Attention, abstract thinking and school achievement among the Finnish 9th graders – multilevel analysis

Kasvatustieteen päivät 27.-28.11.2008, Turku

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1. In this study following effects were tested:
   y=School achievement (GPA).
   y=Abstract thinking level (Formal operations test score).

2. The relationships between the variables in the 3-level models?

**Tested effects**

**Background variables**
Gender, age
METHOD

SAMPLE:

9th graders from the capital area and Eastern Finland, N=769, 51 classes, 7 schools.
MEASURES

1. School achievement

GPA (last report card, from the student register)
2. Formal operations:

**Formula-test** Hautamäki 1984; Hautamäki & al. 2002

(modified version of the original Science Reasoning Tasks, The Pendulum (Shayer et al, 1979) based on one of the Inhelder-Piaget identified formal schemata (Inhelder & Piaget, 1958) called The Formula I

Example of the items:

<table>
<thead>
<tr>
<th>Comparison pair</th>
<th>driver</th>
<th>car</th>
<th>tires</th>
<th>race</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Räikkönen</td>
<td>McLaren</td>
<td>Michelin</td>
<td>Monaco</td>
</tr>
<tr>
<td></td>
<td>Schumacher</td>
<td>Ferrari</td>
<td>Michelin</td>
<td>Monaco</td>
</tr>
</tbody>
</table>

Is it possible to conclude based on this information?

<table>
<thead>
<tr>
<th></th>
<th>no</th>
<th>perhaps</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>effect of driver</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>effect of car</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>effect of tires</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

3. Attention:

Computer-based

**Attention Concentration Test (ACT)**
van der Ven, 2005

**Basis on the Inhibition theory. Prerequisites of the test:**

- Must be overlearned before the actual test
- Can be repeated as many times as needed to pass it

Especially tailored for basic and secondary education
Inhibition theory

- continuously similar action causes adaptation in the signal mediating process
- shows in the test context as a slack of attention/getting tired
- identification of interindividual differences in the speed of adaptation and screen those students who have difficulties in working steadily, continuously and without mistakes.


ACT: passing the test as an approximate screening method?


Test conditions (2 hours per class):

1. ACT: Practice in computer class till the test procedure is clear and the test-taking action is overlearned, (about 20 min).

The test is implemented "individually". Only a few students in the computer class at the time. At least three tries to pass the test and at least three times to improve the gained error-free result till the point when the subject is satisfied.

Degree of difficulty: More difficult parameters (25 rounds, random presence)

Test persons: Two researchers, and graduate students.

2. Formal operation test and self-assessment after the ACT-test.
ACT- test practice session, February 2006 (overlearning phase)
THE RESEARCH OBJECTIVES:

1. What are the effects of class and school on school achievement, abstract thinking and attention concentration?

2. What is the relationship between abstract thinking, attention concentration and school achievement?

3. What is the effect of gender or age-group on studied variables?
RESULTS:

Multilevel analysis (MLWin), 3 levels: individual / class / school

..clustering -> loss of independent observations -> risk of rejecting 0-hypothesis

(Goldstein, 1995; Kreft & de Leeuw, 2006; Snijders & Boske, 1999; Steele, 2008)
(A) School achievement, $y = \text{GPA}$

A1. Analysis of variance components, 0-model

Class level significant, explaining 9% ($p < .01$) of the GPA variance.

Schools homogenous,
School level explanation 1% (non-significant).
(B) Abstract thinking, \( y = \text{formal operations} \)

B1. Analysis of variance components, 0-model

Both class and school level significant explainers of Formal operations variance; school level 7\%, \( p < .001 \); class level 10\%, \( p < .001 \).

Class (left) and school (right) level residuals
(C) Attention, $y=\text{LnSqrtMSRMin20}_07$

D1. Analysis of variance components, 0-model

School level significant, explaining 5%, $p<.05$.
Class level significant, as well, explaining 1%, $p<.05$.

*School (left) and class (right) level residuals*
Gender and school achievement

- Strong effect: being a girl brings almost half of a number into GPA (grading in Finland from 4 to 10)

- Explanation in individual level 6%, class level 7% and school level 2%.

- Effect not homogenous, but varied somewhat by class
Agegroup and achievement

- By agegroups (9 groups based on quarter years): weak but significant effect, class level 4%, other levels less

- In the oldest groups lower GPA, but effect not fully linear
Formaalit operations and achievement

- Effect of formal operations strong especially in the class level, explanation 50%.
- School level explanation 25%
- Individual level explanation 20%.

Thus, there are schools and classes in which the students think in a higher level of abstraction than in others.
Attention and achievement

- Significant but weak effect on school achievement
- Effect faded away when formal operations were added into the model
- Passing the ACT test a strong explainer of achievement both in the class and school level.
- Only passing the test could be seen as an alternative screening method
Gender and formal operations

- No gender effect in the individual level, but a weak one in the class level

- The gender effect in the class level effect not homogeneous but varied by class

- In the oldest groups lowest scores
Attention and formal operations

- Attention stronger explainer of formal operations than of school achievement;
  School level 6%, class level 4%, individual level 3%.

- Passing the ACT test explained 12% of the formal operations scores in the school level, 8% in the class level and 2% in the individual level.
GPA residuals

GPA & Fixed gender

GPA and fixed formal operations
The school achievement in the class level doesn’t need more explainers, when passing the ACT test, gender and formal operations are added…

GPA, 0-model

GPA and three explainers