Co-funded by
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Modern Research-Based Teaching: Evidence-Driven Strategies for Today's Academic Teachers

(based on recent educational research, 2021–2025)

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30 of June 2025

Project no. 2024-1-FR01-KA220-HED-000250882
Work package n°3 - Development of new and modernization of existing selected courses as examples of teachers' collaboration,
Activity 4. Introducing research-based teaching methodology on the set of four courses.

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The newest challenge - AI

Artificial Intelligence Evaporates Long-Term Learning

Bastani Hamsa, Bastani Osbert, Sungu Alp, Ge Haosen, Kabakcı Özge, Mariman Rei, Generative AI Can Harm Learning (July 15, 2024). The Wharton School Research Paper, https://ssrn.com/abstract=4895486 or http://dx.doi.org/10.2139/ssrn.4895486

EXPERIMENT

- Study (2024) of 1,000 students (high school in Turkey):
- A short math lesson and then a quiz with practiced solving related problems.
- Some students - traditional methods—looking through their notes and textbooks to find possible answers
- Others had access to OpenAI's GPT 4.

Results?

- The triumph of technology – 48% better results with access to ChatGPT

EXPERIMENT suite:

Completing the exam without access to any resources

- math skills went up in smoke,
- 17 percent lower results than their peers who relied on pen and paper, until access to it ceased to exist.

Conclusions:

- access to generative AI allows for jumping straight to the answer (can improve performance)
- opportunity to receive the answer without thinking about how to solve it substantially inhibit learning.

Thesis:

Students lack the skills to:

- improve what AI produces,

or

- the maturity and self-awareness to know where the work of AI ends

and

- their own responsibility for the correctness of the developed solution/answer begins.

Learning to love academic mistakes

- The burned resistor at lab session is …… success!

https://youtu.be/r1H898Jq_2E?si=LtTmjzvTH1dLOuKa

Learning from errors versus explicit instruction in preparation for a test that counts

Janet Metcalfe, Judy Xu, Matti Vuorre, Robert Siegler, Dylan Wiliam, Robert A. Bjork, British Journal of Educational Psychology, 11 January 2024, https://doi.org/10.1111/bjep.12651 (*)

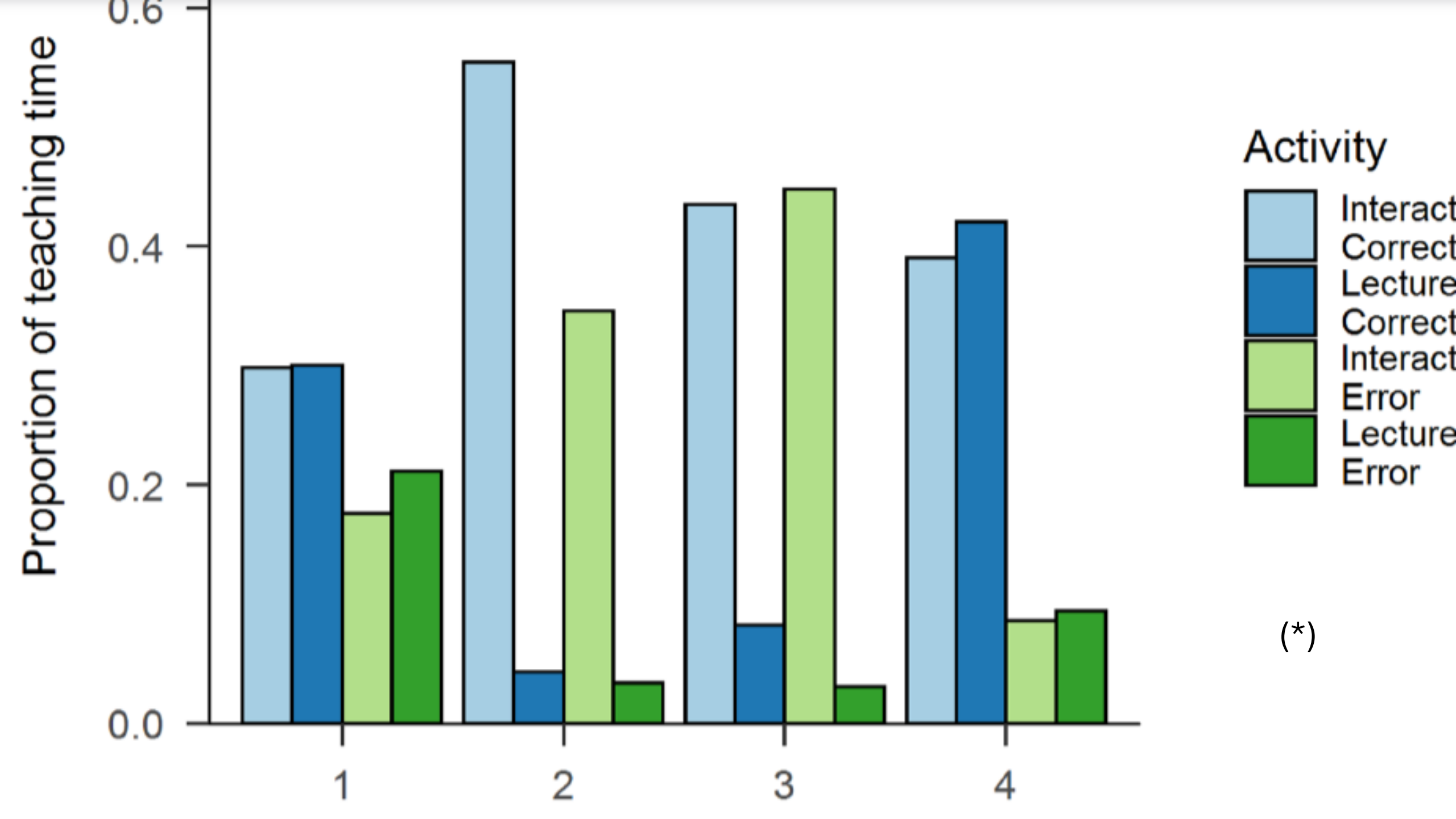
Experiment

- two groups of 88 students each one
- one attended eight math sessions,
- the other “flipped” between four practice “mini-tests” and four sessions devoted to learning from wrong answers.

Result

similar results on the final exam, but

the teachers in the “learning from mistakes” group invested only half the time.


Proportion of teaching time
0.6
0.4
0.2
0.0
1
2
3
4
Activity
Interact
Correct
Lecture
Correct
Interact
Error
Lecture
Error

(*)

Is learning from mistakes really that effective?

Hypothesis:

Increased student engagement due to:

- the fact that the teacher and students delved into the “nature” of mistakes, and
- worked with students to determine “how to prevent them in the future”.

Teachers in this group who talked “with” students, rather than “to” them, spend less time for direct lecturing.

Conclusions:

- Accepting mistakes is a cultural marker: it changes the group climate, deepens relationships, and improves student motivation;
- New discoveries of the value of ungraded tests followed by feedback — and come from support for teachers who seed their work files and engage in groups that are about common mistakes.
- Nobody likes making mistakes; students often wonder how to fear them.
- In most cases, educational systems teach how to avoid mistakes by using various methods of „punishment”.

Failure is a success
if you learn from it

Small victories motivate students

Finn, B., Miele, D. B., & Wigfield, A. (2025). Investigating the remembered success effect with elementary and middle school students. *Journal of Educational Psychology, 117*(2), 308-335 https://doi.org/10.1037/edu0000846

Experiment

- several hundred students were given 10 difficult math problems to solve, and
- half of them received five additional tasks that were much easier – which allowed them to achieve some success in the thicket of difficult questions.

Result

- Students who received additional easier tasks were twice as likely to want to solve another set of difficult tasks.
- They were twice as likely to rate the activity as enjoyable—contrast that with the typical feelings of frustration and discouragement that accompany tedious math.

Conclusion

- Adding easy questions at the beginning or end of a test/exam is most beneficial.

Inattention is contagious

Forrin, N. D., Kudsi, N., Cyr, E. N., Sana, F., Davidesco, I., & Kim, J. A. (2024). Investigating attention contagion between students in a lecture hall. *Scholarship of Teaching and Learning in Psychology.* Advance online publication. https://doi.org/10.1037/stl0000419

Experiment

- 45 participants and 15 research manipulators watched a 30-min lecture video that was immediately followed by a content quiz.

- The manipulators had special mission:
- They took their assigned seats in a lecture hall, and
- They silently sabotaged their peers' attention by slouching, looking bored, and not taking notes.

RESULT

Like dominoes, the students sitting next to the manipulators began to lose focus:

- the previously attentive ones had difficulty paying attention,
- wrote half as many pages of notes, and
- scored far lower on a subsequent quiz.

Thesis

- inattention contagion is an ecologically valid phenomenon that is distinct from peer distraction.
- inattention may be particularly contagious when students are seated beside (vs. behind) inattentive peers.

Theory or practice?
Does there have to be balance?

Comparitive Study of Practicle Education with Theoretical Education, Vaishnav P. Khorate, International Journal of Science, Engineering and Technology 2024, 12:5 ISSN (Online): 2348-4098 ISSN (Print): 2395-4752

Conclusions:

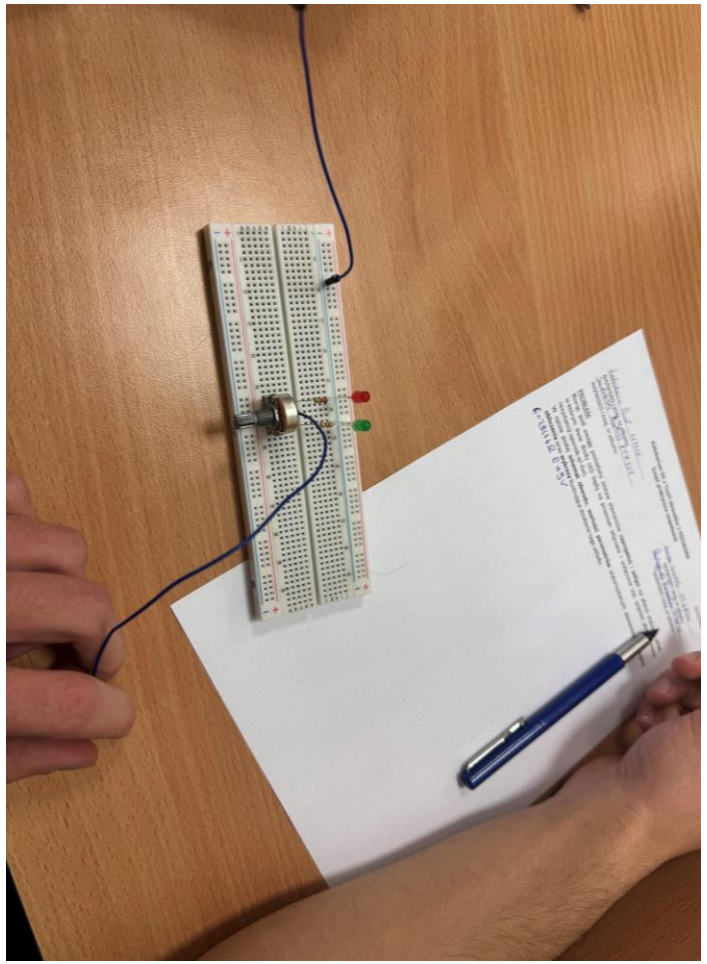
- In engineering sciences, practical experiences are more valuable than theory alone.
- Students who learn through practical tasks better understand the application of theoretical knowledge and are more engaged.

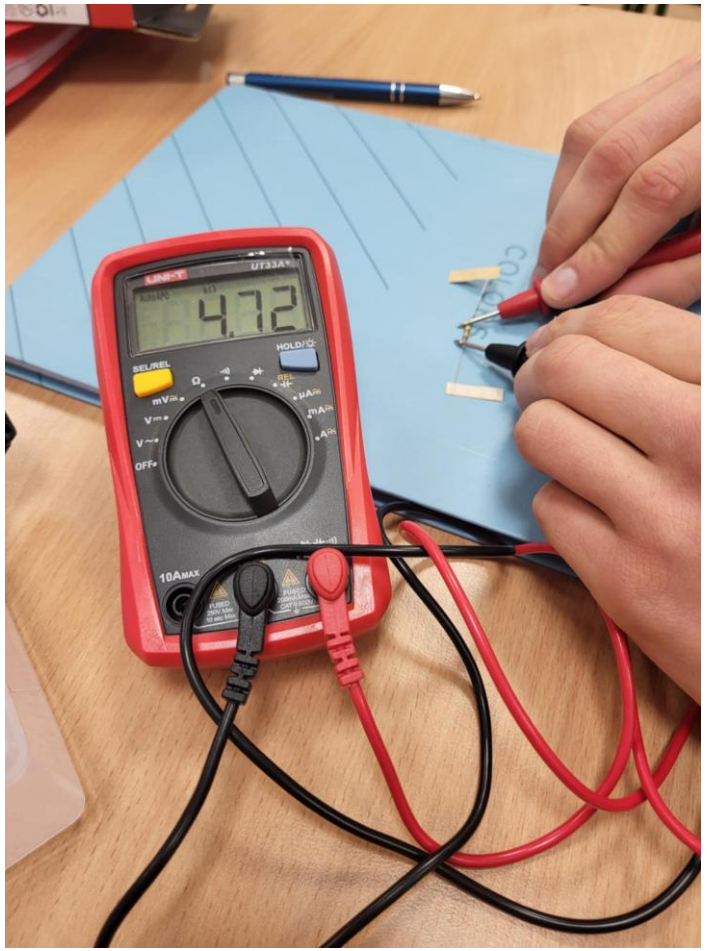
What we can do?

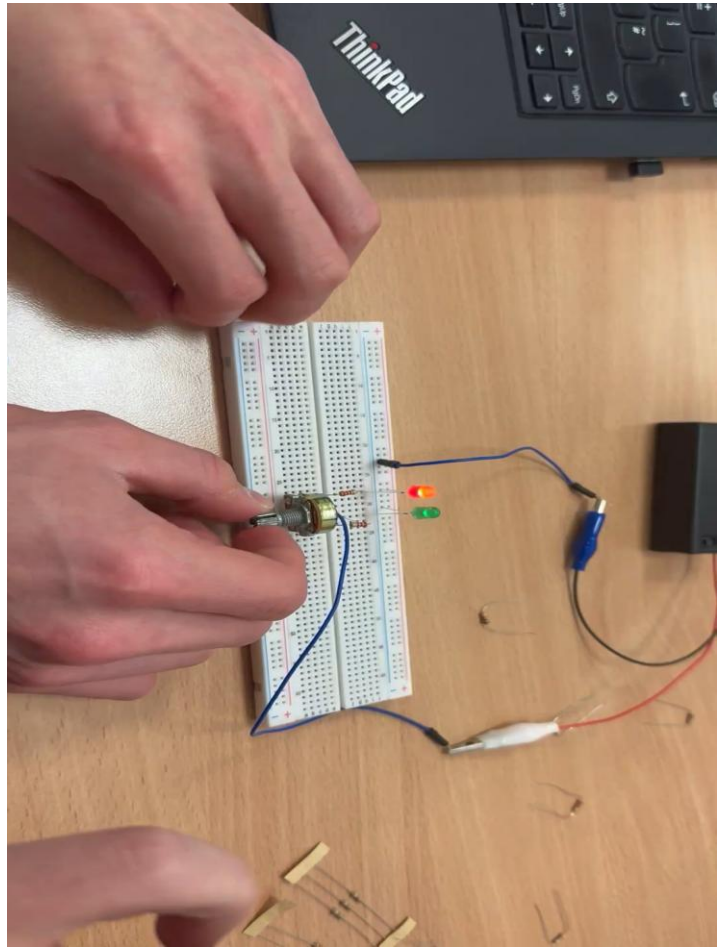
- visit to the laboratory and practical demonstration,
- practical tasks in calculation exercises
- practical tasks on final tests

Example:

- design and assemble on a breadboard a circuit in which changing the resistance of the potentiometer will cause the LEDs to light up alternately







Test on calculation exercises

- Practical learning develops problem-solving skills and independence, while theoretical learning focuses on memorization.
- Theoretical education allows learners to benefit from the observation as well as knowledge of others, giving them a solid substructure in many subjects.
- Practical education highlights the real-world demands.

Peer-to-peer teaching

Zhu, W., Wang, F., Mayer, R. E., & Liu, T. (2024). Effects of explaining a science lesson to others or to oneself: A cognitive neuroscience approach. *Learning and Instruction*, *91*, 101897. https://doi.org/10.1016/j.learninstruc.2024.101897

EXPERIMENT

The college students (n=99) studied a text-based multimedia lesson about the Doppler Effect, and after

- one group explained the material to a real person (explain-to-others group, *n* = 33),
- another one explained the material to themselves (explain-to-oneself group, *n* = 34),
- the last one restudied the text (restudy group, *n* = 32).

EXPERIMENT suite

This study explored the brain activation (as measured by fNIRS) and learning outcomes (as measured by tests).

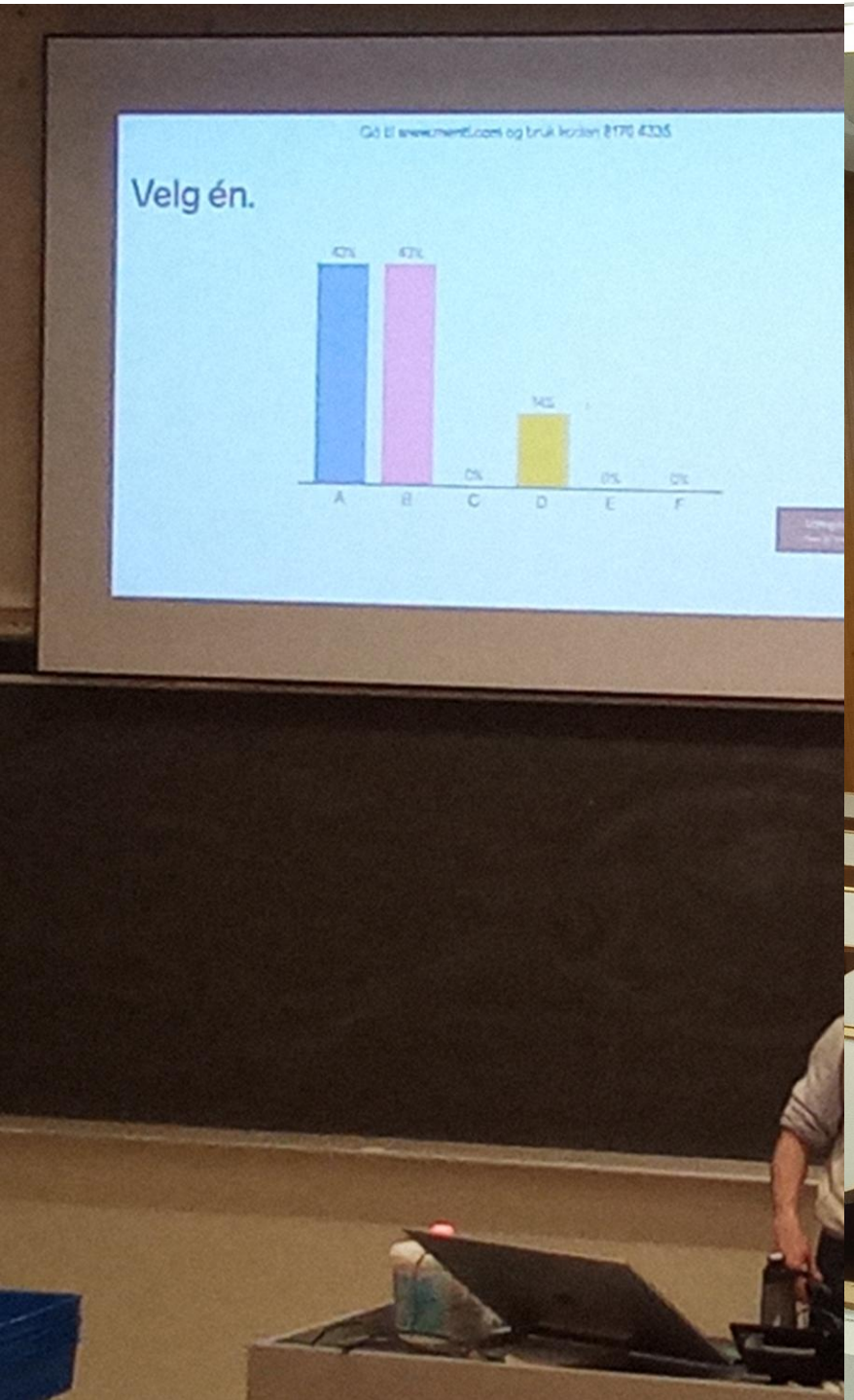
Nakuci, J., Yeon, J., Haddara, N. *et al.* Multiple brain activation patterns for the same perceptual decision-making task. *Nat Commun* 16, 1785 (2025). https://doi.org/10.1038/s41467-025-57115-y

RESULT

- Explaining to others caused greater transfer scores than restudying.
- Explaining to others caused greater brain activity than explaining to oneself.
- Cognitive neuroscience helps explain generative learning activities.

Conclusion

Peer-to-peer learning is more effective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How to do it?

The peer-review sheet (A)

Remember: you play together in the same team.

- point out to your colleague the issues that you do not understand or that are very difficult for you;
- write what you both do not understand and/or what the teacher could explain in more detail;
- give the feedback for teacher about difficulties.

How to do it?

The peer-review sheet (B) - propose a task to be solved in teams of 2

You should:

- Read again the task description from exercise
- Explain what is your idea of solution (don’t worry if you have any idea)
- Ask questions if there are any unclear parts
- Go through checkpoints while analyzing your partner's solution.

Checkpoints:

- What is the aim of the problem?
- What are the quantities you must calculate?
- What method you can use to obtain required values?
- How to check the correctness of solution?

Covid’s Long Tail

COVID time High school – 4 years; University

March 2020	2021	2022	May 2023	2024	2025	2026	2027
1st class	2nd class	3rd class	4th class	1st year			
	1st class	2nd class	3rd class	4th class	1st year		
		1st class	2nd class	3rd class	4th class	1st year	
			1st class	2nd class	3rd class	4th class	1st year

Pandemic Learning Loss: How COVID-19 Academically Impacted College Students, Jessica Bryant, https://www.bestcolleges.com/research/pandemic-learning-loss/ (access 22/06/2025)

- Missing Assignments at Higher Rates
- Increased Dependence on Technology
- Discomfort With Classroom Discussions
- Reluctance to Work in Teams

Problem with mental health

- more and more students struggle with despair, violent thoughts and suicide;
- students feel persistent sadness or hopelessness

Reading Comprehension Skills

Reading Comprehension Challenges and Opportunities, in Charts

By Stephen Sawchuk — January 15, 2024

https://www.edweek.org/teaching-learning/reading-comprehension-challenges-and-opportunities-in-charts/2024/01

RESULTS:

- students of technical fields are good at using digital tools,
- they have poorly developed skills in analysis, evaluation and critical reading of technical texts.

CONCLUSIONS:

- scientific and technical texts require students to not only understand vocabulary, but also to be able to visualize and analyze the structure of the text.
- the lack of these skills makes it difficult for students to learn from textbooks, scientific articles, and technical manuals.

Enhancing Reading Comprehension Skills Of Engineering Students Using The SQ3R Method: A Structured Approach To Technical Texts, V. Ramaiah Chary, International Journal of Creative Research Thoughts (IJCRT), 2025, Volume 13, Issue 4, April 2025 | ISSN: 2320-2882 www.ijcrt.org

SQ3R encourages readers to:

- preview the content (Survey),
- formulate guiding questions (Question),
- actively engage with the material (Read),
- summarize key points (Recite), and
- reinforce learning through review (Review).

Additional references:

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Thank you for you attention

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