Engineering students' communication and visualization during modelling using a simulation tool

Introduction

- Mathematics education for engineering students
- Technology brings in new ways of modelling and visualizing mathematics
- Technology-supported collaborative work

Explorative study

- Digital visualization tool Sim2Bil
- Mathematical tasks
- Investigate students' use of models and visualizations in their communication

Theoretical framework

- The analysis will follow a socio-cultural perspective
- **Modelling:** *a process of developing representational descriptions for specific purposes in specific situations*

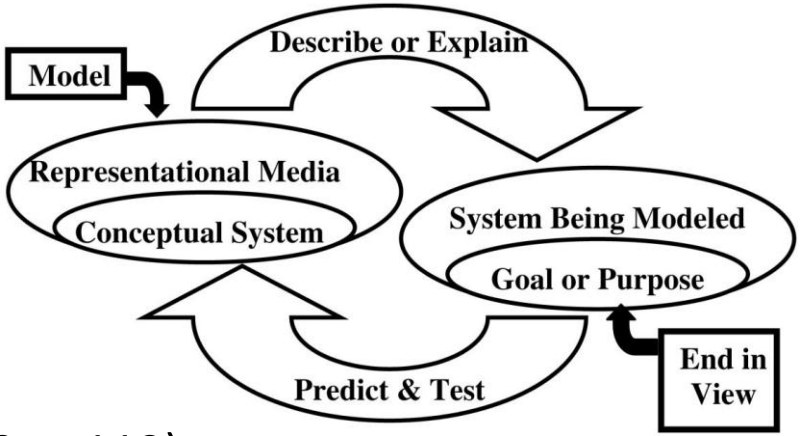
  (Lesh & Lehrer, 2003)

Theoretical framework

- **What is the purpose of modelling?**
  - *to capture, represent, understand, or analyze existing extra-mathematical phenomena, situations or domains, (…) as a means for answering practical, intellectual or scientific questions – and solving related problems – pertaining to the domain under consideration* (Niss, 2015, p. 67)

Theoretical framework

- **A modelling cycle:**



(Lesh & Lehrer, 2003, p.112)

Theoretical framework

- **Modelling practice:**
  - Recognize the need for a given model
  - Developing and revising models (Lesh & Lehrer, 2003, p.112)
  - May give more meaning to the learning and teaching (Blum, 1993)
  - Trend towards including more modelling in schools (all levels)

Theoretical framework

- **Modelling practice - challenges:**
  - Requires a lot of time
  - Difficult to assess
  - More demanding and less predictable (students & teachers)
  - Merely button pressing-practice? (Blum, 1993)
  - Tasks with the right amount of complexity (Niss,2015)

Theoretical framework

- **Visualization:**
  - *the ability, the process and the product of creation, interpretation, use of and reflection upon pictures, images, diagrams, in our minds, on paper or with technological tools, with the purpose of depicting and communicating information, thinking about and developing previously unknown ideas and advancing understandings*

(Arcavi, 2003, p. 217)

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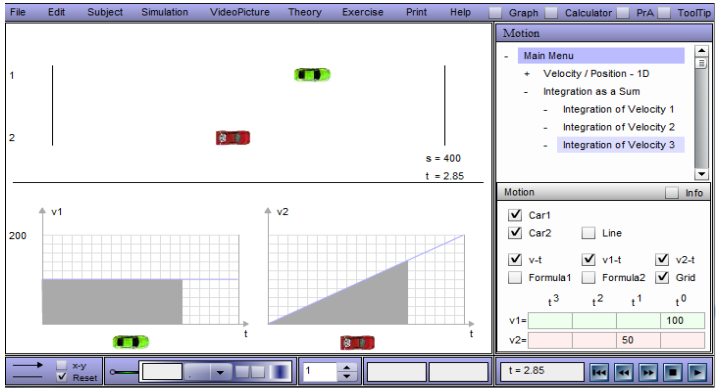
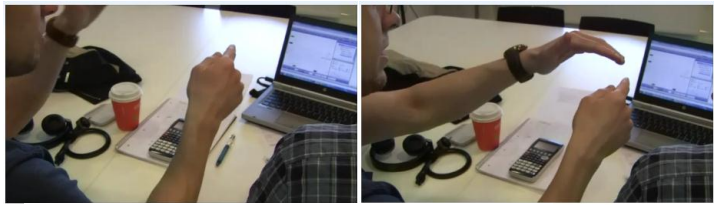
Theoretical framework

- **Mediation:**
  - Cultural tools mediate the activity
  - Examples of tools:
    - Sim2Bil
    - Gestures
    - Language
    - Mathematical inscriptions





$$s(t) = \int_0^t v(t)\,dt$$

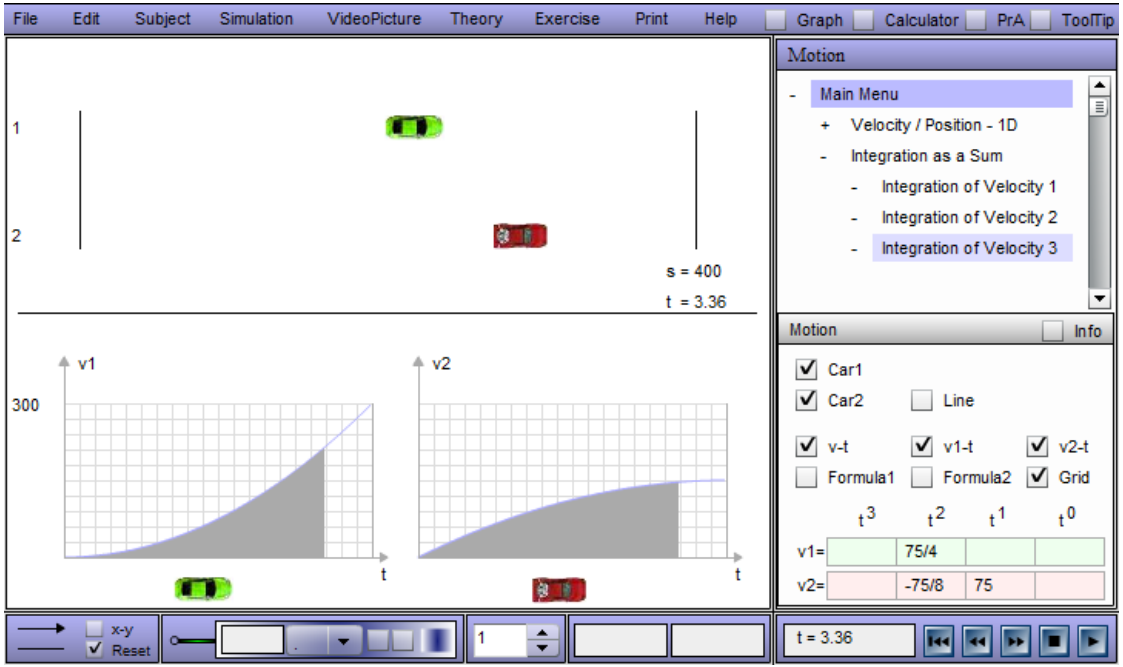
Question

- How do engineering students communicate and visualize during modelling using Sim2Bil?

Methods

- Small-scaled controlled environment (outside normal lectures)
- **Participants:**
  - 3 engineering students (1st year)
  - Unfamiliar to Sim2Bil

Sim2Bil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Calculator
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ToolTip
1
2
s = 400
t = 3.36
v1
300
t
v2
t
Motion
Main Menu
Velocity / Position - 1D
Integration as a Sum
Integration of Velocity 1
Integration of Velocity 2
Integration of Velocity 3
Motion
Info
Car1
Car2
Line
v-t
v1-t
v2-t
Formula1
Formula2
Grid
t3
t2
t1
t0
v1=
75/4
v2=
-75/8
75
x-y
Reset
1
t = 3.36

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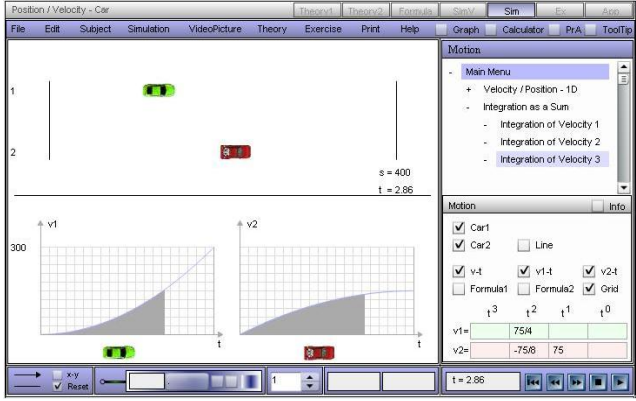

Task

Look around the screen. Find the start button (down at the right corner). The simulation runs for maximum 4 seconds.

a) Press “Start” in the program, and explain to each other what happens. What do the shaded areas represent?

b) Determine other numbers in the table, so that the cars run with different velocities, and arrive at the finish line at the same time.

c) What can you do to make the green car be only half way when the red car reaches the finish line?

d) Find the velocities of the green and the red car (v1 and v2), so that v2 is half of v1 when they reach the finish line simultaneously at 4 sec. Can you prove that your answer is correct?

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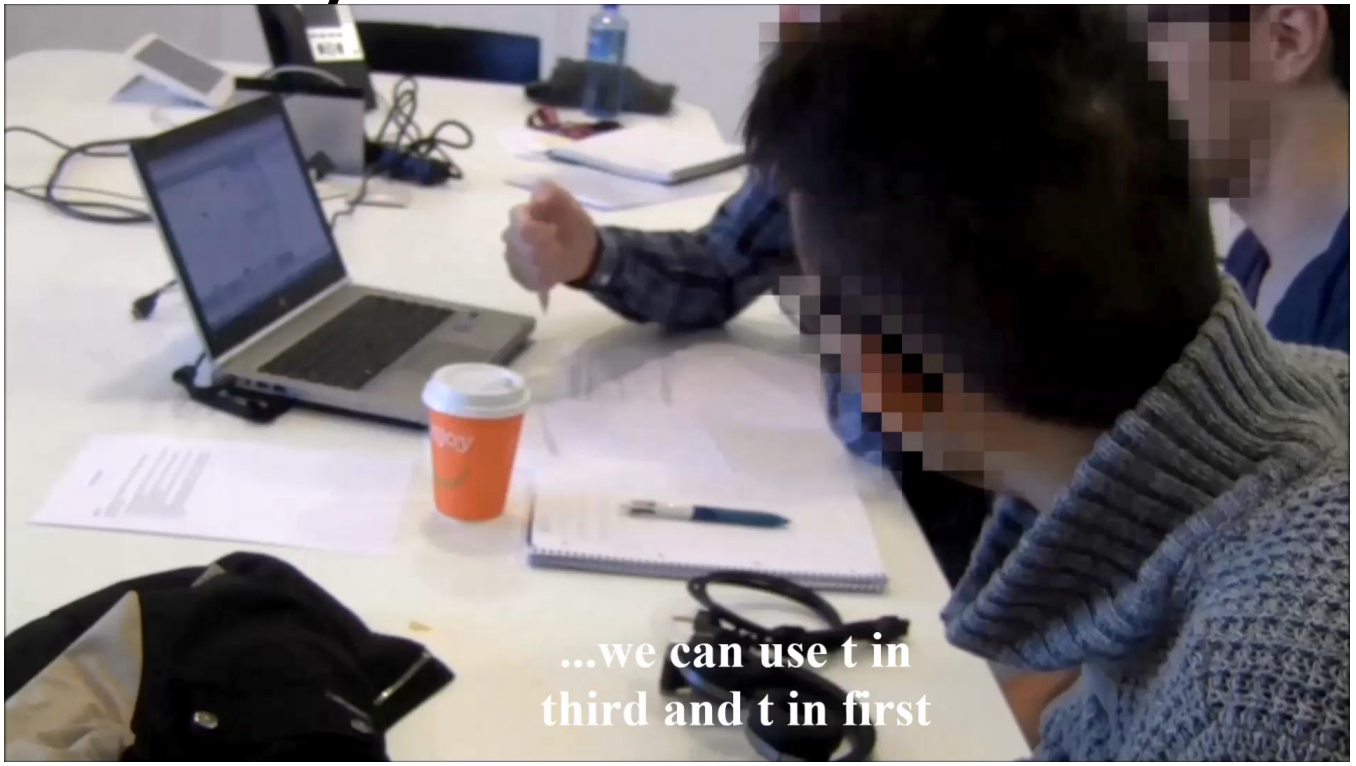
Video analysis

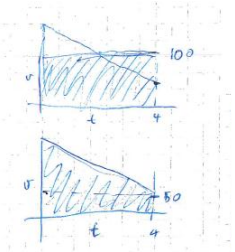


Findings

- 1. Gestured to understand the task

  - Mediated how the cars would run

- 2. Visualized areas on paper
  - Mediated thoughts to peers



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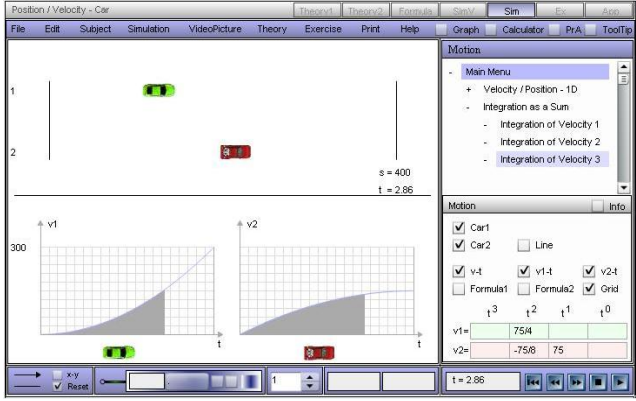
Findings

- Made 5 models:



– 1b)

$$v_1 = 6,25t^3$$

$$v_2 = 18,75t^2$$

– 1c)

$$v_1 = 3,125t^3$$

$$v_2 = 18,75t^2$$

– 1d)

$$v_1 = 100$$

$$v_2 = -25t + 150$$

Final remarks

- ***Visualizations*** *are a great support to many learners*
- *Visualizations require certain media*

- ***Simulations*** *require "experimental space"*

- ***Modelling*** *may* give more meaning to the learning and teaching
- How should we introduce modelling practices to students?

- ***Technology*** *brings new ways of teaching and learning mathematics*

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Thank you!

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