A study of spatial reasoning skills in Carpenters’ training ... and more!

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March 23rd 2011
Context

- Logistics environment is great to teach logistics; can we replicate this success with another profession?

- Criteria to choose profession:
  - Different from logistics
  - Many apprentices
  - Motivated teachers and practitioners
- Carpenters fit those criteria
Field observations

**Bosses of companies**
the profession is changing, no hand-drawing anymore
need more physics building instruction, less drawing

**Apprentices**
They do not say much...

**Teachers**
OK, drawing is not used per se in the professional work...
... yet it is essential, it helps develop the spatial skills

**Spatial skills? Yes, they are useful for carpenters**

(1) can one train spatial skills?
(2) if so, is drawing an appropriate training mean?
Spatial skills

• Very widely studied subject since the 1920s in the context of educational technology

• 3 main findings of interest to us:
  • spatial skills are trainable
  • well-developed spatial skills help for some school subjects and professions
  • men are better than women

• No data on carpenter apprentices’ spatial skills ➞ gather our own by testing their spatial skills
Purpose of study

(1) Are carpenters’ spatial skills better than the other populations’?

(2) Do carpenters’ spatial skills improve during their apprenticeship?
Test settings

- 3 populations: carpenters, logisticians, HS students
- 726 subjects (440 carp., 153 HS, 133 log.)
- 628 male subjects
- 4 years: 0, 1, 2, 3 (only carpenters for year 3)
- Score: $z$-score average $\frac{(x - \text{mean})}{\text{stddev}}$
- 50 questions split in 3 parts:
  - Mental rotation
  - Paper folding
  - Orthographic projections
Question types

Mental rotation (24 questions)

Orthographic projections (6 questions)

Paper folding (20 questions)
Purpose of study

(1) Are carpenters’s spatial skills better than the other populations’?

(2) Do carpenters’s spatial skills improve during their apprenticeship?
• Better than logisticians
• As good as high school students
• General school level of carpenters is closer to logisticians than high school
⇒ their spatial skills are indeed well developed
Purpose of study

(1) Are carpenters’s spatial skills better than the other populations’?

(2) Do carpenters’s spatial skills improve during their apprenticeship?
Year comparison

- No year effect
- Two explanations:
  - carpenters are slightly better before they start
  - ceiling effect of the drawing after one year

![Year comparison chart](chart.png)

- **z-sco**
  - Year comparison
  - n=77 carpenters
  - n=150 HS students
  - n=34 logisticians
  - n=77 year 0
  - n=150 year 1
  - n=148 year 2
  - n=65 year 3
Intermediary conclusion

• Agreement among practitioners and teachers that spatial skills (SS) are key for carpenters
• Study confirmed that carpenter apprentices have above average SS
  • self-selection (already better before the apprenticeship)
  • SS also improve during their training
• Divergence between practitioners and teachers on how to teach those SS
• Idea: create an environment that would help develop SS by complementing drawing
Intermediary conclusion

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The goals of the learning tool

- **Time gain** for a greater exploration
- **Make the 2D-3D transition more intuitive**
- **Be complementary to drawing** (same tools, mixed activities)
- **Force the apprentices to focus on the cognitively hard things** ⇒ **increased learning efficiency**
- **Make a stronger link** between geometry and the profession
How it works

- Tinkerlamp
- 3D tagged blocks
- 3 orthogonal views
- 3D view of the model
- Control via tagged cards
Activities

- Learning activities are built within the Tinkerlamp
- Examples of activities so far:
  1. Model matching
  2. Finding edges selected on the 3D model on each of the 3 projections
  3. Finding the true length of a surface
  4. Detail drawing (épure) of an edge
In the classroom

- 3 levels of interaction:
  - individual
  - group
  - classroom

- Orchestration:
  - done by the teacher
  - organized thanks to the cards and their thoughtful distribution
Tests / Feedback so far

- Two visits to a school, one more next week
  - took apprentices by group of 1 or 2 sequentially and made them do some of the learning activities
- Teachers are enthusiastic... but still need to be convinced to use it for “real teaching”
- Practitioners are thrilled, they see other domains of application (statics, physics building, ...)
- First test in a real classroom environment: end of May 2011
Conclusions

• Identified a need to familiarize intuitively carpenters with 3D geometry
• Developed a tool to respond to this need
Next steps

• Studies in classroom
• Develop missing technical features:
  • depth detection
  • more integration drawing
• Develop more activities
• Integration with CAD (Cadwork, SEMA, ...)

Wednesday, March 23, 2011
Thank you for your attention
Summary of results
Where do apprentices come from?

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<th>VSB</th>
<th>VSG</th>
<th>VSO</th>
<th>Sample</th>
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<td>76.8%</td>
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