

# Navigating a robot through a maze you cannot see: how young blind learners approach the computational concept of abstraction

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18-4-2024



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# Inclusivity in programming education

Participation all learners



Use of computer and tools

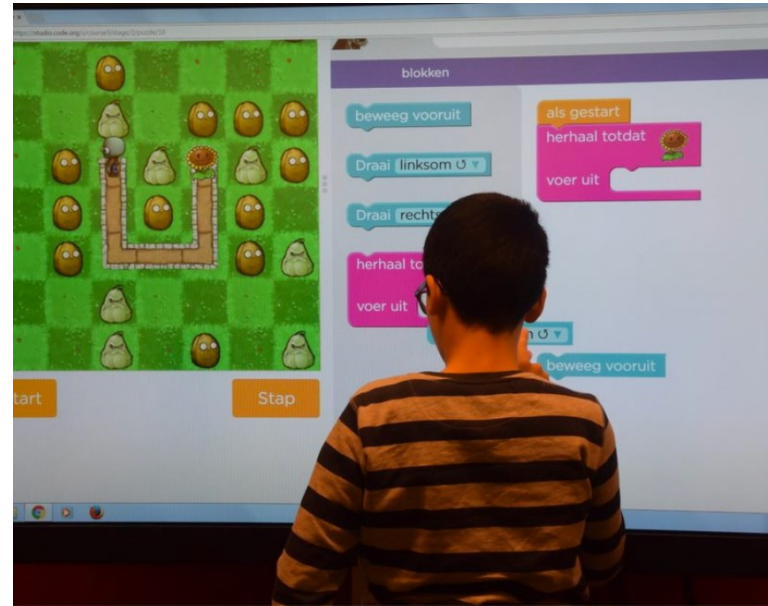
Motivation and involvement

Conceptual thinking

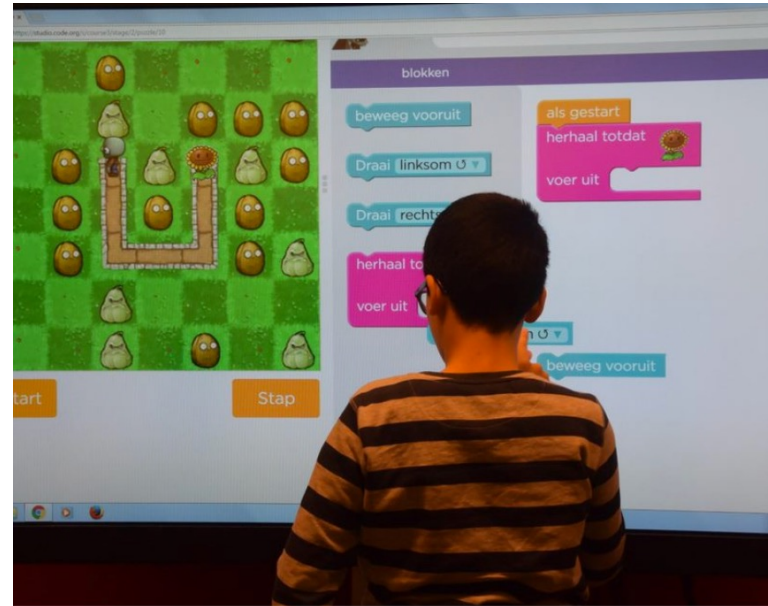
# Learners with visual impairments



# Accessibility and tools

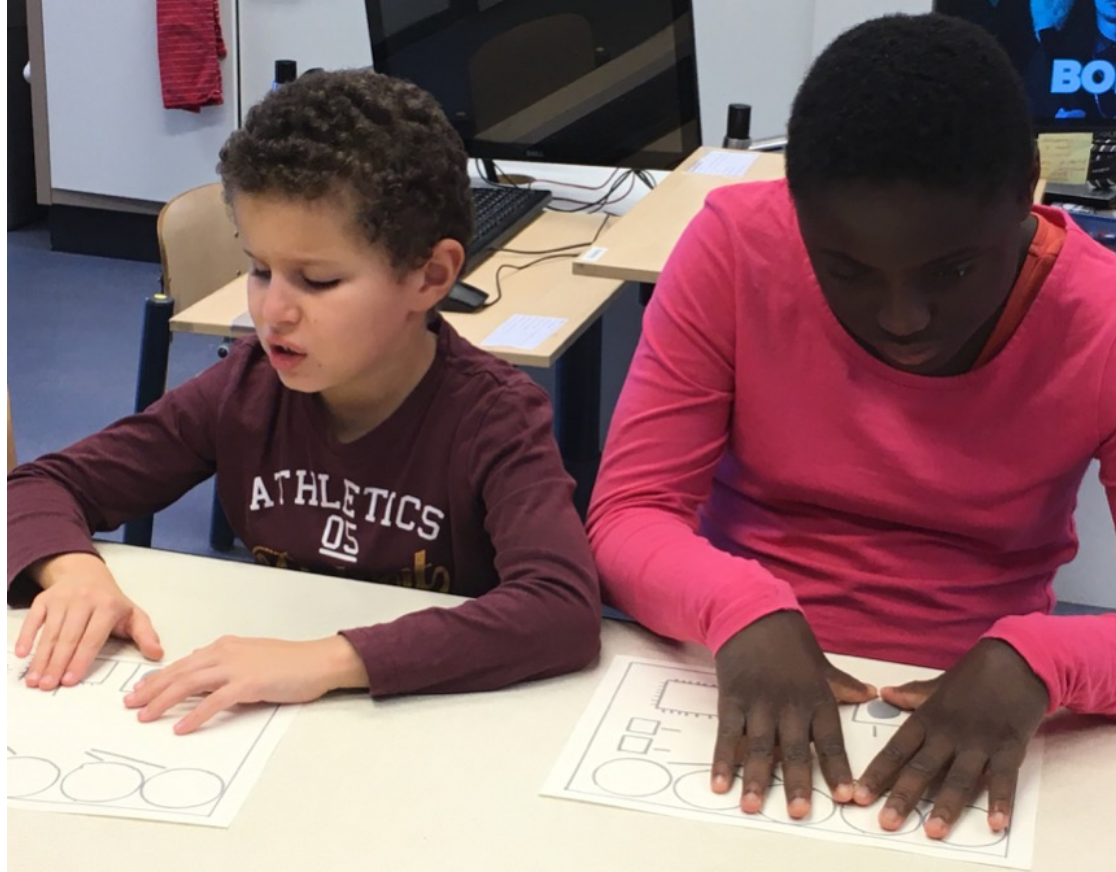


# Accessibility and learning concepts through tools



# Abstract concepts and mental modeling

- Specificities in mental modeling and spatial navigation
- Teaching abstract concepts



# Abstraction

- Various levels in viewing situation
- Model of four layers of abstraction
  - Concrete behaviors approach to programming task
- Four layers
  - Problem
  - Design
  - Code
  - Execution
- Insight into approach and experience concept abstraction

# Assessing abstraction in VI learners



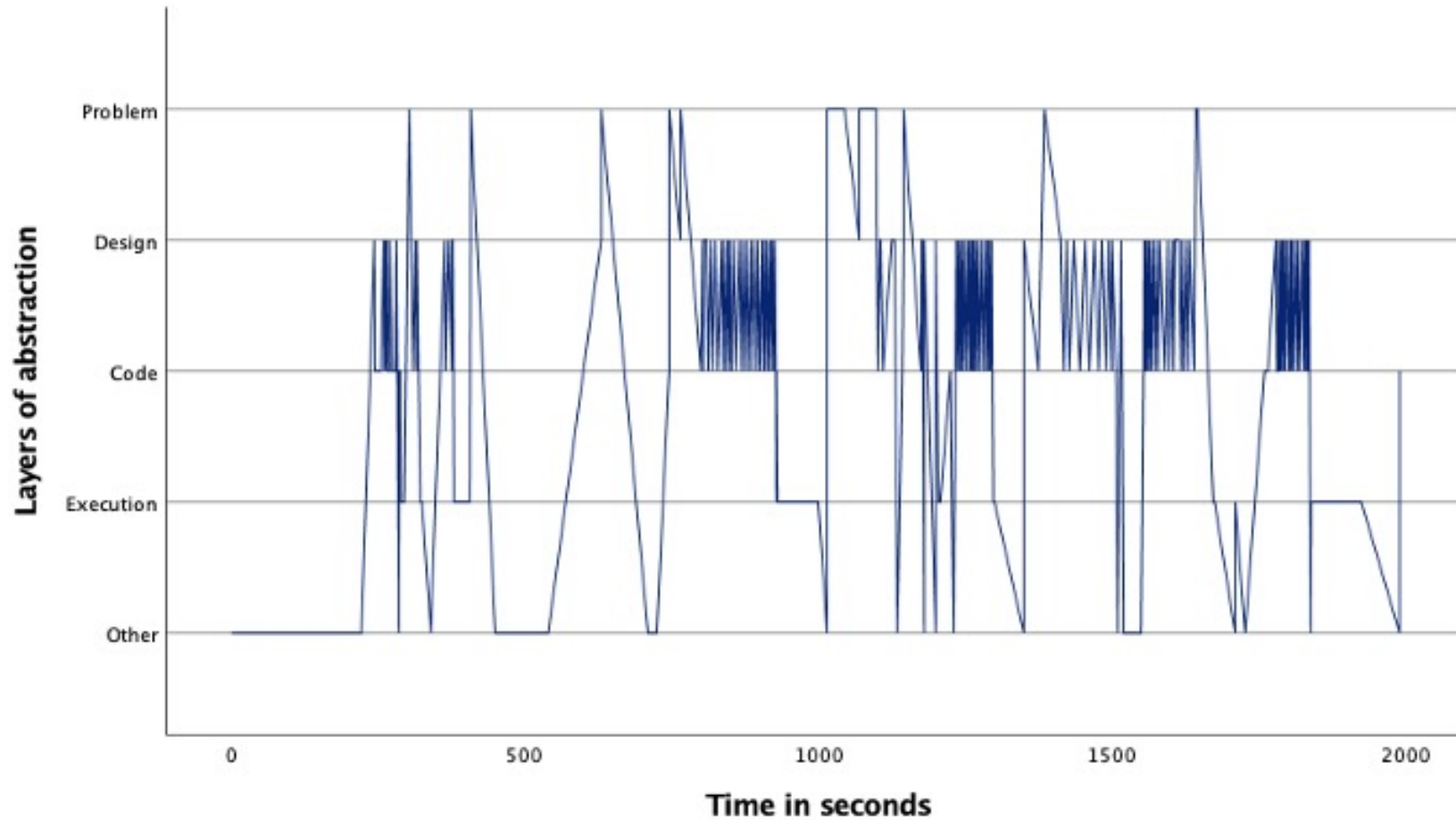


# Assignment set up

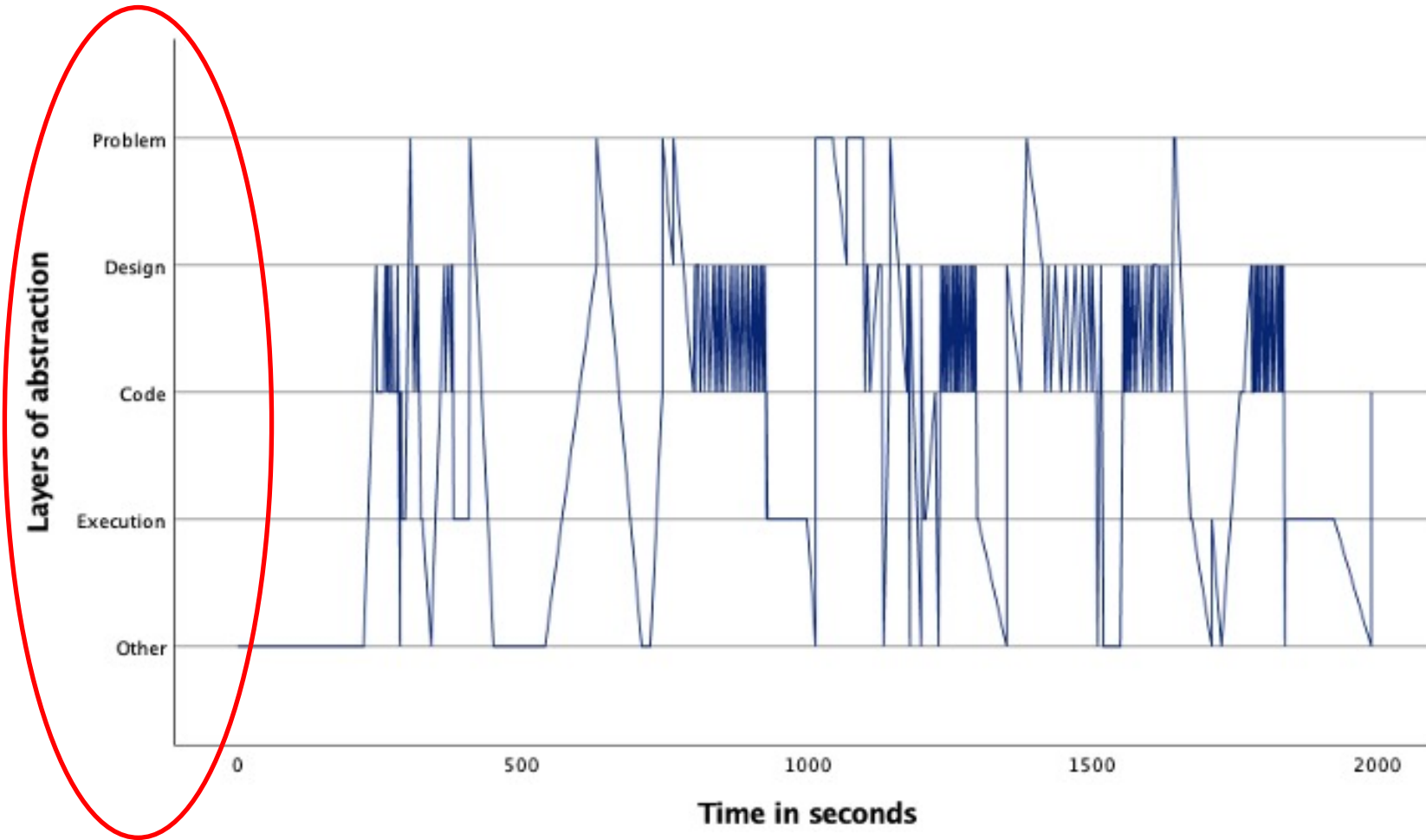
- Pairs of learners
  - Low vision and blind
- Assessing
  - Concrete behaviors engaging in layers
  - Pattern of switching between layers



# Pattern young blind and low vision learner

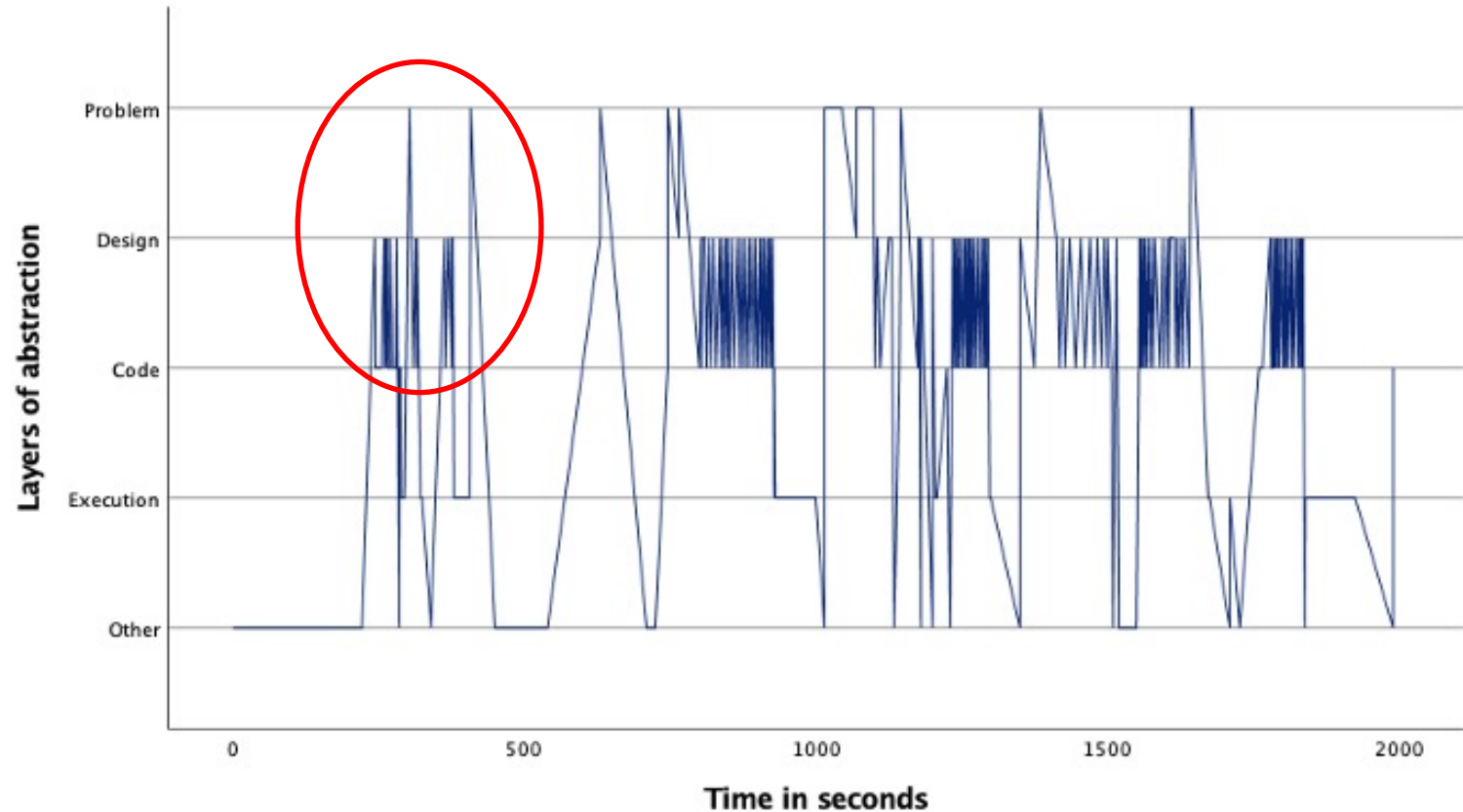


# Pattern of abstraction levels



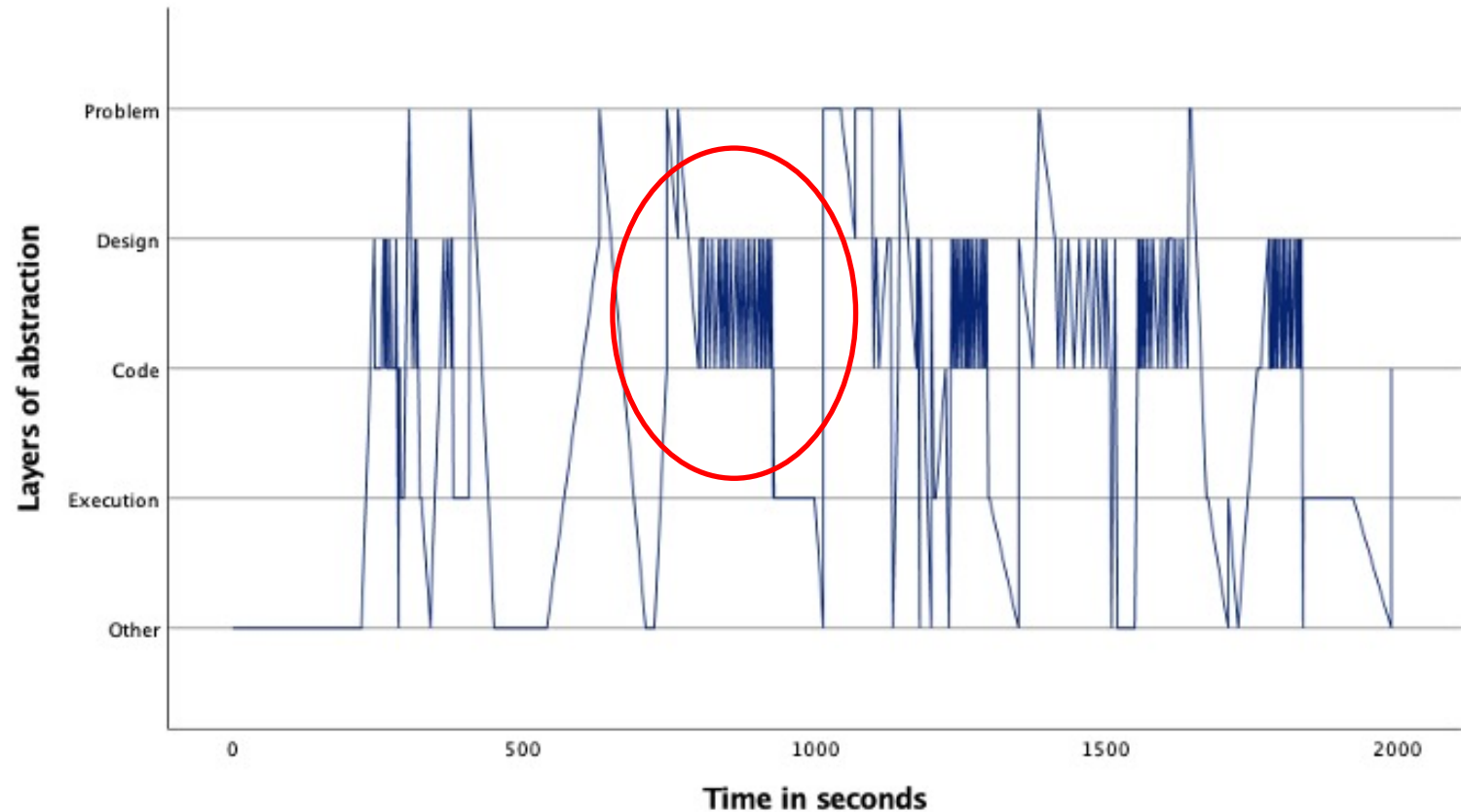
# Pattern of abstraction levels

- Problem and design practices
- Making a plan
- Discussing, pointing, feeling



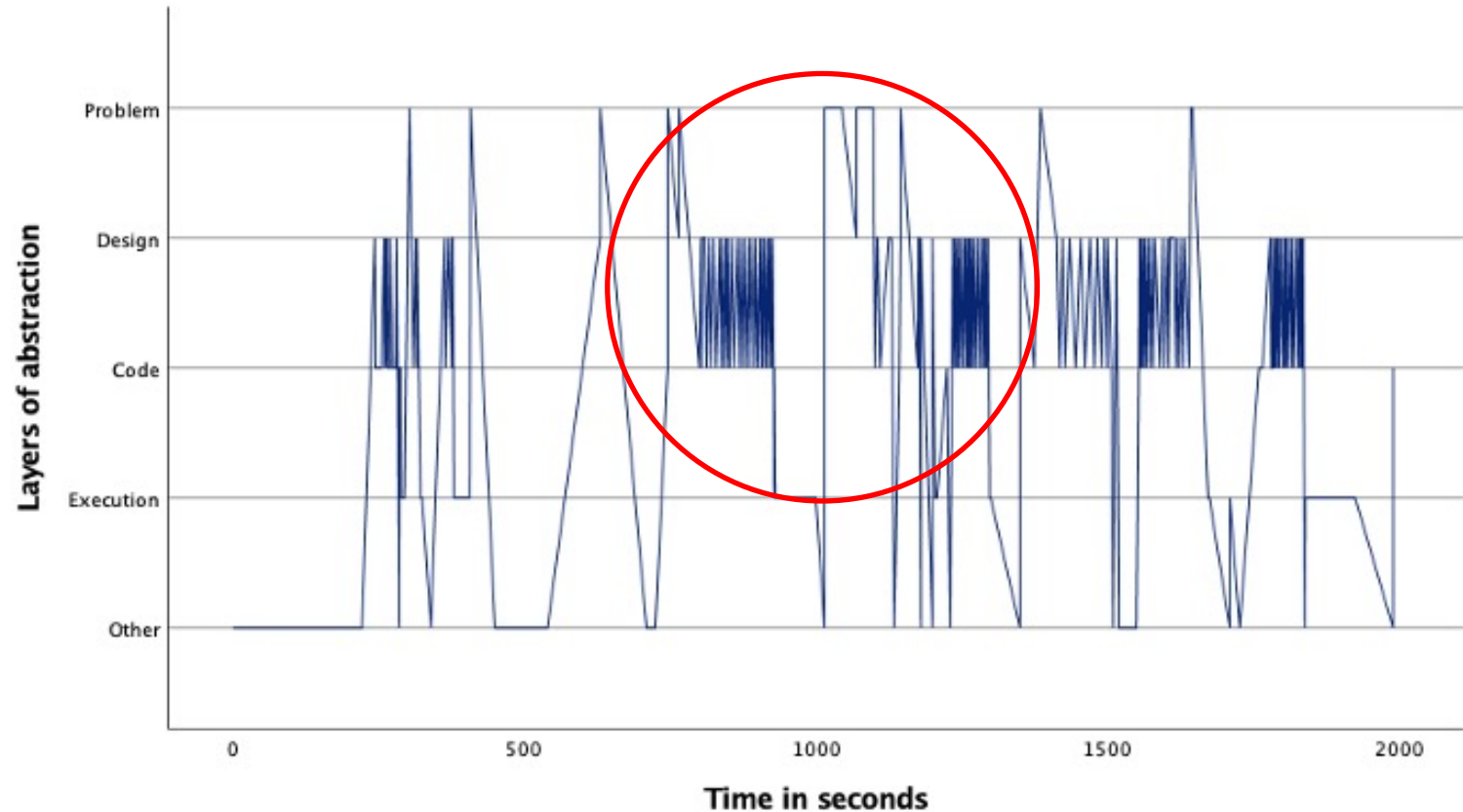
# Pattern of abstraction levels

- Quickly switching between design and coding
- Think of step – code step – think of step – code step – think of step – code step
- Discussing, feeling along, placing bot

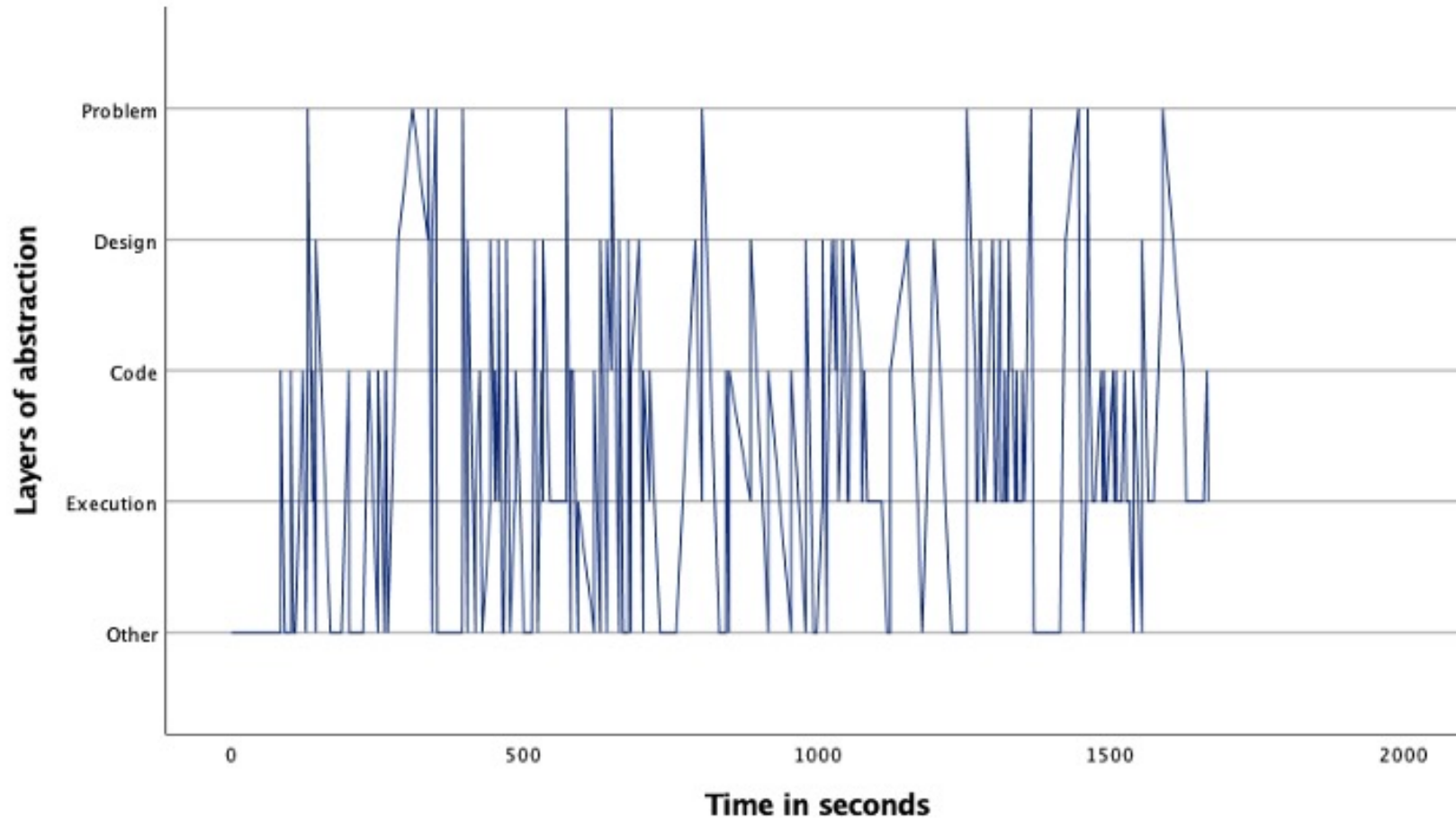


# Pattern of abstraction levels

- After executing program: back to problem, design, code
- Debugging

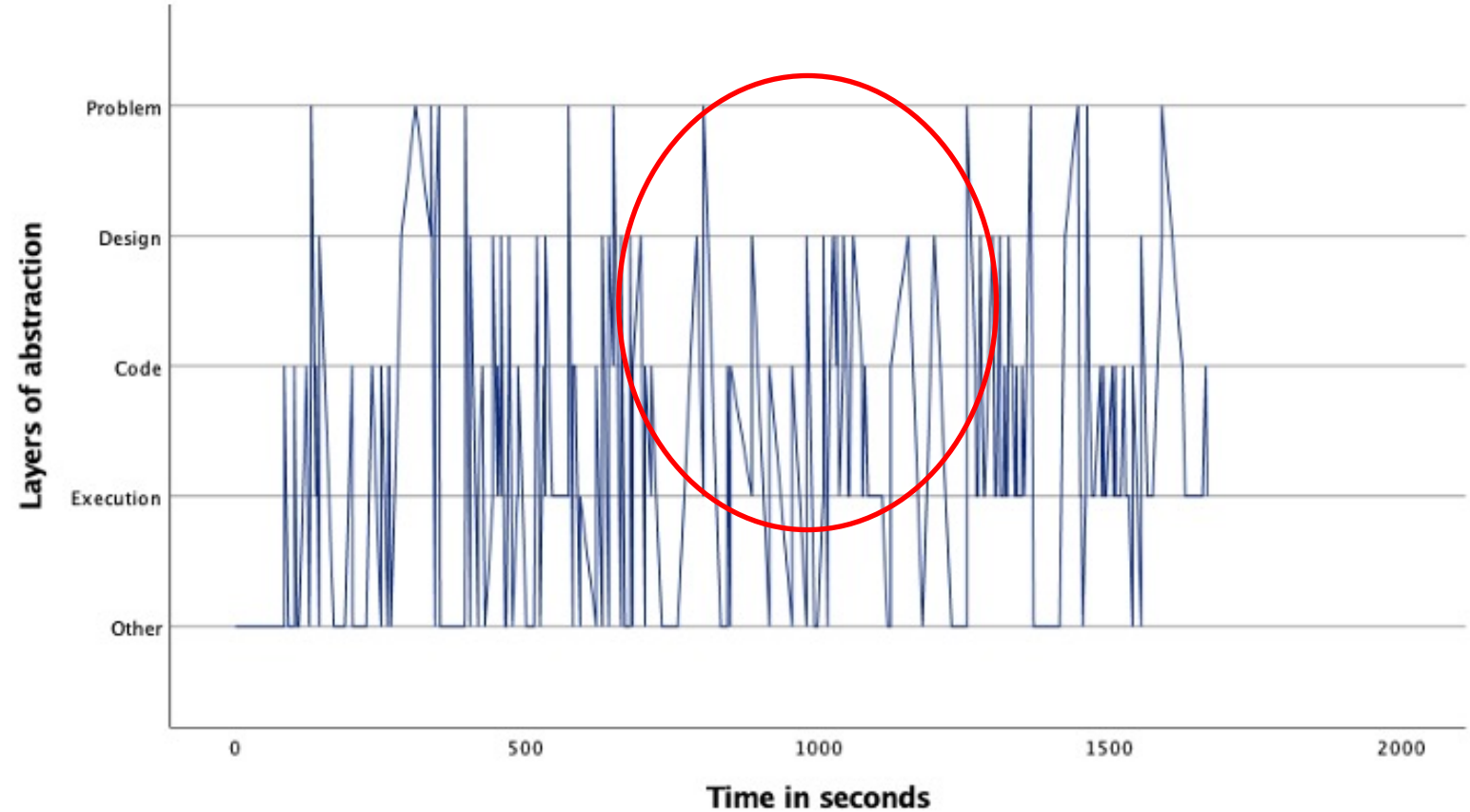


# Pattern two older blind learners



# Pattern of abstraction levels

- Designing and coding part of program - testing





# Overall patterns

- Deliberate switching between layers
  - Iterative processes
  - Redesigning and debugging
- Processes similar to sighted learners
- Behaviors both similar and alternative
- Alternative
  - Manual involvement with bot “Let’s put the bot on the place where it would be next”
  - Physical enactment “Look, look, I take a step, turn, step, step, turn, step, turn”.

# Embodiment

- “Look, look, I take a step, turn, step, step, turn, step, turn”.
- Embodied cognition as educational strategy
- Mental processes mediated by body-based systems



Abrahamson, D., Nathan, M. J., Williams-Pierce, C., Walkington, C., Ottmar, E. R., Soto, H., & Alibali, M. W. (2020, August). The future of embodied design for mathematics teaching and learning. In *Frontiers in Education* (Vol. 5, p. 147). Frontiers Media SA.

# Inclusive education

- Conceptual level
- Inclusion for all learners and embodiment
- “Wow yes it made it!”
- “Let’s now make a parking game for the bot!”



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van der Meulen, A., Hartendorp, M., Voorn, W., & Hermans, F. (2023). Observing the computational concept of abstraction in blind and low vision learners using the Bee-bot and Blue-bot. *Computer Science Education*, 1-23



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