Next speaker: Helge Fredriksen

UiT – The Arctic University of Norway

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Combining inquiry-based learning with flipped classroom teaching of linear algebra in a digital environment

Helge Fredriksen, UiT - The Arctic University of Norway (UiT)

Josef Rebenda, Brno University of Technology (BUT)

Joint Czech-Norwegian initiative for the development of a modern mathematics education for engineers supported by EEA Grants

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Introduction

- Why?
  - Promote active engagement and conceptual thinking in teaching mathematics to engineering students
  - Illustrate how linear algebra can be used in the real world
  - Research and develop together to learn more on active learning approaches
- Who & when?
  - Group of Norwegian students at UiT (Bodø) in April 2021
  - Group of international students at BUT (Brno) during fall 2021.
- How?
  - New material: Videos and tasks for two sessions
  - Inspiration: The work of the IOLA group (Inquiry-Oriented Linear Algebra) (http://iola.math.vt.edu/)

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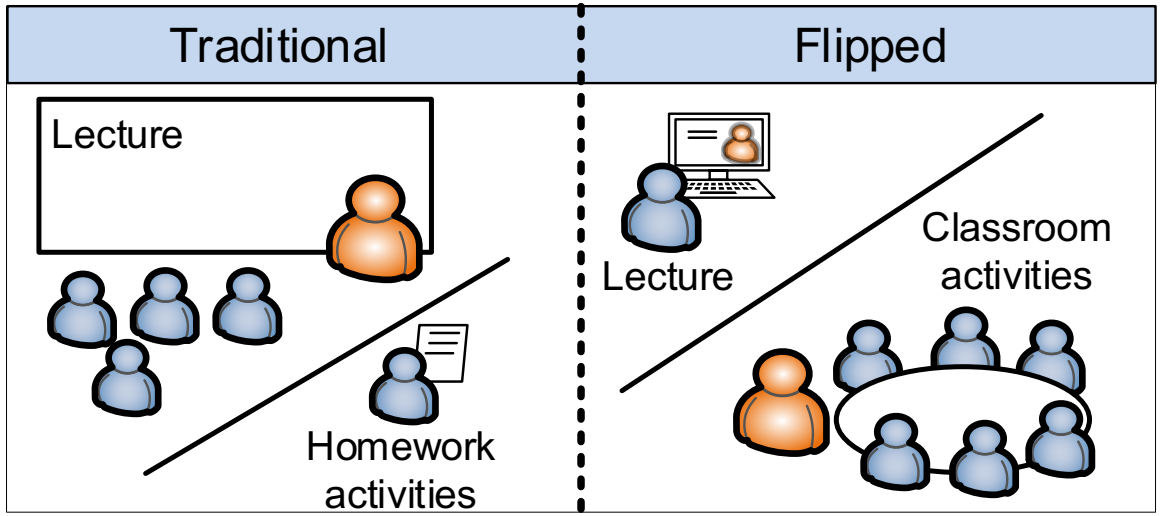
Setup

- Two flipped classroom sessions
- Students prepare out-of-class to «lecture-free» lessons utilizing a set of short videos
- Students work on inquiry-based tasks in-class
- To enhance the collaborative nature of inquiry the students were divided in groups



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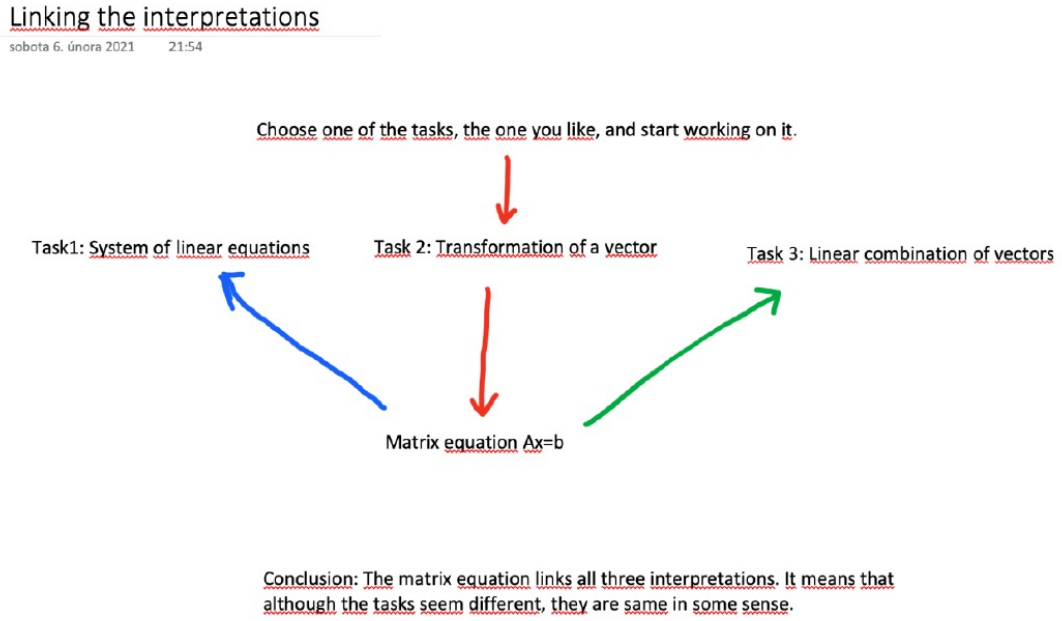
Mathematics

Three interpretations of the linear matrix equation $A\boldsymbol{x} = \boldsymbol{b}$

- System of linear equations
- Linear combination of vectors
- Linear transformation of a vector



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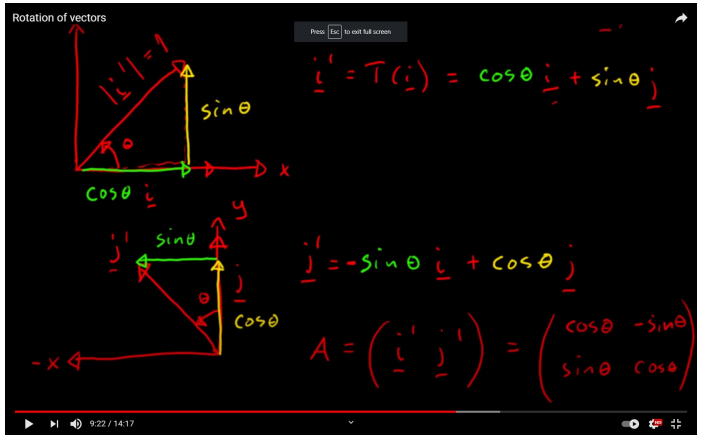
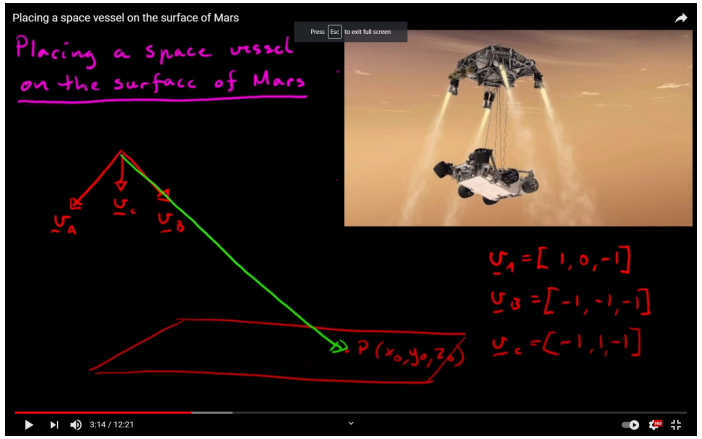
Videos

- Videos for two sessions prepared:
  - Introduction to/repetition of theory
  - Applications



- 4 videos recorded for each session
- Format: Screen-recorded «chalk-and-talk» on a virtual blackboard



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Tasks

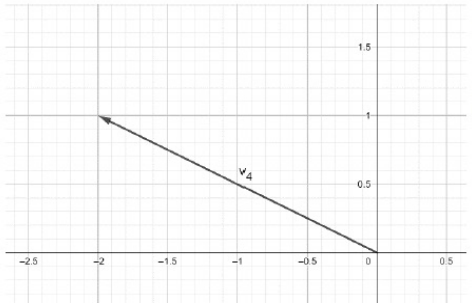
Session 1: Introduction to/repetition of theory

- Lines and planes
- Linear transformations
- Linear combinations

Session 2: Applications

- Markov chains
- Font transformation
- Mars exploration

Se nå på en fjerde vektor $\vec{v}_4$:



a) Er det mulig å uttrykke $\vec{v}_4$ ved hjelp av en lineær kombinasjon av $\vec{v}_1$ og $\vec{v}_2$? Hva med $\vec{v}_1$og $\vec{v}_3$? Og $\vec{v}_2$ og $\vec{v}_3$? (dere trenger nødvendigvis ikke finne konkrete tall for å uttrykke disse kombinasjonene)

b) Er det mulig å uttrykke $\vec{v}_4$ som en lineær kombinasjon av alle tre vektorene $\vec{v}_1, \vec{v}_2$ og $\vec{v}_3$? Hvordan kunne vi skrive det? Prøv å finn en slik lineær kombinasjon.

Task 2)

How would the letter N over (the version on the left-hand side) be transformed if you use these transformation matrices:

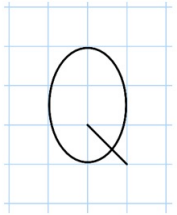
$$A = \begin{pmatrix} -3/2 & 0 \\ 0 & 5/3 \end{pmatrix}$$

$$B = \begin{pmatrix} -1 & -1/3 \\ 0 & -1 \end{pmatrix}$$

$$C = \begin{pmatrix} -1/2 & 1 \\ -1 & 0 \end{pmatrix}$$

Task 3)

What would the transformation matrix do to the letter Q?



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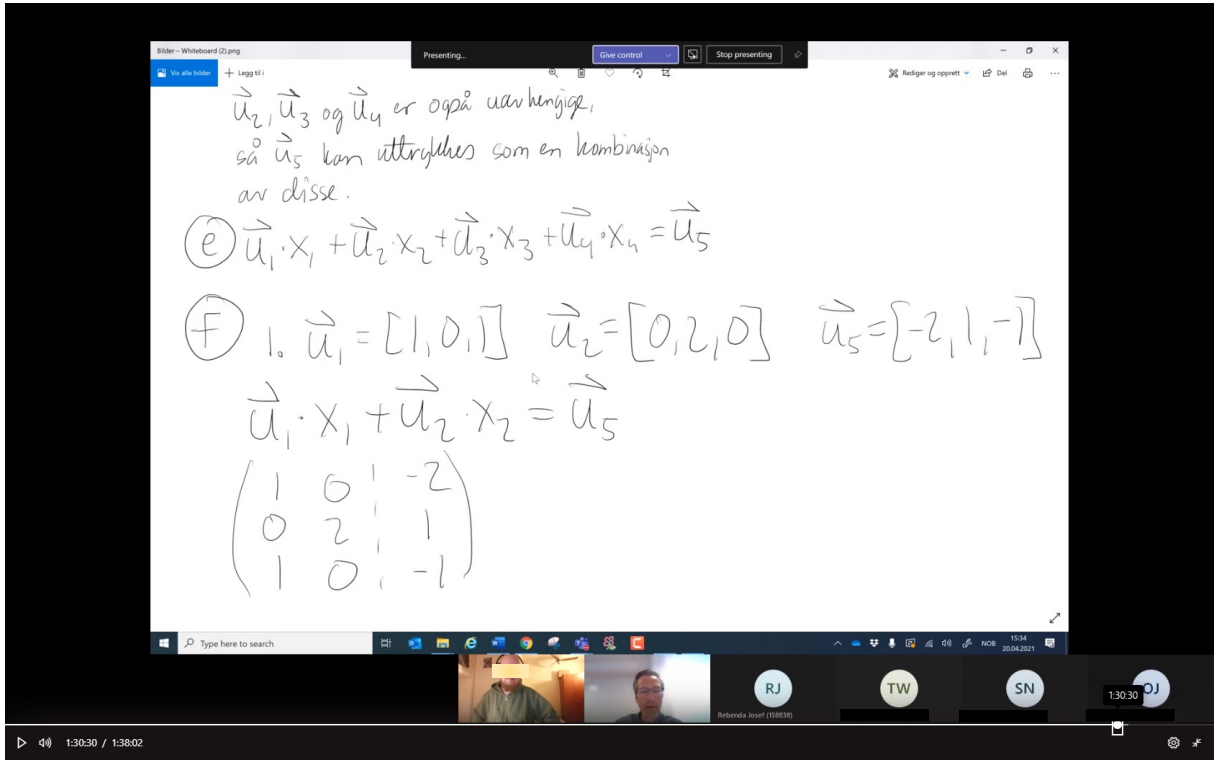
Flipped Classroom sessions

- 4 students participated online via Teams
- Students used to FC teaching
- 2 pairs working on separate tasks
  - Utilizing breakout rooms in Teams for the group work
  - Teacher guidance
- Plenary walkthrough during the last part of the session
  - Each pair presented their work



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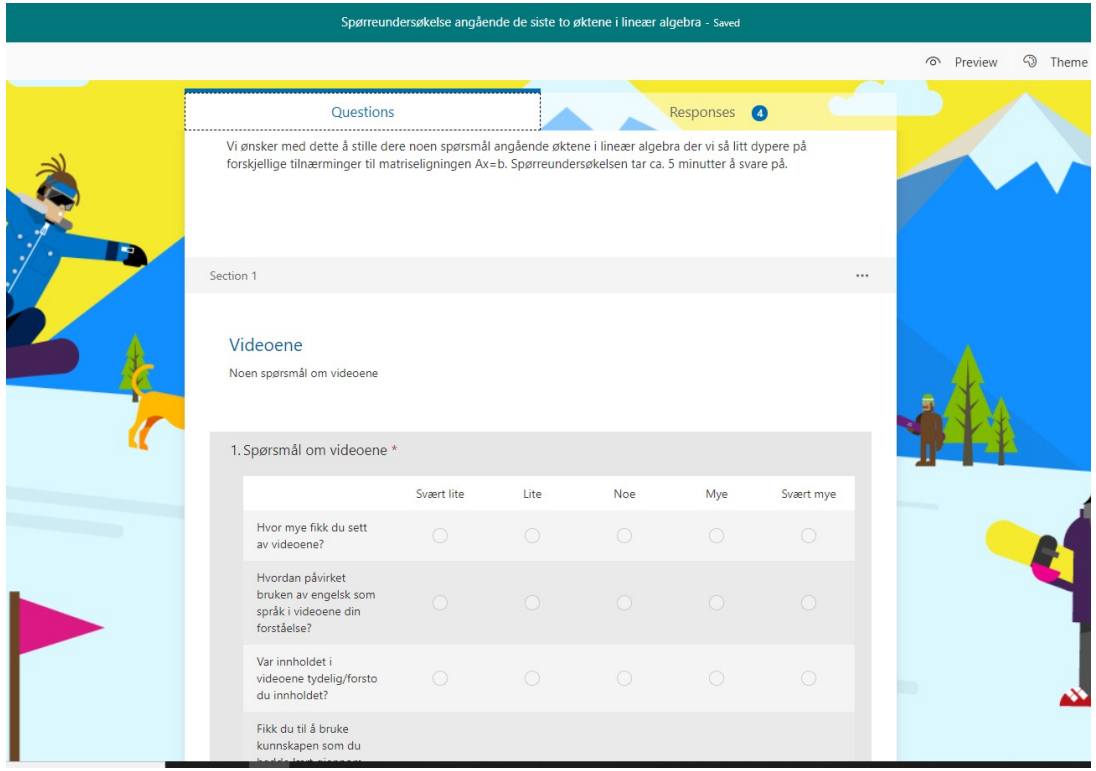
Questionnaire

Likert scale mostly, some free-text questions

- Videos
  - Helpfulness to become more active in discussions
  - Clarity and usability of the content
- Group work
  - How did the discussions affect your understanding
  - Working in breakout rooms
  - Understanding the given tasks
- Use of digital tools
  - GeoGebra, Matlab



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Results

- Two sets of data from the intervention:
  - Teachers' observations of students work in groups (one group in particular)
  - Answers to the questionnaire
- The first test of a combined IBME and FC experience
  - Positive student feedback
  - Students were not definitely positive on spending more time on this type of teaching and learning
  - Data: Few students in the intervention -> not sufficient data

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Student feedback

- Positives:
  - Collaboration: Enhanced focus on discussions/joint work on tasks
  - Videos: Important for the groupwork
  - Digital tools: Breakout rooms, GeoGebra
- Negatives:
  - Collaboration: Fluency of workflow
  - Digital tools: Shared whiteboard function requires touchscreen or tablet based input device

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