Students' metacognitive processes and impact on Self-efficacy in embedded programming

By:

Ole Schultz, Department of Engineering Technology and Didactics, DTU Denmark osch@dtu.dk
Tomasz Blaszczyk, Department of Engineering Technology and Didactics, DTU Denmark tomb@dtu.dk

- Why
- Problem statement
- Proposed Process in programming
- Can we measure self-efficacy or?
- Results
- Further work - perspectives

Why

- We observe that some students are frustrated about the complexity in the digital electronic and programming on 2nd semester – looses interest, don't meet at the exam
- Project in scholarship of teaching – introducing a process in digital electronics and c-programing embedded computers (course 62734)
- Try to measure on students self-efficacy[1] – before and during the process intervention

[1]Albert Bandura: The individual's belief in their capacity to execute behaviors necessary to produce specific performance attainments

Data students enrolled in 62734, and enrolled in exam

Year	enrolled	enr. Ex.	not meet
2017s	62	64	6
2017v	28	29	6
2018s	64	64	7
2018v	26	25	3
2019s	55	52	16
2019v	34	33	14
2020s	64	52	10
2020v	27	25	4
2021s	66	59	10
2021v	37	34	?

Problem statement

- Can metacognitive processes help students to gain more self-confidence and thus continue to be active during the course?

Different factors impact on students self-efficacy

- Literature studies reveals:
  - Inaccurate expectations to programming process => impact on experience with self-efficacy
  - Fluency in programming, time spent, comparing with other students =>feeling bad
  - Group dynamics – supporting each other or not , negative feedback =>low self-efficacy
  - Assignment formulation – understanding =>influence self-efficacy
  - Students mindset - perceived ability – beliefs about malleability influence on self-efficacy

(Gorson, J. et al. 2019, Dweek, C. S 2006, Loksa D. et. al 2016, Kinnunen P et al 2012 and Prather J. et all 2019)

Can we measure on impact from programming process?

- Based upon Gorson's works, we use=> Moments of Programming - Vignette question - for students self-assessment.
- Students negative self-assessment correlates to their overall self-efficacy in their programming course - Gorson. J. et al. 2020

Link to the form https://forms.gle/PoH31jwR9nRpREsK9

Gorson, J., & O'Rourke, E. (2020, August). Why do CS1 Students Think They're Bad at Programming?

Proceedings of the 2020 ACM Conference on International Computing Education Research.

http://dx.doi.org/10.1145/3372782.3406273

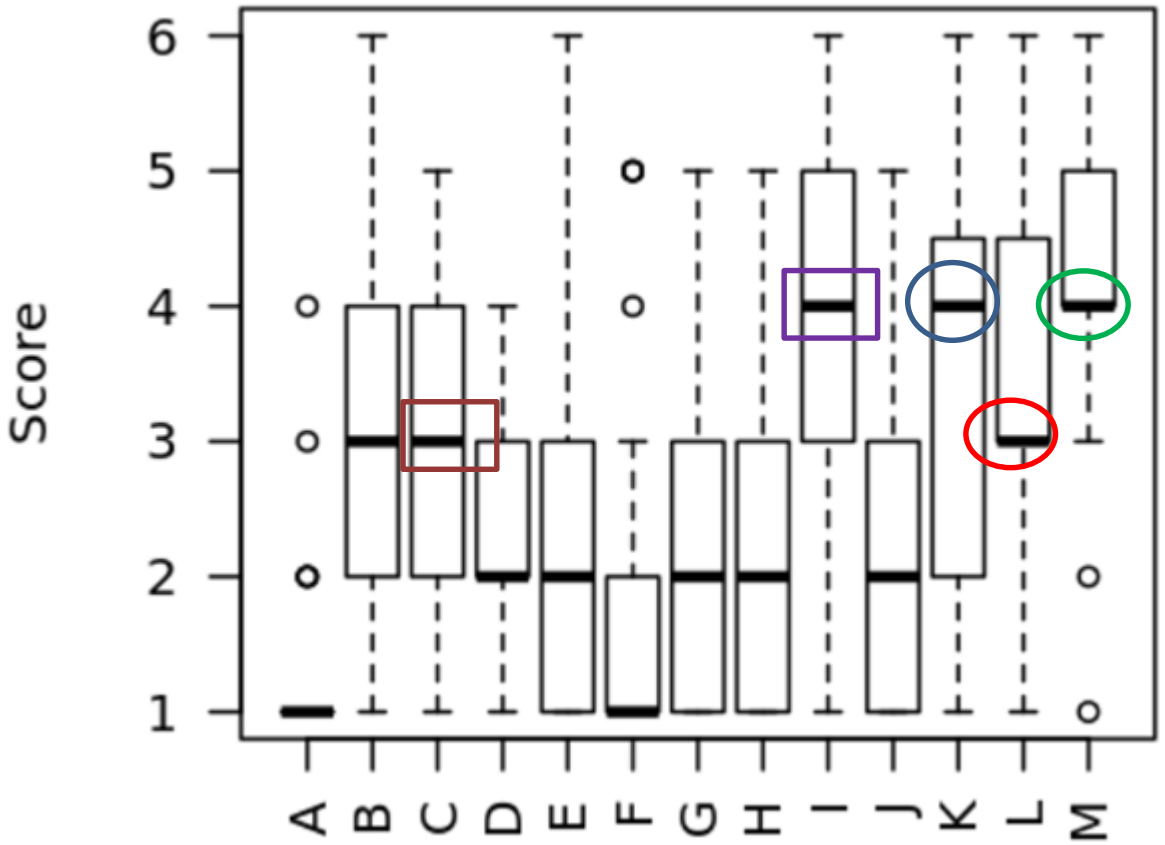
Results

Before

C: Do not understand the error message

I: Do not know how to get started

1st lesson – boxplot with vignette scores – 27 students



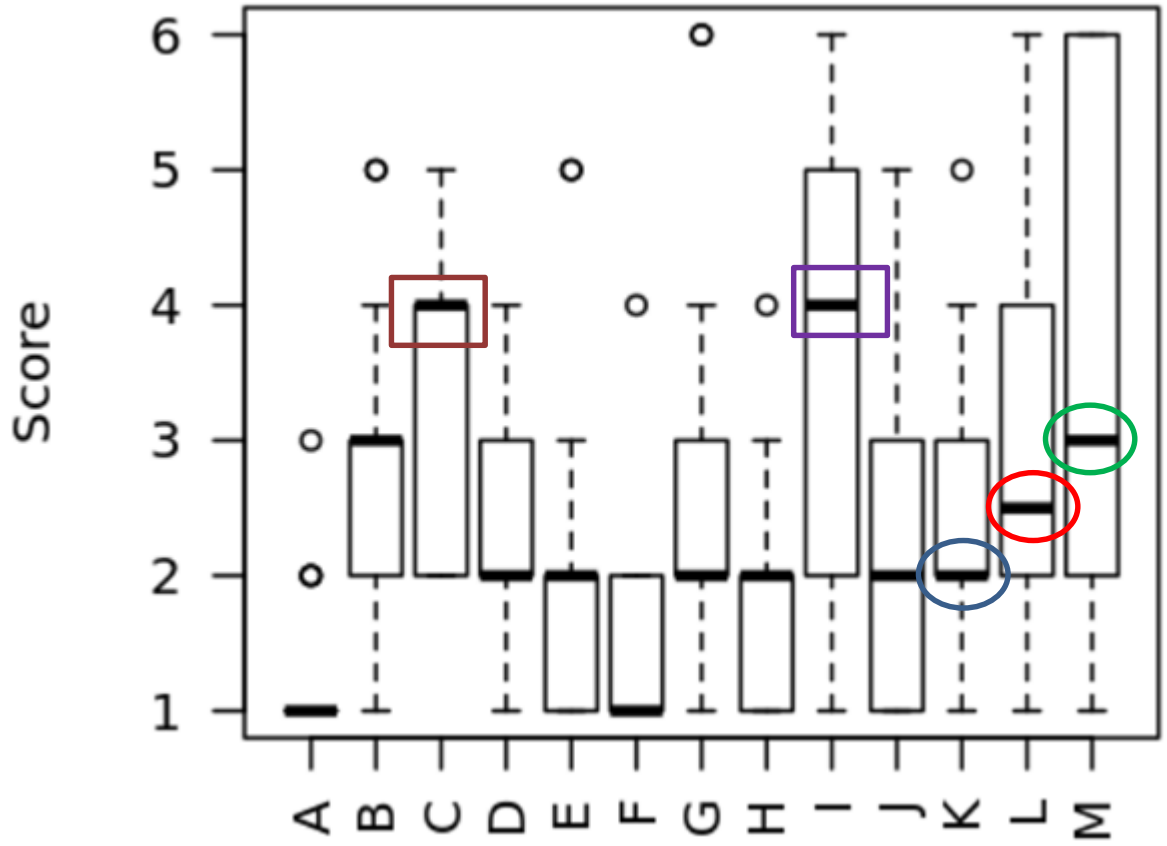
During

K: Struggling to find the error

L: Unable to complete within time

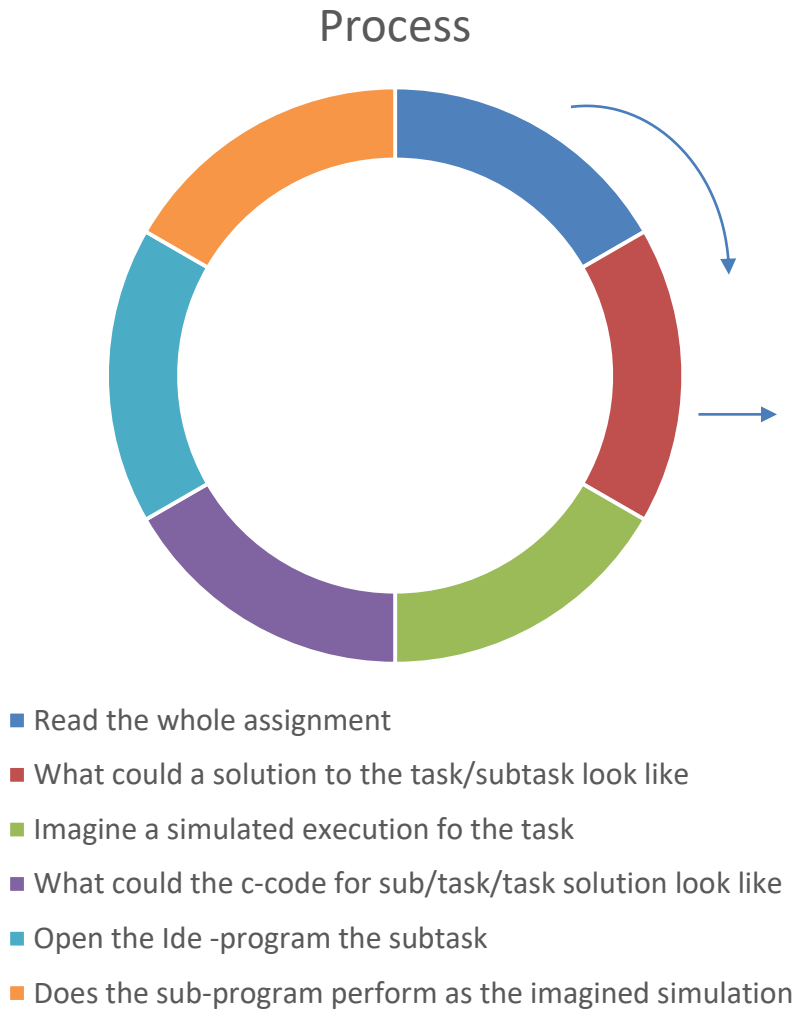
M:Do not understand the problem of the task

8th lesson – boxplot with vignette scores – 22 students



Process used

Loksa, D. et all. 2016, problem solving stages



Falkner, K. et al. 2014 propose a guide to scaffolding activities to assist learning
- Conceptualize by Diagrams, flow chart

Graphical:
Flow charts,
State diagrams,
Sequence diagrams

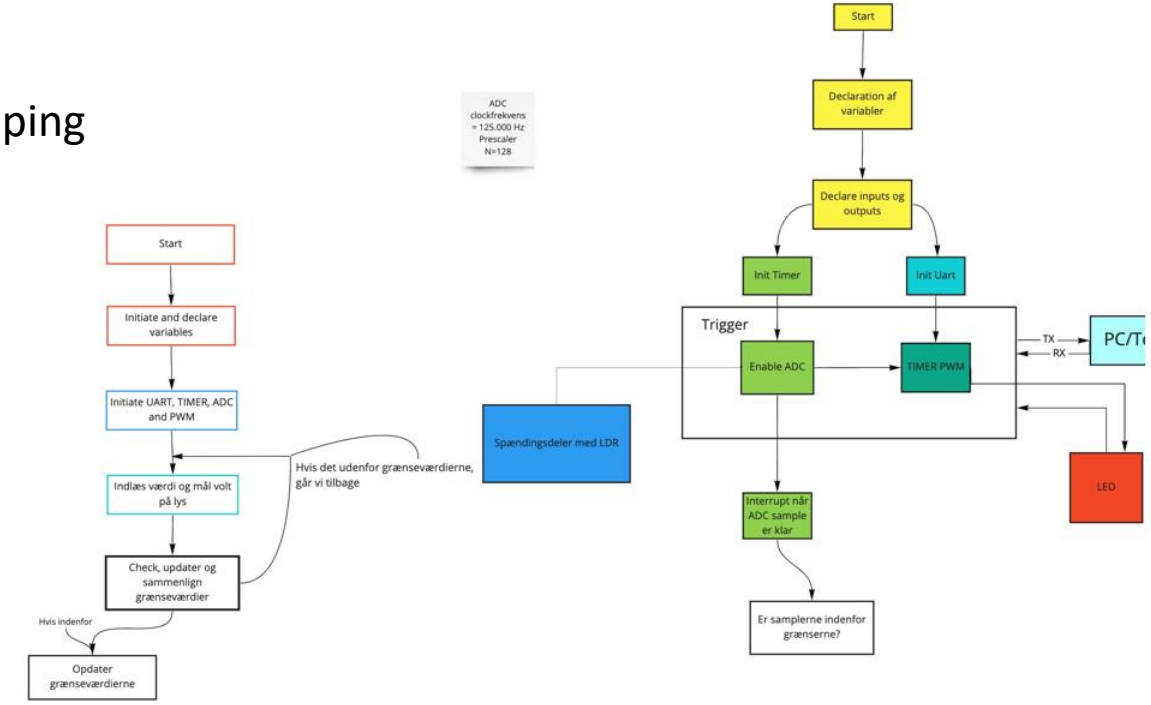
Falkner, K., Vivian, R., & Falkner, N. J. G. (2014). Identifying computer science self-regulated learning strategies. *Proceedings of the 2014 Conference on Innovation & Technology in Computer Science Education - ITiCSE '14*. http://dx.doi.org/10.1145/2591708.2591715

Changes in assignments

Changes: The assignment text was updated – process is included in all 4 assignments

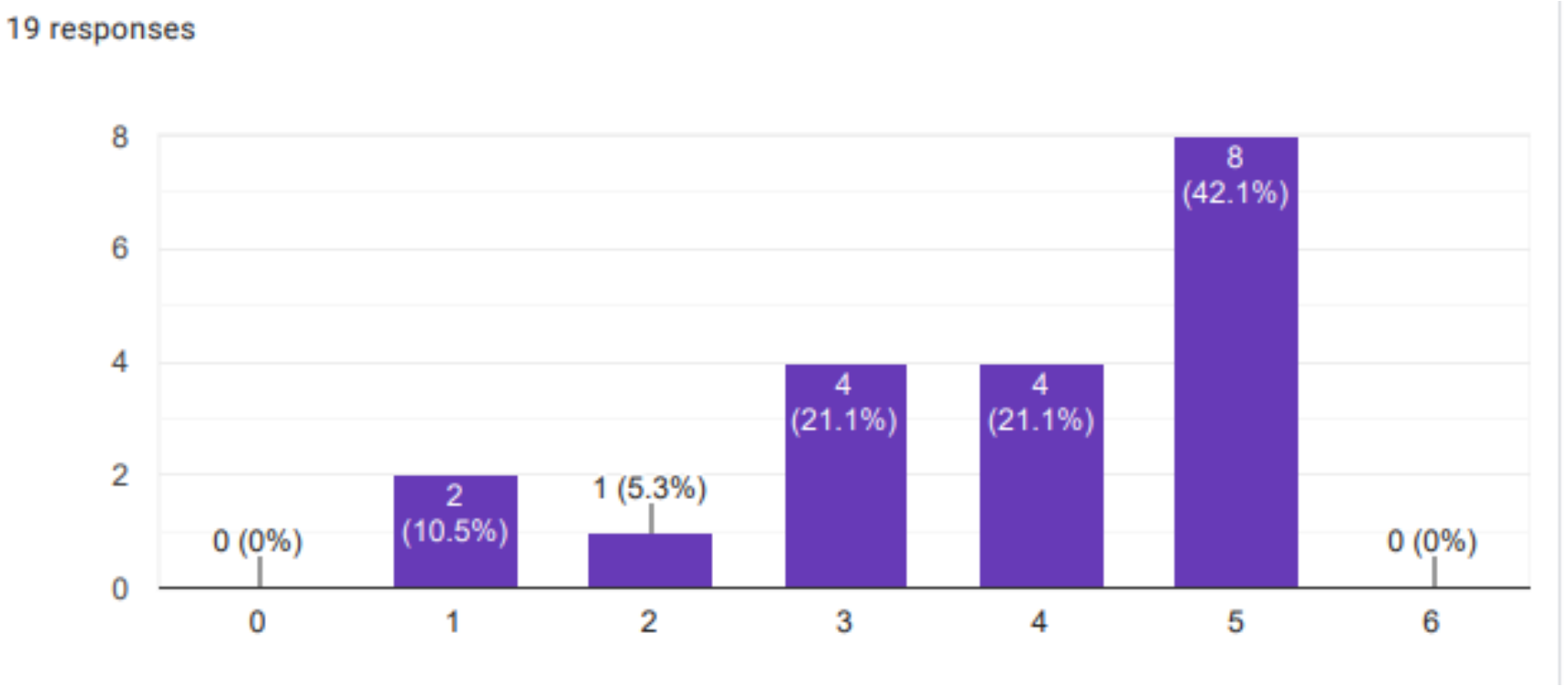
- Intervention in students work by starting the process step 1 and 2 as group work in the lecture – students get 30 min. and then present for ach other flow charts

miro.com as tool for charring and developing



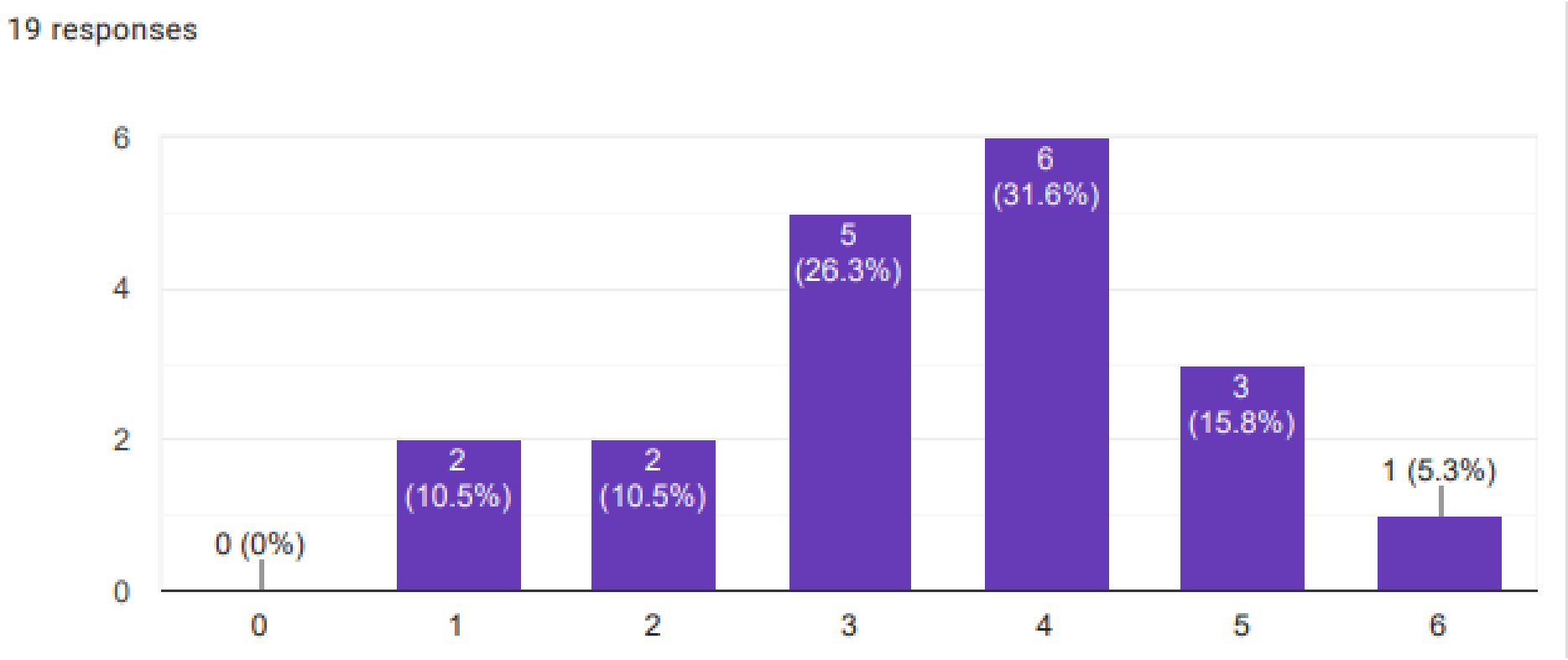
Students evaluation 1 of 2

- How much does the process help you understand what the program / subprogram should perform



Students evaluation 2 of 3

- How much confidence does the process give when you need to program.



Is there something you are missing in the process? Would you recommend to add/remove extra points in the process of strengthening self-confidence, giving more peace of mind?

- It took some time before I started to see meaning in the Flow charts.
- **I thought well sometimes it can be hard to get started recording flowcharts for example**, but once they are made, it **helps a lot to create an overview of the task**, and makes the task easier to understand.
- I would remove the process. it makes the **tasks more confusing**
- **It's good with an overview**. I think the **process is good** as it helps for a more **visual understanding**, but it can also **be hard to get started making flowcharts** etc. if one does not have tried it before. At first I think it was quite confusing to get started the process when I did not know much about programming, and did not know what I really wanted my program to be able to, but now it has become much more clear, and a great help to make some kind of plan for the program.

Conclusion and further work

- The few data (22 students) shows the process has some impact on the self-assessments – less negative for struggling finding the error, Unable to complete within time and Do not understand the problem of the task

- How to improve the process and?
  - A more precise process – more on reflection
  - Test again in the spring more students 60 -70
  - Involve students in the work
  - How to evaluate on the self-efficacy – more data, study and measurements?
  - How motivation can affect self-efficacy?
- Further changes in the course
  - Teach in how to think/reflect to strengthen metacognition by using flow charts and reflection

Thank you