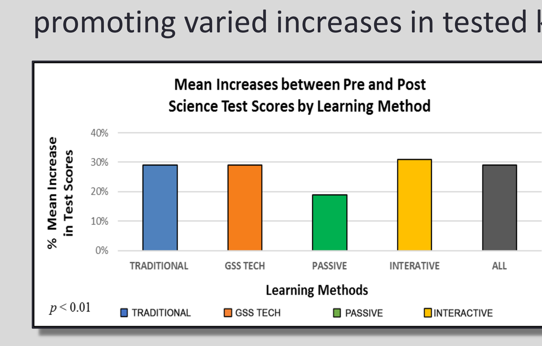
- A **Pre-Instruction Perception Survey** assessed students' knowledge of each learning tool prior to instruction.

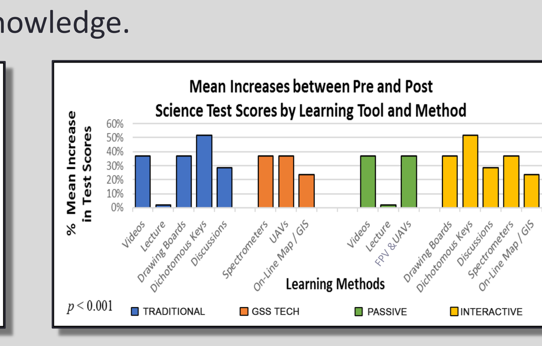
  This survey contained 1-7 Likert scale questions and was administered on day #1 of the project.
- A **Post-Instruction Perception Survey** assessed student perceptions of ease of use, fun, interest, and inspiration of each learning tool. They also solicited open feedback about what students liked the best and worst about their instruction.

  This survey contained "either-or" questions and "open feedback" questions and was administered one week after instruction ended.

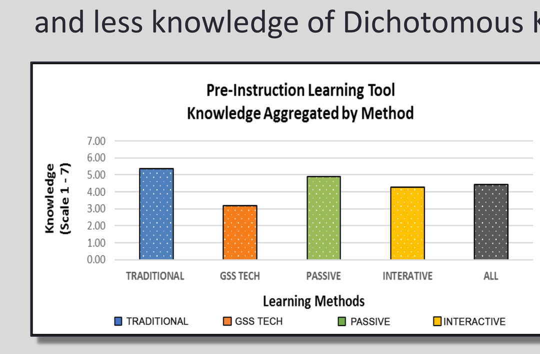
RESULTS AND CONCLUSIONS

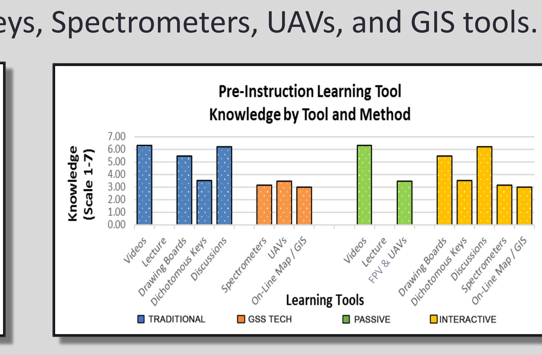
Pre- and Post-Knowledge Test student results showed how Traditional, GSS Technology, Passive, and Interactive learning tools were each successful at promoting varied increases in tested knowledge.



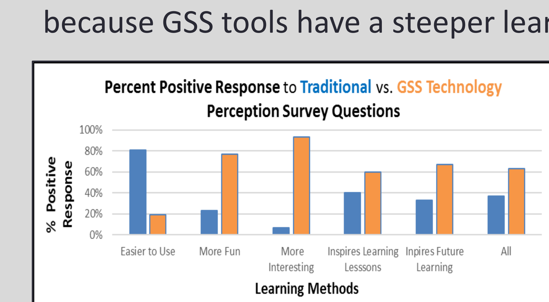


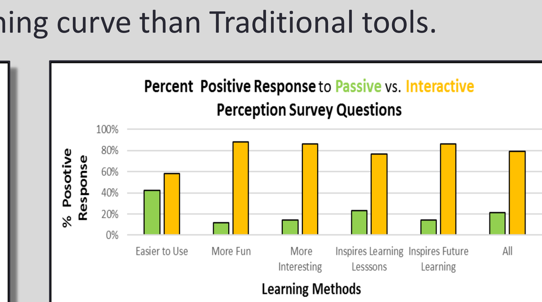
Pre-Instruction Perception Survey results showed that Knowledge test results might have been influenced by students' pre-instruction knowledge. Students self-reported 40.52% more pre-instruction knowledge of Traditional over GSS Technology learning methods, and 12.68% more pre-instruction knowledge of Passive over Interactive learning methods. Students reported more pre-instruction knowledge of Videos, Drawing Boards, and Discussions, and less knowledge of Dichotomous Keys, Spectrometers, UAVs, and GIS tools.





Post-Instruction Perception Survey results showed that both GSS and Interactive learning tools were more fun, interesting, and inspiring for learning lessons and future content, but GSS learning tools were shown to be harder to learn than Traditional tools. Student and teacher feedback implied that this is because GSS tools have a steeper learning curve than Traditional tools.





Open Student Feedback suggests that if GSS tools are to be used for instruction, additional time should be allocated within lesson plans for students to learn the tools so as to not take away from the time needed to learn the science topics themselves. Furthermore, feedback also implied that the introduction of GSS Technology learning tools in small groups of students could reduce the complexity and time needed to learn the tools.

BENEFITS AND IMPACTS

Teachers benefited through the development of:

- A better understanding of how and when to utilize GSS Technology learning tools to inspire the learning of environmental science.
- Stronger ties between high school teaching and university research.

Students benefited through the development of:

- A new inspiration for current and future STEM learning.
- A stronger appreciation for the importance of our coastal ecosystems.
- A better understanding of environmental processes such as sea level rise.
- A new aptitude with GSS Technology tools for environmental monitoring.

The Public benefited through potential development of:

- Increases in the larger body of STEM education research knowledge.
- Better informed next generation environmental stewards.
- More equipped next generation STEM students to enter college.
- Higher skilled next generation STEM employees to enter the work force.

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