Geospatial Science Technological Pedagogical Content Knowledge Professional Development Model: First Year Implementation Findings

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ASTE 2011
Minneapolis, MN

Support from the Toyota USA Foundation
Background

- Science and Environmental Education (EE) is complex and interdisciplinary.
- Few educators have had pre-service experiences that promote EE and Technology integrated learning methodologies.
- Even fewer have had any formal experience in using or teaching with Geospatial Information Technologies (GIT).
**GS-TPACK**

**Geospatial Science Technological Pedagogical Content Knowledge:**

*a way of thinking about how teachers integrate their knowledge of geospatial technology and teaching across science disciplines.*
GS-TPACK Model Overview

- Blends interdisciplinary pedagogical approaches of environmental education with GIT integration

- Designed to enhance the pedagogical content knowledge of inservice science teachers

- Provides opportunity to build requisite spatial thinking skills needed to effectively teach complex environmental issues
GS-TPACK Model Components

- **Geospatial Technology Use (GTU)** - Teacher’s knowledge about and proficiency with GIT tools such as Google Earth or GIS applications.

- **Geospatial Science Content Knowledge (GSCK)** – Teachers understanding of how GIT can be used in science education.

- **Geospatial Science Pedagogical Content Knowledge (GSPACK)** – Ability to adapt teaching strategies, pair GIT to content, and design and implement science curriculum materials that enhance and assess student learning.
GS-TPACK PD Design

- Aligned to the Environmental Literacy and Inquiry (ELI) Curriculum
- Emphasis on geospatial learning activities
  - Spatial thinking skills
  - Analysis and synthesis of spatial patterns data
  - Instructional scaffolding for learning GIT tools within curriculum contexts.
- Investigations with inquiry-based laboratories
- Embedded educative curriculum materials
Participants and PD Implementation

- 8th grade teachers from 2 urban school districts teaching a wide range of ability levels
- First time using GIS in curriculum for all but one teacher
- Energy: 12-hours of face-to-face PD sessions (n=5)
  - 3 - 4hr sessions in summer
  OR
  - 2 - 6hr sessions in Fall
- Land Use Change: 6-hours of face-to-face PD sessions (n=14)
  - 1- full day in April
Assessment Tools and Data Sources

- **GS-TPACK Instrument**
  - Administered before first session and at end of day-long session
  - (Energy: n=5; LUC: n=14)

- **Periodic Feedback Survey (PFS)**
  - Teachers completed multiple times during Energy implementation.
  - (23 responses from 5 teachers)

- **Summative Response and Reflection Survey (SRRS)**
  - Administered at end of Energy curriculum implementation
  - (n=5)
GS-TPACK Results

- Significant increases in GS-TPACK total scores after PD sessions
  - Pre-Post Administration: $t(18)=4.527. \ p<.001$

- Reliability (n=19):
  - Pre-GS-TPACK Total Cronbach’s $\alpha = 0.956$
  - Post-GS-TPACK Total Cronbach’s $\alpha = 0.904$
Geospatial Technology Use

- **Subscale results (n=19)**
  - *Significant increase:* \( \text{GTU } t(18) = 6.68, p < .001 \)
  - **Scale Reliability:**
    - Pre - GTU Cronbach’s \( \alpha = 0.893 \)
    - Post - GTU Cronbach’s \( \alpha = 0.883 \)

- **SRRS results after *Energy* implementation (n=5):**

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly Disagree % (n)</th>
<th>Disagree % (n)</th>
<th>No Opinion % (n)</th>
<th>Agree % (n)</th>
<th>Strongly Agree % (n)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>My knowledge of geospatial technologies increased as a result of my participation in the ELI professional development sessions.</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0% (0)</td>
<td>40.0% (2)</td>
<td>60.0% (3)</td>
<td>4.60</td>
</tr>
<tr>
<td>My geospatial technology skills increased as a result of my participation in the ELI professional development sessions.</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0% (0)</td>
<td>20.0% (1)</td>
<td>80.0% (3)</td>
<td>4.80</td>
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</tbody>
</table>
Geospatial Science Content Knowledge (GSCK)

- **GSCK Subscale results** (n=19)
  - **Significant increase:** GSCK $t(18) = 5.68, p<.001$
  - **Scale Reliability:**
    - Pre-GTU Cronbach’s $\alpha = 0.873$
    - Post-GTU Cronbach’s $\alpha = 0.775$

<table>
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<th>Strongly Disagree % (n)</th>
<th>Disagree % (n)</th>
<th>No Opinion % (n)</th>
<th>Agree % (n)</th>
<th>Strongly Agree % (n)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PFS:</strong> The curriculum and support materials provides me with appropriate content knowledge.</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>4.3% (1)</td>
<td>65.2% (15)</td>
<td>30.4% (7)</td>
<td>4.26</td>
</tr>
<tr>
<td><strong>SRRS:</strong> My content knowledge about the topics presented in the ELI unit I just completed increased as a result of my participation in the professional development sessions.</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>40.0% (2)</td>
<td>60.0% (3)</td>
<td>4.60</td>
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Geospatial Science Pedagogical Content Knowledge (GSPACK)

- **Subscale results (n=19)**
  - **Significant increase:** GSPACK $t(18) = 5.87$, $p<.001$
  - **Scale Reliability:**
    - Pre-GTU Cronbach’s $\alpha = 0.893$
    - Post-GTU Cronbach’s $\alpha = 0.864$

<table>
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<th>PFS: I was able to manage my classroom sufficiently when using geospatial technologies.</th>
<th>Strongly Disagree % (n)</th>
<th>Disagree % (n)</th>
<th>No Opinion % (n)</th>
<th>Agree % (n)</th>
<th>Strongly Agree % (n)</th>
<th>N/A</th>
<th>Mean</th>
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<tr>
<td></td>
<td>0.0% (0)</td>
<td>13.0% (3)</td>
<td>17.4% (4)</td>
<td>21.7% (5)</td>
<td>26.1% (6)</td>
<td>21.7% (5)</td>
<td>3.78</td>
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<th>PFS: The curriculum and support materials provided appropriate teaching ideas to help me use the instructional materials.</th>
<th>Strongly Disagree % (n)</th>
<th>Disagree % (n)</th>
<th>No Opinion % (n)</th>
<th>Agree % (n)</th>
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<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>21.7% (5)</td>
<td>65.2% (15)</td>
<td>13.0% (3)</td>
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<td><strong>SRRS</strong>: My understandings to why certain technologies were used in the curriculum to promote science learning increased as a result of my participation in the professional development sessions.</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>20.0% (1)</td>
<td>40.0% (2)</td>
<td>40.0% (2)</td>
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<td><strong>SRRS</strong>: My understandings of how and when to <strong>adapt my instruction while using geospatial learning tools</strong> (Google Earth or GIS) increased as a result of my participation in the professional development sessions.</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>40.0% (2)</td>
<td>0.0% (0)</td>
<td>60.0% (3)</td>
<td>4.20</td>
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Conclusion

- Data supports the effectiveness of the GS-TPACK PD model
- GS-TPACK instrument had good reliability for the entire instrument and for each subscale
- Teachers geospatial science technological pedagogical content knowledge improved significantly after PD sessions
For More Information

Paper available at:
http://www.ei.lehigh.edu/eli/research/pubs.html

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ELI Curriculum:
http://www.ei.lehigh.edu/eli