Transfer of spatial visualization:
Training with discrete, composite transformation in
USA, Taiwan, and Turkey

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Background of this study
• Spatial skills are important in mathematics
  and science areas in which women have
  historically under-achieved (Casey, Nuttall,
  Pezaris, & Benbow, 1995).
• Elementary school teachers, with a female
  majority, are an important and special
  case worthy of particular attention.

Purpose of this study
• This study investigated:
  – How pre-service elementary school teachers
    learned spatial skills, and to what extent the
    learning of these spatial skills transferred to
    standardized tests of spatial visualization and
    mental rotation.
  – How such spatial learning progressed when
    set in different countries with diverse cultures.

Design and Methodology
• The research population consisted of
  undergraduate students majoring in
  elementary education and enrolled in a
  mathematics methods course required by
  their program.
• This study employed a pretest,
  intervention, posttest design, with
  experimental and comparison groups.

Participants
• The research study included 29 female
  students from Hacettepe University,
  Turkey, 97 female students from the
  University of South Florida, USA, and 44
  female students from National Hualien
  University of Education, Taiwan.
  – USA: two classes of comparison sections and
    two experimental sections
  – Turkey and Taiwan: one comparison section
    and one experimental group

Instruments(1/2)
• The differential Aptitude Test (DAT)
  – A standardized timed test of spatial
    visualization
  – A multiple-choice test, in which participants
    pick a perspective drawing of a three-
    dimensional shape that could result from
    folding up a flattened pattern.

Example of a flattened pattern:
[Diagram of a flattened pattern]
Instruments(2/2)

- The Flag Test
  - A standardized timed test of mental rotation
  - Participants were asked to circle the letter S if the flag shows the same side as the single flag in the box at the left; circle the letter O if the flag shows the opposite side of the single flag at the left.

Materials

- Participants in the experimental group, during six weekly 15-25 minutes interventions, worked through activities with diagnostic work sheets involving three piece of software.
  - The Mathemagic™ computer program (Lamb et al., 2002)
  - The computer program applet developed by Keller, Wasburn-Moses and Hart (2002)
  - The CopyCat Game (Morey, 1997)

Results

- All participants improved on MR from pre to posttest, but the intervention did not make a difference for MR.
- On the DAT test of spatial visualization, the intervention did not make a difference for the U.S.A. However, for both the Turkish and Taiwanese participants, the training made a significant positive difference for SV.

Discussion(1/2)

- The spatial training with sequences of transformations worked for spatial visualization, but not for mental rotation.
  - The training with visualizing sequences of transformations is a good training for multi-step problems involving complex shapes. This is consistent with the definition of SV (the ability to solve multi-step problems involving configurations of shapes).
  - Although there are some learning opportunities involving mental rotation, but no direct structural correspondence between training and test situation.

Discussion(2/2)

- The informality of classroom culture and the research regulations concerning human subjects in the U.S.A. might be the explanation why the U.S.A. was the only country without significant increases in SV in the intervention groups.
  - The U.S.A. participants may not have taken the experimental training as seriously as the others.
  - Research regulations concerning human subjects are required in the U.S. A.

Educational implications

- The findings of this study tentatively showed that spatial visualization can be improved through training if it involves relevant and motivating tasks.
- A program involving multiple contexts and multiple pieces of software may be more likely to increase spatial visualization skills.
- Activities based on composition of discrete, geometric transformations may affect far transfer and some generalization of spatial skills.