BIOLOGICAL BASES OF LEARNING - CAN NEUROSCIENCE HELP US UNDERSTAND EDUCATION

Minna Huotilainen
Professor of educational sciences
University of Helsinki, Finland
Email: minna.huotilainen@helsinki.fi
Twitter: @minnahuoti


WHICH
NEUROSCIENTIFIC
METHODS WE USE TO
UNDERSTAND
LEARNING?

HOW TO STUDY THE LEARNING BRAIN

Child MEG at BioMag Laboratory, Helsinki

Photo: Neuromag

1. Laboratory-based methods can simulate real learning situations
   - MEG (magnetoencephalo-graphy)
   - fMRI (functional magnetic resonance imaging)

HOW TO STUDY THE LEARNING BRAIN

1. Laboratory-based methods can simulate real learning situations
2. Mobile brain research can be taken to actual learning environments
   - EEG (electroencephalo-gram)

Child portable EEG, Univ of Helsinki
Photo: Minna Huotilainen

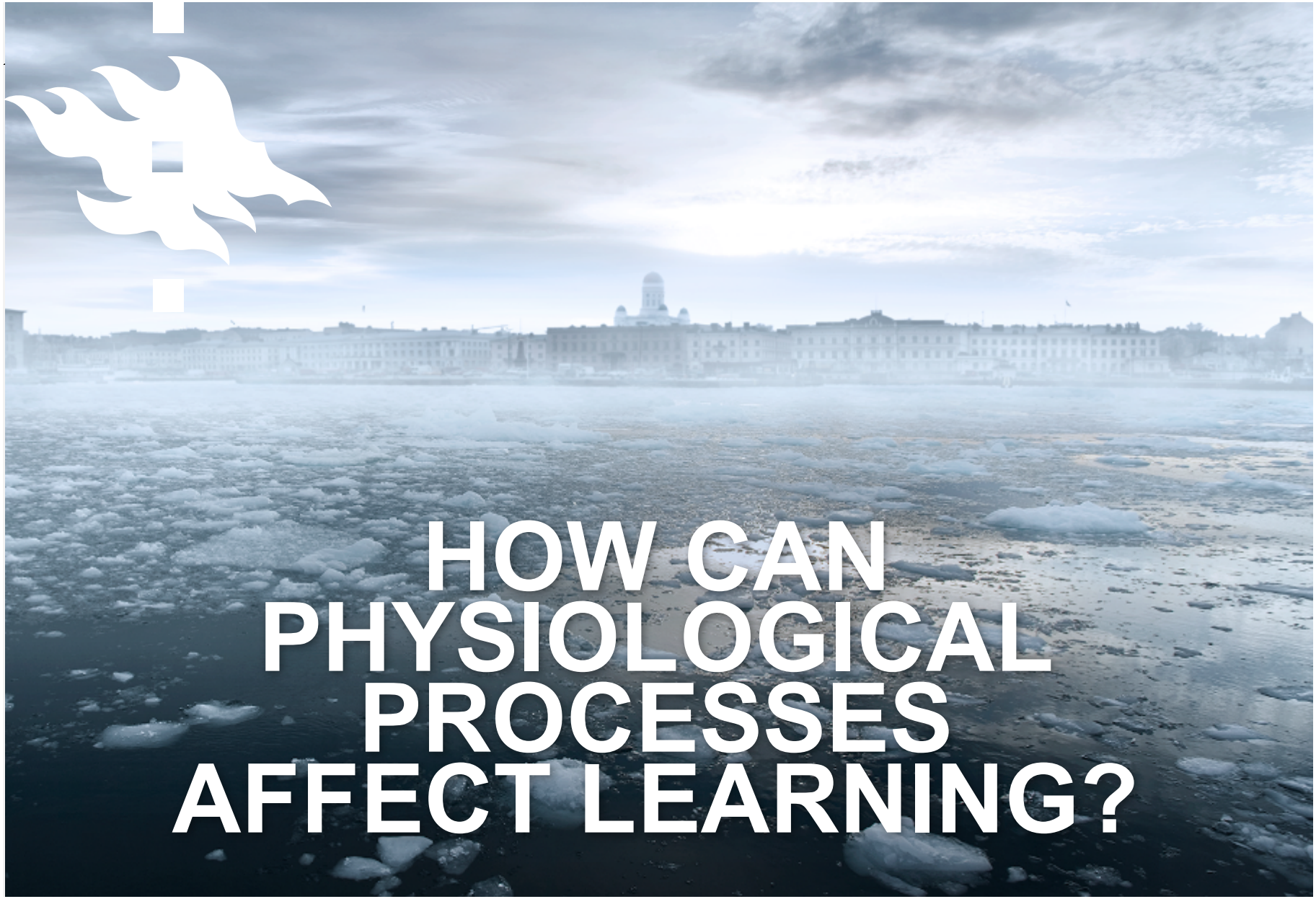
HOW TO STUDY THE LEARNING BRAIN

1. Laboratory-based methods can simulate real learning situations
2. Mobile brain research can be taken to actual learning environments
   - EEG (electroencephalo-gram)
   - Autonomous nervous system measurements

HOW TO STUDY THE LEARNING BRAIN

1. Laboratory-based methods can simulate real learning situations
2. Mobile brain research can be taken to actual learning environments
3. Brain research can be used to demonstrate learning that has not reached the surface level yet

Infant EEG,
Univ of Helsinki
Photo: Veikko Somerpuro


HOW CAN PHYSIOLOGICAL PROCESSES AFFECT LEARNING?

Fight or flight

Flow

Active

threat

inspiration

cynicism

freedom

Drowsy

Sleep

Simplified map of physiological states

Fig: Jori Uusitalo from Tunne aivosi book

HOW CAN PHYSIOLOGICAL PROCESSES AFFECT LEARNING

- Physiological states are very old and automatic
- Fight or flight state prevents deep learning
- Find ways to approach flow state
- Teach students to regulate their state

MUSIC, CURIOSITY, AND PHYSICAL ACTIVITY HAVE STRONG EFFECTS

- Active listening to energetic, appreciated music can help reach the flow state
- Evoking the curiosity of the learner can help reach flow state and attend
- Long periods of physical inactivity may induce drowsy or even fight-or-flight states

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

@minnahuoti

09/08/2018

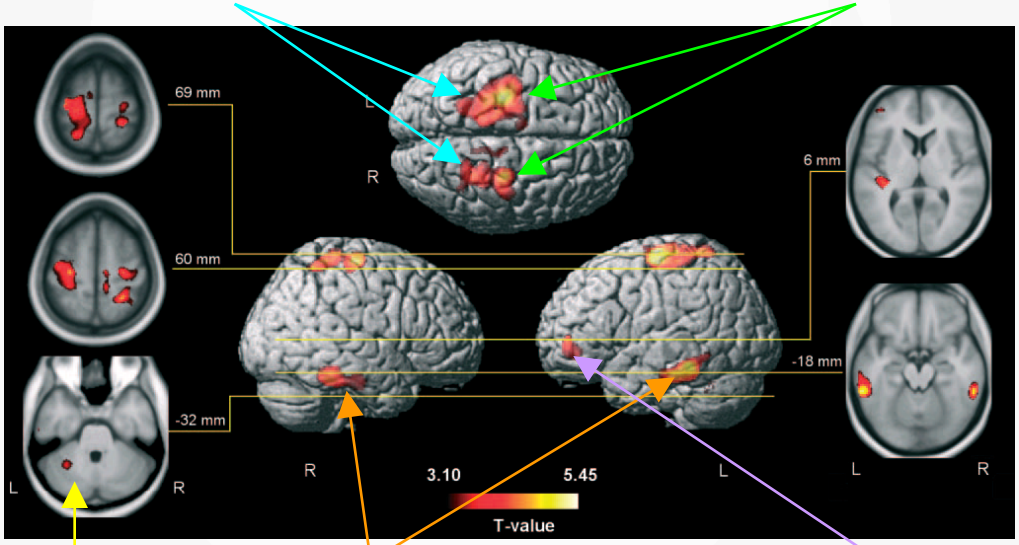
MUSICIANS' BRAINS ARE DIFFERENT: MORE GRAY MATTER

Gaser & Schlaug, 2003

Parietal lobe

Motor and somatosensory

Larger corpus callosum



cerebellum

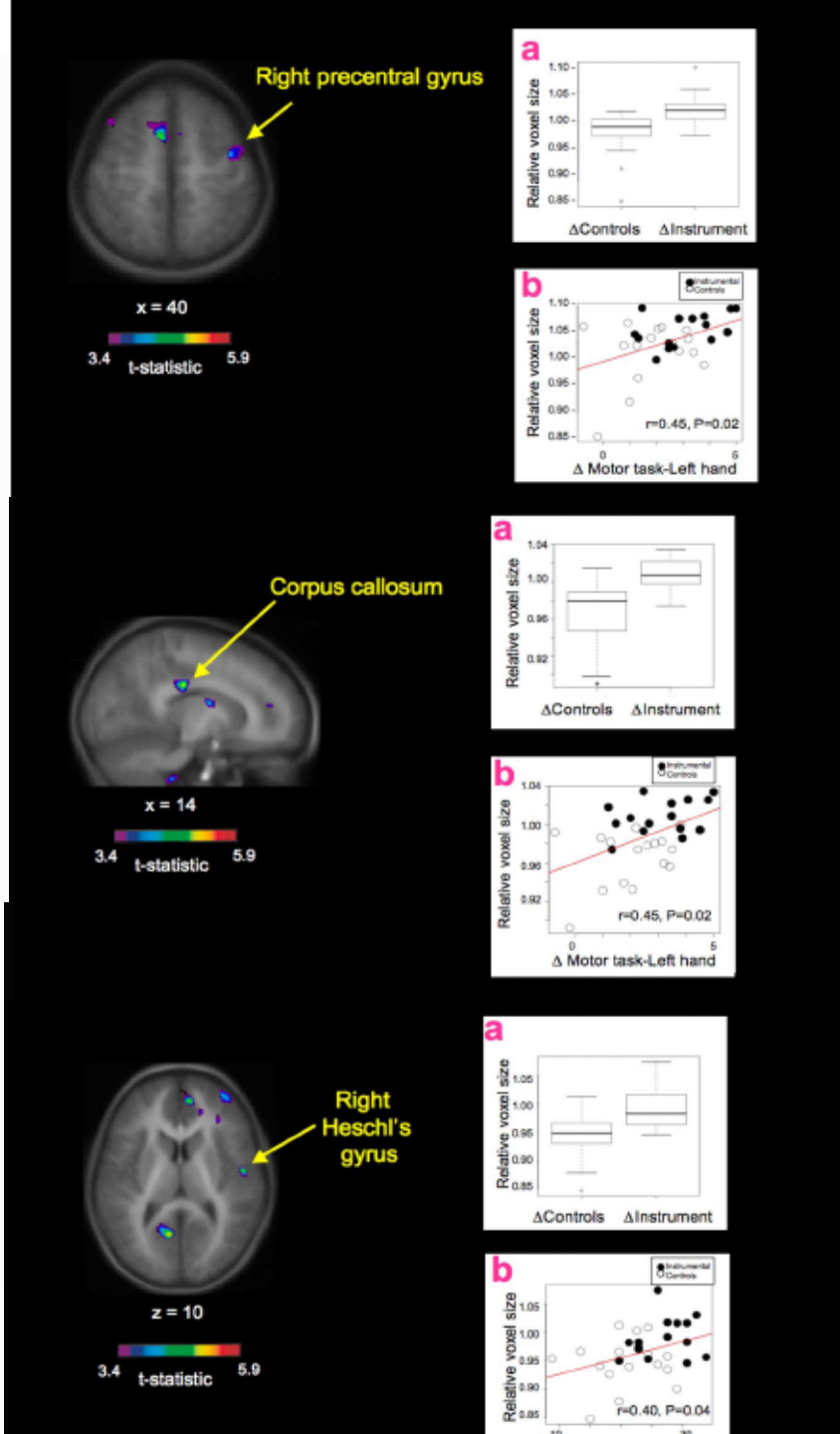
Temporal lobe

Frontal lobe

FAST CHANGES IN CHILDREN'S BRAINS

- After 15 months, similar changes in children's brains (Hyde et al., 2009).
- Practising a musical instrument enhances the activity in these brain areas.
- The resources are available for all similar tasks
  - Listening to speech in noise
  - Fine motor tasks
  - Structural perception in math

- Also similar data by Putkinen et al.



LEARNING MUSIC ENHANCES BRAIN CAPACITY

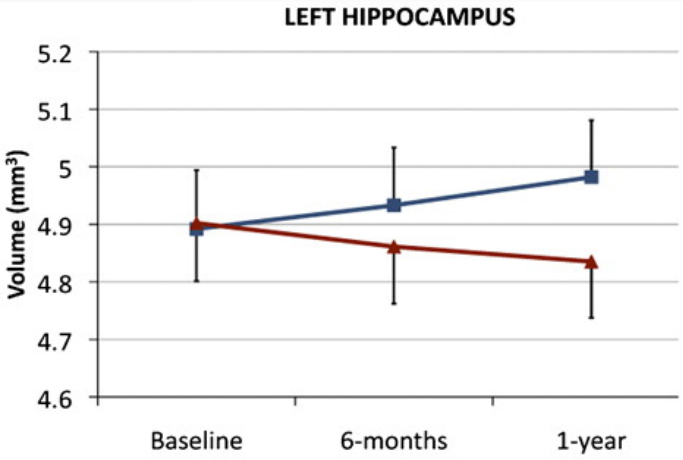
- Learning to play a musical instrument or to sing enhances brain capacity via structural changes in the brain
- This capacity is available for other tasks, too (cognitive benefit, transfer effect)
- Anybody can benefit from these effects at any age
- Music, especially singing, should be viewed as a very effective learning method, especially in ages 3-9 years

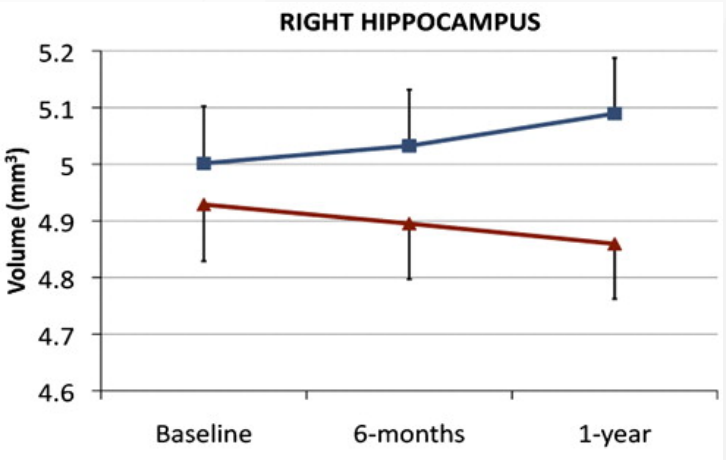

THE BRAIN IS ACTIVE
WHEN
THE BODY IS ACTIVE

INCREASE IN PHYSICAL ACTIVITY INCREASES BRAINS' MEMORY AREAS

-120 healthy, sedentary adults aged 55-80 y
-Intervention: Started walking 3 times per week for 1 year w.60-75% max HR for 40 minutes
-increase in hippocampal volume and better memory performance

Hippocampus





Intervention study by
Erickson K I et al. PNAS 2011;108:3017-3022

THE BRAIN IS ACTIVE WHEN THE BODY IS ACTIVE

- Short-term physical activity (2-30 min) can enhance learning via better regulation of arousal. In Finland, we have only 45 minutes of learning, which is always followed by 15 minutes of physical activity outdoors throughout the day.
- Long-term physical activity can enhance learning via enhancing sleep quality
  - The brain needs sleep for consolidating memory traces
  - i.e., Half of the learning happens at night
- Physically active lifestyle enhances learning and memory

WHAT TO LEARN FROM THE FINNISH EDUCATIONAL SYSTEM

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

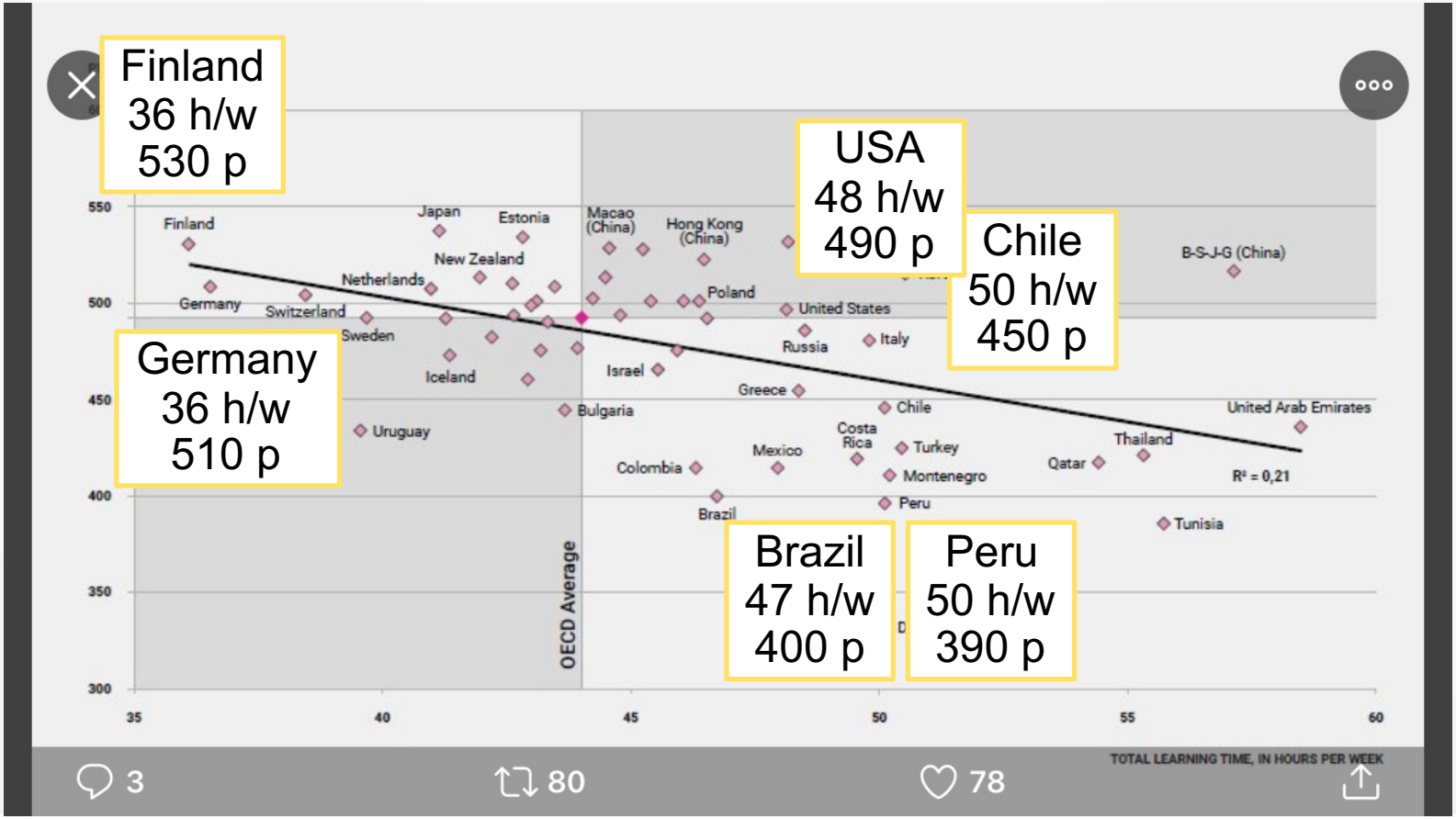
@minnahuoti

09/08/2018

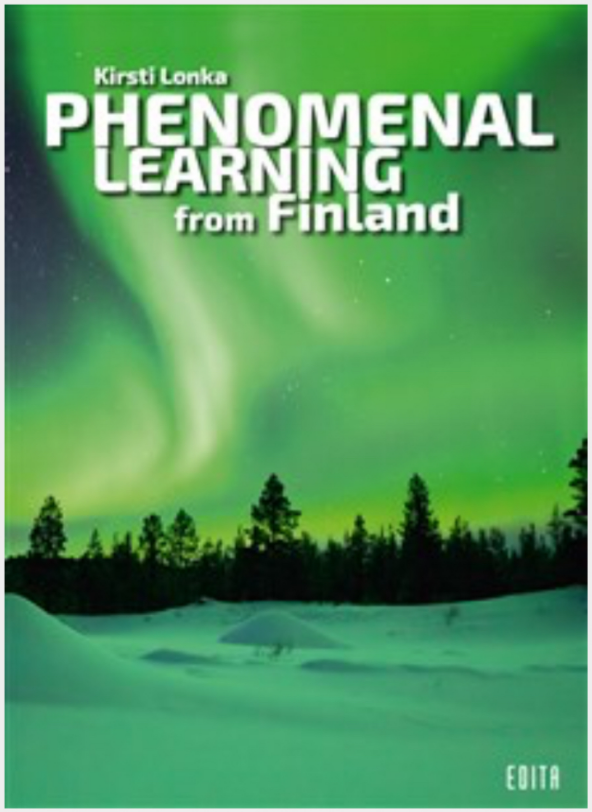
KEY FEATURES OF THE FINNISH EDUCATIONAL SYSTEM

- All teachers have Master's degree from qualified universities
  - Teaching pupils aged 7-12 years: BSc and MSc in education
  - Subject teachers for pupils aged 13-18 years: BSc in subject matter (math, biology, chemistry, etc), MSc in education
- Kindergarten teachers have BSc in education
- School days are short, homework is very little
  - If needed, children can spend time in sport club after school until parents return from work
- Teachers have a lot of freedom to plan the way they teach
- Simple but nutritious warm lunch to all kids every day for free

STATISTICS ON THE AMOUNT OF TIME SPENT IN SCHOOL AND PISA PERFORMANCE



MORE INFORMATION ON THE FINNISH SCHOOL SYSTEM IN THIS BOOK



You can order the book from Booky.fi


Thank you and please visit Helsinki, Finland!