

Complex multiplication and division in Dutch educational assessments:

What can solution strategies tell us?

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aims

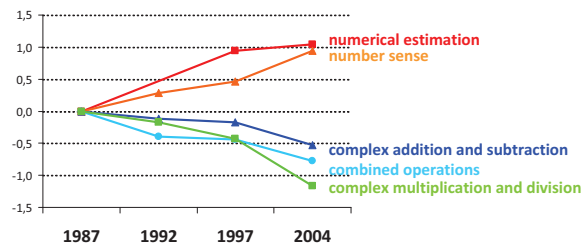
- 1) what can **solution strategies** tell us about the Dutch achievement drop on complex multiplication and division?
- 2) what is the **relation** between solving problems on complex **multiplication** and on complex **division**?

how did we do that?

- by secondary analyses on the student material of the 1997 and 2004 educational assessment cycles,
- coding the solution strategies that students used, based on their written work.

background

in the Netherlands, national assessments of mathematics education at the end of primary school (Grade 6, 12-year-olds) show trends over time (CITO, 2005):



→ achievement drop in **complex arithmetic**,
→ particularly in **complex multiplication and division**.

sample and design	cycle	N students	multiplication	division
	1997	551	11 items	10 items
	2004	995	10 items	13 items
			5 in common	4 in common

solution strategies complex multiplication [18 x 24 = ?]

traditional algorithm

$$\begin{array}{r} 24 \\ 18 \times \\ \hline 192 \\ 240 + \\ \hline 432 \end{array}$$

non-traditional (examples)

$$\begin{array}{l} 10 \times 24 = 240 \\ 8 \times 24 = \dots \\ 24 + 24 = 48 \\ 48 + 48 = 96 \\ 96 + 96 = 192 \\ 240 + 192 = 432 \end{array}$$

$$\begin{array}{l} 10 \times 20 = 200 \\ 10 \times 4 = 40 \\ 8 \times 20 = 160 \\ 8 \times 4 = \frac{32}{432} \end{array}$$

no written working



other

- unclear
- skipped
- wrong (e.g., 24 + 18)

solution strategies complex division [7848 : 12 = ?]

traditional algorithm

$$\begin{array}{r} 12 \overline{) 7848} \quad \backslash \quad 654 \\ \underline{72} \\ 64 \\ \underline{60} \\ 48 \\ \underline{48} \\ 0 \end{array}$$

non-traditional (examples)

$$\begin{array}{l} 7848 \\ \underline{6000-} \quad 500 \times \\ 1848 \\ \underline{1200-} \quad 100 \times \\ 648 \\ \underline{600-} \quad 50 \times \\ 48 \\ \underline{48-} \quad 4 \times + \\ 0 \quad 654 \times \end{array}$$

$$\begin{array}{l} 100 \times 12 = 1200 \\ 200 \times 12 = 2400 \\ 400 \times 12 = 4800 \\ 600 \times 12 = 7200 \\ 650 \times 12 = 7800 \\ 654 \times 12 = 7848 \end{array}$$

no written working

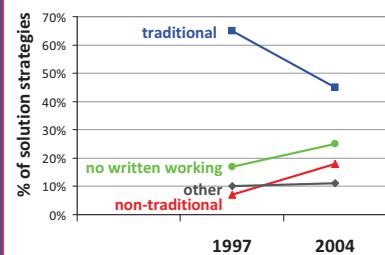


other

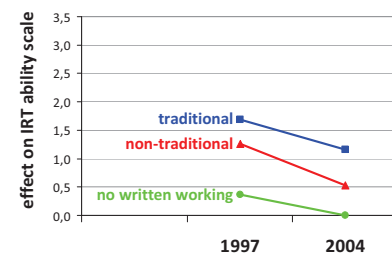
- unclear
- wrong (e.g., 12 x 7848)

results I: changes between 1997 and 2004

in strategy choice

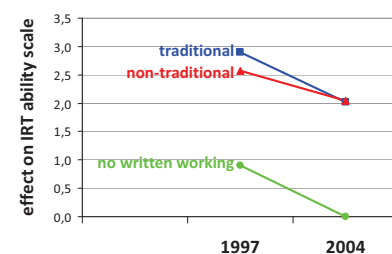
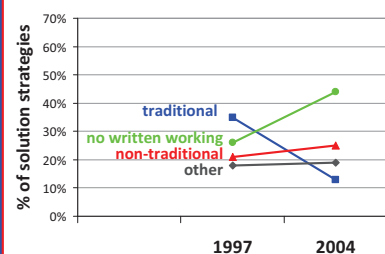


in strategy accuracy



in multiplication

in division



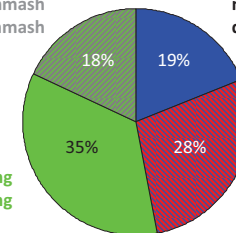
results II: relation strategy choice multiplication and division

latent class analysis

- 4 subclasses of strategy choice profiles;
- characterized by one dominant strategy.

multiplication: mishmash
division: mishmash

multiplication: traditional
division: traditional



conclusions

- 1) two shifts contributed to decline in achievement between 1997 and 2004:
 - a) shift in **strategy choice** from more accurate strategy (traditional) to less accurate ones (no written working; for multiplication also non-traditional);
 - b) homogeneous accuracy decline *within* each strategy.
- 2) there are **individual differences in strategy choice** on multiplication and division problems:
 - a) quite a **high consistency** of strategy choices – *within* operations and *across* operations;
 - b) clear influence of **instructional approach teacher**, particularly regarding division.