The effectiveness of liberal arts education: Perspectives from cognitive science

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Fundamental Assumption

Liberal arts education helps students to acquire not only facts about specific disciplines, but also ways of thinking.
Liberal arts education…

• teaches students to think
• teaches students how to learn
• allows students to see things whole
• enhances students wisdom and faith
• contributes to students happiness

Robert Harris *On the Purpose of a Liberal Education:*
Does Liberal Arts Education Really Change How Students Think?

Is it even possible to teach “thinking”, “reasoning”, “appreciation”, etc. outside of individual disciplines?
Organization

• The bad news
  – The psychology of transfer

• Hope
  – New perspectives on transfer
  – The psychology of analogy: objects and relations

• Suggestions
The Bad News
Edward Thorndike

Founder of educational psychology

Rejected the theory of “Formal Discipline”

The mind is not a muscle
“The mind is...a machine for making particular reactions to particular situations...Improvement in any single mental function rarely brings about equal improvement in any other function, no matter how similar.”
“Any disturbance whatsoever in the concrete particulars reasoned about will interfere somewhat with the reasoning, making it less correct or slower or both.”
Hab.

Habitual
1. What is the square of $x + y$?
2. What is the square of $a^2x^3$?
3. Simplify
   \[4ac + \left( \frac{b^2}{c^2} \times \frac{c}{d^2} \times \frac{d^3}{b} \right).\]
4. What are the factors of $x^2 - y^2$?
5. Multiply $x^a$ by $x^b$.
6. Simplify
   \[ac - [a(b + c)].\]

Ch.

First Changed Form
1. What is the square of $b_1 + b_2$?
2. What is the square of $r_1^3 r_1 l^2$?
3. Simplify
   \[5a^2b +
   (b^2 \div c^2)(c^2 \div d^2)(d^3 \div b).\]
4. What are the factors of $1/x^2 - 1/y^2$?
5. Multiply $4^a$ by $4^b$.
6. Simplify
   \[\rho_1 \rho_3 - [\rho_1(\rho_2 - \rho_3)].\]
Most adults do no spontaneously transfer, unless prompted


Analogical Problem Solving

Mary L. Gick and Keith J. Holyoak
Divers learned and recalled words on land and in water.
The beginning of hope
Having the Memory of an Elephant: Long-Term Retrieval and the Use of Analogues in Problem Solving

Zhe Chen
University of California, Davis, and South China Normal University

Lei Mo
South China Normal University

Ryan Honomichl
University of California, Davis
A couple is spelunking. They want to explore a new cave but are afraid that they won’t be able to find their way out. Can you propose a solution that would help them keep track of their route so they could get out again?
HANSEL AND GRETEL
How can we weigh an elephant?

(At the time, there were no scales that could accommodate an elephant)
Source Tale: “Weigh the Elephant”

The emperor’s young son came up with a solution to weigh an elephant with only a small scale:

Find a boat, put the elephant in it, and mark the new water level on the boat;

Remove the elephant and put smaller stones into the boat until the water level reaches the same mark;

Weigh those stones separately with a small scale; Add up all the weights, and the weight of the elephant is known.
Cave Problem: Like Hansel and Gretel
Tower Problem: Like Weigh the Elephant
Results: % of Students Solving Each Problem Type

- Tower
- Cave

% of Participants Solving the Problem

U.S.
China

0 20 40 60 80

China
U.S.
Results: % of Students Solving Each Problem Type

No significant cultural differences on control tasks
Rethinking Transfer: A Simple Proposal with Multiple Implications
Author(s): John D. Bransford and Daniel L. Schwartz
Published by: American Educational Research Association
Stable URL: http://www.jstor.org/stable/1167267
Accessed: 24-09-2015 15:59 UTC
Bransford and Schwartz

“Our thesis is that evidence of transfer is often difficult to find because we tend to think about it from a perspective that blinds us to its presence.”
Critique of traditional psychological work on transfer

• Sequestered problem solving”
• Assumption of “Direct Application”

• Together, the “perfect storm” for lack of transfer
Real learning is rarely sequestered

• People are
• Social
• Relational
So yes, the mind is limited in what it can transfer

• When the mind is isolated
• When we focus on surface features of problems

• So don’t do it!
Sciences of Education

- Cognitive Science
- Learning Science
- Psychology
Transfer as preparing for future learning

- Preparing for Future Learning
- Transfer is not direct
  - But prior learning does prepare us for future learning, alters course of future learning, makes it better, more effective, etc.
- Transfer exists, but it has been defined and measured in the wrong way.
Other kinds of real-world experiences that support transfer

• Foreign language and study abroad
• Music training
More hope:
Cognitive Science research has provided a deep understanding of analogy and analogical transfer
Dedre Gentner:
Structure mapping theory of analogy
SAMPLE ANALOGIES

The atom is like the solar system.

2 : 4 :: 4 : 8
Relational Match to Sample

A

B

T
"See, Frank? Keep the light in their eyes and you can bag them without any trouble at all."
Analogy at two levels

- Objects
- Relations
Structure-mapping: alignment and projection

- An analogy conveys that partly identical relational structures hold between objects in different domains.
Structural Alignment during Similarity Comparisons

ARTHUR B. MARKMAN
University of Illinois

AND

DEDRE GENTNER
Northwestern University
This is an *alignable* difference.
What’s the difference between a hotel and a motel?
What’s the difference between a hotel and a fork?
The importance of contrasting cases
\[ A = \pi r^2 \]
\[ C = 2\pi r \]
\[ A = \ell w \]
\[ A = \frac{1}{2}bh \]
\[ c^2 = a^2 + b^2 \]

Special Right Triangles

\[ V = \ell wh \]
\[ V = \pi r^2h \]
\[ V = \frac{4}{3}\pi r^3 \]
\[ V = \frac{1}{3}\pi r^2h \]
\[ V = \frac{1}{3}\ell wh \]
Contrasting cases
21 Actual Analogies Used By High School Students In English Essays

1. When she tried to sing, it sounded like a walrus giving birth to farm equipment.

2. Her eyes twinkled, like the moustache of a man with a cold.

3. She was like a magnet: Attractive from the back, repulsive from the front.

4. The ballerina rose gracefully en pointe and extended one slender leg behind her, like a dog at a fire hydrant.

5. She grew on him like she was a colony of E. coli and he was room temperature Canadian beef.
Informal Learning
Recommendations

• Consider transfer in curriculum design
• Blocks of courses as units
• Highlight relational structure
  – Point out common structure
    • Progressive alignment
    • Sequential = sequestered
  – Use relational language
• I’m not a fan of teaching “critical thinking”
  – Need relations AND content
Recommendations

• Liberal arts is a lot more than classes
  – Encourage, promote, facilitate student discussions about what they are learning
  – Sharing of passions, “truths”
Thanks to

• NSF/Spatial Intelligence and Learning Center
• Nora Newcombe
• Nathaniel Meadow
• David Miller