Fixed versus Growth Mindset
Does not Seem to Matter Much
A Prospective Observational Study in
Two Late Bachelor level Computer Science Courses

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Study Goals

- We are teachers in two problematic courses.
- We want to improve observable student outcomes
  - e.g. pass rate, grade distribution
- We have observed students responding poorly to challenges
- We were reminded of the theory of mindsets...
  - ...it seemed to explain exactly what we were seeing
  - We wondered: can we improve students’ outcomes by mindset interventions?
- But first, let us verify that mindsets actually do matter!
### Dweck’s theory of mindsets

<table>
<thead>
<tr>
<th>Implicit theory of intelligence</th>
<th>Fixed mindset</th>
<th>Growth mindset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>entity</td>
<td>incremental</td>
</tr>
<tr>
<td>Behavior patterns</td>
<td>performance</td>
<td>learning</td>
</tr>
<tr>
<td>High effort seen as a sign of</td>
<td>helpless</td>
<td>mastery</td>
</tr>
<tr>
<td>Task choice with a low perceived ability</td>
<td>lack of talent</td>
<td>learning</td>
</tr>
<tr>
<td>Problem-solving performance</td>
<td>easy tasks</td>
<td>challenging tasks</td>
</tr>
<tr>
<td></td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

- The implicit theory of intelligence predicts the rest and thus determines the mindset.
  - We disregard other types of implicit theories (e.g. on programming ability).
- Based on laboratory evidence from the 1970s and the 1980s.
- More recent field evidence is mixed (low or unobservable effect on academic outcomes).
At the University of Jyväskylä, Faculty of Information Technology, Finland, from late October 2017 to January 2018

**TIEA341 Functional Programming 1**
- “FP” in the paper
- usually taken in the third year of Bachelor studies
- Tirronen was the main instructor
- Course design based on action research reported by Tirronen & Isomöttönen in Koli 2011–2012, TOCE 2013, JFP 2015, TOCE 2016

**TIEA241 Automatons and Formal Languages**
- “TCS” in the paper
- nominally a second year course, often taken later
- Kaijanaho was the main instructor
Basic study design

- Strictly observational — minimize effects on courses
- Measure students’ mindset (implicit theory of intelligence) during the courses
- Record students’ academic outcomes on these courses
- Statistically estimate the effect size of the mindset’s influence on outcomes
  - We assume, based on psychological research, that there is an actual causal connection between them.
- Kept the mindset data hidden from us until January 26, 2018
  - Ignored any late completions registered after that date.
<table>
<thead>
<tr>
<th>Students</th>
<th>No answer</th>
<th>Refused consent</th>
<th>Missing data</th>
<th>Included participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>FP1</td>
<td>214</td>
<td>94</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>TCS</td>
<td>139</td>
<td>44</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>overlap</td>
<td>59</td>
<td>14</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>294</td>
<td>124</td>
<td>23</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consent students</th>
<th>Age</th>
<th>Credits</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Included participants</td>
<td>25 (4.3)</td>
<td>138 (95.8)</td>
<td>3 (2.6)</td>
</tr>
<tr>
<td>— all</td>
<td>25 (4.4)</td>
<td>138 (97.6)</td>
<td>3 (2.6)</td>
</tr>
<tr>
<td>— FP1</td>
<td>24 (3.5)</td>
<td>137 (95.1)</td>
<td>3 (2.6)</td>
</tr>
<tr>
<td>— TCS</td>
<td>25 (5.1)</td>
<td>136 (96.3)</td>
<td>4 (2.5)</td>
</tr>
</tbody>
</table>
Predictor measure

- Carol Dweck’s *Implicit Theories of Intelligence Scale—Self Form for Adults* [ref. 10, p. 178] (in English and Finnish)
- 8 items scored from 1 (strongly agree) to 6 (strongly disagree)
- Four items consistent with a fixed mindset, e. g.
  
  “1. You have a certain amount of intelligence, and you can’t really do much to change it.”

- Four items consistent with a growth mindset, e. g.
  
  “5. You can always substantially change how intelligent you are.”

- We average the scores, both for each mindset separately, and combined together (growth mindset items reverse scored).
  
  Rescale to range \([-1, 1]\) so that a one-unit change is easy to interpret.
The observed mindset distribution

- Fixed mindset (24 students)
- Unclear (49 students)
- Growth mindset (60 students)
Following an evidence-based philosophy, we focus on “clinically relevant” outcomes.

- pass/fail
- difference in how pass is recorded in the transcript
- not interested in small changes in grading point scales

Accordingly:

- TCS uses grade (0 for fail/noncomplete, 1–5 for pass)
- FP uses credits (0 for fail/noncomplete, 1–5 for pass)
- For students taking both courses, average the outcomes.
- When used as an ordinal variable, round the average up.
Distribution of observed student outcomes

- 41 students passed FP1
- 39 students passed TCS
- 67 students passed at least one of these courses
The Spearman rank correlation coefficient is $\rho = 0.03 \ (p = 0.76)$ for the whole sample, $\rho = 0.11 \ (p = 0.27)$ for the FP1 attendees (including overlap), and $\rho = -0.02 \ (p = 0.89)$ for the TCS attendees (including overlap). The $p$ values are bootstrapped.
Further analysis

▶ Linear regression turns out to be misspecified.
▶ Binary logistic regression for fail/pass gives an odds ratio of 0.79, 95 % CI [0.34, 1.82]
▶ A proportional odds assumption seems approximately met.
▶ A proportional odds model yields an odds ratio of 0.96, 95 % CI [0.46, 2.03]
  ▶ for gaining one grade point
  ▶ when increasing one unit on the mindset scale
▶ No difference in outcomes between the three groups of fixed, unclear, and growth mindset (Kruskal–Wallis rank sum test, $\chi^2(2) = 0.133$, $p = 0.936$)
No observed effect of mindsets on outcomes

Why?

- The actual effect is too small to be observed in this study.
- Maybe students who are vulnerable to the fixed mindset effect dropped out before the third year.
- Are we missing a variable that masks the effect?

Now what?

- Class-level interventions in these courses seem pointless.
- Maybe there are vulnerable students for which mindset does matter at an individual or subgroup level? Worth studying.
- Maybe should investigate why there are so few fixed mindset students in these courses.