The Future of STEM: Strategies for Spatial Learners

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Einstein

da Vinci

Edison

www.purdue.edu/geri  look under Professional Development
STEM Disciplines & Spatial Ability

- Land Surveyor
- Geo-spatial Technician
- Satellite Operations
- Surgeon
- Cartographer
- GIS (Geographic Information Systems)
- Computer Programmer
- Engineer
  - Electrical
  - Mechanical
  - Aeronautical
  - Environmental
  - Materials
- Physicist
- Chemist
- Geophysicist
- Architect
- Inventor
Why Nurture Spatial Skills?

Schools emphasize verbal, not spatial skills

Traditional assessments (SAT, GRE) do not assess spatial skills (Gohm, Humphreys, and Yao)

Undergraduate majors in 2000:
- Only 5.6 majored in engineering
- A mere 0.8 majored in mathematics

Doctorates earned in U.S. by non-citizens?
- Engineering = 51%
- Mathematics = 43% (NSF)
Individuals gifted in spatial ability were undereducated and underemployed (Gohm, 1998).

Increasingly technological world needs ability to comprehend complex relationships and problem solvers with unique strategies (Shea, Lubinski, Benbow, 2001).

Selecting top 3% based on verbal or mathematical ability results in loss of more than half of students representing top 1% of spatial ability (Shea, Lubinski, & Benbow).
Who are these children?

• Lego maniacs – the builders
• Problem finders
• Creative problem solvers
• Puzzle and maze doers
• Technological geniuses

None of my toys work because I took them all apart to see what makes them work.
How do they learn?

- Visualization
- Whole to part
- The why...then the how
- Difficult is easy
- Aha!
- Intuition
- Discovery
- On the job
Visualize

Show everything - use overhead or white board, color is better than chalkboard

Encourage the child to visualize lists, patterns, situations

Ask the child if he can make a picture of what the topic represents

Ask yourself, “How would I teach this concept to a deaf child?”
Visualization

NLP: Neuro-Linguistic Programming

- Visualize words - spell forwards and backwards
- Visualize concept - how the system works
- Flashcards with answers
Whole to Part
Often perceived as “slow processors”
Perceive relationships between parts and whole
Don’t understand if learning is doled out in small chunks
Can’t grasp isolated facts until the big picture is in view
Have difficulty attending to details
The Why...then the How

Spatial Learners are reflective:

They need extra thinking time therefore, they can appear to be lazy or to be daydreaming.
The Whole Picture

Explain major concepts so child understands instructional goal

Provide real life scenarios - service oriented projects are good

Use a multidisciplinary emphasis
Difficult is Easy

Concepts vs. computation

Detest routine, repetitive tasks and does not learn by rote memorization

Aha!

Often cannot explain the steps of thinking

Understands all or nothing

Once the “Aha” occurs, learning is relatively permanent
Report cards of a highly visual spatial learner

### Concepts - Trigonometry

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Do not force the student to succeed at easier material before trying the difficult work.

Emphasize mastery of higher level concepts instead of perfection of simpler concepts.

How many times do I have to tell you... you’re not supposed to read ahead.
Mathematics

- Give chance to devise own method of problem solving
- Avoid drill and repetition - No timed tests
- Do five hardest problems and go on if successful
- Look for patterns in multiplication charts
  \[ 5678 \quad 56=7\times8 \quad 4\times9=6\times6 \]
- Teach within the context of entire number system
- Division - give divisor, dividend & quotient then let child figure out the system
- Look for patterns within math
- Make it meaningful
# Patterns in Multiplication

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Strategies for Lectures

Pause to allow words to register
Allow student to tape record lectures

Encourage child to take notes in pictorial format

Encourage student to take notes in the 1/3 - 2/3’s format

Emphasize concepts not details i.e. dates

Distribute handouts - don’t expect these students to take dictation
Intuition and Discovery Learning

• Science Experiments - avoid the norm
  – Did the heat cause the change?
    vs.
  – What do you think caused the change?

• Engineering Process
  – Design – avoid the temptation…“That won’t work.”
  – Create
  – Test
  – Redesign - How often do we use this step?

• Discovery Learning-tell child the goal of the instruction and let him figure out a way to get there

• Allow opportunities for inductive learning
On the Job Training

- Mentorships
- Opportunities to act like a practicing professional
- Problem Based Learning
- Interact Simulations
Organizational Strategies

Color code calendars, assignments, books and supplies

Use an hourglass to visualize the passage of time

Teach them to “take a picture” of assignments as they are given

Help them learn to look up to their recall side to remember what it is they need to do

Teach them how to create priority lists and schedules - they may not like it but it is an essential survival skill!
Have the child use highlighters to highlight directions or key concepts.

Color coordinate everything that has to do with one subject i.e. purple math book cover, purple notebook, purple portfolio, etc.

Use overheads or white board with a variety of color; categorize by color.

Have the visual spatial child create his own flashcards in color.

Copy worksheets and study guides on colored paper, it is easier to keep organized and easier on the eyes.
Teacher-Student Interaction

Teach the child to become a spy and notice what is going on in the classroom

- take clues from classmates

Don’t spy on just any student, some are better choices than others!

Institute a moment of silence at the end of class so students can visualize what they will need for homework

- this works well for all children in the class

- take a few deep breaths and relax then picture what happened during the day and what they will need to take home
Reduce unpredictable noise - music works well as it is predictable

Walkman (make that IPod!) ground rules
must be working continually
must be appropriate music
must be quiet enough so no one else can hear it
must not start singing

Use wait time
Allow time for the child to translate the spoken word to images

It may take a visual spatial child longer to begin to answer the question than it took you to ask it.
Oh yeah? Oh YEAH?!?

Well, remember what you said because in a day or two, I'll have a witty and blistering retort. You'll be devastated then, I PROMISE!

HMPH.

I wish I could think of comeback lines on the spot.
And remember...

Encourage the child’s strengths, don’t dwell on his weaknesses. This can be difficult as their strengths are outside of the traditional educational system.

Allow for their learning style but don’t allow them to use their learning style as an excuse.

And most of all.....

Believe in these children, they may well be the future Edisons and Einsteins of the world.