Agenda

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- Introduction (15 minutes)
- Survey on Menti (10 minutes)
- Groupwork (20 minutes)
- Presentations of groupwork (10 minutes)
- Summary and next steps (5 minutes)

NTNU

Introduction

Is there space for critical thinking competence in STEM education in the age of Generative AI?

MNT conference 06.05.2025

Sajid Shah (Post-doc, IDI, NTNU)
George Adrian Stoica (Associate Professor, IDI, NTNU)
Marius Mikalsen (Associate Professor, IDI, NTNU)

NTNU

Background for the workshop

- A seed funding project within NTNU community https://www.ntnu.edu/community
- Addresses challenges for democracy related to generative AI and digital platform-based surveillance economy
- Ojectives: network and identify research topics
- Read more https://s.ntnu.no/ft

Learning objectives of the workshop

- Evaluate the role of critical thinking in STEM Education
- Reflect on the impact of generative AI on critical thinking skills
- Discuss pedagogical approaches for critical thinking

Background & motivation for WS

UA

Start Nyheter Ytring Meny

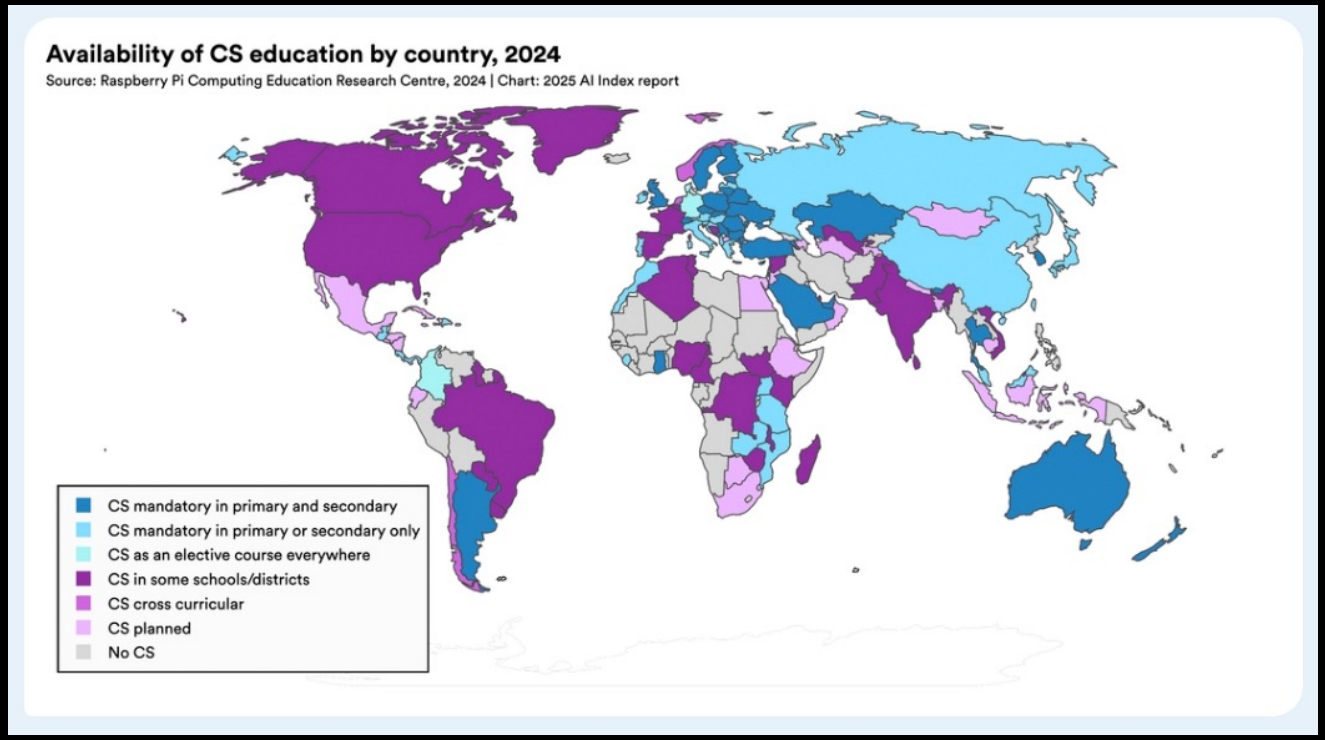
Balansert KI-bruk i utdanningen

- De fleste forelesere er ikke erfarne KI- og språkmodellbrukere, og vi er i hvert fall ikke trent på å inkludere det i våre kurs. Studentene etterspør opplæring i bruken, da må også faglærere læres opp, skriver Bjørn Skallerud.

- I tillegg til å implementere NTNUs nye strategi tror jeg KI-bruk i undervisning og læring blir noe av det viktigste NTNU på alle nivå må jobbe med framover, skriver Bjørn Skallerud. Foto: Benedikt Erikstad Javorovic

Bjørn Skallerud
Professor ved Institutt for konstruksjonsteknikk og medlem i NTNUs styre

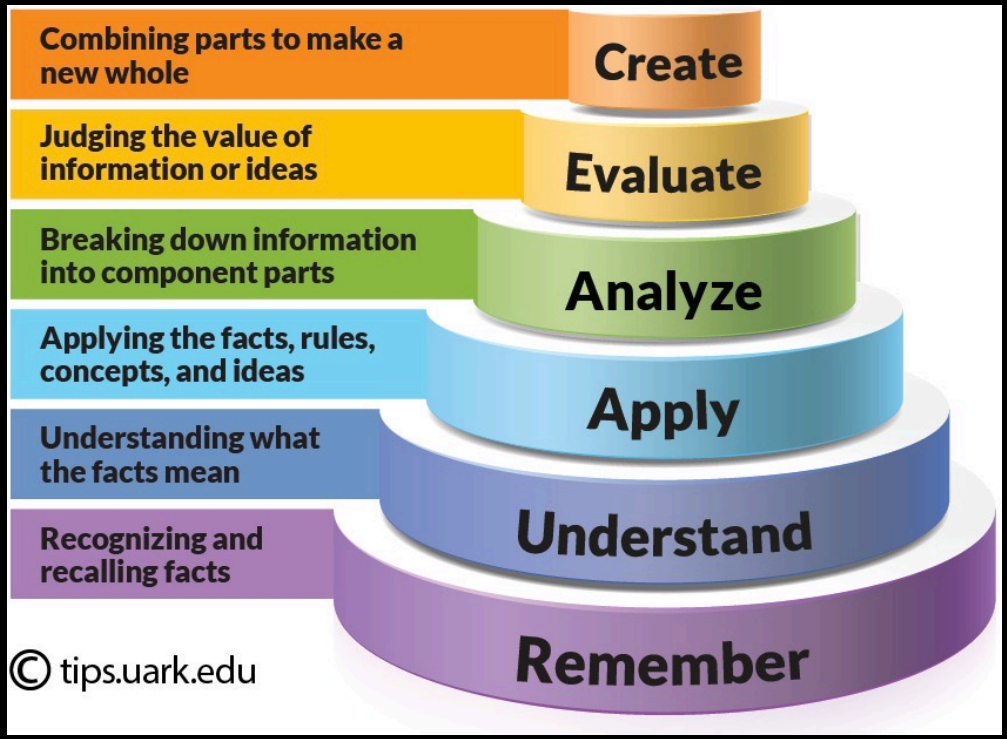
Publisert 25.03.2025 - 09:38



https://hai.stanford.edu/ai-index/2025-ai-index-report

Critical thinking – a take

- "*the ability to thoughtfully analyze and evaluate situations and recommend courses of action that consider stakeholders, implications, and consequences*" (Lovelace, et al., 2016)
- Why Bloom's taxonomy (Lee et al. 2025)



(Bloom et al. 1956; Krathwohl, 2002)

Critical thinking (CT) and education

Opportunities

- Efficiency
- Diverse perspectives
- Supporting learning
- Personalization

Threats

- Superficial learning
- Overreliance
- Misinformation risks
- Evaluation skills gap

Ahmed et al., 2024; Essien et al., 2024; Kasneci, et al., 2023; Monib et al., 2024

Critical thinking (CT) and STEM education

- CT helps evaluate evidence, analyze problems, develop solutions (Ananiadou & Claro, 2009; Kelly, 2012)
- GenAI can support inquiry-based, solution-oriented learning
- Overreliance on AI outputs may weaken CT (Lee et al., 2025)
- Efficiency mindset challenge (Rilley, 2008; Stevens et al., 2014; Trevelyan, 2010)

Practical Insights from a Software Engineering Course

- About the IT1901 Informatics I course
- AI use in the fall semester of 2024
- Notable results and observations

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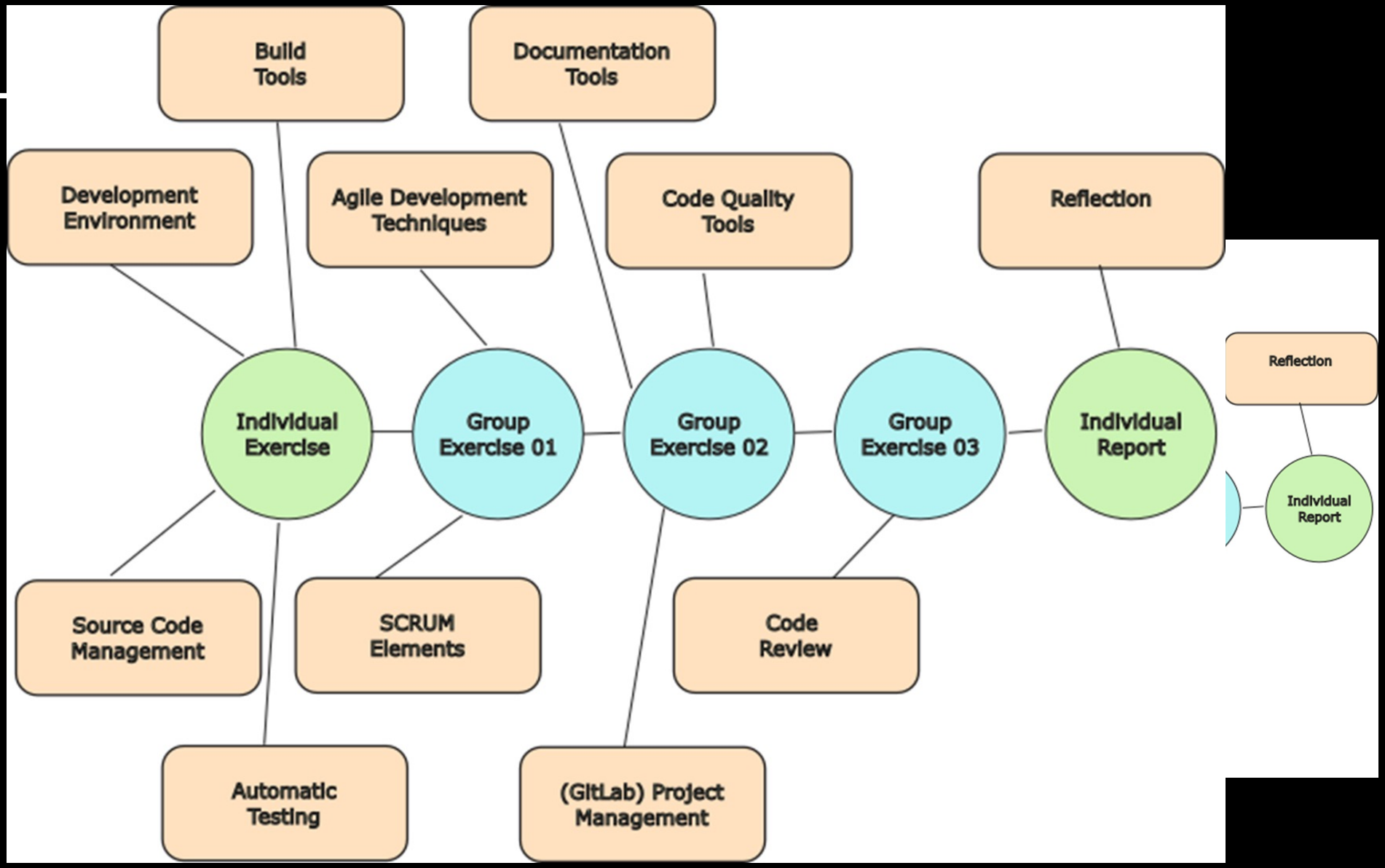
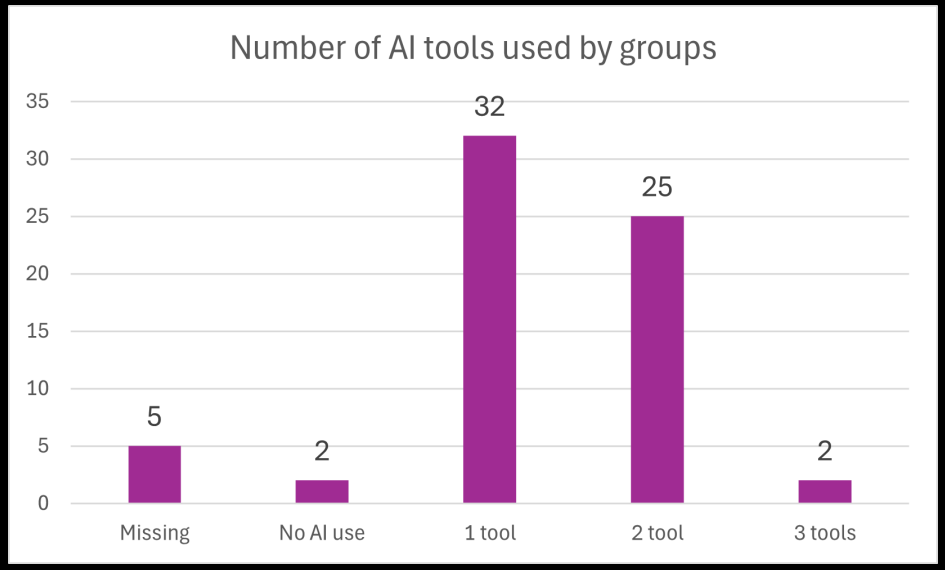
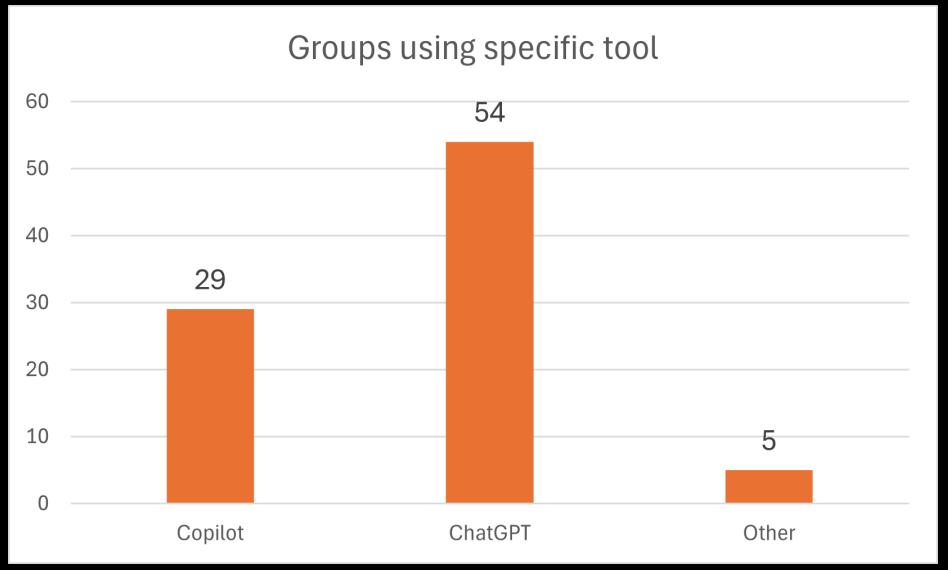

Build Tools
Documentation Tools
Development Environment
Agile Development Techniques
Code Quality Tools
Reflection
Individual Exercise
Group Exercise 01
Group Exercise 02
Group Exercise 03
Individual Report
Source Code Management
SCRUM Elements
Code Review
Automatic Testing
(GitLab) Project Management
Reflection
Individual Report

AI use in the fall semester 2024

- The students were allowed to use any resource available
  - Report + reference accordingly
- 66 groups - 5 of them did not report their AI tools usage.

AI tools used





Interesting observations

- Students see GenAI resources as any other tool
- Groups used only a few popular tools
- Preferred ChatGPT to StackOverflow or a search engine.
- Complex AI setups - increased mindfulness of pitfalls
- Increased usage - increased need to mitigate issues

Typical tasks per tool

- Copilot
  - generating code snippets,
  - boilerplate code,
  - and Javadoc documentation.
  - dependency configurations
  - error troubleshooting
- ChatGPT and Claude
  - generate code snippets
  - unit tests
  - configuration files
  - and documentation.

ChatGPT - Study partner

one of the groups states, they "… turned to AI as a study partner when the TAs were not available, as a helper when resources were not found or when the tasks were hard to understand"

- explains the popularity of ChatGPT among the groups.

Threats

- Reliance on study partner – oblivious to inaccuracies
- Atrophy of critical thinking – relaying problem-solving to AI

Opportunities

- Boilerplate code – generate but understand
- Configuration – dealing with complex dependencies or setup
- Troubleshooting errors

References 1/2

- Ananiadoui, K., & Claro, M. (2009). 21st century skills and competences for new millennium learners in OECD countries.
- Ahmed, Z., Shanto, S. S., Rime, Most. H. K., Morol, Md. K., Fahad, N., Hossen, Md. J., & Abdullah-Al-Jubair, Md. (2024). The Generative AI Landscape in Education: Mapping the Terrain of Opportunities, Challenges, and Student Perception. IEEE Access, 12, 147023–147050. https://doi.org/10.1109/ACCESS.2024.3461874
- Benjamin S Bloom, Max D Engelhart, Edward J Furst, Walquer H Hill, David R Krathwohl, et al. 1956. Taxonomy of educational objetives: the classification of educational goals: handbook I: cognitive domain. Technical Report. New York, US: D. Mckay.
- Essien, A., et al. (2024). The influence of AI text generators on critical thinking skills in UK business schools. Studies in Higher Education, 49(5), 865–882. https://doi.org/10.1080/03075079.2024.2316881
- Hao-Ping (Hank) Lee, Advait Sarkar, Lev Tankelevitch, Ian Drosos, Sean Rintel, Richard Banks, and Nicholas Wilson. 2025. The Impact of Generative AI on Critical Thinking: Self-Reported Reductions in Cognitive Effort and Confidence Effects From a Survey of Knowledge Workers. In CHI Conference on Human Factors in Computing Systems (CHI '25), April 26–May 01, 2025, Yokohama, Japan. ACM, New York, NY, USA, 23 pages. https://doi.org/10. 1145/3706598.3713778
- Kasneci, E., et al. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. Learning and Individual Differences, 103, 102274. https://doi.org/10.1016/j.lindif.2023.102274

References 2/2

- Kelly, R. (Ed.). (2012). Educating for creativity: A global conversation. Brush Education.
- Krathwohl, D.R., 2002. A revision of Bloom's taxonomy: An overview. *Theory into practice*, *41*(4), pp.212-218. https://doi.org/10.1207/s15430421tip4104_2
- Lee, H. P. H., Sarkar, A., Tankelevitch, L., Drosos, I., Rintel, S., Banks, R., & Wilson, N. (2025). *The Impact of Generative AI on critical thinking: Self-reported reductions in cognitive effort and confidence effects from a survey of knowledge workers*, Proceedings of ACM CHI'25
- Lovelace, K. J., Eggers, F., & Dyck, L. R. 2016. I do and I understand: Assessing the utility of web-based management simulations to develop critical thinking skills. Academy of Management Learning & Education, 15: 100–121.
- Monib, W. K., Qazi, A., Apong, R. A., Azizan, M. T., De Silva, L., & Yassin, H. (2024). Generative AI and future education: A review, theoretical validation, and authors' perspective on challenges and solutions. PeerJ Computer Science, 10, e2105. https://doi.org/10.7717/peerj-cs.2105
- Riley, D. (2008). Engineering and social justice. In Engineering and social justice (pp. 47-106). Cham: Springer International Publishing.
- Stevens, R., Johri, A., O'connor, K., & Olds, B. (2014). Professional engineering work. Cambridge handbook of engineering education research, 119-137.
- Trevelyan, J. (2010, December). Mind the gaps: Engineering education and practice. In Proceedings of the 21st annual conference for the Australasian Association for Engineering Education (Vol. 383).

Results from mentimeter

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Is there space for critical thinking competence in STEM education in the age of Generative AI?

Please share your insights

What is your work **role/position**?

Pedagogical advisor

Associate Professor

Teach math

Centerkoordinator

Teacher

Associate teaching professor

Pedagogical advisor

Pedagogy

What is your work **role/position**?

Assistant professor

Universitetslektor

Teacher

Professor

Teacher in an introductory university course

Not teaching at present

Biosciences

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Which **STEM courses** are you primarily engaged with?

- Biology
- Math
- Biotechnology and Molecular Cell Biology
- Chemistry
- Introductory course in electrical engineering
- Støtte i 5-6 elektronikkemner
- Bioscience
- Biology, programming, pedagogy

1 11

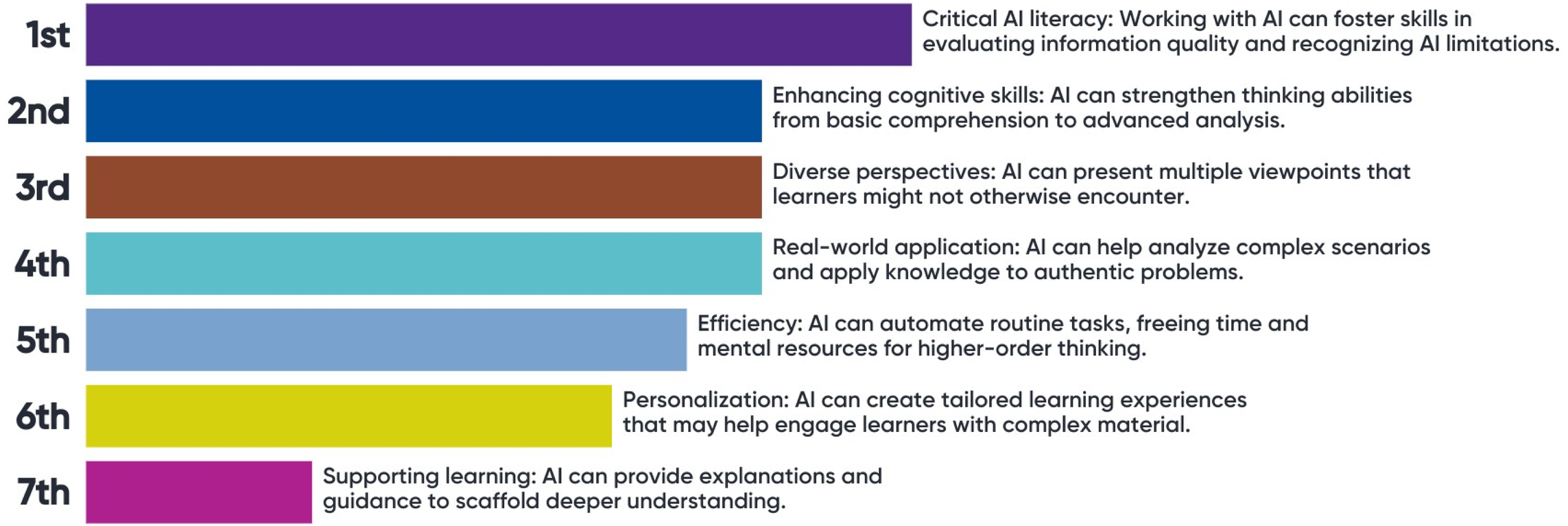
Which **STEM courses** are you primarily engaged with?

Interdisciplinary courses

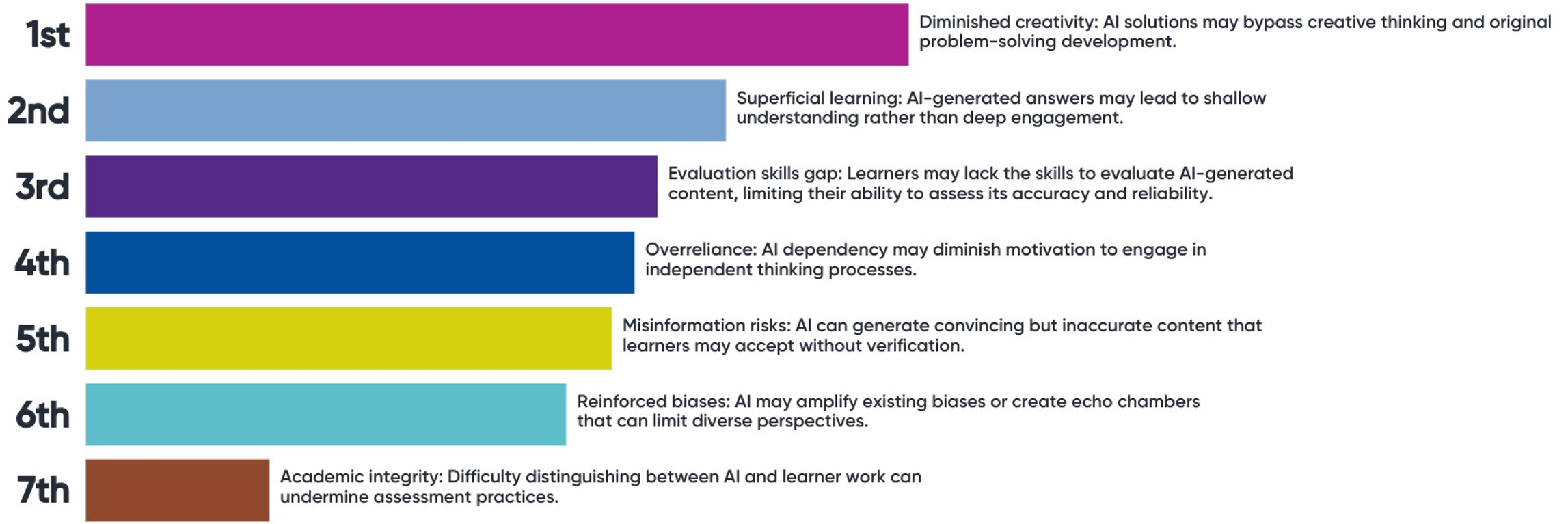
Underviser på forkurs for ingeniørutdannelsen (underviser i norsk og engelsk, så ikke STEM).

Interdisciplinary workshops

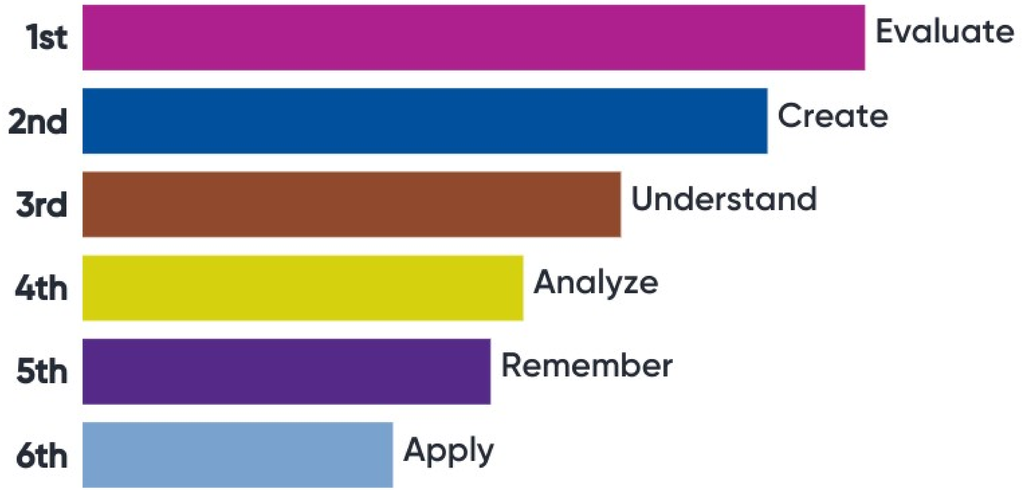
Rank which **opportunities of generative AI** are most promising **for critical thinking** (1 = most promising, 7 = least promising):

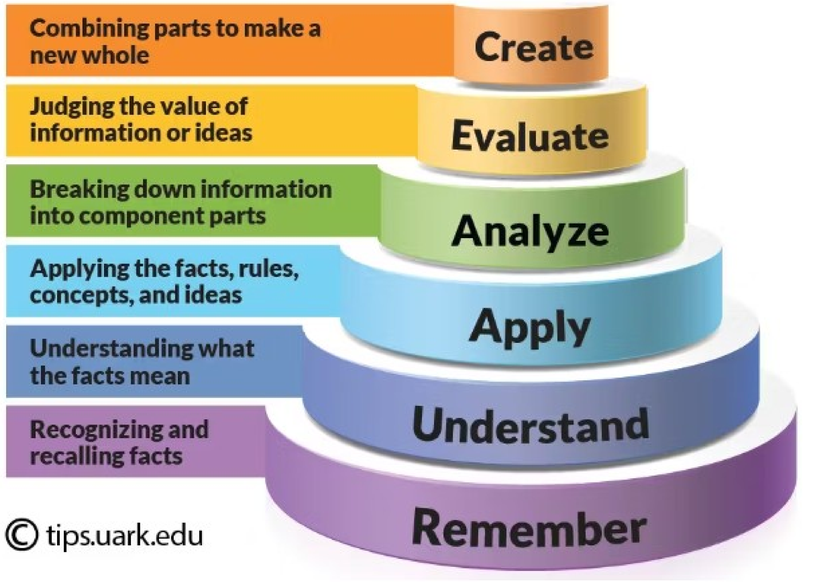


Rank which **threats of generative AI to critical thinking** concern you most (1 = most concerning, 7 = least concerning):



Rank where the **use of generative AI is most problematic** for STEM education (1 = most concerning, 6 = least concerning):

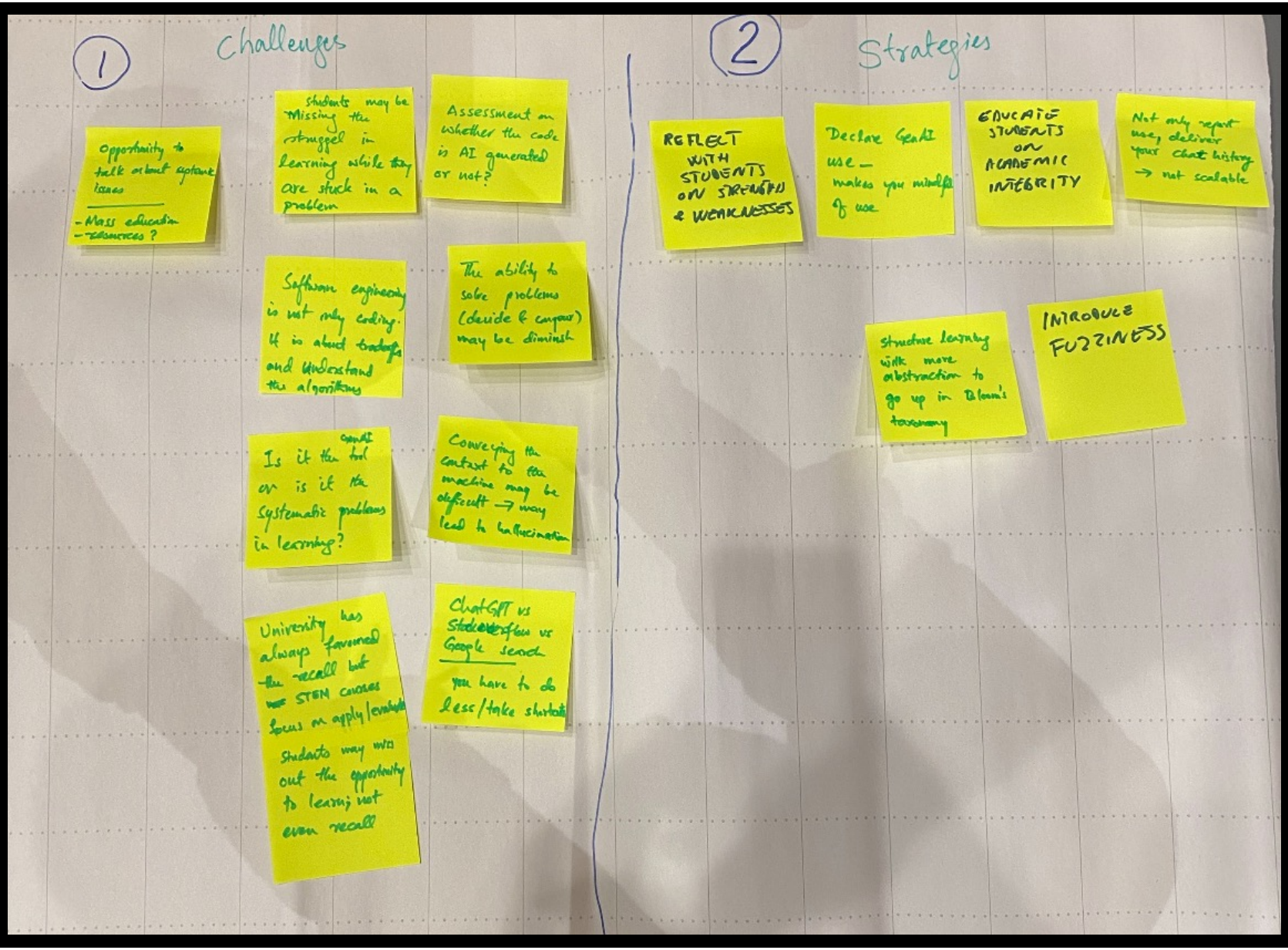


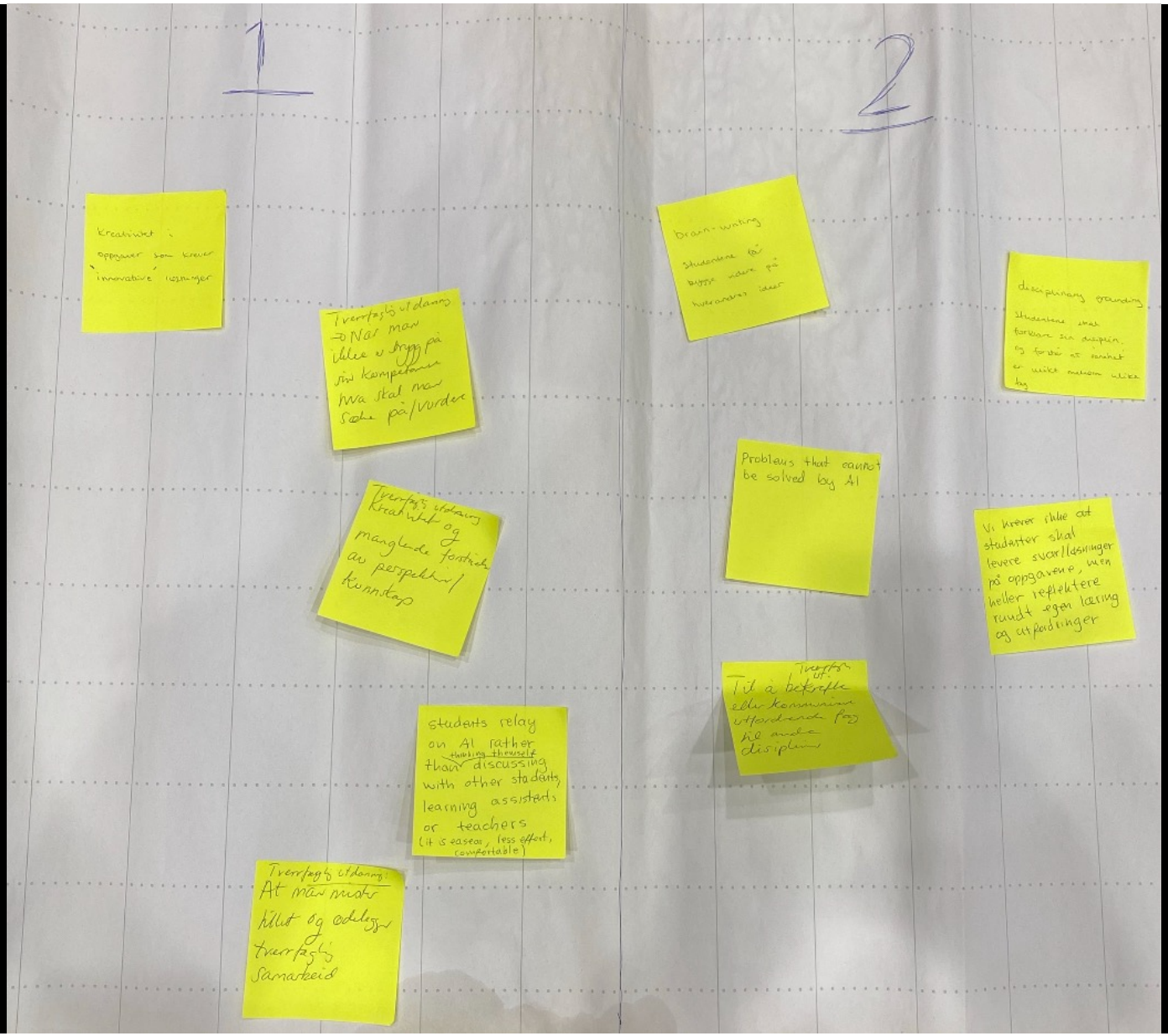


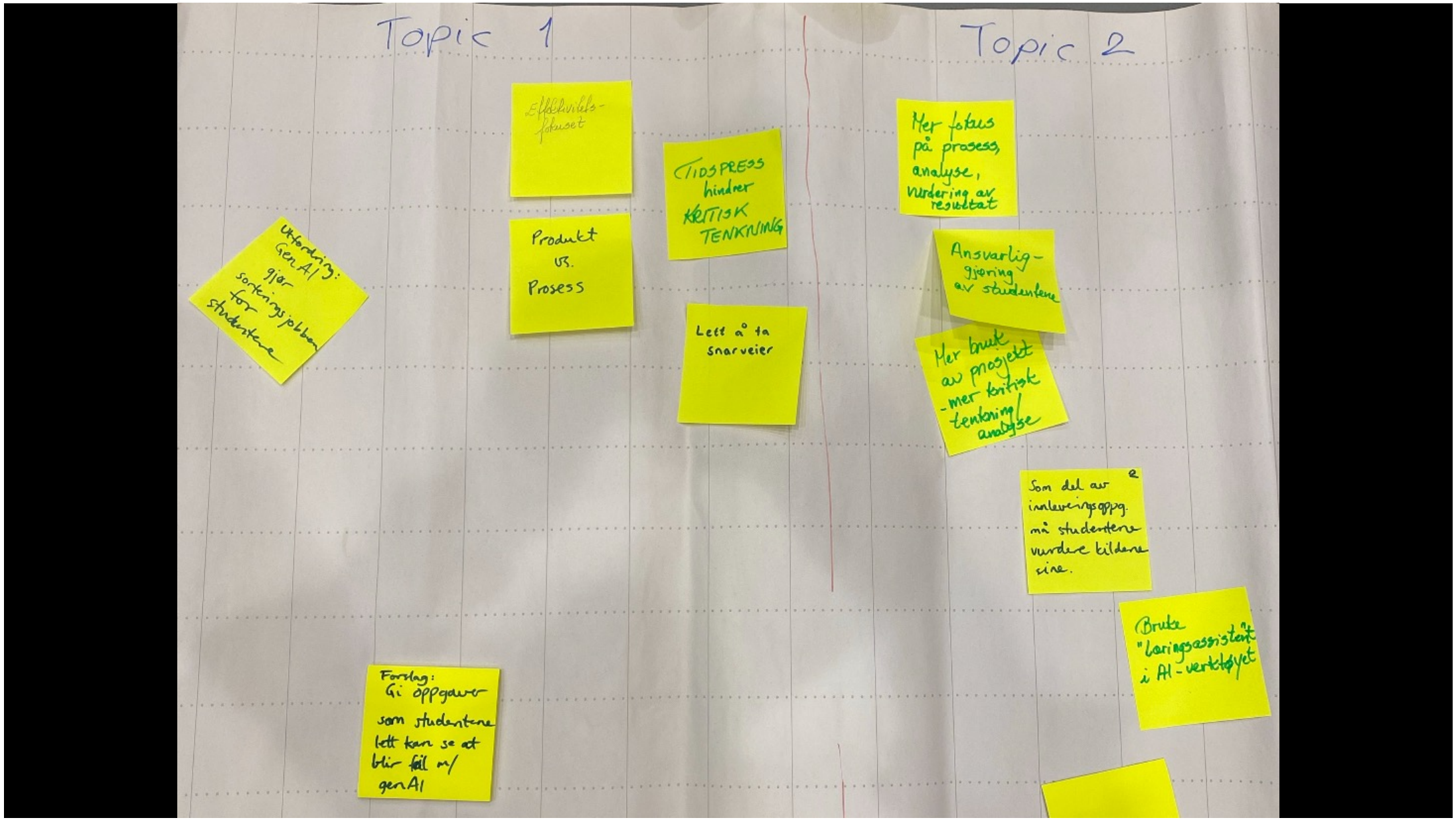
Results from groupwork

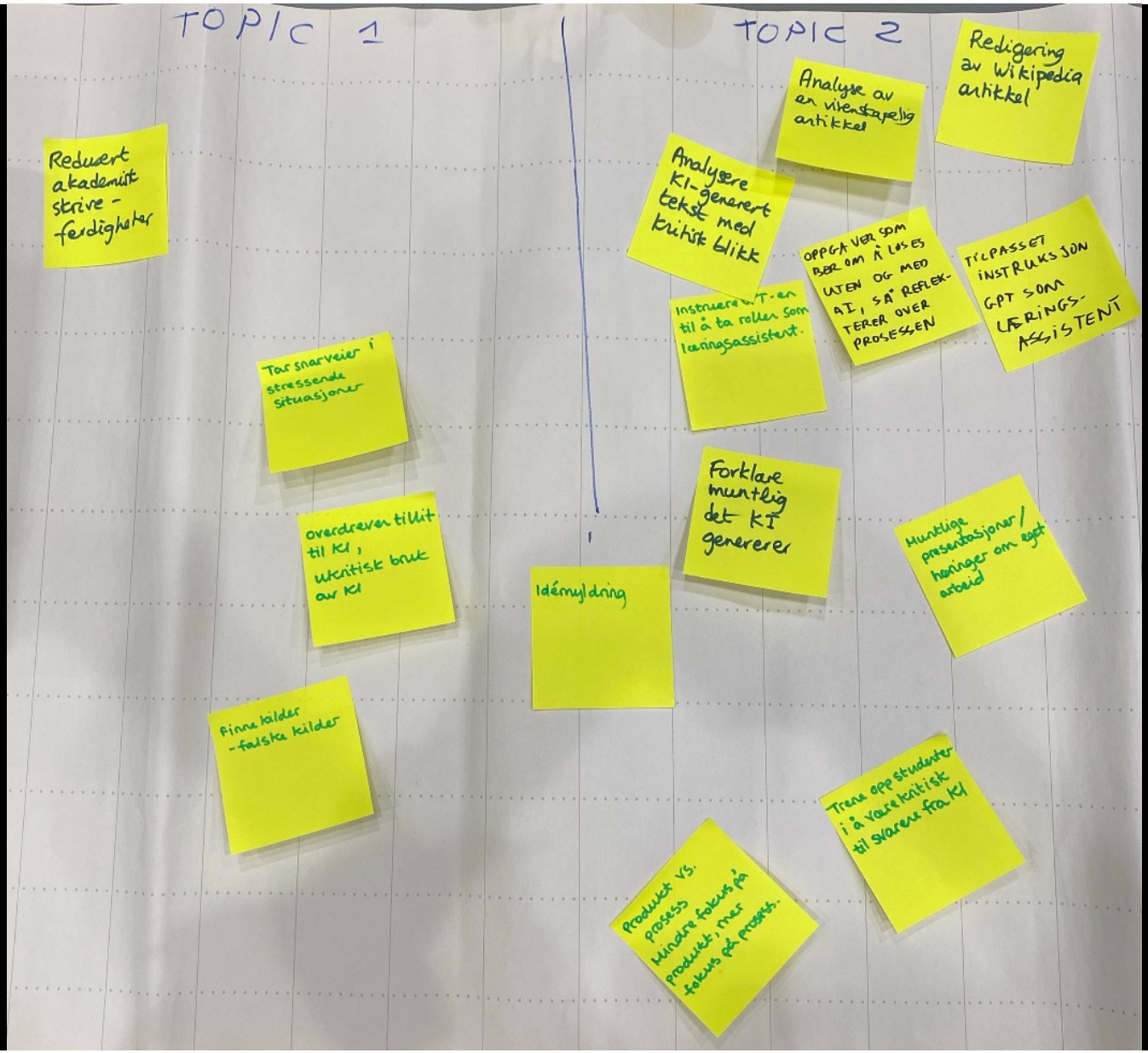
Group work

- 20 minutes to reflect on the following topics
  - Topic 1 – What are the challenges of generative AI for critical thinking in your courses?
  - Topic 2 – What are some practical strategies used in your course(s) to sustain and foster critical thinking?
- Flip overs & post its
- Divide the flip over in two, indicate topic
- Please write clearly (we will take photos to document and share the work)
- Select one group member to present summary in the plenum


1
Challenges
Opportunity to talk about ethical issues
- Mass education
- resources ?
Students may be missing the struggel in learning while they are stuck in a problem
Assessment on whether the code is AI generated or not?
Software engineering is not only coding. It is about thinking and understand the algorithms
The ability to solve problems (decide & empow) may be diminish
Is it the genAI tool or is it the systematic problems in learning?
Converging the context to the machine may be difficult → may lead to hallucination
University has always favoured the recall but not STEM courses focus on apply/evaluate
Students may miss out the opportunity to learn; not even recall
ChatGPT vs Stackoverflow vs Google search
you have to do less/take shortcuts
2
Strategies
REFLECT WITH STUDENTS ON STRENGTH & WEAKNESSES
Declare GenAI use — makes you mindful of use
EDUCATE STUDENTS ON ACADEMIC INTEGRITY
Not only report use, deliver your chat history → not scalable
Structure learning with more abstraction to go up in Bloom's taxonomy
INTRODUCE FUZZINESS


1
2
Kreativitet i oppgaver som krever innovative løsninger
Tverrfaglig utdanning → Når man ikke vi trygg på sin kompetanse hva skal man søke på/vurdere
Tverrfaglig utdanning Kreativitet og manglende forståelse av perspektiv/ kunnskap
students relay on AI rather than thinking themself discussing with other students, learning assistants or teachers (it is easear, less effort, comfortable)
Tverrfaglig utdanning: At man møter blindt og ødelegger Tverrfaglig Samarbeid
Brain-writing studentene får øvelse i å bygge videre på hverandres ideer
Problems that cannot be solved by AI
Til å bekrefte eller kommunisere utfordringer fra andre disipliner
disciplinary boundary studentene skal forsvare sin disiplin, og forstå at forskjell er viktig mellom ulike fag
Vi krever ikke at studenter skal levere svar/løsninger på oppgavene, men heller reflektere rundt egen læring og utfordringer


Topic 1
Effektivitets-fokuset
TIDSPRESS hindrer KRITISK TENKNING
Produkt vs. Prosess
Utfordring: GenAI gjør sorteringsjobben for studentene
Lett å ta snarveier
Forslag: Gi oppgaver som studentene lett kan se at blir feil m/ genAI
Topic 2
Mer fokus på prosess, analyse, vurdering av resultat
Ansvarlig-gjøring av studentene
Mer bruk av prosjekt - mer kritisk tenkning/ analyse
Som del av innleveringsoppg. må studentene vurdere kildene sine.
Bruke "læringsassistent" i AI-verktøyet


TOPIC 1
TOPIC 2
Redigering av Wikipedia artikkel
Analyse av en vitenskapelig artikkel
Analysere KI-generert tekst med kritisk blikk
Redusert akademisk skrive-ferdigheter
OPPGAVER SOM BER OM Å LØSES UTEN OG MED AI, SÅ REFLEKTERER OVER PROSESSEN
TILPASSET INSTRUKSJON GPT SOM LÆRINGS-ASSISTENT
Instruere KI-en til å ta rollen som læringsassistent.
Tar snarveier i stressende situasjoner
Forklare muntlig det KI genererer
overdreven tillit til KI, ukritisk bruk av KI
Muntlige presentasjoner / høringer om eget arbeid
Idémyldring
Finne kilder - falske kilder
Trene opp studenter i å være kritisk til svarene fra KI
Produkt vs. prosess Mindre fokus på produkt, mer fokus på prosess.