Discovery or Direction?

Induction and Deduction in STEM Education

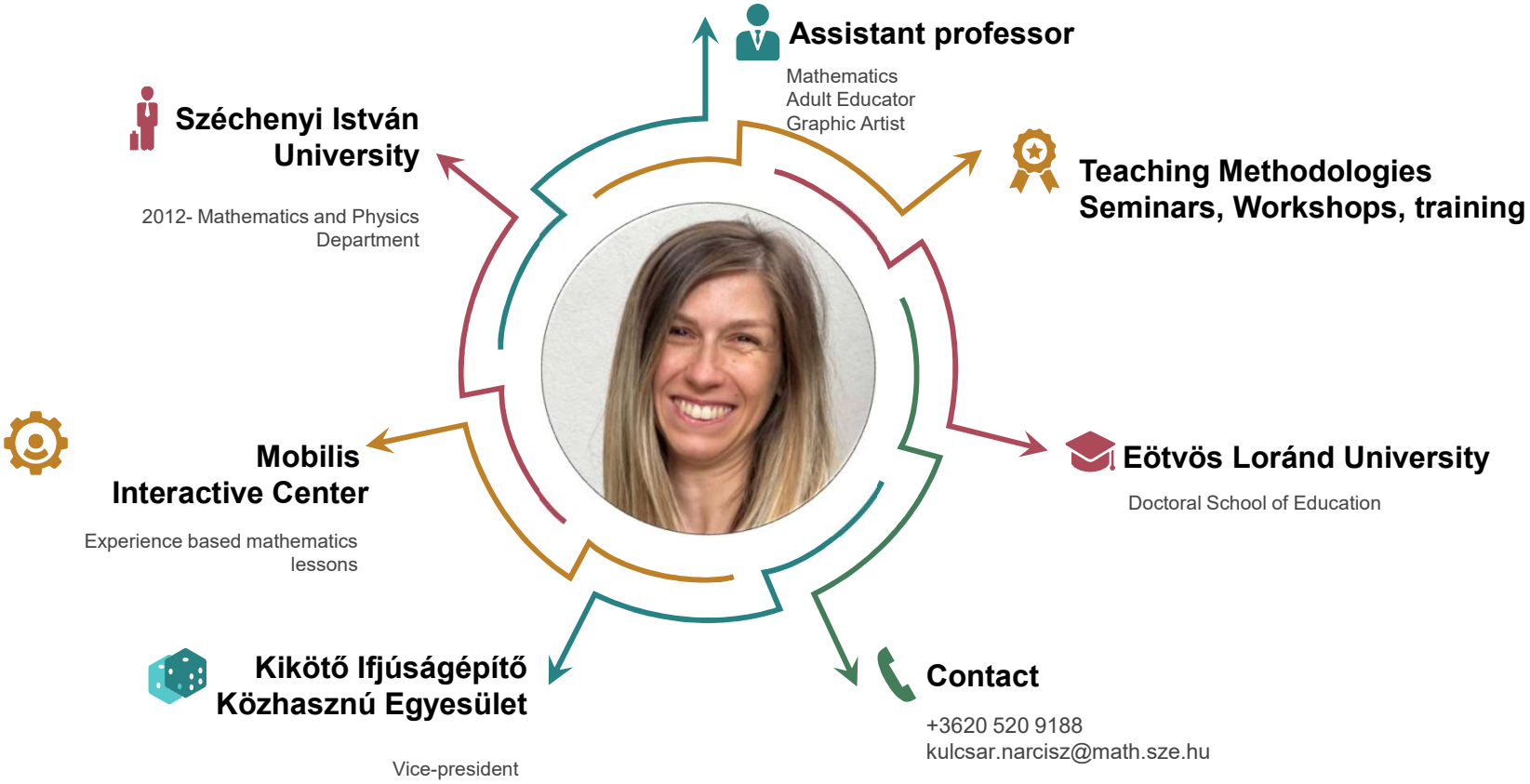
Nárcisz Kulcsár

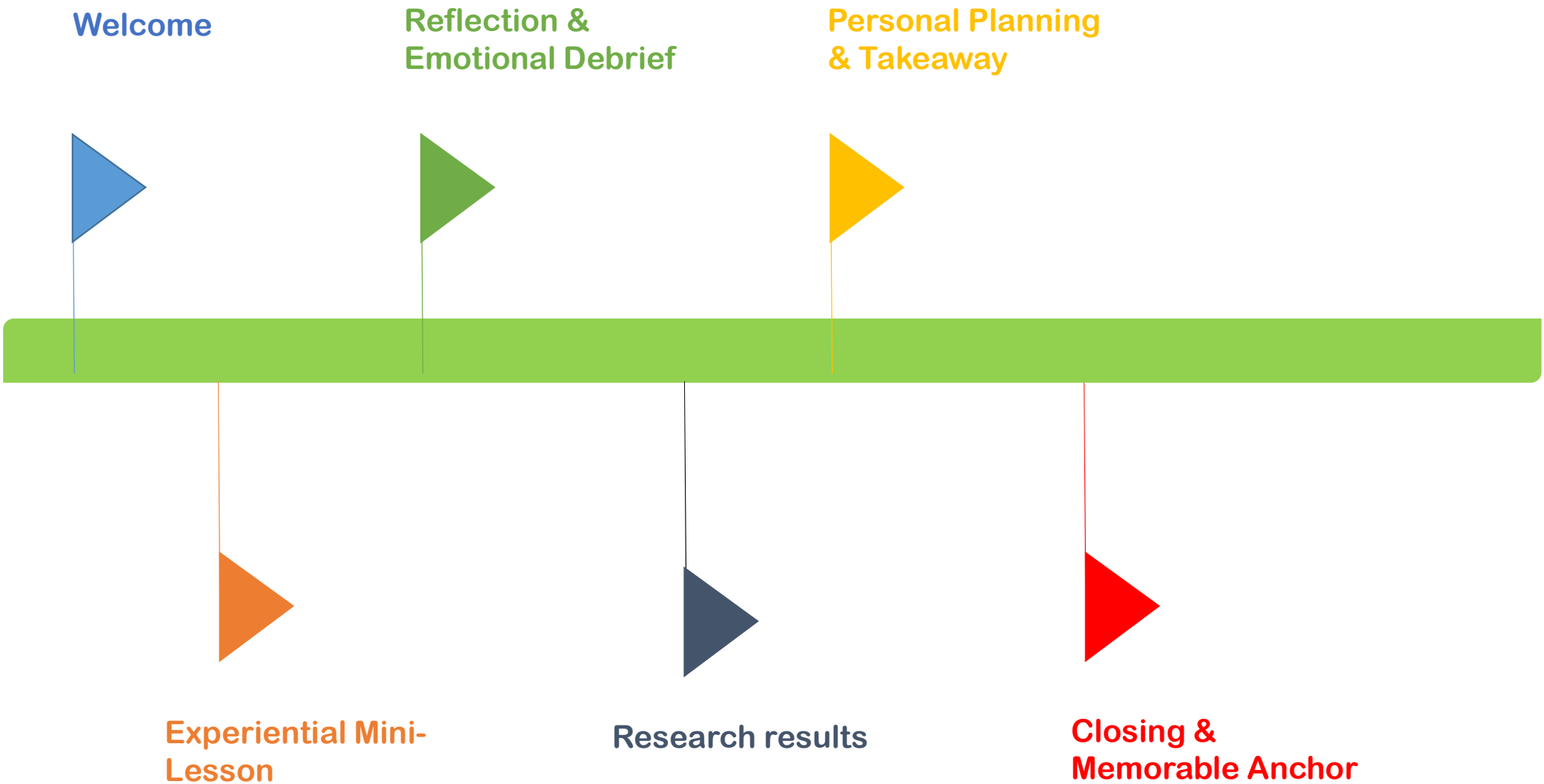
SZÉCHENYI EGYETEM
UNIVERSITY OF GYŐR

Wrocław University of Science and Technology

Visegrad Fund

TECHNICAL UNIVERSITY OF KOŠICE


Assistant professor
Mathematics
Adult Educator
Graphic Artist
Széchenyi István University
2012- Mathematics and Physics Department
Teaching Methodologies
Seminars, Workshops, training
Mobilis
Interactive Center
Experience based mathematics lessons
Eötvös Loránd University
Doctoral School of Education
Kikötő Ifjúságépítő Közhasznú Egyesület
Vice-president
Contact
+3620 520 9188
kulcsar.narcisz@math.sze.hu


Welcome
Reflection &
Emotional Debrief
Personal Planning
& Takeaway
Experiential Mini-
Lesson
Research results
Closing &
Memorable Anchor

Pregnancy perspective

Inductive	Deductive
I discovered my baby reacts to tastes and music.	My doctor advised me not to lift heavy things.
Joy through discovery	Relief in trusting expertise.

DEDUCTION vs INDUCTION

Theory
↓
Hypothesis
↓
Observation
↓
Confirmation

Theory
↑
Hypothesis
↑
Pattern
↑
Observation

ARISTOTLE

SHERLOCK

Engineering perspective

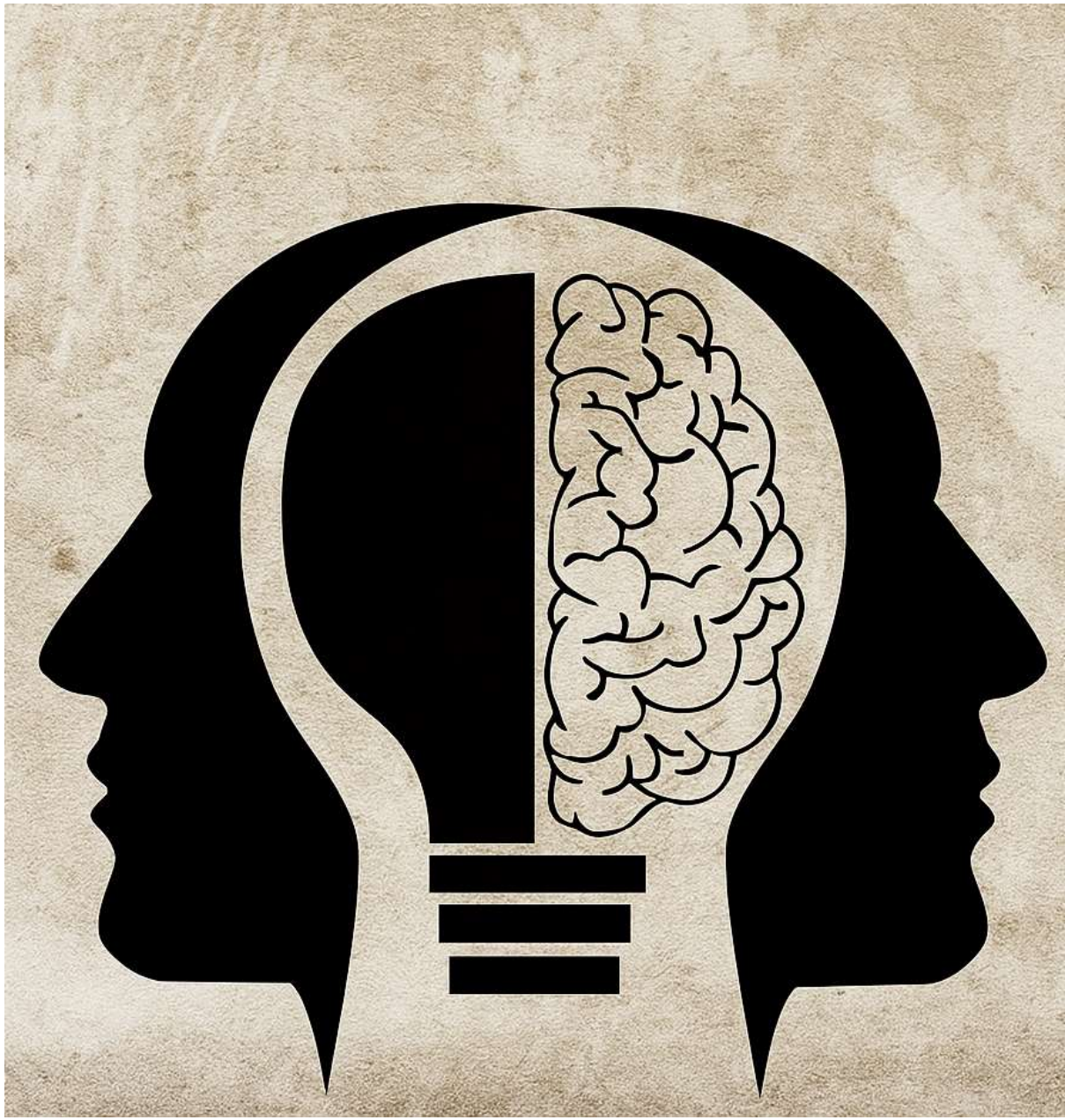
Inductive

Failure analysis: When a machine part breaks, engineers collect data (examples of cracks, vibrations, heat maps) and infer underlying principles or causes.
Materials testing: Running stress–strain experiments and then deriving constitutive laws from the results.
Signal processing: Observing patterns in noisy sensor data and then inferring the governing model or filter needed.
Design iteration: Building prototypes, testing them, and extracting lessons for the next version.

Deductive

Structural design: Applying equations of statics or strength of materials to predict load-bearing capacity.
Control systems: Using differential equations to design controllers and ensure stability.
Thermodynamics: Applying the first and second laws to calculate efficiency of engines or turbines.
Circuit design: Using Ohm's law and Kirchhoff's rules to compute voltages and currents before building a circuit.

“If you had to learn integration from scratch tomorrow, which would you choose—rules first, or examples first?”



Puzzle: The “Rule of Shapes” Game

Puzzle: The “Rule of Shapes” Game

Debrief Questions

- How did it feel to apply/figure out the rules?
- When did motivation spike or drop?
- What would have helped?
- Which method would you use if you had only 5 minutes? Which if you had a whole semester?

Brain-Based Learning Theory: Connecting Experience to Science

1. Pattern Recognition

- Our brains love patterns—they help us predict, understand, and remember.

2. Emotional Engagement

- Emotion enhances memory and motivation. When learners *feel* a "lightbulb moment," the brain tags it as important.

3. Cognitive Load

- The brain can only handle a limited amount of new information at once. Overloading it decreases retention.

4. Active Learning

- Learning by doing strengthens neural connections more than passively receiving information.

5. "Head + Heart Alignment"

- Optimal learning happens when **cognitive understanding** (head) and **emotional engagement** (heart) work together.

Research results

- Calculus 2 (vehicle engineering project based program)
- Topic: integration
- 2 worksheets, tests

Table 1. Test results in the different groups

	Mean of the first test results	Missing "+C"	Missing absolute value in the case of lnx	Mean of the second test results	Missing "+C"	Missing absolute value in the case of lnx
Inductive Learning Group	4	3	2	3.13	1	4
Deductive Learning Group	3.36	3	1	3.78	0	4

- Questionnaire (Learning Experience and Understanding, Example-Driven vs. Problem-Solving Approach, Motivation and Emotional Factors, Summary and Suggestions)

Combined Approach

Inductive = engaging, but sometimes confusing
Deductive = clear, but sometimes demotivating

} strengths of both

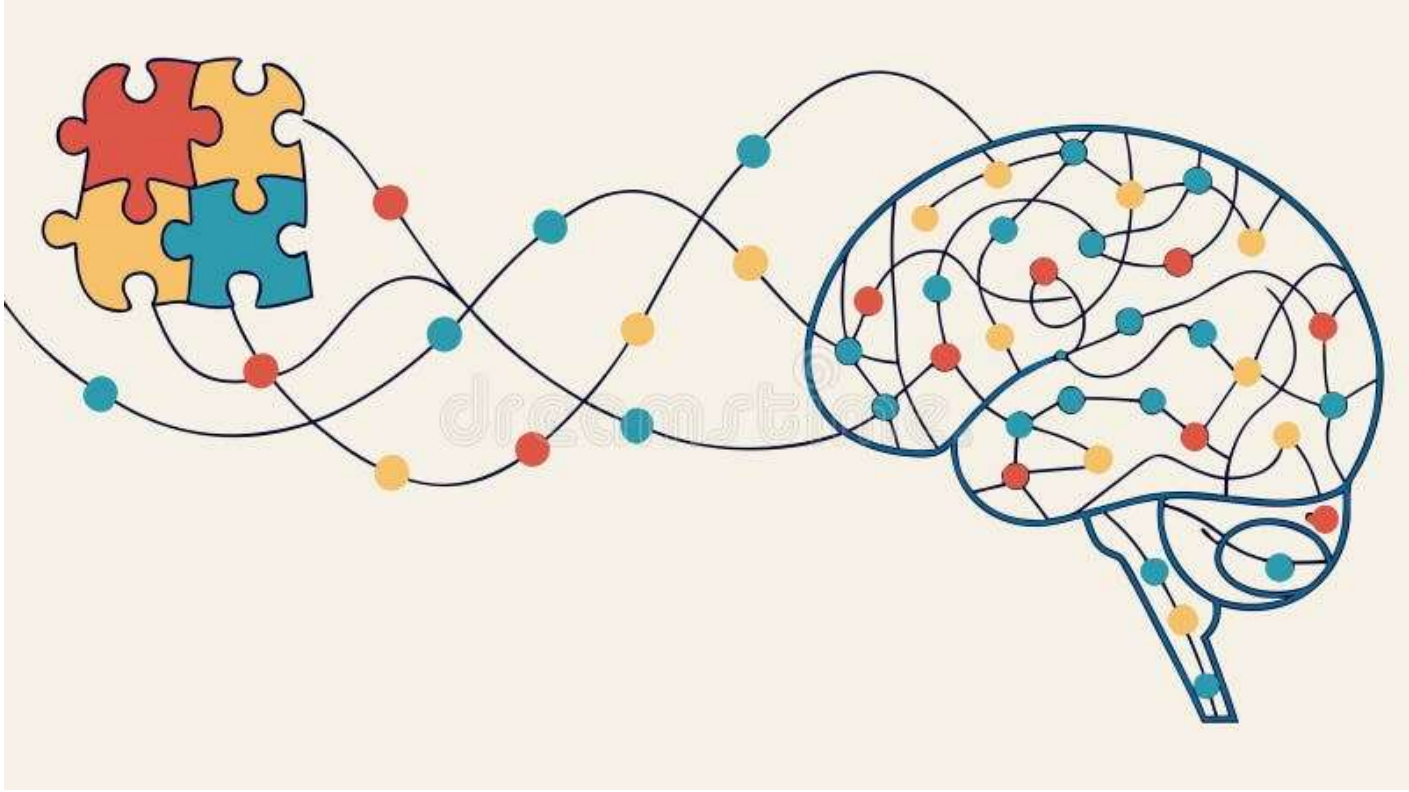
•**Option A: Mini-induction → Deduction**
1.Example(s) first: Let students notice a pattern or struggle with a real problem.
2.Structured rule next: Once curiosity is high, give the formula/rule to clarify and anchor.
→ Works best when you want to *spark curiosity* first.

•**Option B: Deduction Anchor → Inductive Exploration**
1. Give the rule or formula upfront: Provide a clear anchor point.
2. Explore examples/problems: Let students see how the rule plays out and make meaning.
→ Works best when content is heavy and students need a foothold before exploring.

Choose an engineering topic that you teach and sketch a 15-min activity using a hybrid approach.

Share and get quick feedback.

Teaching only with deduction is like giving students a finished puzzle. Induction lets them feel the satisfaction of putting it together—but a hybrid approach gives them the box lid and the pieces.



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