Expanding Room for Tacit Knowledge in Mathematics Education

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Mathematics is not a popular subject

Facts:

- Pupils and students are equally intelligent as before
- Mathematics teachers are trying hard
- The negative attitude is long-lasting

What do we do wrong?

Motto 1:

In mathematics you don't understand things. You just get used to them.
Johann von Neumann
(1903 - 1957)

Motto 2:

We used to think that if we knew one we knew two because one and one are two.
We are finding that we must learn a great deal more about „two".

Sir Arthur Eddington
(1882 - 1944)

Teaching Mathematics is
Pure Education

Will *Mathematics* follow the destiny of *Latin*?

Business persistency depends on:

- Accountability and responsiveness to the community
- Opening channels for information exchange with its environment
- Building loyalty of your clients

Teaching Mathematics is
a Form of Business

Implications for Mathematics teachers:

- Identify its „market value"
- Invite people to share your and their visions
- Form their personal ties to Mathematics
- Learn from Management courses (*Knowledge Management*, in our case)

Knowledge: Result of Learning

What do we gain during learning?

- *Explicit Knowledge:*
  - *Articulated*
  - *Codified*
  - *Stored using certain media*

- *Tacit Knowledge:*
  - *Only in human brains*
  - *Guides our activities*
  - *The owner may not be aware of it*

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Tacit and Explicit Knowledge

Prof. Back's lecture (Hagenberg, 2010):

- Calculate
$$\tan \frac{17\pi}{3}$$

= {factor out 2.π}
$$\tan\left(\frac{6.2\pi + 5.\pi}{3}\right)$$

Tacit knowledge

= {write angle in the form 2.π + α}
$$\tan\left(2.2\pi + \frac{5.\pi}{3}\right)$$

Applications of Tacit Knowledge

- Which operation to use?
- If there are several options, which one is the most appropriate?
$$\tan \frac{17\pi}{3} = \tan \frac{(12+5)\pi}{3}$$

Why not 13+4?

- What does „appropriate" mean?

Applications of Tacit Knowledge (cont.)

- Building the solving strategy

$$\tan\frac{17\pi}{3} = \tan\frac{(12+5)\pi}{3}$$

$$\tan\frac{17\pi}{3} = \tan\frac{(18-1)\pi}{3}$$
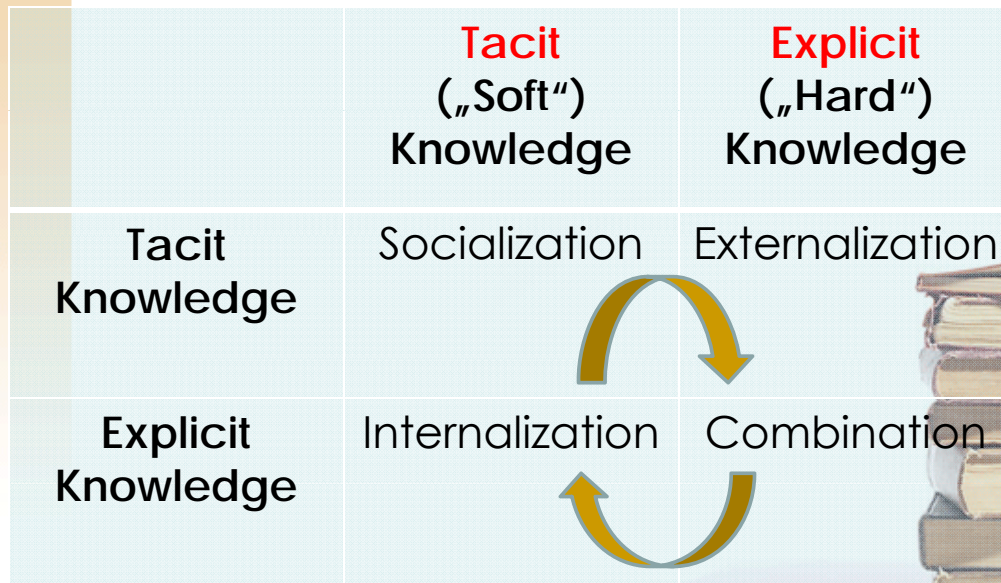

Several Levels of Tacit Knowledge

1. Which rule to apply?
2. Where do my manipulations lead?
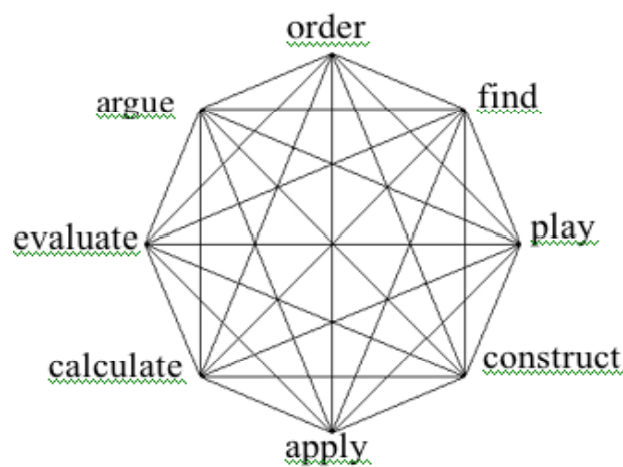
$$\tan\frac{5\pi}{3} \; or \; \tan\frac{-\pi}{3} ?$$

3. Which one is the result?
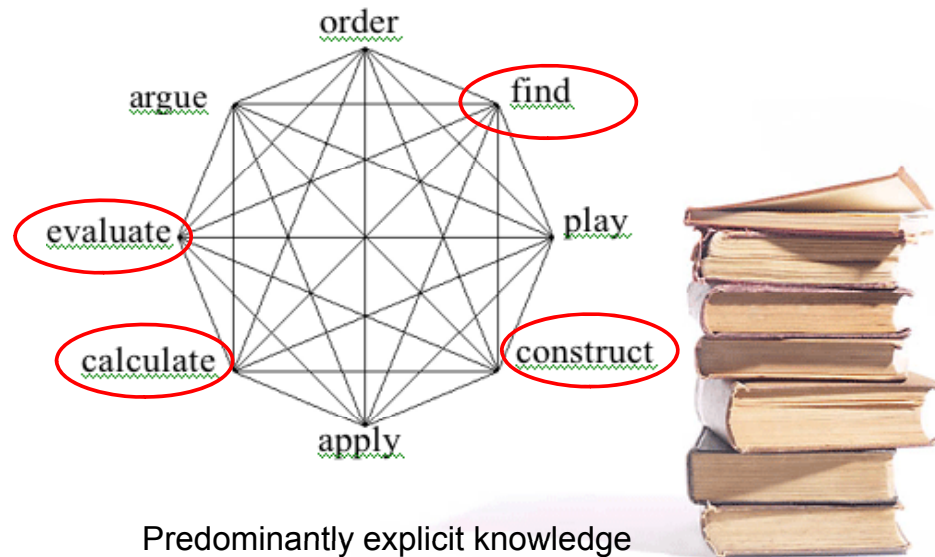4. What if my CAS calculates something else?
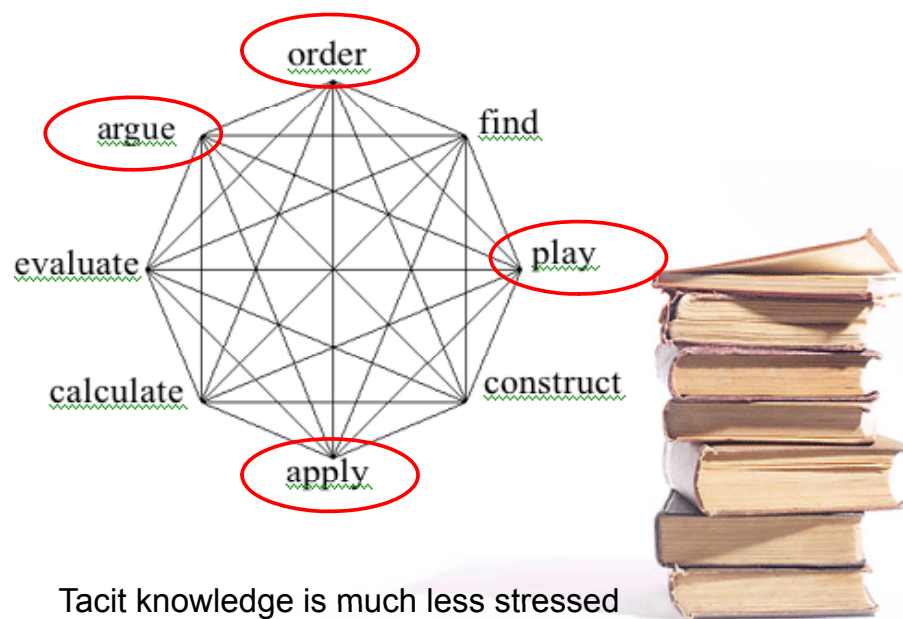
Nonaka-Takeuchi SECI Model

	Tacit ("Soft") Knowledge	Explicit ("Hard") Knowledge
Tacit Knowledge	Socialization	Externalization
Explicit Knowledge	Internalization	Combination

What Does Mathematics Consist of?

Zimmerman's octagon

Zimmermann, B. 2003. *On the Genesis of Mathematics and Mathematical Thinking - a Network of Motives and Activities Drawn from the History of Mathematics*. In L. Haapasalo and K. Sormunen (Eds.) *Towards Meaningful Mathematics and Science Education.* University of Joensuu. Bulletins of the Faculty of Education 86, 29-47.

Current preferences – „Hard" skills

Predominantly explicit knowledge

CAS Clients' Needs – „Soft" skills

Tacit knowledge is much less stressed

Can Someone Comprehend the Role of Mathematics without Remembering **EVERYTHING**?

- Mathematics as a goal – stressing explicit knowledge
- Mathematics as a tool – stressing tacit knowledge

Consequences of the Current Approach

1. Economists, physicians, engineers do not expect that mathematicians could co-operate in solving their problems. (Communication also belongs among "soft" skills.)
2. Many potential job opportunities for mathematicians are lost (by their not-creating).

Covering both Mathematics and SECI Model
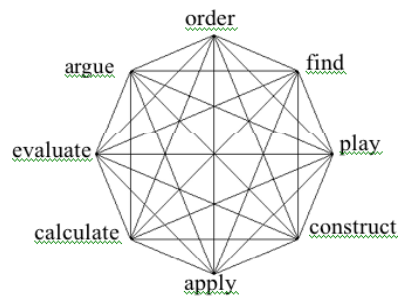
	Tacit Knowledge	Explicit Knowledge
Tacit Knowledge	**Socialization** (Argue, Play)	**Externalization** (Find, Evaluate)
Explicit Knowledge	**Internalization** (Apply, Order)	**Combination** (Calculate, Construct)

Thank you for your attention!

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