Skills & Technology

Paul Drijvers
Freudenthal Institute
p.drijvers@fi.uu.nl

www.fi.uu.nl/~pauld

2011-06-06

ELAM

Universiteit Utrecht

[Faculteit Bètawetenschappen

FISME Freudenthal Institute for Science and Mathematics Education]

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Outline

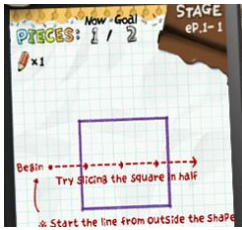
1. Introduction on tools and tool use

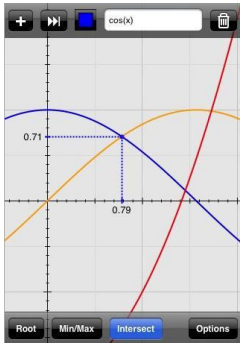
2. Paper-and-pencil skills and tool skills / techniques

3. Basic skills and higher order skills / thinking skills

4. Pedagogical skills and technical skills

5. Conclusion





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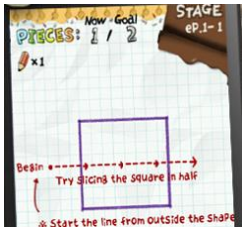

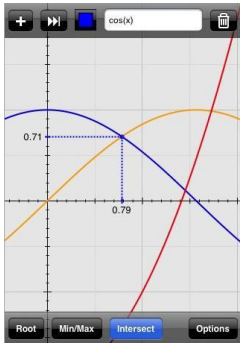

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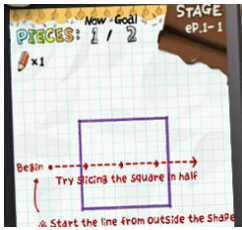
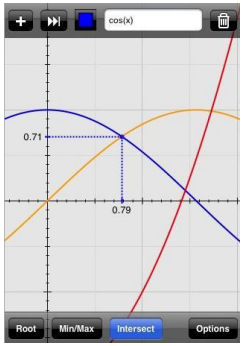




1. Introduction on tools and tool use

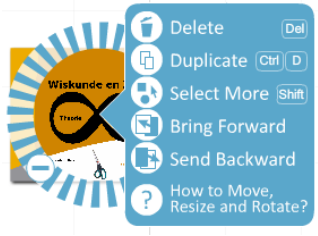
Conclusion

- ICT can improve skill acquisition and performance, including both basic skills and higher order skills.

- The relationship between tool use and skill acquisition, however, is complex and subtle, and achievement depends on didactical setting (teacher skills!), tasks, and opportunities for transfer

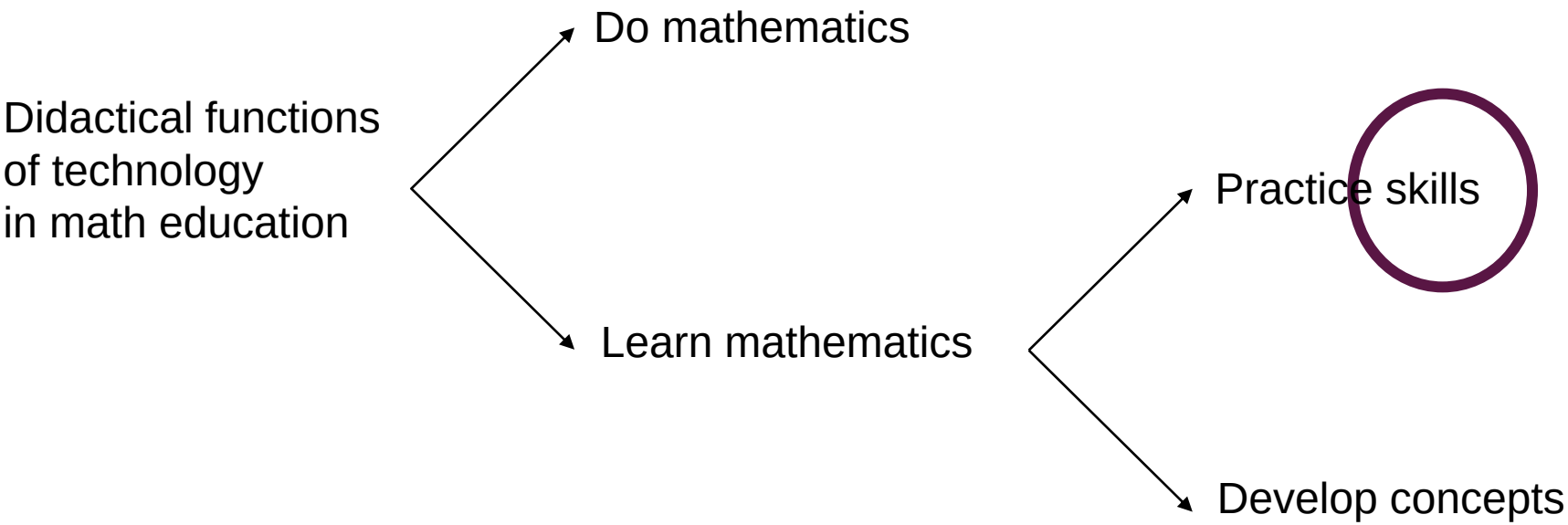
1. Introduction on tools and tool use

Tools matter!



1. Introduction on tools and tool use

Didactical functions of digital tools



Drijvers, P. & Zwaneveld, B. (2008). Van knoppen naar kennis.
Handboek Vakdidactiek Wiskunde. www.elwier.nl

1. Introduction on tools and tool use

Quotes like these are widespread:

> "Presently the benefits of software in education are apparent and widely acknowledged."

But how about this one:

> "Presently the benefits of *paper and pencil* in education are apparent and widely acknowledged."

> We might need to be more specific when we consider technology in education....

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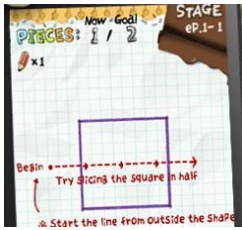
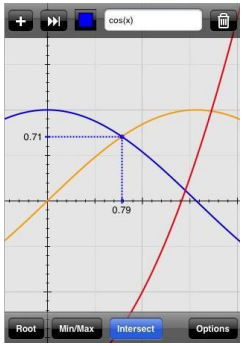




2. Paper-and-pencil skills and tool skills / techniques

- Example Geogebra: www.fi.uu.nl/dwo/dpict

Gelijke afstand tot twee punten

Gegeven zijn de punten *A* en *B*.

a Teken alle punten op afstand 5 van *A* en alle punten op afstand 5 van *B*.

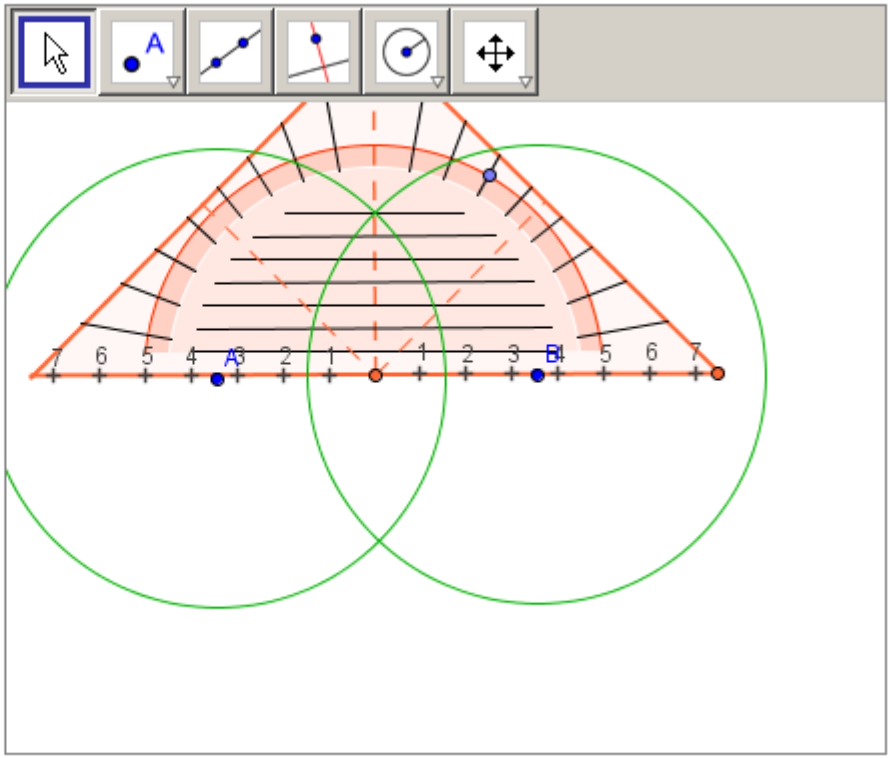
b Hoeveel punten liggen er op afstand 5 van zowel *A* als *B*?

Antwoord: ☐ punten

c Teken alle punten op afstand 6 van zowel *A* als *B* en alle punten op afstand 4 van zowel *A* als *B*.

d De punten die je net hebt getekend liggen op een lijn. Wat is de hoek van deze lijn met de lijn *AB*?

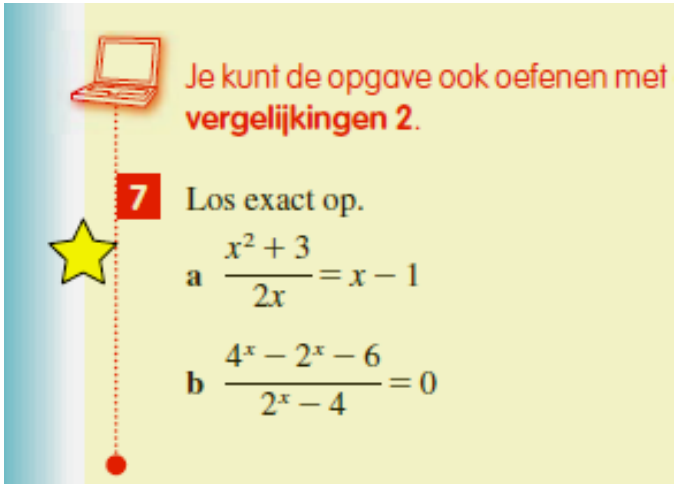
Antwoord: ☐ graden

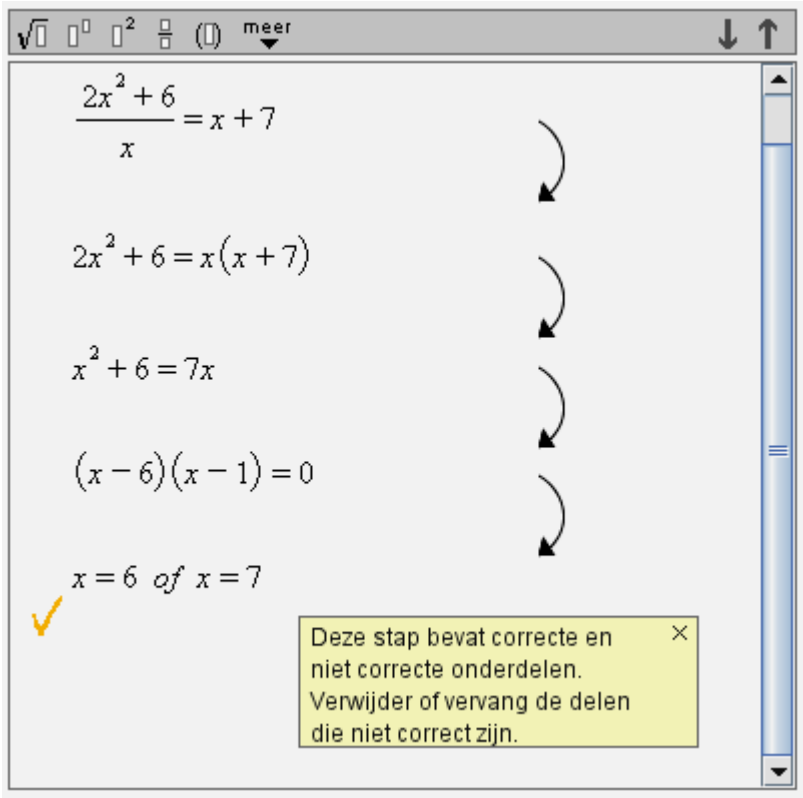


Sietske Tacoma, Peter Boon

2. Paper-and-pencil skills and tool techniques

- From book to screen:

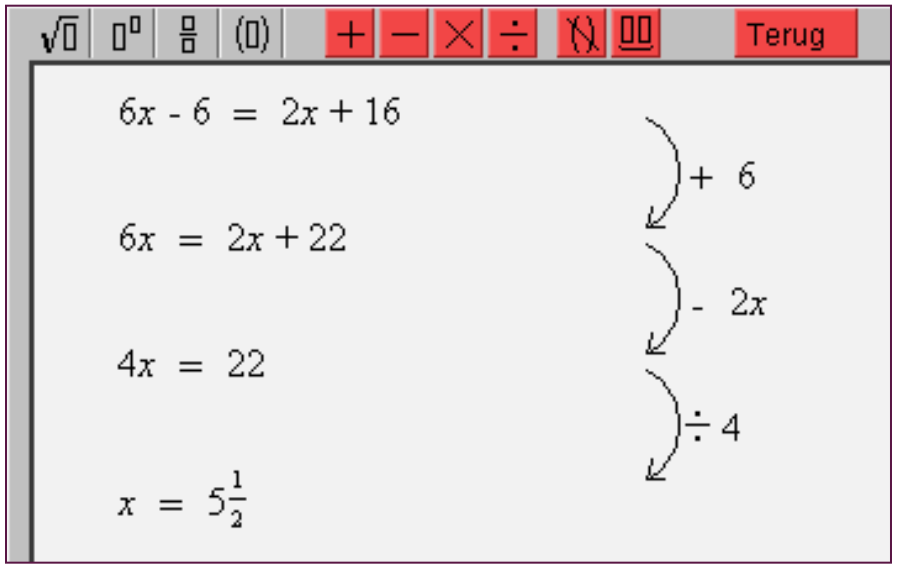


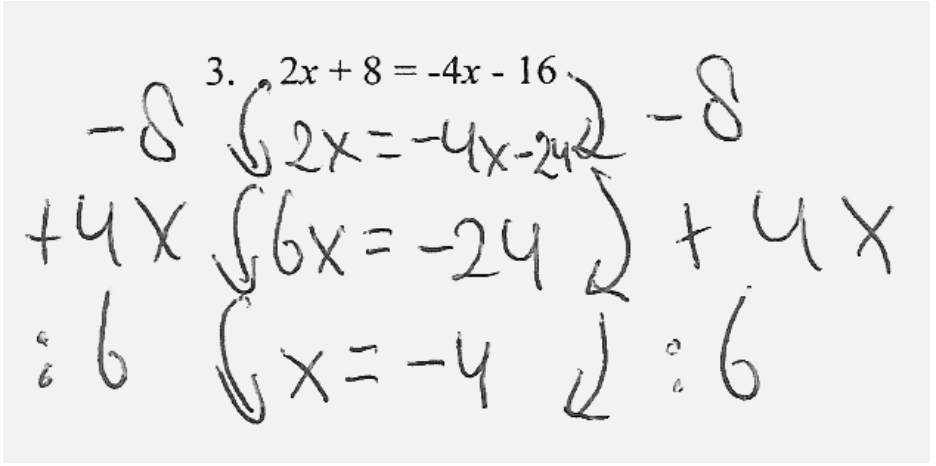


http://www.fi.uu.nl/dwo/gr-pilot/

2. Paper-and-pencil skills and tool techniques

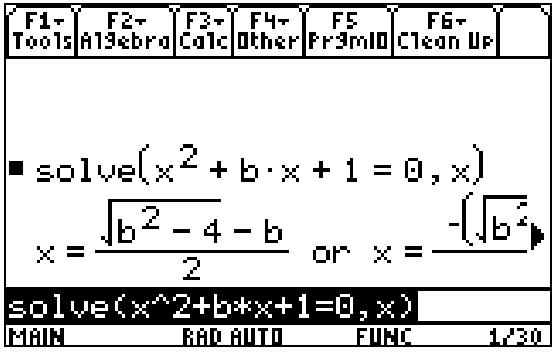
- From screen to notebook: transfer between computer tool techniques and paper-and-pencil techniques

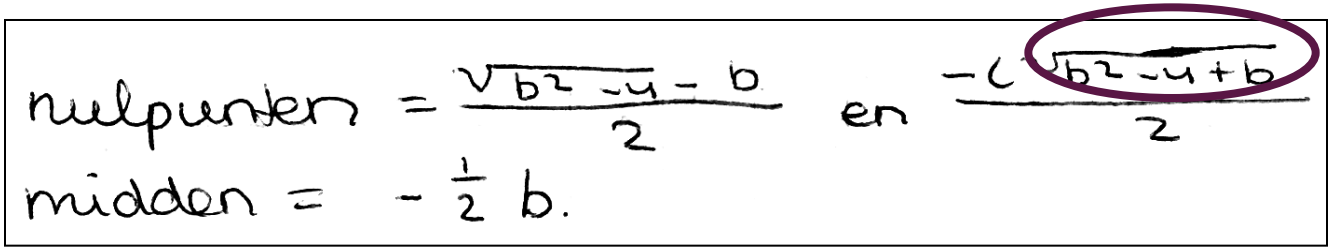




2. Paper-and-pencil skills and tool techniques

- Such transfer is not always straightforward:

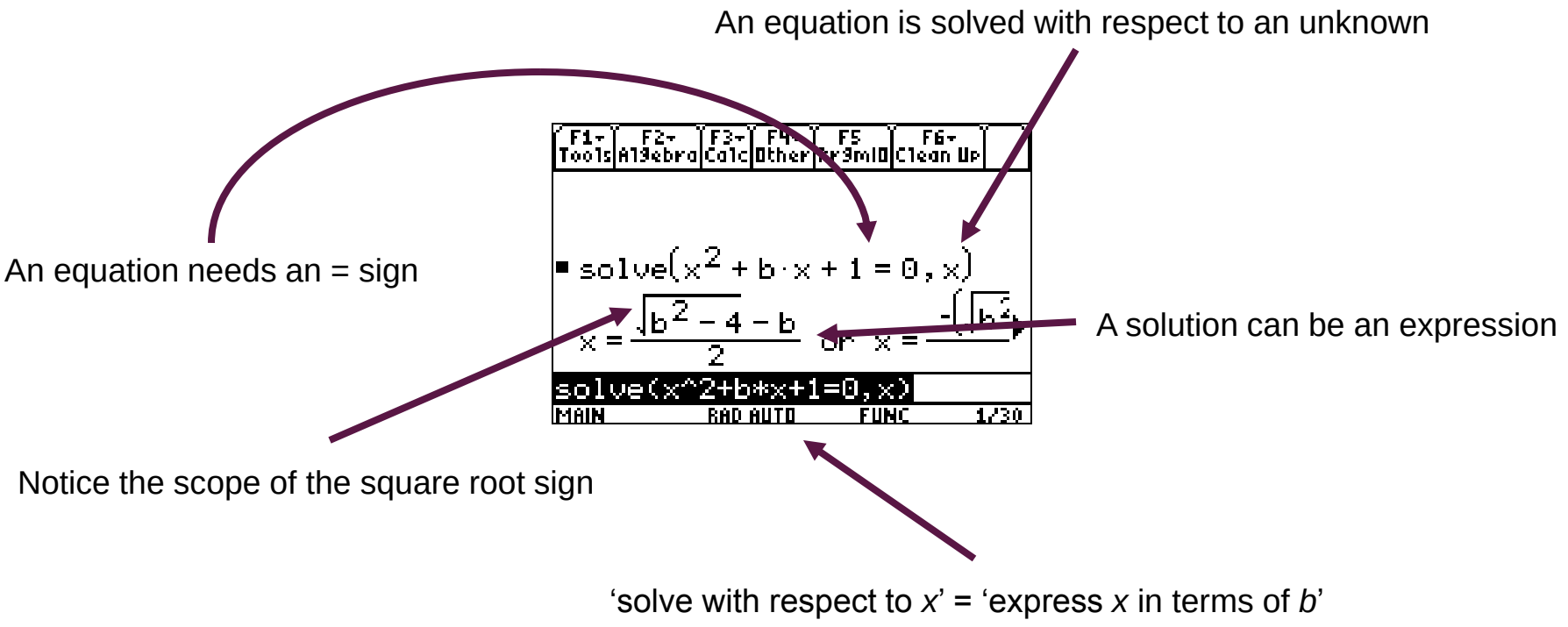




Drijvers, P. (2003). *Learning algebra in a computer algebra environment.* www.fi.uu.nl/~pauld/dissertation

2. Paper-and-pencil skills and tool techniques

Solving an equation is not straightforward either:



Intermezzo Instrumentation: Artefact and instrument

- A good artefact does not imply nice music!
- Instrument = Artefact + Schemes
- Scheme = Technique + Concepts

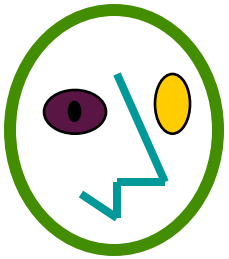
Schemes and techniques

- A *technique*: a concrete way to carry out a task using an artefact
  -> what you **do** with the artefact

- A *scheme*: a method for solving a class of problems, including the corresponding insights
  -> what you **think** while carrying out a technique

- What you think determines what you do, but the artefact's affordances and constraints guide your thinking

Instrumentation: a sketch

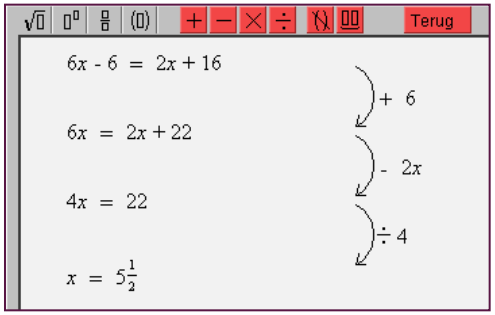


Mental scheme

Technique

Solve an equation

Type of tasks



Artefact

Instrument

Instrumentation: conclusion

- There is a close relationship between
  - Techniques and representations that tools invite and offers, and
  - Mental schemes that students develop

- This relation has to be taken into account and exploited for educational goal

- Tools + Task + Technique ->
  Cognitive development

Drijvers, P. (2007). Instrument, orkest en dirigent: een theoretisch kader voor ICT-gebruik in het wiskundeonderwijs. *Pedagogische Studiën, 84* (5), 358-374.

2. Paper-and-pencil skills and tool techniques

Conclusion:

- Paper-and-pencil skills can benefit from the work with technology.
- There is a subtle relationship between student skills, tool use, and paper-and-pencil use.
- Transfer needs to be considered carefully.

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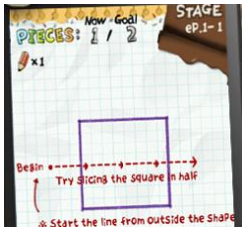
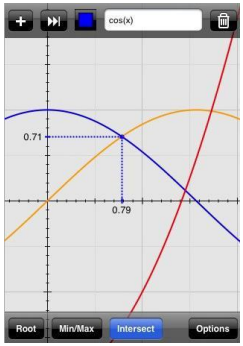




3. Basic skills and higher order skills

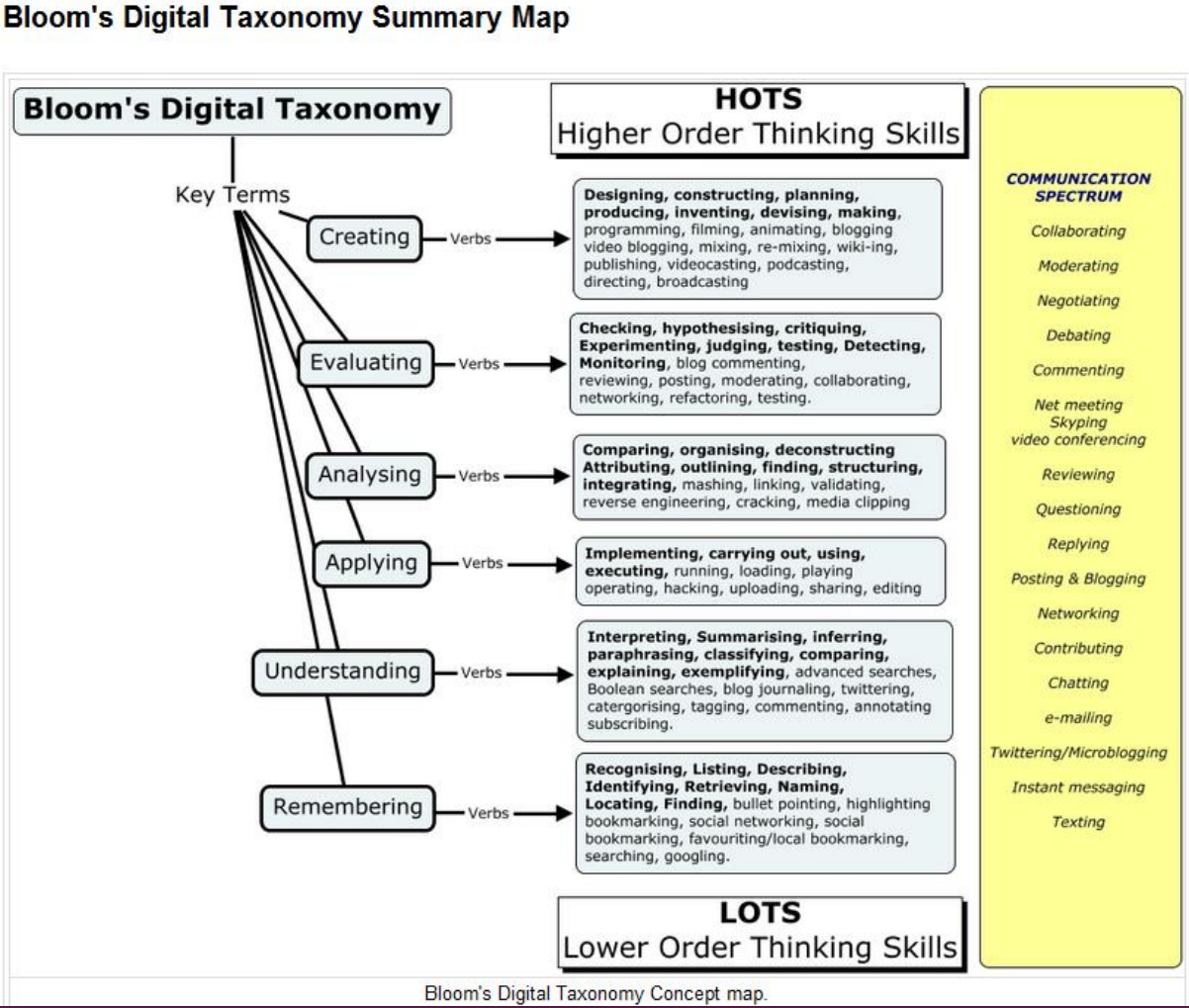
cTWO 'thinking activities' in mathematics education:

- Modelling and algebrizing
- Ordening and structuring
- Analytical thinking and problem solving
- Algebraic manipulation
- Abstraction
- Logical reasoning and proving

? Can technology help here, or is is just for the rote learning of basic skills?

3. Basic skills and higher order skills

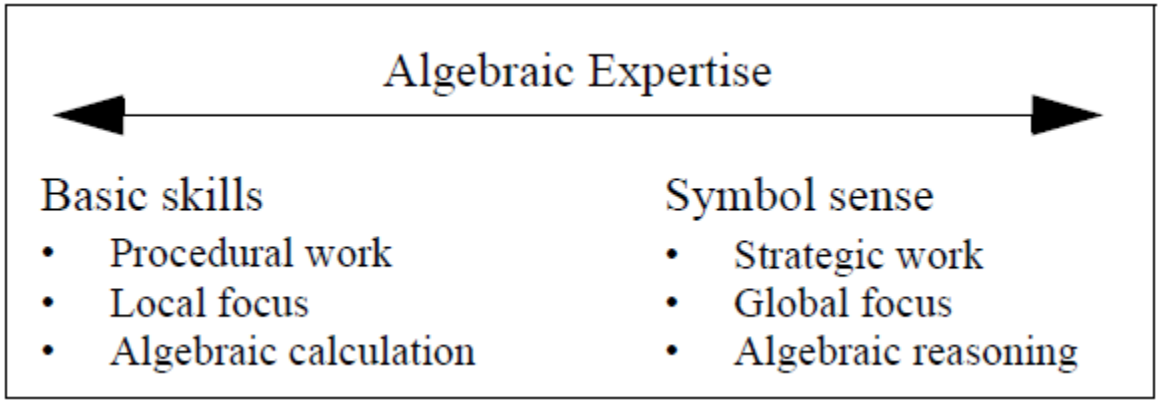
Technology in education can invite both ‘HOTS’ and ‘LOTS’!



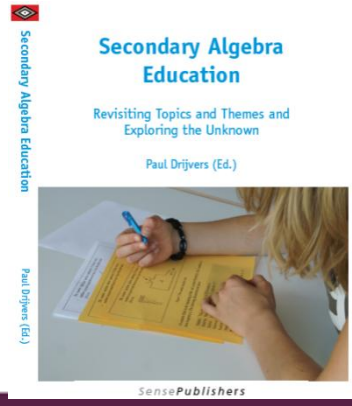
Bloom's Digital Taxonomy Concept map.

3. Basic skills and higher order skills

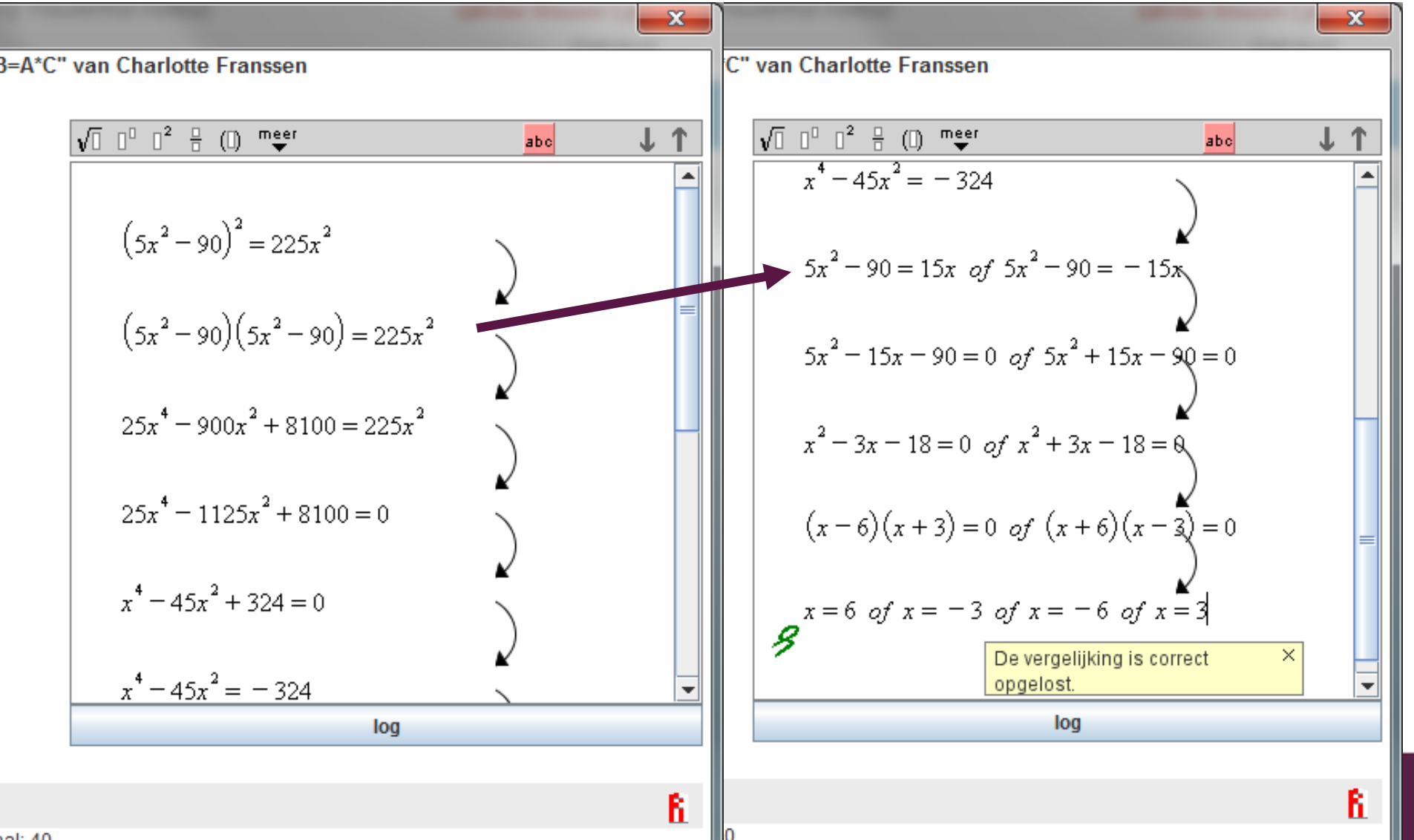
- LOTS & HOTS specifically for algebra:



Drijvers, Kindt, & Goddijn, 2010

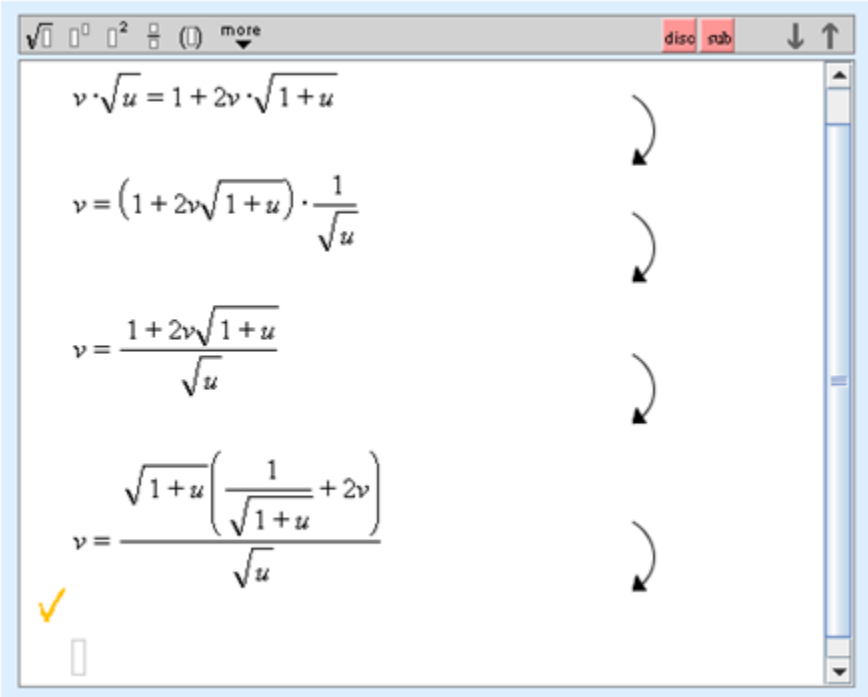


3. Basic skills and higher order skills



3. Basic skills and higher order skills

- A lot of LOTS, a lack of HOTS:



Δt	Technique	Interpretation
0 3	Rewrite	The student isolates v by dividing by $\sqrt{u}$ ($\neg$V)
4	Rewrite	
5	Factor	The student realizes $2v$ poses a problem and tries to lose this term by factoring
9		The student tries a next step, backtracks, tries again and finally gives up

Bokhove & Drijvers, 2010

3. Basic skills and higher order skills

Conclusion

- Can technology invite higher order skills, or is is just for the rote learning of basic skills?
- Yes, it can, but this largely depends on the type of tools, the type of tasks, and the educational setting

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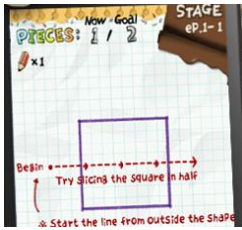
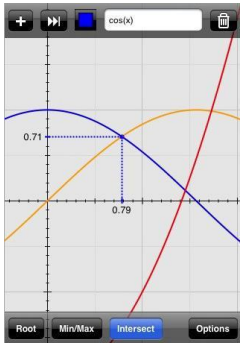


3. Basic skills and higher order skills / thinking skills

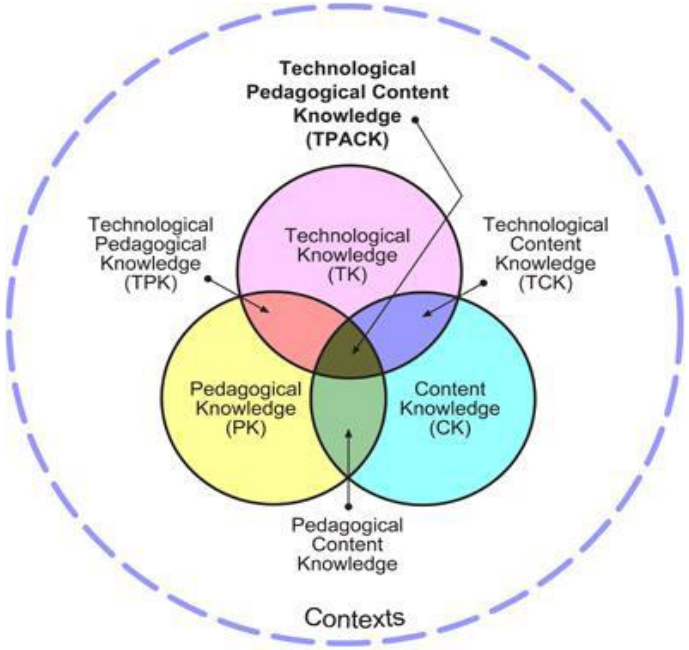
4. **Pedagogical skills and technical skills**



5. Conclusion

4. Pedagogical and technical skills

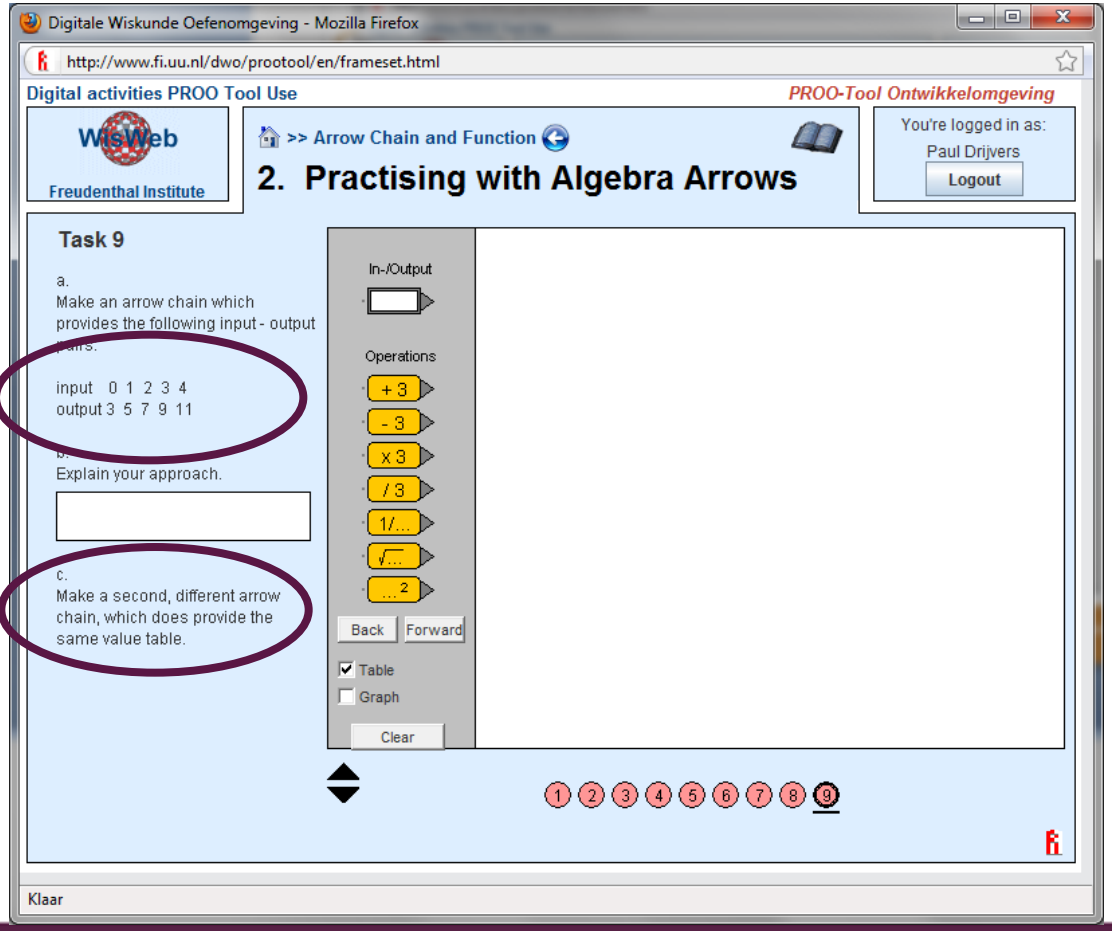
- In the development of LOTS & HOTS with technology, and in the transfer to paper-and-pencil, teachers play a crucial role
- This requires both technological and technical skills:



www.tpack.org

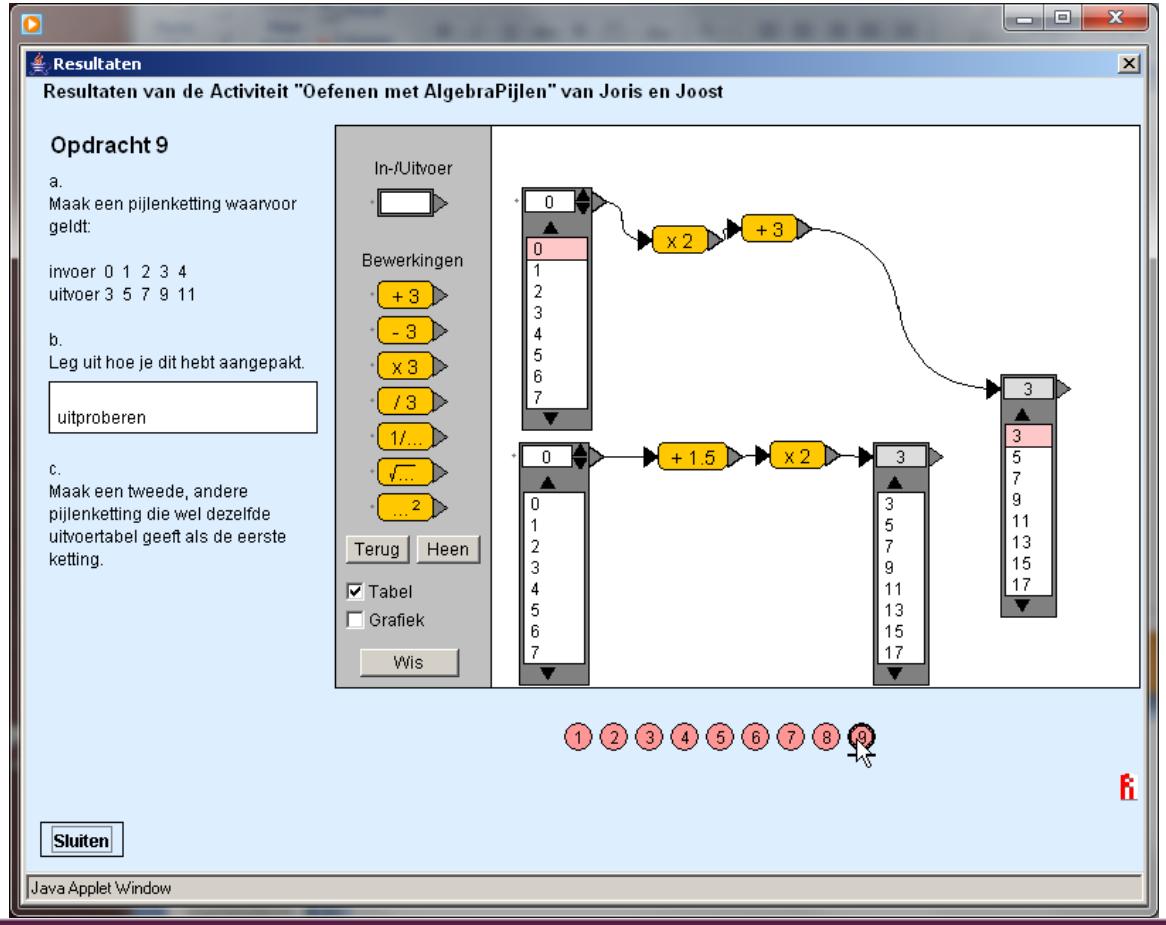
4. Pedagogical and technical skills

- An example: transfer screen - board



4. Pedagogical and technical skills

- Student work:

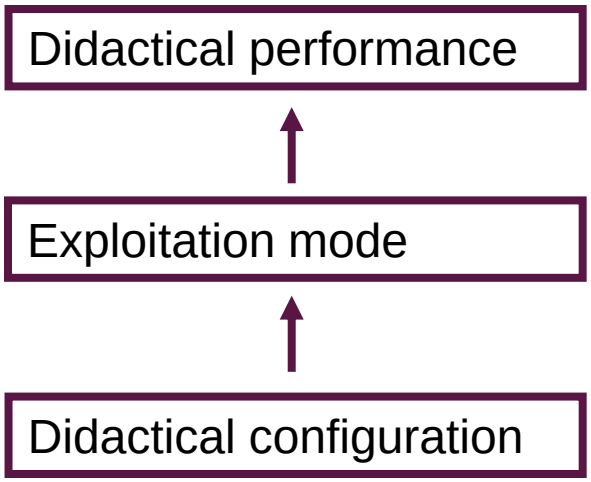


4. Pedagogical and technical skills

- Teacher work:

Intermezzo: orchestration

Instrumental orchestration



Drijvers, P., Doorman, M., Boon, P., Reed, H., & Gravemeijer, K. (2010). The teacher and the tool: instrumental orchestrations in the technology-rich mathematics classroom. *Educational Studies in Mathematics, 75*(2), 213-234.

4. Pedagogical and technical skills

Conclusion:

- Teachers remain crucial in exploiting the opportunities offered by technology
- Teachers need both pedagogical and technical skills to do so
- This requires a process of professional development

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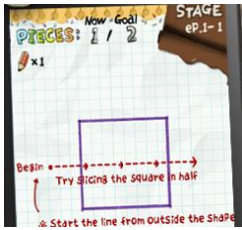

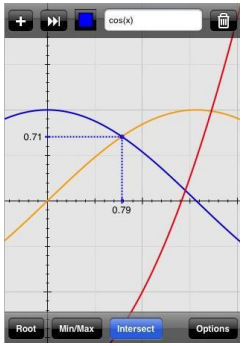

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