Math Garden: a self-organizing adaptive learning tool

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Web-based adaptive practice and monitoring systems

- Idea: Digital notebooks for daily work in classroom
- Choice practice items automatically adapted to child, differentiation
- Combining (playful) practicing and pupil monitoring
  - Less tests in classrooms
- No checking, automatic score profiles
- Web-based (cloud)
- New type of adaptive testing (psychometrics)

New computer-adaptive method

- Based on Elo rating system for paired comparisons from chess
  Chess players gain or lose rating based on the outcome of chess games and the rating of their opponent.
- Children and items play against each other
  If a child responds incorrectly, the item wins rating points, dependent on the rating difference between the item and the child.
- Pretesting is not necessary
  less time and money

Elo for tests

Which item is more difficult?

- 8 + 9
- 44 + 3
- 3 + 6
- 80 + 10
- 19 + 58
- 2 + 2
- 1 + 70
- 80 + 10
- 44 + 3
- 8 + 9
- 9 + 66
- 19 + 58
**High Speed High Stakes rule**

- Speed and accuracy integrated
- HSHS punishes quick guesses
- Easy to visualize

**Advantages new CAT**

- No pretesting required
  - less time and money
- Response time and accuracy integrated in one measure
- Speed accuracy trade-off problem solved
- Guessing problem solved
  - high speed, high stakes
- Allows for easy items because we use information from response time (P+ = .75).

**The games**

- Basic
  - Counting
  - Number series
  - Numbers
- Main operations
  - Addition
  - Subtraction
  - Multiplication
  - Division
  - Speed mix
  - Slow mix
- Advanced
  - Fractions / percentages / ratio sums
  - Clock
- Other
  - Balance
  - Mastermind
  - '24 game'
  - Working memory
  - Each with hundreds of items from very easy to extremely difficult

**Reports for teachers**

**self-organizing adaptive learning tool**

Users (teachers) add
- Items
- Videos

On the fly item estimation

Automatic scoring and reporting

Adaptive item choice

**Youtube instruction**

Youtube Rekentuin channel

Youtube how to:
- solve the Rubik cube
- paint the MONA LISA with MS PAINT
- repair a flat bicycle tire
- calculate a Double Integral
- kiss
- build a Laser Security System

Teachertube, schooltv, etc.

www.ihateensdien.nl
Instructional videos in Math Garden
Laat eens zien! (Cedicu)

• A cloud appears when suitable videos are available.
• Both videos and math problems are tagged using the same tagging system.

Tags Addition

• Simple addition problem (both operands < 10)
• The largest operand in the problem consists of 2 digits
• The largest operand in the problem consists of 3 digits
• The largest operand in the problem consists of > 3 digits
• Problem contains decimals
• One or both of the operands contains one or more zero’s
• The solution of the problem contains one or more zero’s
• Tie problem (operands are equal)
• Carrying is required
• Specific tags, describing the problem format in more detail
  • \(470 + 240 = HT0 + HT0\)
  • \(47 + 240 = TU + HT0\)

Tag matching and Tag specificity

Math garden (nightmares): tags
• Item 1: 1, 3, 5
• Item 2: 1, 7
• Item 3: 2, 3, 9
• Item 4: 3, 9

Cedicu (videos): tags
• Video 1: 1, 3, 7, 8
• Video 2: 2, 4
• Video 3: 1, 5
• Video 4: 1, 3, 5, 8, 11, 13

Number of matches: video 4
Number of matches – number of mismatches: video 3
No video repetitions within certain period

Tagging: reference levels

<table>
<thead>
<tr>
<th>Item</th>
<th>Grade</th>
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<tbody>
<tr>
<td>3 + 3</td>
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</tr>
<tr>
<td>11 + 70</td>
<td>4</td>
</tr>
<tr>
<td>31 + 110</td>
<td>6</td>
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<td>55 + 39</td>
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<tr>
<td>7 + 45</td>
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<td>0.3 + 67.8</td>
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<tr>
<td>8.97 + 3.70</td>
<td>15</td>
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<tr>
<td>9.02 + 3.70</td>
<td>15</td>
</tr>
<tr>
<td>9.06 + 1.75</td>
<td>15</td>
</tr>
</tbody>
</table>

But also

Problem of item time limit

Tag problems

• Response time and time limits
• Hierarchical tags
• Too many tags
Instructional ideas

- Organize instructions (video, tekst, etc.) not vertically (as in standard methods) or horizontally (internet, no structure) but in networks

- Create an individual cycle of practicing, analysis and instruction, in which practicing is the motor.

Thank you for your attention.

Questions?

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