Factors influencing Spatial Thinking capabilities in a Geoscience classroom

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Geoscience @ NUS

- Geoscience is taught within the department of Geography
  - Minor Programs
    - Geoscience
    - Petroleum Exploration
  - The modules are offered NUS-wide
    - Arts
    - Science
    - Engineering
- Future scope
  - NUS – proposed Masters in Petroleum Engineering
  - Geoscience skills are in demand by Govt. & Industry
What is Spatial Thinking?

- **Spatial thinking** is thinking that finds meaning in the *shape*, *size*, *orientation*, *location*, *direction* or *trajectory*, of *objects*, *processes* or *phenomena*.

- **Spatial thinking** uses *space* and *orientation* as a vehicle for structuring problems, for finding answers, and for expressing solutions.

Spatial Thinking & Geoscience?

- 3D visualization from 2D
Spatial Thinking & Geoscience?

- **Field Observations to 3D processes**

- Anticline
- Syncline
Spatial Thinking & Geoscience?

- Maps & Cross-sections

Dome

Anticline

www.gg.uwyo.edu
Measuring Spatial Thinking skills

- **Aptitude tests (measuring IQ)**
  - Numerical Reasoning
  - Verbal Ability
  - Non-Verbal ability

\[
\frac{30}{35} \text{ can be reduced to:} \quad \frac{6}{7} = \frac{13}{15}
\]

Ben is rich but Jim is richer. Mike is poorer than Jim.

*Who is richest?*
Measuring Spatial Thinking skills

- Spatial Relations Test

- Spatial Orientation Test
What influences Spatial Thinking

- Baldwin & Wallace (2002) Experiment
  - High School
    - HSE & HSC (*Geography computing & mapping courses*)
  - Geoscience Modules
    - Geos 218 (Geologic Disasters) & Geos 212 (Oceanography)
    - Geos 251 (Physical Geology) & Geos 256 (Computing Geoscience)
  - 2 similar test (one before the course and one after)
  - 2 sections in each test (*Spatial Relations & Spatial Orientation*)
Geoscience & Spatial Thinking

- **Simple participation** in a Geoscience module improves spatial thinking.

Gender & Spatial Thinking

- Males fare **better** than female counterparts

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Majoring Discipline & Spatial Thinking

- **Science** majors perform *better* than their *non-science* counterparts.

Present Experiment

- Objectives of our experiment at Geography
  - Can we vindicate Baldwin-Wallace (2002)
    - Do they apply Today & for the NUS context?
  - Can we detect variations in inputs which can be considered to develop teaching methods
    - Categorize students participating in the module into different spatial thinking skills?
Methodology

- **Use information from IVLE**
  - Gender
  - Majoring Discipline
  - Prior Geospatial Exposure

- **Indirect spatial skills assessment**

  - Performance in spatially challenging questions during the module’s CA and tests.
Results

- Male students fare better than their female counterparts
- Students majoring in a scientific discipline fare better
- Students with high – prior geospatial exposure fare better
Pedagogic Implications

Inputs

- Wide variance in spatial skills

Classroom Environment

- Traditional teaching strategies

Outcomes

- Disparate outcomes
- Teaching Strategies aimed at bridging skill gap
- Consistent outcomes

Adapted from Astin 1984
Pedagogic Implications

- Pre-classify students enrolled from a geoscience program into spatial skill groups based on IVLE information
  - Gender
  - Prior Geospatial exposure
  - Majoring discipline

- Approach different skills groups with methods aimed at bridging spatial thinking skill gap
  - Tutorial and exercises that challenge spatial thinking
  - Field based methods of teaching
  - Virtual tools (animations, 3D graphics) for explaining geoscience objects, processes and phenomena
Thanks